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Business risk, credit constraints, and corporate taxation ☆

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Abstract

This paper analyzes the effects of differential tax treatment of corporate and non-corporate income in the U.S. on capital accumulation, the allocation of resources across sectors, entrepreneurship, and the distribution of wealth. I develop an entrepreneurial choice model with two important frictions, financial constraints and uninsurable business risk, that is broadly consistent with empirical regularities on firm formation and dynamics. I then calibrate the model and use it to evaluate the quantitative effects of eliminating the corporate income tax. I find that when these two frictions are explicitly accounted for, removing the corporate income tax has different consequences than those suggested by the standard models of corporate taxation. First, the magnitudes of the effects of the tax reform on capital accumulation, aggregate output, entrepreneurship, and the allocation of capital are significantly reduced and the direction of these effects may even change for some plausible situations. Second, contrary to conventional wisdom, wealth concentration diminishes.

JEL classification: D31; E21; E62; H20

Keywords: Differential tax treatment; Corporate tax; Financial constraints; Business risk; Distribution

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1. Introduction

The corporate income tax has long been viewed as a distortionary tax since income from the corporate sector is taxed twice – first at the corporate level and then at the individual level – while capital and business income from the non-corporate sector is only taxed at the personal level. This differential taxation of corporate and non-corporate incomes discourages the use of capital in the corporate sector and provides incentives to undertake unincorporated entrepreneurial activity. Furthermore, the double taxation of corporate income might lead to a reduction in the overall rate of return on savings, thereby negatively impacting capital accumulation.[1] Standard models of corporate taxation have shown that the economic costs of these distortions are substantial (e.g., Gravelle and Kotlikoff, 1989, 1995; Jorgenson and Yun , 1990; Fullerton et al., 1981). For example, Gravelle and Kotlikoff (1989, 1995), in an entrepreneurial choice model, show that these costs are 10 times larger than what is obtained in Harberger (1962). Consequently, these studies suggest that eliminating the corporate income tax would have substantial aggregate and allocative effects.

This literature has, however, largely overlooked two key observations associated with entrepreneurs. First, entrepreneurs face financial constraints. Using panel data, Evans and Jovanovic (1989) analyze transitions to entrepreneurship and find that the coefficient on assets was positive and statistically significant, pointing to the presence of liquidity constraints.[2] Second, entrepreneurship is a risky venture. For instance, Borjas (2003) documents that the standard deviation of income is higher among entrepreneurs than among paid workers, suggesting that entrepreneurial risk is substantial.[3]

This paper shows that financial constraints and business risk are key in understanding the effects of corporate taxation.[4] Specifically, the consequences of eliminating the corporate income tax can be different from those suggested by standard models. First, the magnitudes of the effects of the tax reform on capital accumulation, aggregate output, entrepreneurial activity, and the allocation of capital are significantly reduced and these effects may even change direction for some plausible situations. Second, the wealth distribution becomes *less* concentrated. These findings suggest that allowing for financial constraints and business risk could change fundamentally the implications of the corporate income tax: under the circumstances considered in this paper, the removal of such a tax would lead to much smaller increases in capital accumulation and aggregate output than in standard modelling frameworks.

[1] Harberger (1962) is the first to study the effects of the corporate income tax. Gravelle (1994, Chapter 4) provides a comprehensive survey of the distortionary effects of corporate income taxation.

[2] See also Evans and Leighton (1989), Holtz-Eakin, Joulfaian, and Rosen (1994a, b), Gentry and Hubbard (2004), Quadrini (2000), and Cagetti and De Nardi (2006).

[3] See also Knight (1921), Gentry and Hubbard (2004), Quadrini (2000), and Moskowitz and Vissing-Jorgensen (2002).

[4] The importance of liquidity constraints and business risk has also been suggested by Gravelle and Kotlikoff (1995), but they do not account explicitly for these two features of entrepreneurship.

The framework used is a general equilibrium, overlapping generations model of occupational choice with financial constraints and uninsurable entrepreneurial risks.[5] Financial constraints are modeled as a borrowing limit and a financial intermediation cost when borrowing for business activity. During their working lives individuals choose whether to be workers and invest in financial assets, or to become entrepreneurs and operate in the non-corporate sector. Because of the financial constraints and the absence of insurance markets against business risk, this decision depends not only on abilities to manage a business, but also on personal wealth. Workers receive a non-stochastic labor income and are subject to double taxation on their savings. They can avoid the double taxation of their savings by undertaking entrepreneurial activity, as entrepreneurs are only subject to personal income tax. Becoming an entrepreneur, however, entails a more variable income and a higher propensity to save than being a worker. Entrepreneurs have a higher savings rate than workers because they save not only for retirement but also to start a business and to self-insure against idiosyncratic business risk.[6] These assumptions (uninsurable idiosyncratic business risk and financial constraints) lead to an endogenous distribution of wealth and give the model the ability to study how the repeal of the corporate income tax affects wealth inequality. This ability represents a key difference between the current paper and previous work, such as Gravelle and Kotlikoff (1989, 1995).

