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Entrepreneurship, taxation and capital investment

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Abstract

Augmenting a standard Bewley model with an entrepreneurial sector and occupational heterogeneity allows us to study important channels through which fiscal policies affect aggregate variables, factor prices, wealth distribution and welfare. To disentangle the forces involved, we consider flexible forms of taxation that distinguish between sources of income. Our quantitative analysis shows that reducing the tax burden on capital formation stimulates investment, but the effects vary depending on whether we target entrepreneurial capital or non-entrepreneurial capital. A low tax on capital income from savings increases the aggregate capital stock and production, but it also raises the opportunity cost of business investment. General equilibrium effects further discourage entrepreneurial investment due to a higher wage cost and a compensating tax increase on other sources of income. The reform is most effective when we reduce the tax on business income. A flat business tax of 10% will raise entrepreneurial investment by 20% in the long run. Workers also benefit as the wage increases by 5%. However, the adjustment costs associated with the transition make political support for such reforms difficult.

JEL classification: E62; H24; H31; J23

Keywords: Income taxation; Entrepreneurship; Heterogeneous agents

1. Introduction

Entrepreneurs contribute to the US economy in a significant way. Though not so large in population (12% of the total), they own 40% of wealth and produce a half of the total output. Entrepreneurs constitute a unique class of agents and behave differently from workers in response to changes in fiscal policies. We demonstrate that the addition of the entrepreneurial sector to a standard Bewley model allows us to learn about important channels through which tax policies affect aggregate variables, factor prices, wealth distribution and welfare.[1]

We construct a dynamic general equilibrium model where agents choose between being a worker and an entrepreneur and face two sources of uninsurable risks. Each agent is endowed with a labor productivity shock that dictates his potential earnings as a worker, and also an entrepreneurial ability shock that determines his potential profitability from being an entrepreneur. Every agent has access to one-period riskless saving, but there is no insurance market against the stochastic processes for labor productivity and entrepreneurial ability. An entrepreneur decides the project

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[1] For a Bewley model, see for example Bewley (1986), İmrohoroğlu (1992), Huggett (1993) and Aiyagari (1994).

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size optimally by choosing capital and labor inputs. To finance investment, he can borrow from a bank, subject to a borrowing constraint that depends on his asset levels.

We find that reducing the tax on capital income effectively stimulates economic activities and increases aggregate investment and output. However, the effects are very different depending on whether the tax targets entrepreneurial capital (business income) or non-entrepreneurial capital (capital income from riskless savings). The reform is shown to be most effective when we lower the tax on business income and target productive entrepreneurs who invest at an inefficient level due to financial market imperfections. A lower tax on entrepreneurial income will not only provide an incentive to invest more capital but also stimulate labor demand and increase the wage, which benefits workers. When the business tax is set at 10%, for example, entrepreneurial investment increases by approximately 20% and the wage by 5% from the benchmark US economy. Although the economy will enjoy a higher level of output in the long run and agents will be better off from an ex ante perspective, such reforms will require a decrease in consumption during the transition and the wage will increase only gradually. For most of the workers, the costs associated with the transition weigh more than the long-run benefits. As a result, political support will be hard to obtain unless some measures are taken to compensate for the transitional loss.

A lower tax on capital income from saving is shown to encourage capital accumulation and aggregate production, but entrepreneurs shift more resources away from their business since the opportunity cost is higher. In addition, general equilibrium effects (a higher wage and a compensating tax increase on other sources of incomes) further discourage entrepreneurial investment and the net aggregate effect is not as significant as when we reduce the tax on business income. We repeat the exercise in an economy without entrepreneurs in order to highlight the role of the non-corporate sector. We find that the quantitative results are very different and the macroeconomic effects can be significantly overestimated in a model without an occupational choice. In a model with only workers, a policy of eliminating capital taxation would simply encourage saving and aggregate capital increases by more than 20%, versus only 5% in the economy with entrepreneurs. We show that in the benchmark economy 80% of the households would support a reform raising the capital tax to 40%. However, the same reform would fail to gain majority support in the worker-economy, where the reform's long-run effects on aggregate variables are more severe. We also calibrate another version of worker-economy that generates as much concentration of wealth as in the US economy. We demonstrate that it is not simply the wealth distribution but the existence of the entrepreneurial sector that drives our main results.

This paper is related to existing work along different lines of macro literature. Firstly, it builds on the recently growing literature on entrepreneurship. Many papers investigate the unique roles of entrepreneurs in capital accumulation and economic growth.[2] It has been shown that a model with entrepreneurs is more successful in replicating the wealth distribution in the US, especially in its upper tail, as demonstrated by Quadrini (2000) and Cagetti and De Nardi (2006a) among others. While entrepreneurs make a significant economic contribution, there are market frictions that limit the scope of their business. The existence of borrowing constraints, for example, has been shown to restrict entrepreneurial activities and impose welfare costs.[3] Some recent papers use dynamic models with heterogeneous agents that are similar to ours and study fiscal reforms in an economy with entrepreneurs. Li (2002) constructs a model with an occupational choice to investigate the effect of government credit subsidies. She demonstrates that a program that targets the poor and capable entrepreneurs will effectively promote entrepreneurial investment and raise total output. Cagetti and De Nardi (2006b) study the effect of estate tax reforms and show that lowering an estate tax significantly increases aggregate activities since it relaxes the financial constraints faced by entrepreneurs and encourages their investments. Meh (2005) builds on Quadrini's (2000) framework and studies the effect of a proportional income tax reform. We focus on the capital income tax reforms, where we endogenize entrepreneurs' optimal decision of the business entry/exit and a project size. To disentangle the forces involved in different sectors, we distinguish between sources of income for taxation among wage, capital and business incomes. Also, we explicitly compute the transition dynamics upon the reform implementation and study the welfare costs associated with the transition, which none of the existing models on entrepreneurs has done.

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[2] See among others Evans and Jovanovic (1989), King and Levine (1993), Carroll et al. (2000), Gentry and Hubbard (2004) and Cagetti and De Nardi (2006a).

[3] See, for example, Evans and Jovanovic (1989), Holtz-Eakin et al. (1993, 1994), Fernández-Villaverde et al. (2003), Gentry and Hubbard (2004), Buera (2006) and Cagetti and De Nardi (2006a).

Secondly, our work also adds to the study of income taxation in incomplete market models, by adding an entrepreneurial sector and income risk associated with stochastic investment returns. Chamley (1986) and Judd (1985) demonstrated optimality of zero capital income tax under the complete market. Since then their finding has been re-examined and challenged in various models with market incompleteness.[4] These papers, however, assume no heterogeneity in agents' occupations and production is undertaken in a single sector. We demonstrate how the existence of entrepreneurs alters the analysis of capital tax reforms by contrasting the results to an economy without entrepreneurs.

The rest of the paper is organized as follows. The next section presents the model. Section 3 describes the calibration of the model parameters and Sections 4 and 5 discuss the benchmark economy and policy experiments. The last section concludes.

2. The model

2.1. Endowment

Agents are infinitely-lived. Each agent enters a period with an occupation that he chose in the previous period. An entrepreneur in our model is defined as an agent who has chosen to own and run a business of his own, instead of supplying labor for a wage in the market.[5] As in Quadrini (2000), an entrepreneur in our model is the owner of an enterprise and combines his managerial ability and efforts together with employed capital and labor for production. Entrepreneurs can manage only one entrepreneurial business at a time and they can not diversify away the return risk by investing in multiple projects. The rest of the agents are workers.

Each agent is endowed with labor productivity η, which follows a finite-state Markov process drawn from a set $\mathbb{H} = \{\eta_1, \ldots, \eta_{N_\eta}\}$. It represents efficiency units per unit of work hours. Agents are also endowed with entrepreneurial ability θ, which is drawn from a set $\Theta = \{\theta_1, \ldots, \theta_{N_\theta}\}$. The parameter θ represents how productively the agent can operate the business given capital and labor inputs.

2.2. Preference

Preferences are assumed to be time-separable with a constant subjective discount factor β. Agents rank a sequence of consumption $\{c_{t+j}\}_{j=0}^{\infty}$ according to the expected discounted utility given as

$$E_t\left\{\sum_{j=0}^{\infty}\beta^j u(c_{t+j})\right\}, \tag{1}$$

where one-period utility from consumption c is defined as a standard CES form, $u(c) = c^{1-\sigma}/(1-\sigma)$. σ is the coefficient of relative risk aversion.

2.3. Technology and production

The economy has two sectors of production. One sector that we call the non-corporate or entrepreneurial sector consists of entrepreneurial households engaged in risky projects. The other sector is called the corporate sector and is populated by larger firms. The former is distinguished from the latter in that an entrepreneurial firm's activities are tied up with the owner's decisions and constrained by his characteristics (available assets, entrepreneurial ability, etc.), while the latter is characterized by diversified risk and anonymity of the operations. Description of each sector follows.

[4] See, for example, Aiyagari (1995), Erosa and Gervais (2002), Golosov et al. (2003) and Conesa et al. (2006).

[5] Our definition of entrepreneurship differs from that of venture capitals that in fact constitute a very small fraction of economics activities. Moskowitz and Vissing-Jorgensen (2002) show that venture capitals account for less than one percent of the entire private equity market. Entrepreneurs own a more diverse set of businesses than venture businesses. Among the samples in the study of Gentry and Hubbard (2004), agriculture comprises 26%, retail 16%, construction 13%, professional practices 11%, personal and business services 10% and manufacturing services 5%.

Non-corporate sector. Each entrepreneur runs his own technology and produces output according to the production function,

$$y = f(k, n, \theta) = \theta k^{\nu_1} n^{\nu_2},$$

where k is invested capital, n is efficiency units of labor employed in the firm, θ is entrepreneurial ability and ν_1 and ν_2 are the parameters that determine the input share of capital and labor. $(1 - \nu_1 - \nu_2)$ is the share of output retained as rents by the entrepreneur for managing his investment project. With $\nu_1 + \nu_2 < 1$, the production function exhibits decreasing returns to scale to capital and labor, capturing an entrepreneur's limited "span of control" as in Lucas (1978). Capital depreciates at a constant rate δ after the production. Note that a higher entrepreneurial ability θ implies a higher level of output both on average and at the margin for a given level of factor inputs.

Corporate sector. The corporate sector consists of competitive firms with an identical Cobb–Douglas production function, $Y = F(K, N) = AK^{\alpha}L^{1-\alpha}$, where K and N are the total capital and labor used in the sector, A is a constant parameter and α is the capital share. Capital K is rented from households through an intermediary at the riskless rate. Factor prices are determined competitively by the marginal productivity conditions. Capital depreciates at a constant rate δ.

2.4. Borrowing and intermediary sector

The intermediary sector consists of competitive banks, which collect deposits from households and lend the proceeds to firms in the corporate and non-corporate sectors. As individuals, entrepreneurs can borrow from an intermediary, but workers face a no-borrowing constraint and cannot hold negative assets. We assume that the banks charge a fixed cost ϕ per unit of funds intermediated to the non-corporate sector, while they can lend costlessly to the corporate sector. We assume that this cost is a waste that is "thrown away into the ocean" and does not contribute to anything in equilibrium. The entrepreneurs' borrowing cost is $r_d = r + \phi$, where r is the risk-free rate, the rate at which the corporate sector borrows from the bank and the bank pays to the depositors as interest.

We assume that an entrepreneur can borrow but only up to a limit determined as an increasing function of his net worth. Entrepreneurial ability θ is not publicly observed and the borrowing limit cannot depend on this parameter. This implies that even if an agent is fortunate to possess a high entrepreneurial ability, lack of assets could constrain him from expanding his business. It could also prevent an agent from starting up a business because the earnings from a small-scale project may be less attractive than earning a wage as a worker. We make an assumption that the borrowing limit is proportional to the entrepreneur's net worth as in Evans and Jovanovic (1989) and the maximum leverage ratio is set at d, which is common across agents, i.e. an entrepreneur who owns assets a can invest no more than $(1 + d)a$. We don't allow for default by entrepreneurial firms.

2.5. Government

The government raises tax revenues to finance its consumption and investment expenditures G. A balanced budget is imposed every period. An individual income tax is described by a function $T(I)$ of income I of each agent, which is calibrated to capture the progressive income tax system in the US. We discuss more about the tax function in the calibration section. The government also taxes consumption at a constant rate τ_c.

2.6. Household problem

Timing of events. The occupation of each agent is predetermined from the previous period. At the beginning of each period, a pair of idiosyncratic shocks (labor productivity η and entrepreneurial ability θ) are realized. Given these shocks, agents make allocational decisions. In addition to the consumption and saving decision, an entrepreneur also chooses the amount of labor and capital used in his project. Then production takes place in both the corporate and non-corporate sectors, followed by factor payments and the repayment of loans. Workers and entrepreneurs pay an income tax, consume part of their disposable assets and choose an occupation for the next period. Since there is no other uncertainty between the realization of shocks in two periods, all decisions, including the next period's occupation, can be made right after the realization of current shocks.

Optimization problem. Workers and entrepreneurs with assets a and realized labor productivity η and entrepreneurial ability θ make allocational decisions to maximize the present discounted utility in Eq. (1). In what follows, we solve the problem in a recursive way. We denote by V^W and V^E the value function of a worker and an entrepreneur respectively.

(1) **Workers' problem**

$$V^W(a,\eta,\theta) = \max_{c,a',i}\left\{u(c) + i\beta E V^W(a',\eta',\theta') + (1-i)\beta E V^E(a',\eta',\theta')\right\} \tag{2}$$

subject to

$$(1+\tau_c)c + a' = \eta w + (1+r)a - T(I), \tag{3}$$

$$I = \eta w + ra, \tag{4}$$

$$a' \geqslant 0, \quad c \geqslant 0, \quad i \in \{0,1\}$$

where i is an indicator function that takes a value 1 if the agent is a worker in the next period and 0 otherwise. The expectation operators in Eq. (2) are with respect to the stochastic processes η and θ. I in Eq. (4) represents the worker's taxable income, which consists of labor income, ηw, and capital income from saving, ra. Each worker inelastically supplies labor, which is normalized to unity, and the labor services provided by each agent l are simply his efficiency units η. Equation (3) is a worker's flow budget constraint. Labor income and assets plus interest net of the income tax $T(I)$ are allocated between consumption and saving.

(2) **Entrepreneurs' problem**

$$V^E(a,\eta,\theta) = \max_{c,a',i}\left\{u(c) + i\beta E V^W(a',\eta',\theta') + (1-i)\beta E V^E(a',\eta',\theta')\right\} \tag{5}$$

subject to

$$(1+\tau_c)c + a' = \pi^E(a,\eta,\theta), \tag{6}$$

$$a' \geqslant 0, \quad c \geqslant 0, \quad i \in \{0,1\}.$$

Equation (6) is an entrepreneur's flow budget constraint and π^E is the net-of-tax income available to the entrepreneur after the production, factor payments, repayment of loans and income tax payment, and it is determined as follows:

$$\pi^E(a,\eta,\theta) = \max_{k,n}\left\{f(k,n,\theta) + (1-\delta)k - (1+\tilde{r})(k-a) - w\cdot\max\{n-\eta,0\} - T(I)\right\} \tag{7}$$

where

$$I = f(k,n,\theta) - \delta k - \tilde{r}(k-a) - w\cdot\max\{n-\eta,0\}, \tag{8}$$

$$k \leqslant (1+d)a \tag{9}$$

and

$$\tilde{r} = \begin{cases} r & \text{if } k \leqslant a, \\ r_d = r + \phi & \text{if } k > a. \end{cases}$$

I is the entrepreneur's taxable income as defined in Eq. (8). The first term on the RHS is the entrepreneur's output from the production, which depends on the choice of capital k and labor n, as well as his entrepreneurial ability θ. $-\delta k$ is the depreciation cost. If the agent is a net borrower, i.e. $k > a$, the interest payment for the borrowing is deducted as operational costs. If only part of his assets are invested, i.e. $k \leqslant a$, the remaining $(a-k)$ earns a riskless return, which is added to the tax base of the entrepreneur as capital income. We assume that entrepreneurs dedicate their time endowment to their own project, but not to other firms. Their supply of labor is counted as part of labor services n used in the production. Entrepreneurs pay the market wage to the outside labor, as long as the total labor demand exceeds his own supply of labor η, i.e. the wage payment is given as $w\cdot\max\{n-\eta,0\}$.[6] Equation (9) is the borrowing constraint.

[6] Note that given there is no disutility from work and the production is increasing in the labor input, entrepreneurs use all of their labor endowment, except for the case where it is optimal not to produce anything, in which case no wage payment is made, including the payment to the entrepreneur himself.

2.7. Stationary competitive equilibrium

At the beginning of each period, agents are heterogeneous in four dimensions summarized by a state vector $s = (a, \eta, \theta, \xi)$, i.e. asset holdings a, labor productivity η, entrepreneurial ability θ, and occupation $\xi \in \{W, E\}$. Let $a \in \mathbb{A} = \mathbb{R}_+$, $\eta \in \mathbb{H}$, $\theta \in \Theta$ and $\xi \in \Xi$. Also denote by $\mathbb{S} = \mathbb{A} \times \mathbb{H} \times \Theta \times \Xi$ the entire state space. An equilibrium consists of prices $\{r,w\}$, allocations of workers and entrepreneurs, the government tax system, intermediaries, value functions and the distribution of agents over the state space $\mathbb{S}$ given by $\Phi(s)$, $s \in \mathbb{S}$, such that

(1) Given the prices and the government tax system, the allocations solve the above described maximization problem for a household in each state s.
(2) The prices satisfy the marginal productivity conditions, i.e. $r = F_K(K, N) - \delta$ and $w = F_N(K, N)$, where K and N are total capital and labor employed in the corporate sector.
(3) The government budget is balanced:

$$G = \int \bigl[\tau_c c(s) + T\bigl(I(s)\bigr)\bigr] \,\mathrm{d}\Phi(s).$$

(4) The intermediary sector is competitive. Banks receive deposits from households and pay interest r, and offer loans to the corporate and non-corporate sectors at rates r and $r + \phi$ respectively, where ϕ is the cost of intermediating funds to entrepreneurs.
(5) Capital and labor markets clear:

$$\int k(s)\,\mathrm{d}\Phi(s) + K = \int a(s)\,\mathrm{d}\Phi(s),$$
$$\int n(s)\,\mathrm{d}\Phi(s) + N = \int l(s)\,\mathrm{d}\Phi(s).$$

(6) The distribution Φ is time-invariant. The law of motion for the distribution of agents over the state space $\mathbb{S}$ satisfies

$$\Phi = R_\Phi(\Phi),$$

where R_Φ is a one-period transition operator on the distribution, i.e. $\Phi_{t+1} = R_\Phi(\Phi_t)$.

The algorithm used to compute the stationary equilibrium is described in Appendix A.

3. Calibration

This section describes calibration of the parameters used in the benchmark model. Calibrated parameters are summarized in Table 1.

3.1. Preference, endowment and technology

Preference. The coefficient of relative risk aversion σ is set to 2.0 following the estimates in the literature. The subjective time discount factor β is set to 0.9428 so that the economy attains an aggregate capital–output ratio of 2.65 in the stationary equilibrium.[7]

Labor productivity. We assume the logarithm of the stochastic component of labor income η follows a first-order autoregressive process and approximate the process by a Markov transition matrix with $N_\eta = 5$ grid points, using the method of Tauchen and Hussey (1991). The process in a continuous space is given as

$$\ln \eta_t = \rho \ln \eta_{t-1} + \varepsilon_{\eta,t},$$

[7] In the absence of public capital, capital in the model corresponds to equipment and structures, inventories, land and residential structures, which we target at 2.65 following Quadrini (2000) and Li (2002).

Table 1
Parameters calibration

Parameter	Description	Values
Preference		
σ	relative risk aversion	2.0
β	discount factor	0.9428
Production technology		
α	capital share in the corporate sector	0.36
ν	non-corporate production parameter	0.88
δ	depreciation rate of capital	0.06
Labor productivity		
ρ	autoregressive coefficient for η process	0.94
σ_η^2	AR(1) error variance for η process	0.02
Tax system		
$\{a_0, a_1, a_2\}$	parameters for non-linear income tax schedule	$\{0.258, 0.768, 0.438\}$
τ_I	proportional tax rate on income	3.16%
τ_c	consumption tax rate	5.67%

where $\varepsilon_{\eta,t} \sim N(0, \sigma_\eta^2)$. The AR(1) coefficient ρ and the residual variance σ_η^2 are set to 0.94 and 0.02 respectively, which is in the range of estimates in the literature.[8] The grid of η is normalized so that the unconditional mean of η is unity. The calibrated Markov process is presented in Appendix B.

Entrepreneurial ability and technology. Entrepreneurs use capital k and labor n and produce output y. Recall the production function

$$y = f(k, n, \theta) = \theta k^{\nu_1} n^{\nu_2}.$$

We assume that the ratio of parameters on capital and labor are the same as in the corporate sector, i.e. $y = \theta(k^\alpha n^{1-\alpha})^\nu$, where α is the capital share in the corporate sector and $\nu = \nu_1 + \nu_2 \in (0, 1)$. We are left to set the parameter ν, which determines the degree of returns to scale.

θ is stochastic entrepreneurial ability. The calibration of this process is somewhat challenging, due to the lack of appropriate micro data or estimations. We assume that it follows a four-state Markov process, and the state vector is proportional to $[0, 1-x, 1, 1+x]$, where $x \in (0, 1)$. The vector is scaled by $\bar{x}$ and given as $\bar{x} \cdot [0, 1-x, 1, 1+x]$. The transition matrix P_θ is of the size 4×4, with an (i, j)th element p_{ij}, which is the probability of drawing θ_j next period conditional on having θ_i this period. We assume that entrepreneurial ability develops over time but only gradually. From one period to the next, it jumps up and down by at most one grid to the adjoining θ, i.e. we assume $p_{ij} = 0$ if $|i - j| > 1$. Hence we have the following grid of θ and transition matrix P_θ:

$$\text{grid } \theta = \bar{x} \cdot [\,0 \quad 1-x \quad 1 \quad 1+x\,],$$

$$\text{transition matrix } P_\theta = \begin{bmatrix} p_{11} & (1-p_{11}) & 0 & 0 \\ p_{21} & p_{22} & (1-p_{21}-p_{22}) & 0 \\ 0 & p_{32} & p_{33} & (1-p_{32}-p_{33}) \\ 0 & 0 & 1-p_{44} & p_{44} \end{bmatrix}.$$

In an effort to reduce the number of parameters to calibrate, we also assume that the non-zero elements in the middle two rows are the same, i.e. $p_{21} = p_{32}$ and $p_{22} = p_{33}$.

We calibrate the six parameters that define the process of θ and the parameter ν for the entrepreneur's production function to match the following seven targets in the equilibrium: the fraction of entrepreneurs in the economy, the share of income earned by entrepreneurs, the average exit rate of entrepreneurs, the exit rate of new entrepreneurs with a one-period tenure, the share of capital used in the entrepreneurial sector, the share of assets owned by entrepreneurs and the ratio of median assets of entrepreneurs to workers.

[8] See, for example, Storesletten et al. (2004) and Hubbard et al. (1994).