In the framework used here, eliminating the corporate income tax has two opposing effects on capital accumulation. First, the removal of the corporate income tax increases the after-tax return on savings and increases capital accumulation. This effect has traditionally been emphasized in studies that do not account for liquidity constraints and business risk. The second effect, which is the main focus of this paper, leads to a decrease in capital accumulation. The intuition behind this mechanism is as follows. The increase in the after-tax return on savings that arises from removing the corporate tax eliminates the incentive to become an entrepreneur to avoid the double taxation of corporate income. As a result, the number of entrepreneurs decreases and this can lead to a decrease in capital formation since entrepreneurs have higher marginal rates of saving than non-entrepreneurs. To quantify the net effect, I contrast the steady-state implications of eliminating corporate taxation in two distinct model economies: one in which entrepreneurs face financial constraints and uninsurable business risk, and the standard one in which these two characteristics of entrepreneurship are not taken into account.

I find that in the model economy with financial constraints and business risk, the elimination of the corporate income tax leads to increases in aggregate output and capital formation of only 1.3% and 6.9%, respectively, compared to the 9.2% and

[5] Evans and Leighton (1989) and Leung and Robinson (2001) provide evidence that life-cycle effects are important for explaining self-employment.

[6] Using the Panel Study of Income Dynamics (PSID), Quadrini (1999) finds a higher saving rate for entrepreneurs than for the rest of the population. A similar conclusion arises also from Gentry and Hubbard's (2004) analysis of the 1983–1989 panel of Survey of Consumer Finance (SCF).

22.5% increases in the same variables in the standard model. Moreover, the model economy with financial constraints and business risk experiences an increase of 7.9% in the fraction of total capital employed in the corporate sector and a decrease of 21.3% in the number of entrepreneurs, while in the standard model, the former increases by 51.1% and the latter decreases by 43.9%.[7] Further, for relatively high (but plausible) levels of risk aversion, the second effect actually dominates in the model economy with financial constraints and business risk so that removing the corporate tax results in a decrease in capital accumulation and output of 16.8% and 5.3%, respectively.

I also find that, contrary to conventional wisdom, eliminating the corporate income tax leads to a decrease in wealth inequality, as measured by the Gini index of the distribution of wealth, which falls by 0.029% points. Wealth inequality decreases chiefly because the disparity between the groups of entrepreneurs and non-entrepreneurs has been reduced. Removing the double taxation of corporate income substantially increases the after-tax returns on savings from 4.1% to 5.9%, and therefore leads to an increase in savings of (young) workers, which reduces the fraction of workers with zero assets. At the same time, the rise in savings increases capital accumulation and thus the pre-tax wage rate, which in turn reduces profits of entrepreneurs and entrepreneurial savings. The combination of these two effects narrows the gap between entrepreneurs and non-entrepreneurs.

This paper is related to the large literature studying the effects of taxation on entrepreneurial activity. Gentry and Hubbard (2000, Section 2, pp. 2–7) provide an excellent overview of tax policy and entrepreneurship.[8] None of the papers surveyed, however, addresses the importance of liquidity constraints and business risk. This paper is also related to the literature on the effects of capital taxation on capital formation and aggregate output (e.g., Summers, 1981; Auerbach and Kotlikoff, 1987; Lucas, 1990; Atkeson et al., 1999). Most of these models argue for the desirability of eliminating capital taxation. Aiyagari (1995), however, argues that in an incomplete market economy a positive capital income tax is desirable because of the over-accumulation of capital.[9] Most of these papers on capital income taxation neither do account explicitly for the corporate income tax, nor for occupational choices. Meh (2005) shows the quantitative importance of entrepreneurship when examining tax policy.

The rest of the paper is organized as follows. Section 2 briefly discusses empirical evidence regarding liquidity constraints and business risk. Section 3 describes the model. Section 4 presents the calibration procedure. Section 5 describes the results. Section 6 shows the importance of liquidity constraints and business risk in examining the corporate income tax. Section 7 presents some sensitivity analysis and Section 8 summarizes the paper and presents the main conclusions.

[7]The increase in the fraction of capital used in the corporate sector is consistent with Gravelle and Kotlikoff (1989, 1995), Harberger (1962), and U.S. Department of the Treasury (1992), among others.

[8]See also Cullen and Gordon (2006) who explore the degree to which the tax system affects the amount of entrepreneurial activity, both theoretically and empirically.

[9]İmrohoroğlu (1998) also shows that in an incomplete markets setting the capital income tax that maximizes the steady-state welfare is positive.

2. Related literature: evidence on liquidity constraints and business risk

In this section, I briefly present evidence on liquidity constraints and business risk. Many economists have extensively argued that liquidity constraints play an important role in business formation. Evans and Jovanovic (1989), Evans and Leighton (1989), Holtz-Eakin et al. (1994a, b), Quadrini (1999), and Gentry and Hubbard (2004) investigate the link between entry into entrepreneurship and net worth. They find that there is a positive correlation between an individual's personal wealth and the probability that an individual becomes an entrepreneur. For example, using the National Longitudinal Survey of Young Men, Evans and Jovanovic (1989) estimate a structural model and find that entrepreneurs can only borrow up to 50% of their personal net worth. Ando (1985) finds that most new businesses are likely to face severe borrowing constraints and that personal savings and loans from relatives play a critical role in business formation. Ham and Melnik (1987) provide empirical evidence of liquidity constraints even for some relatively large firms. They report that most credit agreements place an upper limit on borrowing and that about 20% of the firms in their sample reached this limit. These findings suggest that new businesses are liquidity constrained and that the amount of capital available to them is limited by business owners' personal wealth.

Several papers also document that rewards to entrepreneurial activities are more variable than returns to working for someone else and investing in financial assets. Knight (1921) argues that to bear risk is a crucial feature of entrepreneurship. Recent studies also present evidence that business ownership is risky.[10] Holtz-Eakin et al. (2000) find that households entering self-employment experience more upward and downward mobility in the income distribution than households that continue to work for someone else. Borjas (2003) reports that the standard deviation of log weekly income is higher among the self-employed than among paid workers. Gentry and Hubbard (2000) and Quadrini (1999) show that new entrepreneurs and continuing entrepreneurs experience more mobility in terms of the distribution of wealth, income, and the ratio of wealth to income. Moskowitz and Vissing-Jorgensen (2002) document that a standard deviation of annual return of 50% or even more is not unreasonable for small firms. This evidence suggests that entrepreneurship entails more variable payoffs than continuing to work for someone else.

The need to accumulate assets to overcome financial constraints and to self-insure against idiosyncratic uninsurable business risks can also lead to high savings among entrepreneurial households. Using 1983–1989 panel data from the Federal Reserve Board Surveys of Consumer Finance, Gentry and Hubbard (2004) show that entrepreneurs have a higher savings rate than non-entrepreneurs. A similar conclusion arises also from Quadrini's (1999) analysis of the PSID.

3. Model economy

The model economy builds on work by Gravelle and Kotlikoff (1989, 1995), Li (2002), and Erosa (2001). Its key features are as follows: (i) the model economy is

[10] See Gentry and Hubbard (2004, Section 2) for a review of the literature.

populated by a continuum of heterogeneous agents; (ii) at the end of each period, agents choose whether to be entrepreneurs or to work for someone else and invest in financial assets in the next period; (iii) entrepreneurs face uninsurable idiosyncratic technology shocks that cause fluctuations in their business income, whereas workers earn non-stochastic labor income – this assumption captures in a simple way the empirical evidence that business income is more volatile than labor income; (iv) agents cannot borrow for consumption; (v) within a period, entrepreneurs can borrow capital to finance their business, but borrowing is subject to a natural borrowing limit and a financial intermediation cost, and the amount of capital that they rent cannot be diverted to other purposes; and (vi) there is a single good which is produced by both corporate and non-corporate sectors.

3.1. Preferences and occupation

3.1.1. Preferences

The model economy is populated by overlapping generations of individuals who live for J periods. The population as well as the size of each cohort is assumed to be constant. Each individual of age j maximizes their expected discounted lifetime utility:

$$\mathrm{E}\left\{\sum_{j=1}^{J}\beta^{j-1}\left(\frac{c_j^{1-\sigma}}{1-\sigma}\right)\right\}, \tag{1}$$

where β is the intertemporal discount factor, σ is the coefficient of relative risk aversion, and c_j is the non-negative consumption at age j.

3.1.2. Endowment and occupation

In each period, age-j individuals are endowed with ε_j units of labor efficiency. This endowment of labor efficiency is the same within a cohort, but it varies between cohorts. At the mandatory age of retirement, R, and thereafter, the endowment of efficiency units of labor is zero.[11] Individuals of age below $R-2$ decide between two occupations in the next period: wage work or entrepreneurship. Whereas workers supply their efficiency units of labor inelastically to the market in return for the common fixed wage rate, w, entrepreneurs use their entire labor efficiency to manage a single firm and receive the (stochastic) rents from operating that business. When the agent chooses the next period's occupation, they must stay with that occupation for at least one period. I also assume that newly born agents are workers who have no initial stock of assets.[12]

3.1.3. Information

At the beginning of each period, each entrepreneur is associated with a productivity shock, z, from a finite set, $\mathscr{Z}=\{z^1,\ldots,z^{N_z}\}$. The shock, z, captures

[11] This implies that agents are allowed to work or to run a business only up to age $R-1$ (inclusive). All agents are endowed with one unit of time every period that is transformed into efficiency units of labor.

[12] As we will see below, newly born agents differ only in the entrepreneurial abilities they receive at the beginning of the period.

the ability to manage or organize a business. The idiosyncratic shock faced by entrepreneurs follows a finite-state first-order Markov process, with conditional transition probabilities given by[13]

$$\Psi(z', z) = \Pr(z_{t+1} = z' \mid z_t = z), \tag{2}$$

where $z', z \in \mathscr{Z}$. The transition probability is increasing in z, in the sense of first-order stochastic dominance.