Table 2
Calibration targets and results

	Target	Model
capital–output ratio	2.65	2.650
government expenditures/GDP	18%	18.00%
income tax/total tax revenue	65%	65.00%
fraction of entrepreneurs	12%	11.93%
share of entrepreneurs' income	27%	29.08%
exit rate (overall)	20%	21.30%
exit rate (new entrants)	40%	37.48%
capital used by entrepreneurs	35%	35.88%
assets owned by entrepreneurs	40%	37.12%
ratio of median assets (entrepreneur to worker)	8	8.02

Quadrini (2000) reports a fraction of entrepreneurs in the US economy at 12% using the average of family data from the PSID for the period of 1970–1992 and from the SCF data for 1989–1992.[9] Gentry and Hubbard (2004) use the SCF data in 1989 and report a fraction of entrepreneurs according to three alternative definitions of an entrepreneur. Households who reported owning active business assets without restriction on the asset size constitute 11.5% of the samples. Hipple (2004) reports that 11.1% of the labor force is identified as self-employed using Current Population Survey data for 2003. We set a target fraction of 12% in our model. We also target the fraction of total income earned by entrepreneurs at 27%. Quadrini (2000) reports that entrepreneurs earned 22% of income from the PSID samples for 1984, 1989 and 1994, and Quadrini (1999) reports 25% using 1989 PSID data. These numbers, however, underestimate the entrepreneurial income in our theoretical model since the model is not capable of capturing all the operational costs and deductions that entrepreneurs can actually exploit and utilize.

For the exit rate of entrepreneurs, we target the overall average exit rate of 20% for all the entrepreneurs and 40% for the new entrepreneurs with one year of their business tenure. As shown in Quadrini (2000, Table IV), there is a substantial difference in the mobility between the experienced and inexperienced entrepreneurs, reflecting the "learning process" of entrepreneurs who accumulate business skills over time and exit at a lower rate as the tenure increases.

Quadrini (2000) argues that the fraction of aggregate capital employed in unincorporated businesses is estimated to be around 30%, but that the number underestimates the size of the sector in the model since some businesses take the form of corporations. We set a target so that the entrepreneurial sector employs 35% of aggregate capital. Gentry and Hubbard (2004) report that entrepreneurs own 40.8% of total assets and the median net worth of entrepreneurs is 8 times as large as that of non-entrepreneurs. We target these figures in the benchmark model.

Table 2 exhibits the moments we used as the calibration targets and the values obtained from the model, as well as some other statistics that we don't explicitly target. We match all the targets within 8% precision. The Markov process of entrepreneurial ability θ is presented in Appendix B.

Corporate technology. In the corporate sector, the production function is given as $Y = F(K, L) = AK^{\alpha}N^{1-\alpha}$. We normalize the parameter A to unity. The share of output that goes to capital, α, is fixed at 0.36 in both the corporate and non-corporate sectors. The depreciation rate δ is set at 6%.

Intermediary sector. The loan premium ϕ represents the spread between the borrowing and lending rates of households, which we set at 5% based on the study by Díaz-Giménez et al. (1992). The maximum leverage ratio d is set to 50%. Evans and Jovanovic (1989) conduct an empirical study on entrepreneurs' liquidity conditions and argue that "a person can not use more than 1.5 times of his or her initial assets for starting a new venture."[10]

[9] Quadrini (2000) defines entrepreneurs as families that own a business or have a financial interest in some business enterprise, as we do in our model. The identification of entrepreneurs is based on an interview question. See Quadrini (1999) for more details.

[10] Evans and Jovanovic (1989) estimated the parameter to be in the range of (0.31, 0.59) with 99% confidence.

3.2. Government

The government spending G is assumed to be exogenously given as a fixed fraction of GDP in the benchmark economy. The ratio is set at 18%, which is computed as the share of the government consumption and gross investment excluding transfers, at the federal, state and local levels (*The Economic Report of the President*, 2004).

The consumption tax rate is fixed at $\tau_c = 5.67\%$, which is the average over 1965–1996, based on the computation of an effective consumption tax rate in Mendoza et al. (1994) and also their unpublished data for more recent years available on Mendoza's web page.

To approximate the US income tax system, we employ a parametric assumption and use the following functional form for the tax schedule:

$$T(I) = a_0\{I - (I^{-a_1} + a_2)^{-1/a_1}\} + \tau_I I, \tag{10}$$

where I is the total taxable income of an individual.[11] The first non-linear part captures the progressive income tax system in the US. $\{a_0, a_1\}$ are the parameters that determine the shape of the function. The parameter a_2 varies with the unit of measurement, i.e. if income is scaled by a factor $\lambda > 0$, we need to adjust a_2 so that $\widetilde{a}_2 = a_2\lambda^{-a_1}$ in order to raise the tax liabilities proportionally. Gouveia and Strauss (1994) use individual tax return data provided by the Internal Revenue Service and estimate this parametric version of the tax function. Their definition of income (the taxable base) include all sources of income identifiable from the tax returns, including labor income, interest, dividends, capital gains and sole proprietorship income. They obtain estimates of $a_0 = 0.258$ and $a_1 = 0.768$ to approximate the effective tax system in the US, which we use in the benchmark model. The parameter a_2 is pinned down in equilibrium so that the share of the government expenditures raised by the non-linear part of the function equals 65%, the fraction of government tax revenues raised by the income tax in data (OECD, 2003).

The second part of tax liabilities $\tau_I I$ captures the rest of individual taxation, the part which is neither a consumption tax nor an income tax, and we assume it to be proportional to income. τ_I is determined in equilibrium so that we achieve an overall balanced government budget.

3.3. Economy without entrepreneurs

To highlight the role of entrepreneurs in the policy experiments, we also consider and calibrate an economy without entrepreneurs in two alternative ways. In both, we maintain the values of baseline parameters at the benchmark levels, except for the subjective discount factor to achieve the same capital–output ratio of 2.65 and the tax parameters to satisfy the government budget constraint. The difference between the two worker-economies is the calibration of the idiosyncratic labor productivity process. In the first, we use the same specification as in the benchmark. In the second, the process is calibrated so that the distribution of wealth matches the one in the benchmark model with entrepreneurs. In particular, I take the approach as in Castañeda et al. (2003), where agents face a highly persistent process of labor productivity with more than 60% of the population belonging to the lowest grid and a very small probability of possessing superb productivity that is more than 1000 times the median in the economy.[12]

4. Benchmark economy

Entrepreneurship and wealth distribution. The model generates a considerable degree of inequality that matches the data fairly well. Table 3 displays some statistics for the wealth distribution in the benchmark economy and compares the performance with the data in the US as well as the two model economies without entrepreneurs.

In a model without entrepreneurs, the wealth is much less concentrated, unless we alter the labor income process as we do in the second model without entrepreneurs. It is now known that a typical Bewley model tends to be un-

[11] We use the same individual income tax schedule for workers and entrepreneurs. Many entrepreneurs choose to form a business so that they can avoid the double taxation that a regular C-corporation is subject to. In the study of Gentry and Hubbard (2004), sole proprietorships constitute 49% of entrepreneurs, partnership 24, S-corporations (pass-through entities) 11 and C-corporations 14%.

[12] The exact productivity process of Castañeda et al. (2003) would generate even more wealth concentration in our model and we adjust the value of the highest productivity shock so that we achieve the wealth Gini coefficient that is equivalent to the value in our benchmark model.

Table 3
Wealth distribution: data and models

	Wealth Gini	Percentage wealth in the top					
		1%	5%	10%	20%	40%	60%
US data	0.803	34.7	57.8	69.1	81.7	93.9	98.9
benchmark model	0.801	19.6	50.4	69.3	84.7	94.9	98.7
no entrepreneurs (1)	0.423	3.4	14.1	25.4	44.3	71.4	88.7
no entrepreneurs (2)	0.801	35.4	58.4	66.0	80.9	96.1	99.9

The US data are from Budría Rodríguez et al. (2002). "no entrepreneurs (1)" indicates the model with the labor income process as in the benchmark and in "no entrepreneurs (2)", the process is calibrated to match the wealth Gini of the benchmark.

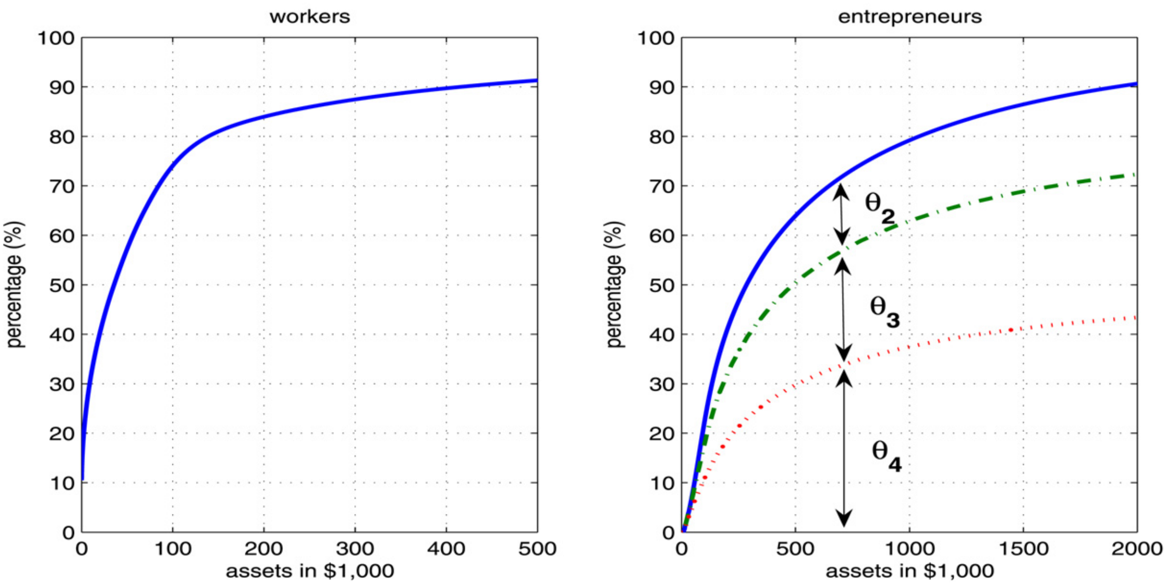


Fig. 1. Benchmark model: CDF of assets.

successful in replicating the concentration of wealth, especially in the upper tail of the distribution and that modeling entrepreneurship as in Quadrini (2000) and Cagetti and De Nardi (2006a) is one way of overcoming the issue.[13]

More characterization of entrepreneurs. Entrepreneurs in our model are characterized by a higher level of assets and entrepreneurial ability θ than workers. Figure 1 compares the cumulative distribution of assets for workers and entrepreneurs. While there are many workers with zero or few assets, entrepreneurs possess a greater amount of assets. As shown in Table 4, although entrepreneurs constitute only about 12% of the entire population, their presence is much more significant in the upper tail of the wealth distribution in a degree comparable to the data.

Figure 2 displays the distribution of θ for the entire population and for entrepreneurs. Agents with the highest ability θ (those at the right end of the distribution) are highly likely to become entrepreneurs. The fraction of entrepreneurs decreases as the value of θ goes down and no one chooses to run a business with the lowest θ. Table 5 presents more characterization of entrepreneurs across different values of θ. More productive entrepreneurs with higher values of θ undertake larger projects and rely more heavily on outside financing as shown by the average leverage ratios in the last column.

Figure 3 shows the investment by entrepreneurs across different levels of asset holdings. We plot the investment by the agents with θ's that are positive (θ_4, θ_3 and θ_2). First, look at the curve on the top, the investment by entrepreneurs

[13] The additional ingredients in Cagetti and De Nardi (2006a) are the altruistic bequest motives and the transmission mechanism of successful business and large fortunes over a dynasty. The features are shown to help a model generate further concentration of wealth, especially in the hands of the wealthiest 1%.

Table 4
Entrepreneurs and wealth distribution

top	US data		Benchmark model	
	% of wealth held	% of entrep. in percentile	% of wealth held	% of entrep. in percentile
1%	30	63	20	47
5%	54	49	50	40
10%	67	39	69	37
20%	81	28	85	33

The US data are from Cagetti and De Nardi (2006a).