Each worker is also associated with an *imperfect* signal about the next period's business quality in the event that the worker decides to become a business owner. This signal can also be interpreted as indicative of the comparative advantage of a worker in undertaking an entrepreneurial activity. With a slight abuse of notation, I denote this signal by $z \in \mathscr{Z}$. The worker draws z from the cumulative distribution function, $H(z)$, with a probability density function, $h(z)$.

Notice that the shock, z, observed by a worker does not affect his/her current income.[14] In contrast, z observed by entrepreneurs affects their entrepreneurial income. Furthermore, fluctuations in entrepreneurs' incomes caused by z are not insurable, because idiosyncratic technology shocks are not verifiable by a third party. Finally, the shock, z, is independently and identically distributed among entrepreneurs and workers. This distributional assumption, combined with the large number of individuals in the model economy, ensures that there is no aggregate uncertainty.

3.2. Production sectors

Following Gravelle and Kotlikoff (1989, 1995) and Quadrini (2000), I assume that corporate and non-corporate firms coexist while producing the same single good.[15] For such a coexistence to occur, some advantages and disadvantages must exist for each organizational form. Corporations are assumed to rely on large amounts of capital raised from equity markets, but they are subject to the corporate tax. Non-corporate organizations are small, better able to encourage entrepreneurial skills, and primarily reliant on personal wealth to operate, but they face greater difficulties in insuring and diversifying entrepreneurial risk.[16] The above assumptions are consistent with the work of Fazzari et al. (1988) and Gertler and Gilchrist (1994).

[13] All variables denoted by prime (′) refer to next period variables.

[14] The shock, z, received by workers affects savings and future occupation decisions. Therefore (everything else being equal), a high z received by workers today will make them save more to become entrepreneurs tomorrow.

[15] Harberger (1962, 1966) and extensions of his model do not allow corporations and non-corporate firms to produce identical goods, and thus ignore the within-industry substitution that may arise between corporate and non-corporate production of the same commodity. Consequently, Ebrill and Hartman (1982) point out that the Harberger model is based on tax differentials across industries, while the corporate tax is based on the legal form of organization. Empirical evidence provided by Gravelle and Kotlikoff (1989, 1995) suggests that corporations coexist with non-corporate firms in every two-digit industry and in most of the three-digit ones.

[16] In contrast to Quadrini (2000), Gravelle and Kotlikoff (1989, 1995) do not allow for liquidity constraints and entrepreneurial risks. Quadrini (2000), however, does not study the effects of the corporate

3.2.1. Corporate sector

Corporate output is produced by a constant-returns-to-scale Cobb Douglas production function,

$$F(K_c, N_c) = K_c^{\theta} N_c^{1-\theta}, \tag{3}$$

where K_c and N_c are capital and labor efficiency inputs, respectively, and θ denotes the corporate capital income share. Capital used in the corporate sector is assumed to depreciate geometrically at a rate of δ.

3.2.2. Non-corporate sector

The non-corporate sector consists of a set of small firms run by entrepreneurs who finance their businesses either using their own funds or by borrowing from financial institutions. Each small firm (proprietorship) consists of a single entrepreneur with an uninsurable idiosyncratic technology shock, z, k homogeneous units of capital, and n efficiency units of labor. As stated earlier, the technological shock, z, is observed at the beginning of each period and is independently and identically distributed among entrepreneurs according to a finite-state Markov process with a transition probability function, $\Psi(z, z')$. The output per entrepreneur is given by a decreasing-returns-to-scale production function:

$$f(z, k, n) = zB(k^{\theta} n^{1-\theta})^{v}, \tag{4}$$

where $0 < v < 1$ determines the degree of returns to scale and B is a scalar. Note that $1 - v$ represents the share of output retained as rents by entrepreneurs.[17] Production in the non-corporate sector is the aggregation of production by all entrepreneurs. Capital used in the non-corporate sector depreciates at the same rate as corporate capital.

3.3. Financial institutions

In this model economy, all borrowing and lending is intermediated. The number of financial institutions (hereafter called capital mutual funds) is large, and these financial intermediaries make zero profits.

In the model, individuals can save by holding corporate capital equity, k_c, by making deposits at financial institutions, d, or by financing their business with their own funds, k_s, if they are entrepreneurs. In equilibrium, the rates of return on corporate equities and deposits at financial intermediaries should be the same (before or after the imposition of the corporate tax), because both assets are risk-free and neither provides an extra service. Hence, there are no arbitrage opportunities, which means that, in terms of the composition of their asset portfolios, individuals are indifferent between corporate capital equity and deposits at financial intermediaries.

(*footnote continued*)
tax. He investigates the importance of business ownership in explaining the high concentration of wealth in the U.S. economy.

[17] In other words, v is the share of output that goes to non-entrepreneurial inputs, such as capital and labor.

Consequently, I can define the sum of an individual's deposits at financial institutions and corporate capital equity as the amount of net asset holdings, a.