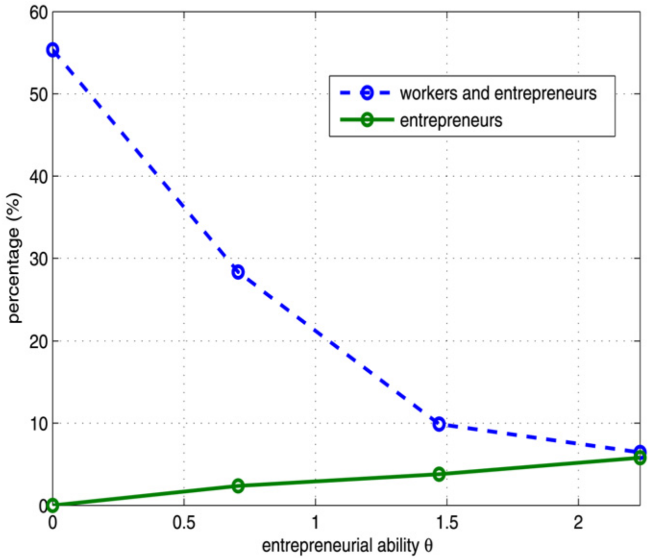


Fig. 2. Benchmark model: distribution of entrepreneurial ability θ.

Table 5
Benchmark model: entrepreneurial activities by ability θ

θ grid	θ value	% in pop.	% in entrep.	avg. invstm. in \$1,000	avg. assets in \$1,000	avg. lev. ratio %
θ_1	0.000	0.00%	0.00%	–	–	–
θ_2	0.706	2.36%	19.78%	136	598	2.4%
θ_3	1.470	3.79%	31.74%	524	710	15.2%
θ_4	2.234	5.78%	48.48%	1,173	917	32.6%
total	–	11.93%	100.00%	–	–	–
average	–	–	–	762	788	21.1%

with the highest $\theta = \theta_4$. For each level of assets, the vertical distance between the curve and the 45 degree line represents the borrowing from an intermediary, $k - a$. Many of the most productive entrepreneurs are borrowing up to the borrowing limit $(1 + d)a$ to expand their business and maximally exploit the profitable opportunity. As the investment increases, the marginal return decreases since the production function exhibits decreasing returns to scale. Once the level of investment is high enough that the marginal return from investment equals the borrowing cost, it no longer pays-off to borrow for additional investment by paying an extra premium on the external borrowing. From there on, the same level of investment is maintained and the leverage ratio decreases as the fraction of own assets used for investment increases, as shown in the flat part of the curve. For entrepreneurs with lower θ, the return from investment will hit the borrowing cost at a lower asset level and fewer of them can afford to use the costly external

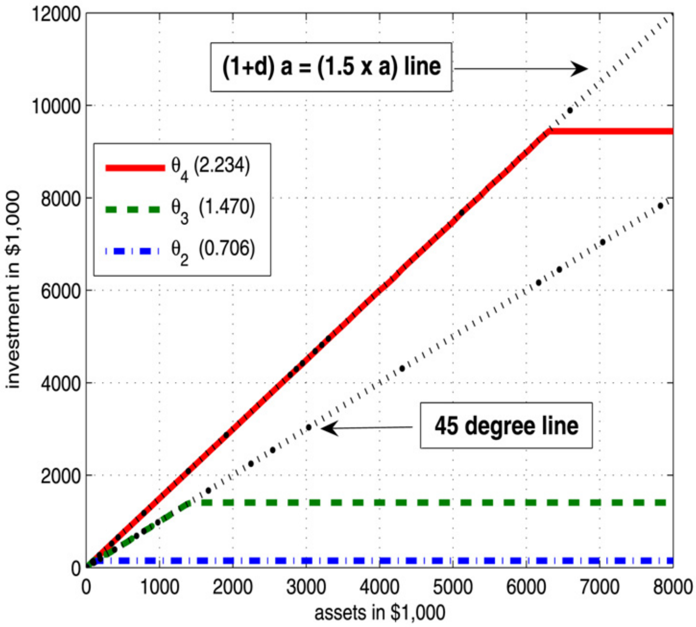


Fig. 3. Benchmark model: entrepreneurs' assets and investment.

financing. Once the decreasing return reaches the opportunity cost of investment, i.e. the return from riskless saving, the investment levels off.

In our model, three features contribute to the model's capability to generate an endogenously determined non-degenerate distribution of the firms' size. First, with the decreasing returns to scale technology, the optimal firm size is endogenously determined. Second, the existence of borrowing constraints precludes those with few assets from expanding business or even from starting up. Lastly, the borrowing premium contributes another dimension of heterogeneity. For a given level of assets, stochastic ability generates heterogeneous break-even points of investment and optimal levels of borrowing as shown in Fig. 3.[14]

5. Policy experiments

In this section, we conduct two sets of policy experiments to study the incidences of capital income taxation in our model economy. In the first experiment, we study the effect of alternative tax rates on the return from savings. In the second, policies that isolate entrepreneurial business income are studied. The results of the first experiment are also compared with the same experiment in the two economies without entrepreneurs. All the policy experiments are revenue neutral tax reforms, i.e. we fix the government expenditures at the benchmark economy level.

For each experiment, we conduct two sets of analysis. Firstly, we compute and focus on the steady state implied by the new tax policy. We present a positive and normative comparison with the benchmark economy. Secondly, we compute the transition dynamics. We assume that in period 0, the economy is in the steady state of the benchmark economy. In period 1, an unanticipated change in the tax policy is announced and implemented and the economy starts to make a transition to the new steady state. Throughout the transition, the proportional tax rate τ_I is adjusted so that the government budget balance is satisfied in every period. The computation method of the transition path is discussed in Appendix A.

Once we solve for the transition dynamics, we compute the consumption equivalent variation ("CEV") in order to compare the welfare effect of different tax systems. It measures the constant increment in percentage of consumption

[14] We have conducted sensitivity analysis of the benchmark model when we use alternative parameters that are linked to the entrepreneurial activities, as well as policy experiments under alternative parameterizations. We will not discuss them in the paper due to the space constraint, but an appendix with more details is available from the author upon request.

in every state that has to be given to each agent so that he is indifferent between remaining in the benchmark economy and moving to another economy that makes a transition to a new steady state implied by the alternative tax system.

5.1. Capital income tax on savings

We implement a proportional capital income tax on the return from riskless saving, with a flat rate denoted by τ_K ranging from 0% (i.e. abolishing the capital income tax) up to 40% by a 5% increment. We use the proportional tax rate τ_I on other sources of income to balance the government budget. Let I_K denote an agent's capital income and $\tilde{I}$ denote the rest of income, i.e. $I = \tilde{I} + I_K$, where I is total income. The total income tax liabilities of an agent who earns capital income I_K and non-capital income $\tilde{I}$ are given by:

$$T(I_K, \tilde{I}) = \tau_K I_K + a_0\{\tilde{I} - (\tilde{I}^{-a_1} + a_2)^{-1/a_1}\} + \tau_I \tilde{I}.$$

Steady states. Results from the steady states are summarized in Fig. 4. As shown in Fig. 4(d), a lower capital income tax encourages savings and raises the level of aggregate capital and output. Figure 4(b) shows that the interest rate goes up with the capital tax rate, together with a decrease in the capital–labor ratio in the corporate sector. The wage is high when the tax is low since labor becomes scarcer relative to the capital.

Figure 4(e) displays the activities in the non-corporate sector. Investments by entrepreneurs fall when the capital income tax is low. To understand this, firstly, notice that entrepreneurs find saving a more attractive use of assets relative to entrepreneurial investment than before. The net-of-tax return from saving is higher and other sources of income including the profit from an entrepreneurial business are taxed at a higher rate to compensate for the reduction in the tax revenue (see Fig. 4(c) for the changes in the proportional tax rate τ_I). The pre-tax interest income from saving is lower, but for the agents who face a sufficiently high marginal tax rate, the favorable effect of a lower capital tax dominates the net effect on the after-tax return. Secondly, the increase in the wage raises the production cost borne by entrepreneurs. They rely more heavily on labor inputs and their capital–labor ratio is lower than in the corporate sector, since they can invest only up to the borrowing limit and face a loan premium for borrowing through the intermediary. Therefore entrepreneurial production is more severely hurt by the wage increase. As shown in Fig. 4(a),

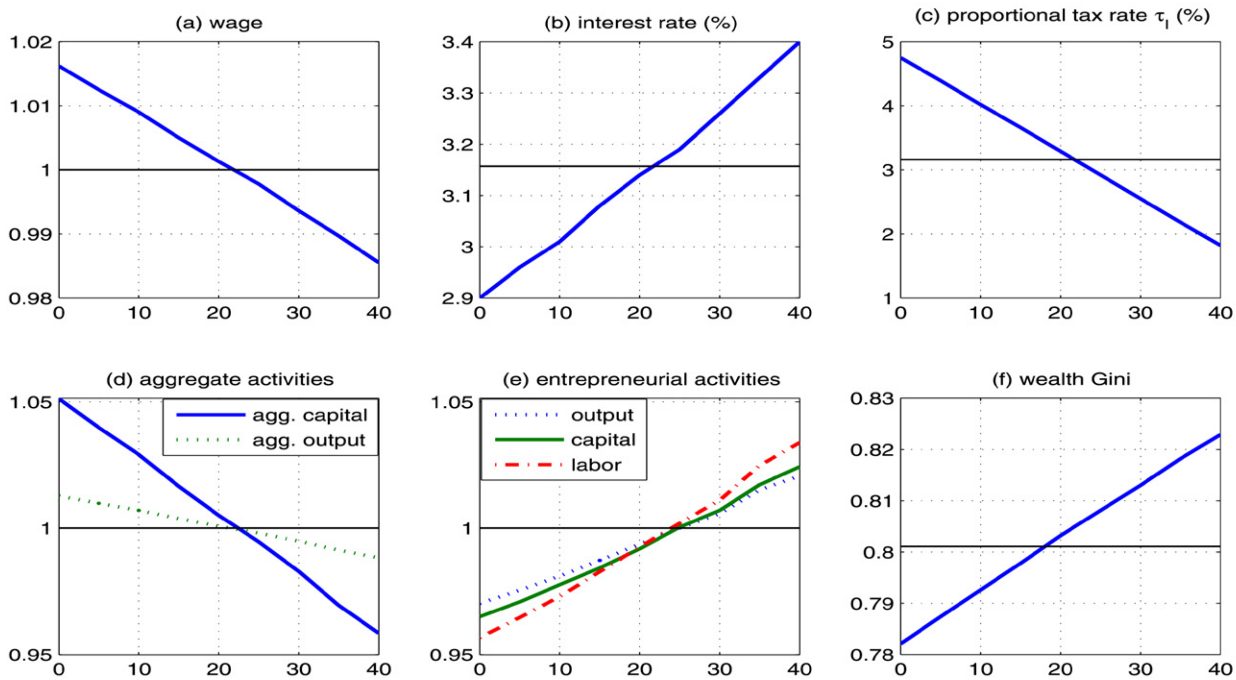


Fig. 4. Flat capital income tax: steady states: On horizontal axes are the capital income tax rates τ_K (%). Straight horizontal lines indicate the levels in the benchmark economy.

when the capital tax is zero, wages are 1.5% higher than in the benchmark, which forces entrepreneurs to adjust the input shares and reduce the total labor used in the sector by more than 4%.

In terms of the fraction of entrepreneurs in the economy, there will be slightly more entrepreneurs when the capital tax is lower, but the difference is negligibly small, ranging between 12.0% when $\tau_K = 0\%$ and 11.8% when $\tau_K = 40\%$. With a low capital tax, rich workers can accumulate more wealth and they are less likely to be financially constrained from becoming an entrepreneur when an opportunity arises, slightly increasing the overall entry rate to businesses. At the same time, however, the higher return from savings raises the opportunity cost of running a business and the exit rate is higher as well. With these two effects, the total number of entrepreneurs remains almost the same.