Intermediaries collect deposits from households with positive balances (by paying the interest rate, r_d) and lend those funds to other households and the corporate sector. While there is a positive proportional cost, ϕ, 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 $r_l = r_d + \phi$ for loans to the household sector.[18]

In this paper, loans are provided only for entrepreneurship. I assume that entrepreneurs cannot use the funds borrowed from intermediaries for purposes other than business investments. I also assume that there is no intertemporal borrowing, that is, *capital markets are incomplete*, and therefore, individuals have to save to self-insure against uninsurable idiosyncratic business risk ($a' \geqslant 0$).

When making intraperiod loans to entrepreneurs, financial intermediaries adopt a lending strategy so that entrepreneurs can always pay back their loan. When borrowing ($k - a > 0$) from financial intermediaries where k is the size of the business, entrepreneurs are subject to the following constraint:

$$(1 + r_l)(k - a) \leqslant (1 - \delta)k. \tag{5}$$

Eq. (5) shows that principal and interest payments must be less than or equal to the undepreciated part of capital, $(1 - \delta)k$.

After rearranging Eq. (5), the above constraint becomes

$$k \leqslant \Delta a, \tag{6}$$

where $\Delta = \left(\frac{1+r_d+\phi}{r_d+\phi+\delta}\right) > 1$. Eq. (6) shows that in a given period, the maximum amount of capital entrepreneurs can invest in their own business is equal to Δa. This is consistent with Evans and Jovanovic (1989), who document that entrepreneurs are financially constrained and can only borrow up to a fraction of their initial assets.[19] Furthermore, entrepreneurs cannot default on their loan (this assumption does not appear to be unreasonable, because most loans are collateralized in practice).

3.4. Government

The government is assumed to levy proportional taxes on individuals' incomes at a rate of τ_i, and on capital used by the corporate sector at a rate of τ_c. Tax revenues are in turn used to finance government consumption, G. Agents' incomes subject to

[18] Since corporations and capital mutual funds behave competitively, it is straightforward to show that the interest rate, $r_d = (1 - \tau_c)[F_K(K_c, N_c) - \delta]$, where τ_c is the corporate tax and $F_K(K_c, N_c)$ is the marginal product of corporate capital.

[19] Ando (1985) presents evidence showing the existence of liquidity constraints on small firms: 'Several conclusions emerge from these studies. One is the critical role of personal savings and loans from friends and relatives, particularly in business formation. It is by far the largest source of capital for new firms and for firms beginning to grow. Once the firm is established, the role of personal savings diminishes as institutional investors perceive less risk and become more willing to provide capital.'

taxation are the sum of wage, capital, and/or entrepreneurial income (the taxable entrepreneurial income will be more clear in the entrepreneur's budget constraint). The opportunity cost of an entrepreneur's own capital invested in the business is not fully tax deductible; however, the depreciation is. Although corporate capital is subject to corporate and personal income taxes, the capital that entrepreneurs invest in their own businesses, as well as their borrowed capital, is subject to personal income tax only. The government operates under a balanced budget.

3.5. Timing of events

The timing of events during a period is as follows, and is identical across all periods.
Beginning of period:

- Individuals (workers and entrepreneurs) observe the current shock, z;
- after observing the productivity shock, z, entrepreneurs rent capital, k, hire labor efficiency units, n, and then produce;
- workers and entrepreneurs make consumption and saving decisions;
- workers and entrepreneurs make the next period's occupation decisions.

End of period: Individuals of age 1 are born as workers. Age-j individuals below the mandatory age of retirement observe their current shocks, z. In particular, age-j workers below $R-1$ receive an imperfect signal about their entrepreneurial ability, and entrepreneurs of age j below R observe an idiosyncratic productivity shock.[20] Once the information is revealed, entrepreneurs decide how much of their own funds to invest in their own businesses, how much capital to borrow from financial institutions, and how many units of labor efficiency to hire. Production in the corporate and non-corporate sectors then takes place, and the corporate tax rate, τ_c, is paid by the corporate sector. At the end of the period, factor payments are made and entrepreneurs receive an entrepreneurial income. Entrepreneurial income is the residual of output after payments of wages, interest on capital borrowed from financial intermediaries, and depreciation. Consumers then pay taxes, τ_i, on their income and consume. Once the savings decision is made, individuals choose their next period's occupation. This choice of occupation depends on age-j savings and the current realization of the technological shock. The risk from entrepreneurial activities comes from the fact that the decision on the next period's occupation is made currently without knowing the realization of the next period's productivity shock and from the fact that after observing the shock the agent cannot go back to being a worker next period.

3.5.1. The income of entrepreneurs and workers

Before describing the household's problem it is useful to define the (gross) incomes of workers and entrepreneurs of age-j as a function of their net worth, a, and the

[20] At age $R-1$, workers do not receive any signal, since at age R they will be retired. Entrepreneurs, by contrast, still receive the productivity shocks at age $R-1$.