Figure 4(f) shows the wealth Gini coefficients across experiments. With a lower capital tax, entrepreneurs reduce investment and the share of their income declines. As a consequence, the economy is more equal in the wealth distribution as reflected in a lower Gini coefficient. A lower tax rate on savings will benefit agents who hold large assets and further increase their wealth, but this effect is mitigated by the lower interest rate.

Transition dynamics. We present in Fig. 5 the evolution of macroeconomic variables along the transition path for the two experiments of setting τ_K to 0 and 40%. When the capital tax is abolished, the aggregate capital stock does not jump up upon the announcement since it is predetermined in the previous period. Agents react by reducing consumption and increasing savings. The saving rate is immediately driven up from 17 to 18.3% as aggregate consumption jumps down by 2%. The reduction in revenue from the capital tax, coupled with a lower consumption tax revenue, triggers an immediate increase in the proportional tax rate τ_I from 3.2 to 5.0%. Entrepreneurs start to reduce their investment and allocate more assets to riskless savings. While the output in the non-corporate sector monotonically decreases in the first years after the policy change, the corporate sector absorbs the increased savings from households and produces more output. In the long run, aggregate consumption is higher than before, but it remains below the initial level for the initial two decades.

When the capital tax is set at 40%, agents immediately reduce savings and consumption jumps up by 1.5% upon the policy announcement. The saving rate remains below the benchmark level throughout the transition although it increases slightly as the interest rate goes up.

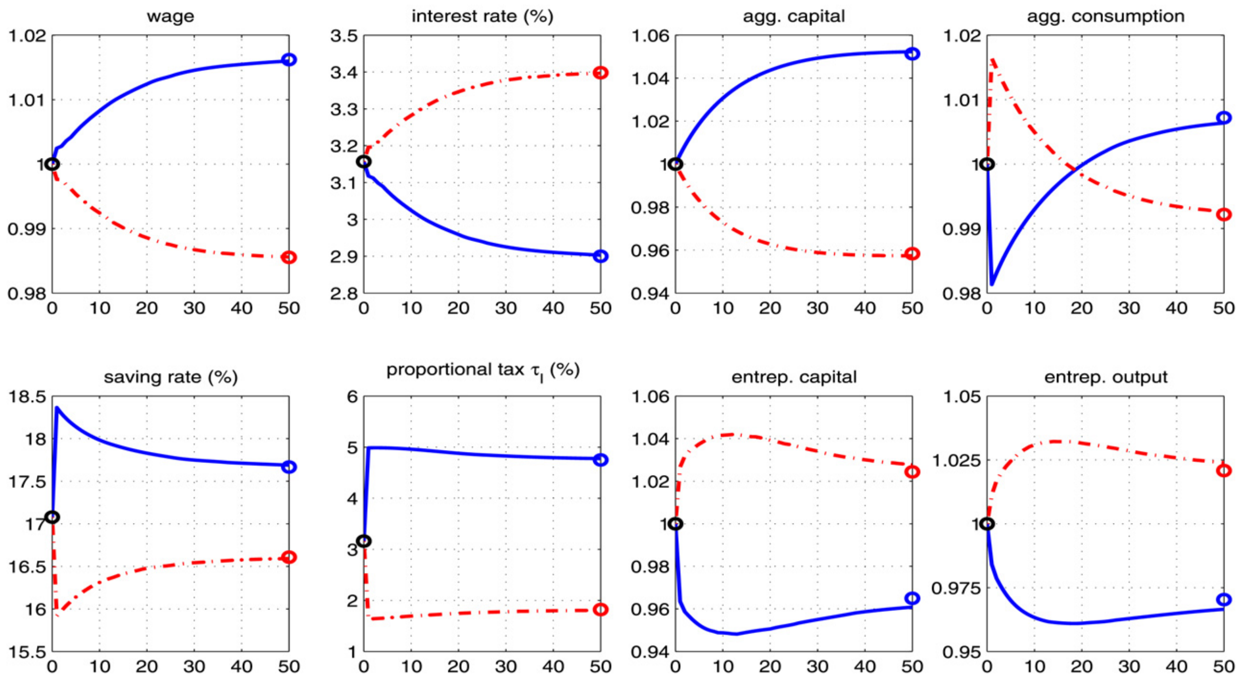
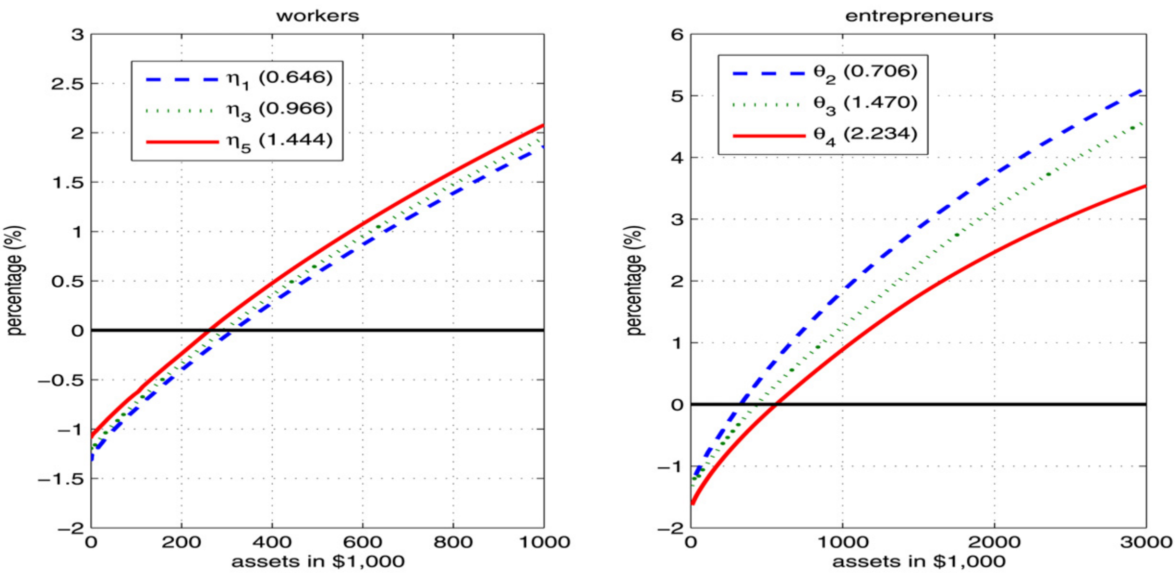
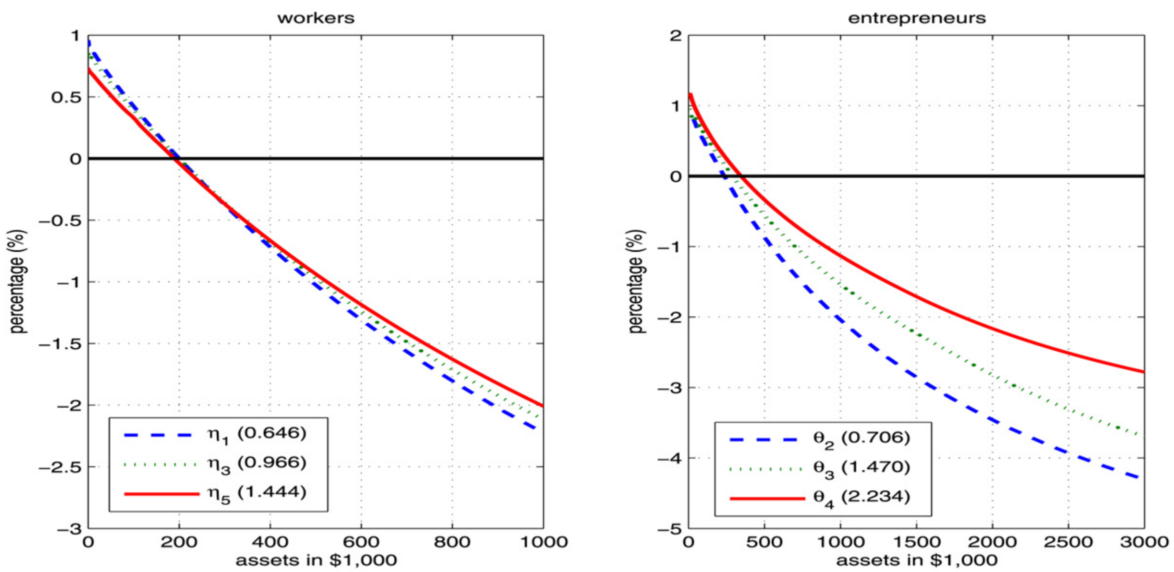


Fig. 5. Evolution of aggregate quantities: capital income tax: On horizontal axes are the time periods (years) since the announcement of the reform. The solid lines represent the experiment of capital income tax $\tau_K = 0\%$ and the dash-dot lines represent $\tau_K = 40\%$. The circles in each plot in the first and the last periods indicate the levels in the initial and final steady states.



(a) Capital income tax $\tau_K = 0\%$



(b) Capital income tax $\tau_K = 40\%$

Fig. 6. Consumption equivalent variation: capital income tax.

Welfare consequences of the reform. The top panels of Fig. 6 show the CEVs of workers and entrepreneurs over assets when the capital tax is 0%.[15] In evaluating welfare, we take into account the costs associated with the transition, except in computing the ex ante CEV used to compare two steady states that we discuss later. Both workers and entrepreneurs with large assets gain from the tax cut. Those with fewer assets will benefit less from the lower capital tax and the net welfare effect is negative since they face a higher tax burden on wage and business income.

Workers with higher productivity η gain slightly more than others since they have a better chance of accumulating more assets and benefit from the new regime. For entrepreneurs, those with lower ability θ allocate a larger fraction of their assets to savings rather than investment and benefit more from the lower capital tax. For those entrepreneurs

[15] To make the figures easy to read, we plot the CEVs for only three values of η (η_1, η_3 and η_5) averaged over θ for workers, and three values of θ (θ_2, θ_3 and θ_4) averaged over η for entrepreneurs.

towards the lower end of the wealth distribution, the increasing wage cost and the higher tax rate on business profits dominate in the net welfare effect. As shown in Table 6, households with positive CEVs account for only 16% of the population and concentrate in the right end of the wealth distribution.

When the capital tax is raised to 40%, the rich will suffer from a lower after-tax return from savings. For example, as shown in the lower panels of Fig. 6, entrepreneurs with assets worth more than $2 million (approximately 20% of entrepreneurs) will face a welfare loss equivalent to more than 2% of consumption across states. Those with a lower level of θ lose more since they are less productive in their business and rely more heavily on capital income. When we compare the result with the case of zero capital tax, the magnitude of the loss for the rich in this experiment is considerably larger than the loss for the poor in the other experiment. However, the large tax burden on the rich translates into a benefit for many households through the lower tax rate τ_I. As shown in Table 6, as many as 79% of the households would support such a reform. Conditioning on occupation, 83% of workers and 50% of entrepreneurs would gain from the reform.

Another welfare criterion that is often used is the comparison of ex ante CEVs from a "veil-of-ignorance" perspective. Figure 7 displays the welfare results according to such a criterion. The left panel shows the CEVs when the transition cost is taken into account, i.e. we ask an agent if he would like to stay in the benchmark economy, or if he would rather be born in the economy that is about to make a transition to the new steady state upon the surprise announcement of the tax reform. He does not know his state as he enters the economy (hence the name "ex ante") and evaluates the values of possible states according to the invariant distribution. On the right is the comparison of the two steady states that does not take into account the transition costs. We simply ask if a household prefers to be born to the new steady state implied by the new tax system and if so, how much is the gain in terms of the percentage change in consumption across states. The difference in the two panels is startling. We would conclude that the zero capital tax brings a large welfare gain if we focused only on the final steady state, since the new economy would produce more in the long run. However, once we take into account the transition dynamics, the result reverses. The adjustment of capital comes at the cost of the transitional pain from the lower level of consumption, which weighs more than the gain from higher consumption far in the future. Although such a reform may be desirable in the long run, the proposal may face strong opposition from low to middle class workers and turn out to be politically infeasible.