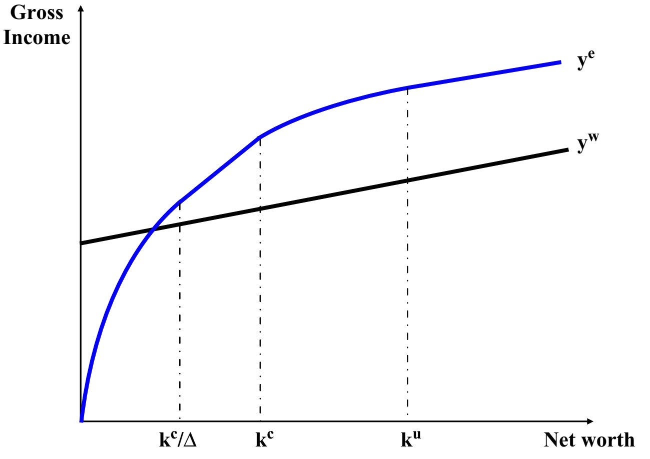

Fig. 1. Entrepreneurial and workers' income as a function of personal net worth.

current technological shock, z.[21] The gross income of workers, $y^w(z,a,j)$, is defined as follows:

$$y^w(z,a,j) = w\varepsilon_j + (1 + (1 - \tau_i)r_d)a. \tag{7}$$

Workers' income, $y^w(z,a,j)$, is depicted in Fig. 1.

The gross income of an entrepreneur is denoted by $y^e(z,a,j)$. Recall that an entrepreneur observes the technology shock *before* choosing capital and labor inputs (there is no adjustment cost in capital and labor inputs). As a result, those inputs are chosen by solving an intratemporal profit maximization problem. Given z and a, the entrepreneurial income net of tax of an age-j entrepreneur is given by the following expression:

$$\begin{aligned} y^e(z,a,j) = (1 + r_d)\max\{a-k,0\} + f(z,k,n) - wn - (1 + r_d + \phi) \\ \times\max\{k-a,0\} + (1-\delta)k - \tau_i[r_d\max\{a-k,0\} + f(z,k,n) \\ - wn - (r_d + \phi)\max\{k-a,0\} - \delta k]. \end{aligned} \tag{8}$$

The first term in expression (8) is the return on the entrepreneur's deposits, $\max\{a-k,0\}$, at financial intermediaries.[22] The second term is the residual output after factor payments plus the non-depreciated part of the entrepreneur's capital invested in the firm, $(1-\delta)k$. The tax paid on entrepreneurial income (return on deposits and business income) is the third term. As noted earlier, the government deducts the depreciation of δk and the interest payment $(r_d + \phi)\max\{k-a,0\}$.

[21] For simplicity, the model abstracts from social security and this would provide agents with incentives to save more since their only source of income is from accumulated assets.

[22] It is implicitly assumed that when an entrepreneur invests capital in their business, they cannot take out the capital invested within that period. As a result, the amount of capital an entrepreneur has at the capital mutual fund is $\max\{a-k,0\}$.

After rearranging expression (8), the entrepreneur's net income becomes

$$y^{e}(z,a,j) = (1+(1-\tau_i)r_{d})a + (1-\tau_i)[f(z,k,n) - wn - (r_{d}+\delta)k - \phi\max\{k-a,0\}]. \tag{9}$$

Define $\pi(z,a)$ as the adjusted entrepreneurial profit for given z and a.[23] The entrepreneur chooses k and n to maximize their net income (which is equivalent to maximizing the adjusted business income) by taking w, r_{d}, z, and a as given. The adjusted profit maximization problem is as follows:

$$\pi(z,a) = \max_{k,n}\{f(z,k,n) - wn - (r_{d}+\delta)k - \phi\max\{0,k-a\}\}$$
$$\text{s.t}$$
$$k \leqslant \Delta a. \tag{10}$$

It is useful to define, when constraint (6) is not binding, the optimal capital input, k^{u}, for an interest rate r_{d}, and the optimal capital, k^{c}, for an interest rate, $r_{l} = r_{d} + \phi$. They are given by the following equations from the first-order conditions:

$$k^{u}(z) = \left[\frac{zBv\theta\left(\dfrac{(r_{d}+\delta)(v-v\theta)}{w\theta v}\right)^{v-v\theta}}{r_{d}+\delta}\right]^{1/(1-v)}, \tag{11}$$

$$k^{c}(z) = \left[\frac{zBv\theta\left(\dfrac{(r_{d}+\phi+\delta)(v-v\theta)}{w\theta v}\right)^{v-v\theta}}{r_{d}+\phi+\delta}\right]^{1/(1-v)}. \tag{12}$$

The expressions of k^{c} and k^{u} are similar except in the intermediation cost, ϕ. Because of this cost the business size k^{c} is smaller than the optimal business size under the risk-free rate, r_{d}.

Thus, the decision rules for capital and labor inputs are given, respectively, by[24]

$$k(z,a) = \begin{cases} k^{c}(z) & \text{if } a \leqslant k^{c}(z) \leqslant \Delta a, \\ a & \text{if } k^{c}(z) < a < k^{u}(z), \\ k^{u}(z) & \text{if } a \geqslant k^{u}(z), \\ \Delta a & \text{if } k^{c}(z) > \Delta a, \end{cases} \tag{13}$$

[23]The adjusted profit takes into account all the tax treatments of proprietorships by the government.