Table 6
Fraction of households with welfare gains: capital income tax

Wealth (in $1,000)	Workers		Entrepreneurs		All	
(a) Capital income tax $\tau_K = 0\%$						
0–10	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
10–50	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
50–100	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
100–250	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
250–500	3.6	(77.4)	0.3	(15.8)	3.9	(58.9)
500–1000	3.9	(100.0)	1.7	(88.9)	5.6	(96.4)
1000–2000	2.6	(100.0)	1.4	(100.0)	4.1	(100.0)
>2000	1.6	(100.0)	1.2	(100.0)	2.8	(100.0)
all	11.7	(13.3)	4.6	(38.9)	16.3	(16.3)
(b) Capital income tax $\tau_K = 40\%$						
0–10	26.4	(100.0)	> 0.0	(100.0)	26.4	(100.0)
10–50	22.4	(100.0)	0.9	(100.0)	23.3	(100.0)
50–100	15.2	(100.0)	1.6	(100.0)	16.8	(100.0)
100–250	9.3	(81.5)	2.9	(98.6)	12.2	(85.1)
250–500	0.0	(0.3)	0.6	(31.2)	0.6	(9.6)
500–1000	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
1000–2000	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
>2000	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
all	73.3	(83.2)	6.0	(50.2)	79.3	(79.3)

In parentheses are the fractions of households with welfare gains conditional on their occupation and their wealth category.

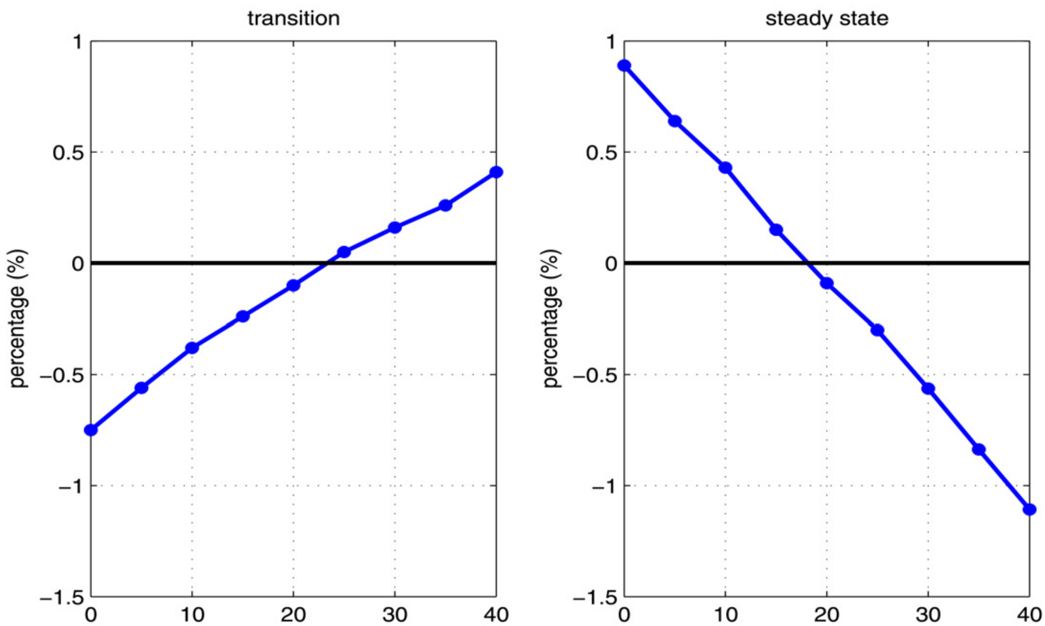


Fig. 7. Ex ante welfare comparison: transition and steady state: flat capital income tax: On horizontal axes are the capital income tax rates τ_K (%).

Table 7
Flat capital income tax: economy without entrepreneurs

	$\tau_K = 0\%$			$\tau_K = 40\%$		
	bnch.	no E(1)	no E(2)	bnch.	no E(1)	no E(2)
interest rate	0.919	0.787	0.851	1.076	1.265	1.121
wage	1.016	1.074	1.050	0.986	0.925	0.964
agg. capital	1.051	1.220	1.145	0.958	0.808	0.903
agg. output	1.013	1.074	1.050	0.988	0.926	0.964
proportional tax τ_I (change in %)	+1.59	+4.60	+5.49	−1.34	−4.38	−3.03
% with CEV > 0	16.3	46.4	15.8	79.3	38.1	64.0

The variables are normalized by their benchmark level, except for the proportional tax rate τ_I and the percentage of the population with a positive CEV. In the initial steady state, $\tau_I = 3.16$, 3.03 and 3.03% in the three economies.

Economy without entrepreneurs. We now compare the results of the capital income taxation when the economy is populated by only workers. Table 7 shows the summary statistics on aggregate activities and welfare when the capital tax is set at 0 or 40%. "No E(1)" denotes the worker-economy using the benchmark calibration of the labor income process and "no E(2)" is the one where we calibrate the process to match the wealth distribution in the benchmark economy with entrepreneurs.

Qualitative effects on macro variables are similar in the three economies. A low capital tax encourages savings and raises the aggregate capital and output. The size of the effects, however, are remarkably different, especially between the benchmark and the first economy without entrepreneurs. For example, when the capital tax is eliminated, aggregate capital goes up by more than 20% in the worker-economy, while it goes up by only 5% with entrepreneurs. The wage increases by 7.4% as opposed to 1.6% with entrepreneurs. In the benchmark, a low capital tax discourages undertakings of entrepreneurial businesses and their demand for capital and labor inputs go down, which results in only a moderate increase in aggregate capital and output, compared to a case without entrepreneurs. No such channels exist in the worker-economy, where a low capital tax simply increases savings and the economy's capital stock. Transition dynamics exhibit a movement of macro variables similar to those in the benchmark (not displayed), but the initial responses and the long-run effects are much larger without entrepreneurs.

In the second worker-economy, we let a very small fraction of workers receive an extraordinarily superb labor shock that is persistent and accumulate large assets so that the model generates a high concentration of wealth. When the capital income tax is low, the rich will increase their savings, but not as much as the agents with lower assets in terms of the percentage change in their wealth. Given the decomposition effect, i.e. more wealth concentrated in the hands of the few with low saving elasticities, we have less quantitative effects compared to the first economy. However, comparing to the benchmark economy with entrepreneurs, we would still overestimate the effects significantly (for example, aggregate capital is up by 15 versus 5%).

In terms of the welfare effect, similar to what we observed in the benchmark economy, the wealthy households who can exploit the higher after-tax return will benefit from the lower capital tax. Given that the wealth is more concentrated in the benchmark and in the second worker-economy, fewer people gain from the tax cut than in the first worker-economy, where the wealth is more evenly distributed. The fraction of the population with a positive CEV is 16.3, 46.4 and 15.8% in the benchmark and the two worker economies as shown in Table 7.

In summary, the consequence of not including a non-corporate sector is that a model will miss the fraction of households (entrepreneurs) who allocate resources between business and riskless savings based on the differentials in their after-tax returns. Reducing the tax burden on one source of income (savings) will discourage investment. Without entrepreneurs, the model will only capture the increase in savings by worker households and the tax incidence on aggregate variables as well as welfare can be considerably overestimated.

5.2. *Taxation on entrepreneurial business income*

In this section, we consider a system that distinguishes entrepreneurs' business income at the firm level from other individual income for the purpose of taxation. The current US individual income tax code does not distinguish between sources of income. Accordingly, we combined all sources of income in the benchmark model to derive a single income tax base, including wage income, capital income from saving and income from an entrepreneurial business.[16] The focus of this section is to understand the effect of changing the tax on the part of income from the entrepreneurial business.

We can think of this exercise as a policy experiment where entrepreneurs are taxed twice as separate taxpayers but without double taxation, once at the firm level for the business income just as at regular corporations, and once at the individual level for the rest of the income. Alternatively, the experiment can be interpreted as having entrepreneurs receive some special tax treatment for their business income in computing their tax obligations.

The tax base for entrepreneurial business income is given as

$$I_{E1} = f(k, n, \theta) - \delta k - w \cdot \max\{n - \eta, 0\} - rk - \phi \max\{0, k - a\}, \tag{11}$$

where the last term $-\phi \max\{0, k - a\}$ represents the part of the interest expense subtracted from the tax base in case part of the investment is financed by borrowing with a loan premium ϕ. Income taxed at the individual level is given as $I_{E2} = ra$, the capital income earned on assets a.

When we consider the tax system for an entrepreneur's income at the firm level, it is difficult to make it comparable to the corporate tax system in the US. Although the US government levies a relatively high statutory tax rates on corporate profits compared to other OECD countries, the actual collection of taxes from corporations is very small in size, only 1.4% of GDP (OECD, 2003), implying that the shape of the effective tax function is very different from that of the statutory tax system. It is a challenging task to estimate such an effective tax function. Therefore, we do not try to mimic or make a comparison to the statutory US corporate tax schedule, and instead we conduct experiments on a simple linear tax function.

We consider a proportional tax levied on entrepreneurs' business income, denoted by τ_{E1}. The income at the individual level is taxed in the same way as the workers' income is taxed, i.e. based on the same progressive tax schedule plus a proportional tax rate τ_I. We let τ_I adjust so that the government budget is balanced. The total tax liabilities of an entrepreneur with income I_{E1} (business income) and I_{E2} (individual income) are given as

$$T(I_{E1}, I_{E2}) = \tau_{E1} I_{E1} + a_0\{I_{E2} - (I_{E2}^{-a_1} + a_2)^{-1/a_1}\} + \tau_I I_{E2}.$$

For a worker who earns income I_W, the tax liabilities are given as

$$T(I_W) = a_0\{I_W - (I_W^{-a_1} + a_2)^{-1/a_1}\} + \tau_I I_W.$$

[16] In the US tax system, income from entrepreneurial businesses is also combined with other personal income unless a C-corporation is formed.

We conduct experiments over the flat tax rate τ_{E1} on business income and vary it from 0% to 40% in 5% increments.

Steady states. Steady state results are summarized in Fig. 8. As shown in Fig. 8(e), a low marginal tax on business income effectively stimulates entrepreneurs' investment and output in the non-corporate sector is significantly higher. For example, when the business tax is 10%, non-corporate investment increases by as much as 19%. With the increase in savings and more labor services allocated to the entrepreneurial sector, the capital–labor ratio is higher in the corporate sector, reducing the interest rate. The increase in entrepreneurial output comes mostly from the increase in capital rather than labor input, since the labor cost is much higher while the rental cost of capital is lower.

In terms of the wealth distribution, entrepreneurs enjoy increased profitability from businesses when taxes are low, which results in an even higher concentration of wealth among rich entrepreneurs. Figure 8(f) shows that when the tax is low, the Gini coefficients are substantially higher than in the benchmark economy.