[24]Notice that $k(z,a)$ and $n(z,a)$ also depend on age j.

$$n(z,a) = \left[\frac{(v - v\theta)zBk(z,a)^{v\theta}}{w}\right]^{1/1-(v-v\theta)}. \tag{14}$$

Notice that the optimal sizes of the business, $k^{\mathrm{u}}(z)$ and $k^{\mathrm{c}}(z)$, are an increasing function of the productivity shock, z. This implies that the higher is z, the higher is the likelihood that entrepreneurs are financially constrained.

Fig. 1 reports the gross income of entrepreneurs and workers as a function of net worth. There are four distinct regions of net worth according to how entrepreneurs's income vary with an extra unit of net worth (see also Erosa, 2001 for a similar graph but without the borrowing limit). In the first region ($a < \frac{k^{\mathrm{c}}(z)}{\Delta}$), the net worth is so small that the borrowing limit binds and therefore they make the maximum investment for a given net worth. A one-unit increase in net worth implies an increase in the income of entrepreneurs by the slope of $y^{\mathrm{e}}(z,a)$. When the borrowing limit is binding, the change in entrepreneurs' gross income associated with an increase in wealth is linked to the marginal productivity of capital in their businesses. In the second region ($\frac{k^{\mathrm{c}}(z)}{\Delta} \leqslant a < k^{\mathrm{c}}(z)$), the net worth is not too low and therefore the borrowing limit is not binding. In this case, one unit increase entrepreneurial savings decreases the use of external financing and entrepreneurial income goes up by the interest rate on loan, that is, the marginal product of capital is equal to the loan rate. In the third region ($k^{\mathrm{c}}(z) < a < k^{\mathrm{u}}(z)$), entrepreneurial net worth is sufficient to self-finance the business. It is, however, low enough that entrepreneurs use all their wealth to operate their business. In the fourth region ($a \geqslant k^{\mathrm{u}}(z)$), entrepreneurial net worth is sufficiently high that it is optimal for entrepreneurs to fully finance their businesses and invest any additional wealth as bank deposits. In this situation, the marginal productivity of capital is equal to the interest rate on deposits and income varies according to the interest rate on deposits.

3.6. The individual's decision problem

In this paper, I consider only stationary equilibria in which the distribution of agents over individual states is constant and prices do not change over time. At the beginning of each period, the state of an agent in the model includes the current occupation; the net amount of asset holdings, a; the technology shock, z, observed at the beginning of the period; and the age, j.

To simplify the description of the model, define $V^{\mathrm{w}}(z,a,j)$ to be the value function of an age-j worker whose current period entrepreneurial ability is z and beginning-of-period net asset holdings are a. Similarly, define $V^{\mathrm{e}}(z,a,j)$ as the value function of an age-j entrepreneur whose beginning-of-period productivity shock is z and net asset holdings are a. Notice that, at age R and thereafter, for a given age, j, the value functions $V^{\mathrm{w}}(z,a,j)$ and $V^{\mathrm{e}}(z,a,j)$ are identical for every $z \in \mathscr{Z}$. Therefore, I assume that a retired person is a worker (with zero labor efficiency). The household's decision is described in recursive language in which, after the terminal period, J, the value function is set to zero: $V^{\mathrm{w}}(z,a,J+1) \equiv 0$.

3.6.1. The entrepreneur's problem

An age-j entrepreneur's problem is described below in a dynamic programming language:

$$V^{\mathrm{e}}(z,a,j) = \max_{\{a',e'\}}\left\{u(c)+\beta\max\left\{\sum_{z'\in\mathscr{Z}} h(z')V^{\mathrm{w}}(z',a',j+1),\right.\right.$$
$$\left.\left.\times\sum_{z'\in\mathscr{Z}}\Psi(z',z)V^{\mathrm{e}}(z',a',j+1)\right\}\right\} \tag{15}$$

subject to

$$c=(1+(1-\tau_i)r_{\mathrm{d}})a+(1-\tau_i)\pi(z,a)-a', \tag{16}$$

$$e'\in\{W,E\}, \tag{17}$$

$$a',c\geqslant 0. \tag{18}$$

Entrepreneurs choose a non-negative amount of consumption, c, and the next period's risk-free asset holdings, a', which is restricted to be non-negative. The non-negativity constraint on a' implies that there is no intertemporal borrowing; consequently, people's assets must be positive to finance their consumption during retirement and to take advantage of entrepreneurial opportunities. Since the lowest rent on operating a business is almost zero, the non-negativity constraint on the asset holdings is equivalent to financial intermediaries lending funds to entrepreneurs for consumption, such that the latter are always able to repay their debts in the following period.[25] In addition, entrepreneurs choose the next period's occupation, e', which takes the value of E if the worker decides to be an entrepreneur, and W otherwise. The expected value of continuing to be an entrepreneur for an age-j entrepreneur in the next period (at age $j+1\leqslant R$), conditional on the beginning of the next period's asset holdings, a', and current technology shock, z, is given by $\sum_{z'\in\mathscr{Z}}\Psi(z',z)V^{\mathrm{e}}(z',a',j+1)$; the expected value of an age-j entrepreneur becoming a worker in the next period (at age $j+1$), conditional on the beginning of the next period's asset holdings, a', is $\sum_{z'\in\mathscr{Z}}h(z')V^{\mathrm{w}}(z',a',j+1)$. If the expected value of continuing to be an entrepreneur in the next period is greater than or equal to the expected value of becoming a worker, then e' is E; otherwise, it equals W. The function, π, in the budget constraint is the net of tax business profit defined in Eq. (10). Recall that π accounts for the fact that an entrepreneur's personal net worth invested in the business is not subject to double taxation.