Compared to the first set of experiments on the capital income tax on savings, the aggregate effects are much more significant. For example, cutting the tax on business income to 10% will raise aggregate capital by more than 10%, while even the complete elimination of capital income taxation will increase the capital by only 5%. Both policies are intended to reduce the tax burden on returns from capital, but one is targeted at corporate investment through increased household savings while the other one targets entrepreneurial investment. Entrepreneurs, even though some are highly productive, are unable to invest at an efficient level due to the constraints they face, i.e. the borrowing limit and the premium on outside finance. If a policy can mitigate the financial market imperfection and relax the constraints, it can be very effective and increase aggregate output significantly. In the current experiment, we not only target the non-corporate sector as a whole, but also provide a larger benefit to entrepreneurs with higher productivity, since those are the ones who face a very high tax burden under the progressive income tax regime. Of course, other policies that loosen the financial constraints of entrepreneurs will stimulate their investment in a similar way. We have also studied the effect of government subsidies for the borrowing cost and the policy of allowing accelerated depreciation deduction in the current framework.[17]

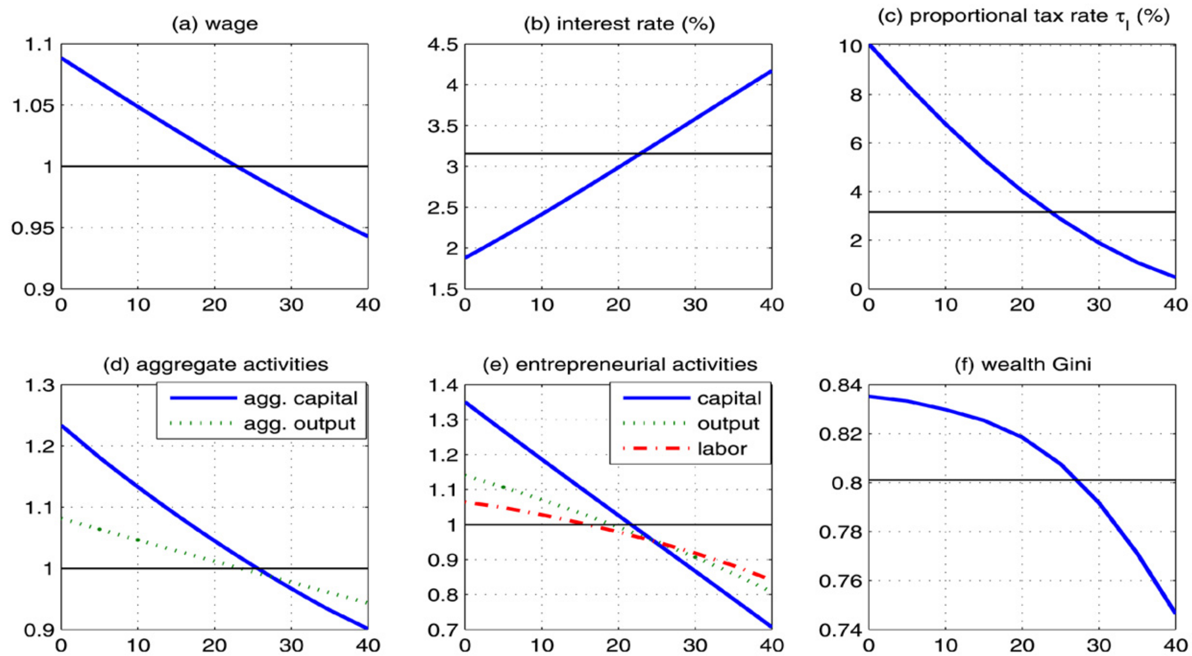


Fig. 8. Flat tax for entrepreneurs' business income: steady states: On horizontal axes are the flat tax rates on entrepreneurs' income τ_{E1} (%). Straight horizontal lines indicate the levels in the benchmark economy.

[17] Results are available from the author upon request.

Table 8
Flat tax on entrepreneurs' business income

(a) Entrepreneurs in the population

	% of entrepreneurs				exit rate (%)	entry rate (%)
	θ_2	θ_3	θ_4	all		
benchmark	2.4	3.8	5.8	11.9	21.3	2.9
$\tau_{E1} = 10\%$	2.6	4.0	5.9	12.5	21.6	3.1
$\tau_{E1} = 40\%$	0.9	2.4	5.1	8.4	21.0	1.9

(b) Investment by entrepreneurs

	avg. investment in $1,000			
	θ_2	θ_3	θ_4	all
benchmark	136	524	1,173	762
$\tau_{E1} = 10\%$	144	554	1,394	863
$\tau_{E1} = 40\%$	128	574	968	763

Another notable difference in the business tax experiment is the effect on occupational choice of households. As shown in Table 8(a), more households undertake entrepreneurial business when the business tax is set at a low level. Since the lower tax increases business profitability, the entry threshold is lower and more households start the business. There is not a large change in the number of entrepreneurs with the highest θ across the experiments since most of them are already in business. However, as discussed above, productive entrepreneurs do respond to a tax reform by significantly changing the size of the investment. When τ_{E1} is 40%, the investment in the non-corporate sector goes down by as much as 30% as shown in Fig. 8(e). Tables 8(a) and (b) show that the decrease comes from the lower entry rate into the sector and the smaller entrepreneurial population. Somehow interestingly, the average size of business remains unchanged from the benchmark, since many of the low productive entrepreneurs drop out of the sector and those who still remain are the ones that own larger assets and invest more.

Transition dynamics. Figure 9 shows the transition dynamics of the experiments when the business tax rates are 10 and 40% respectively. A lower business tax will immediately increase after-tax profit and entrepreneurs quickly increase investment, pushing up the saving rates of the economy. Workers face a higher tax burden on their income from both labor supply and savings. The proportional tax rate τ_I has to jump up by more than 4% upon the policy announcement to compensate for the revenue loss from the business tax reduction.

The policy of setting 40% business tax will significantly cut down entrepreneurs' net profit and discourage them from investing. Capital in the non-corporate sector drops by 25% over the first 10 years of the reform and continues to decrease by another 5% in the long run. Although the wage rates are lower and the labor used in the non-corporate sector does not decline by as much as the capital investment, the output of the non-corporate sector decreases by 20%. Workers also suffer from the falling wages during the transition although the effect is mitigated by the lower proportional tax τ_I.

Welfare consequences of the reform. Figure 10 shows the CEVs of workers and entrepreneurs across different levels of assets in the two experiments. When the business tax is set at 10%, although the wage will be eventually higher and workers enjoy more consumption than in the benchmark, the costs associated with the transition weigh more than the benefits. Those with very few assets suffer severely because the increase in the tax on their wage income directly translates into a drop in consumption as they lack savings to absorb the shock. The wealthier workers can use the saving to buffer against the negative income shocks, but their large savings now pay much less because of the lower interest rate and a higher tax rate τ_I. Entrepreneurs with high ability θ undertake larger projects and benefit from the increased net profit. Entrepreneurs with lower θ also benefit from the low business tax, but the scale of their business is much smaller on average and they rely more on the income from savings. The net welfare effect is highly negative for those lower ability entrepreneurs in the upper tail of the wealth distribution.

When τ_{E1} is set at 40%, both workers and entrepreneurs with large assets gain since they enjoy the higher interest rate plus a lower tax τ_I on the return. Workers in the low to middle-income class also benefit from lower τ_I, but the decrease in the wage rate is more significant and dominates the sign of their CEVs. The biggest losers are the entrepreneurs with high ability θ, who used to borrow and invest their assets maximally in the benchmark. Their after-tax return from business is considerably reduced after the reform.

As we did in the capital income tax experiments, Fig. 11 compares the welfare results according to the ex ante criterion. If we ignore the transition costs and simply compare the two steady states, a lower tax on the business income will be preferred by a yet-to-be-born agent. However, once we explicitly take into account the costs associated with

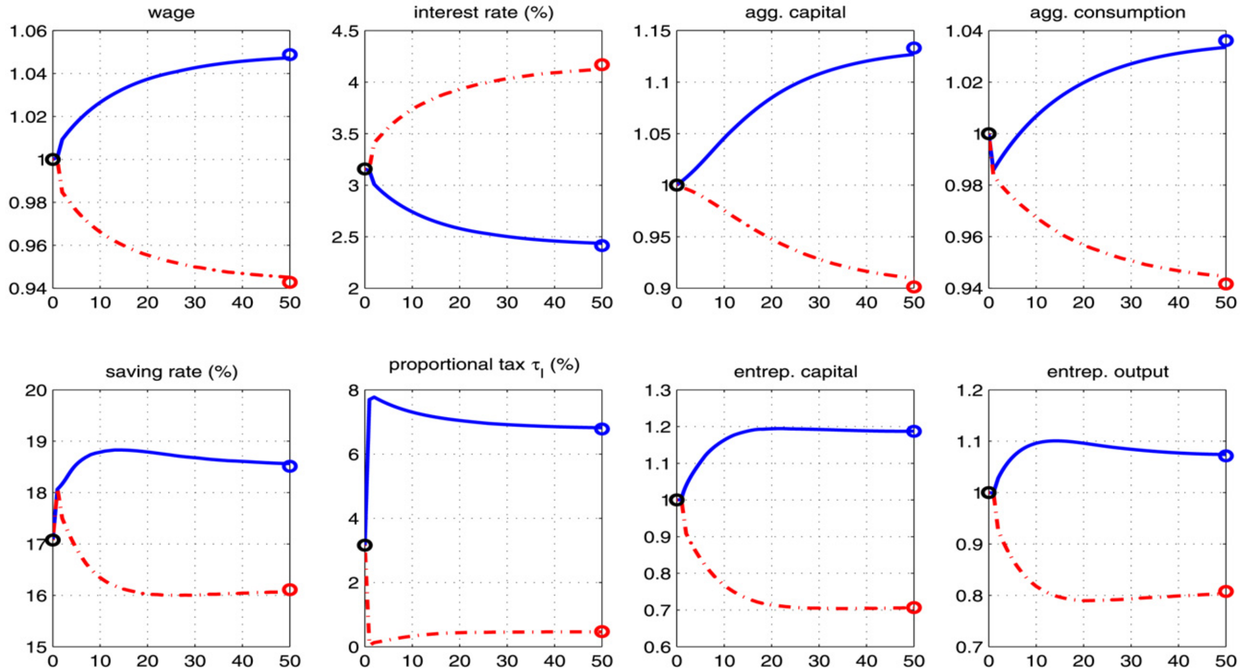
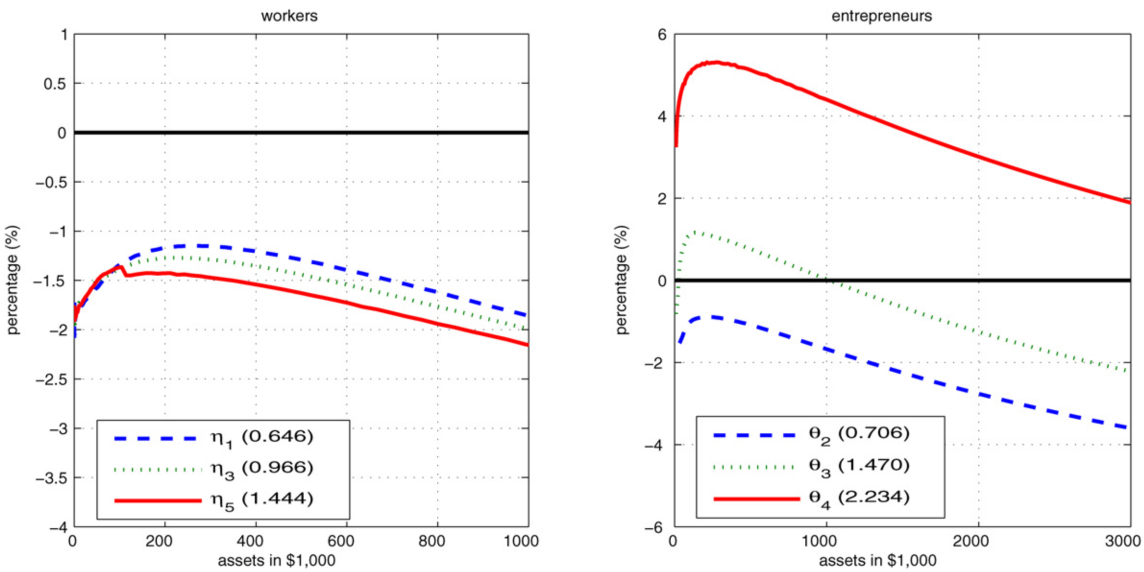
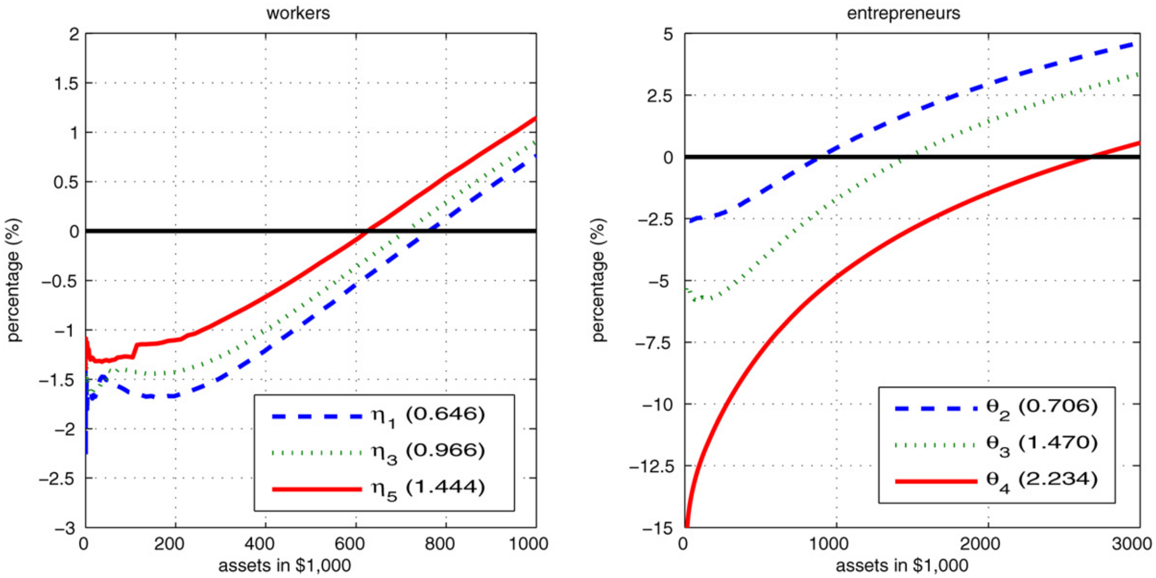


Fig. 9. Evolution of aggregate quantities: flat business income tax: On horizontal axes are the time periods (years) since the announcement of the reform. The solid lines represent the experiment of capital income tax $\tau_{E1} = 10\%$ and the dash-dot lines represent $\tau_{E1} = 40\%$. The circles in each plot in the first and the last periods indicate the levels in the initial and final steady states.



(a) Business tax $\tau_{E1} = 10\%$

Fig. 10. Consumption equivalent variation: flat tax on entrepreneurs' business income.



(b) Business tax $\tau_{E1} = 40\%$

Fig. 10. *continued*

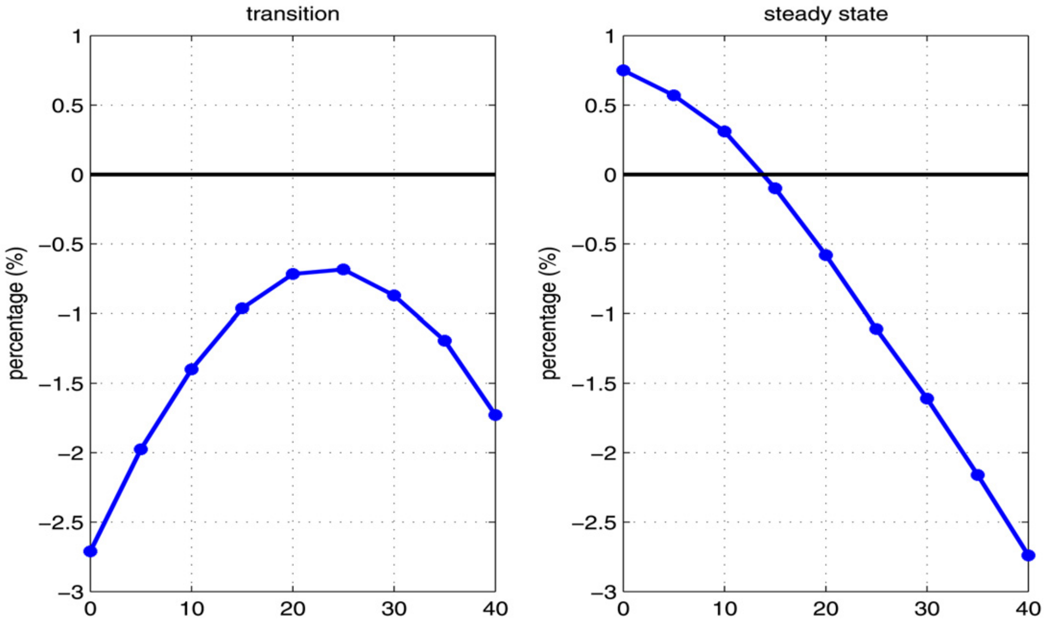


Fig. 11. Ex ante welfare comparison: transition and steady state: flat tax on entrepreneurs' business income: On horizontal axes are the flat tax rates on entrepreneurs' income τ_{E1} (%).

the transition, he will prefer the status quo. As we saw above, workers, that constitute the majority of the population, will suffer from the higher tax on non-business income and lower consumption during the transition. Eventually, the economy enjoys much higher output and wages, but they will come only gradually at the high cost of transition.

Such a reform will be very difficult to gain majority support unless some compensation is made, for example, by transferring some of the increased tax burden on workers to either entrepreneurs or to future generations. As shown in Table 9 when the policy of a 10% business tax is implemented, the CEV is positive for only 2.6% of workers, while 72% of entrepreneurs gain from such a policy. The other policy of a 40% business tax is supported by only a small fraction of the population at the top end of the wealth distribution.

Table 9
Fraction of households with welfare gains: flat tax on entrepreneurs' business income

Wealth (in $1000)	Workers		Entrepreneurs		All	
		(a) Entrepreneurial business tax $\tau_{E1} = 10\%$				
0–10	0.2	(0.9)	>0.0	(77.0)	0.3	(0.9)
10–50	0.3	(1.4)	0.7	(83.3)	1.0	(4.5)
50–100	0.8	(5.2)	1.2	(74.8)	2.0	(11.7)
100–250	0.6	(5.5)	2.2	(75.6)	2.9	(20.0)
250–500	0.3	(5.4)	1.6	(80.5)	1.8	(28.0)
500–1000	0.1	(2.3)	1.6	(81.4)	1.7	(28.3)
1000–2000	0.0	(0.0)	0.8	(54.3)	0.8	(19.4)
>2000	0.0	(0.0)	0.6	(46.6)	0.6	(19.7)
all	2.3	(2.6)	8.6	(72.3)	10.9	(10.9)
		(b) Entrepreneurial business tax $\tau_{E1} = 40\%$				
0–10	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
10–50	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
50–100	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
100–250	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
250–500	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
500–1000	2.0	(50.5)	0.0	(34.6)	2.0	(34.6)
1000–2000	2.5	(97.5)	0.4	(73.0)	3.0	(73.0)
>2000	1.6	(100.0)	1.0	(91.7)	2.6	(91.7)
all	6.1	(7.0)	1.4	(11.8)	7.5	(7.5)

In parentheses are the fractions of households with welfare gains conditional on their occupation and their wealth category.

6. Conclusion

We studied the effects of taxation on capital and business income in an economy where agents have access to a risky production technology by choosing to become an entrepreneur. Augmenting a Bewley model with the occupational heterogeneity introduced a set of additional channels through which fiscal policies affect economic activities.

We have shown that reducing the tax on capital income increases aggregate investment and output, but the reform can be much more effective when we target entrepreneurial investment. A low capital tax on riskless saving encourages capital accumulation and raises aggregate production, but entrepreneurial investments are reduced due to three general equilibrium effects. First, a higher wage pushes up the input cost of entrepreneurs' production since the sector is more labor intensive due to the capital market imperfections faced by entrepreneurs. Second, the higher after-tax return from saving increases the opportunity cost of business investment and more resources are pulled out of the business. Lastly, the government is required to raise a tax on other sources of income, including income from entrepreneurial businesses, which discourages investment in them. All of these channels are absent in a model without entrepreneurs and we have shown that the effect of a reform can be significantly overestimated in a model of only workers.

In the experiment of business income taxation, we showed that reducing the tax burden on entrepreneurs encourages their entry into business and effectively increases the investment by the most productive entrepreneurs. However, although the economy will enjoy a higher level of welfare in the long run, such a reform fails to achieve a plurality due to the costs associated with the transition.

We have demonstrated that the departure from a single-occupation model of incomplete markets provides interesting and possibly very important implications for the discussion of capital income tax policy. The tax incidences on entrepreneurs are very different from those on workers and can have significant effects on aggregate variables if the target of the policy is properly set. An interesting extension is to explore the possibility of a Pareto-improving fiscal reform by allowing for redistributive transfers, which I leave for future research.

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Appendix A. Computation algorithm

This appendix describes the solution algorithm to compute a stationary equilibrium of our model and the transition path between two steady states. The computation of the transition dynamics is similar to that in Conesa and Krueger (1999). Given the high non-linearity of our household problem, we solve for an equilibrium by iterating on value functions in a discretized state space. We allow agents to choose savings from the asset space of 3000 discrete points, and entrepreneurs to choose capital and labor from 1000 points respectively.

Computation of steady state

- **Step 1.** Guess a set of value functions for each state, fiscal policy and the capital–labor ratio and compute factor prices r and w.
- **Step 2.** Solve individual problems and derive policy functions for each state and a new set of value functions.
- **Step 3.** Given the transition rules derived in Step 2, compute an invariant distribution Φ.
- **Step 4.** Compute aggregate capital and labor using the invariant distribution derived in Step 3 and obtain a new capital–labor ratio. Check if the value functions and the capital–labor ratio are the same as before. If so, go to Step 5. If not, adjust them and go back to Step 2.
- **Step 5.** Compute the total tax revenue. Check if the government budget is balanced. If not, adjust the tax function and go back to Step 2.

Computation of transition path. Assume that the economy is in the initial steady state in period 0 and the new policy is announced and implemented in period 1. The economy makes a transition to reach the final steady state in period T. Choose T large enough so that the transition path is not affected by increasing T.

- **Step 1.** Guess the path of the capital–labor ratio and the fiscal policy and compute the path of factor prices r and w.
- **Step 2.** Use the value function of the final steady state for the period T and solve the households' problem backwards from period $T-1$.
- **Step 3.** Use the distribution of the initial steady state and the policy functions from Step 2 and compute the path of the distribution.
- **Step 4.** Compute the path of aggregate capital and labor using the distribution derived in Step 3. Obtain new capital–labor ratios and check if they are the same as before. Also compute the total tax revenue and check if the government budget balance is met in each period. If the conditions are not satisfied, adjust the capital–labor ratios and/or fiscal policy and go back to Step 2.

Appendix B. Markov processes for η and θ

The Markov process for the labor productivity η is given as follows:

$$\eta \text{ grid} = [\,0.646 \quad 0.798 \quad 0.966 \quad 1.169 \quad 1.444\,],$$

$$\text{transition matrix } P_\eta = \begin{bmatrix} 0.731 & 0.253 & 0.016 & 0.000 & 0.000 \\ 0.192 & 0.555 & 0.236 & 0.017 & 0.000 \\ 0.011 & 0.222 & 0.533 & 0.222 & 0.011 \\ 0.000 & 0.017 & 0.236 & 0.555 & 0.192 \\ 0.000 & 0.000 & 0.016 & 0.253 & 0.731 \end{bmatrix},$$

$$\text{stationary distribution} = [\,0.166 \quad 0.218 \quad 0.232 \quad 0.218 \quad 0.166\,].$$

The Markov process for the entrepreneurial ability θ is given as follows:

$$\theta \text{ grid} = [\,0.000 \quad 0.706 \quad 1.470 \quad 2.234\,],$$

$$\text{transition matrix } P_\theta = \begin{bmatrix} 0.780 & 0.220 & 0.000 & 0.000 \\ 0.430 & 0.420 & 0.150 & 0.000 \\ 0.000 & 0.430 & 0.420 & 0.150 \\ 0.000 & 0.000 & 0.220 & 0.780 \end{bmatrix},$$

$$\text{stationary distribution} = [\,0.554 \quad 0.283 \quad 0.099 \quad 0.064\,].$$

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