[25]The lowest entrepreneurial income is obtained when the entrepreneur receives the lowest value of technological shock.

3.6.2. The worker's problem

An age-j worker's (or retired individual's) problem is described recursively under the conditions that, after the terminal period, J, the value function is set to zero, $V^{\mathrm{w}}(z, a, J+1) \equiv 0$.

$$V^{\mathrm{w}}(z,a,j) = \max_{\{a',e'\}}\left\{u(c) + \beta \max\left\{\sum_{z' \in \mathscr{Z}} h(z')V^{\mathrm{w}}(z',a',j+1), \right.\right.$$
$$\left.\left. \times \sum_{z' \in \mathscr{Z}} \Psi(z',z)V^{\mathrm{e}}(z',a',j+1)\right\}\right\} \tag{19}$$

subject to

$$c = (1-\tau_i)w\varepsilon(j) + (1 + (1-\tau_i)r_{\mathrm{d}})a - a',$$
$$e' \in \{W, E\},$$
$$c, a' \geqslant 0. \tag{20}$$

Workers and retired agents choose a non-negative consumption, c, and the next period's risk-free asset holdings, a', which is restricted to be non-negative. Workers also choose the next period's $(j+1 \geqslant R)$ occupation, e'. At any point in time, a worker's resources come from the return on the asset holdings, a, and labor efficiency endowment, ε_j. Asset holdings pay an after-corporate-tax risk-free rate of interest, r_{d}, and labor receives a real wage, w. Labor income and return to capital are taxed at a rate of τ_i. For simplicity, the model abstracts from social security and therefore the only source of income for retired individuals is the after-tax return on accumulated wealth. Accumulated assets being the sole source of retirement income provide an extra incentive to save. Appendix A defines a steady-state equilibrium.

3.7. Entrepreneurial choices and the corporate tax: an illustration

Before moving to the calibration and the policy experiment, this section illustrates the relationship between the corporate tax and the individual's entrepreneurial decisions. To do so I consider first the worker's problem defined in (19). Given the assumptions made above, it can be shown by using standard dynamic programming techniques in Stokey et al. (1989) that $V^{\mathrm{w}}(z,a,j)$ is increasing in a, and $V^{\mathrm{e}}(z,a,j)$ is increasing in a and z. The expected value, $\sum_{z' \in \mathscr{Z}} h(z')V^{\mathrm{w}}(z',a',j+1)$, of an age-$j$ individual continuing to be a worker in the next period, conditional on the beginning of the next period's asset holdings, a', is independent of the current entrepreneurial ability, z, while the expected value of becoming an entrepreneur, $\sum_{z' \in \mathscr{Z}} \Psi(z',z)V^{\mathrm{e}}(z',a',j+1)$, conditional on current z, and next period asset holdings, a', is increasing in z. The expected value of becoming an entrepreneur and the expected value of staying a worker are the upward sloping curve and the horizontal curve in Fig. 2, respectively. If z takes its lowest realization, (say zero), the value of becoming an entrepreneur is lower than the value of staying a worker, since entrepreneurial profit will be very low. This implies that if the two curves

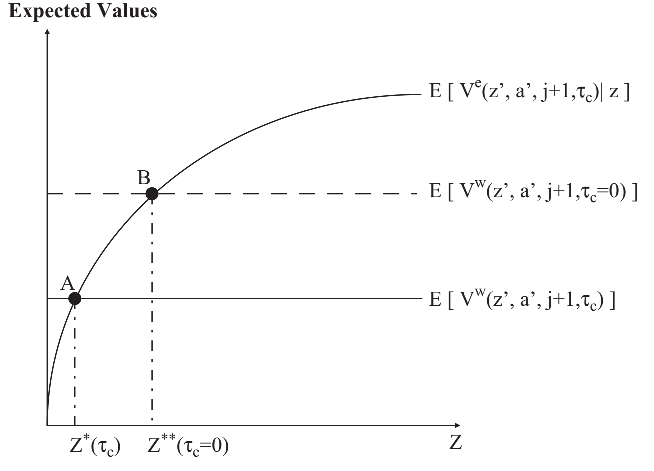

Fig. 2. Entrepreneurial choices and corporate tax.

intersect, it will be from below, and therefore there is a critical level of entrepreneurial ability for each level of the next period asset holdings, $z^*(a',j;\tau_c)$, where the agent is indifferent between the two occupations. If the individual's entrepreneurial ability is above this critical level he or she will become an entrepreneur, otherwise he or she will stay a worker. Note that since savings a' is an increasing function of current asset holdings, a, the cutoff level can be written as, $z^*(a,j;\tau_c)$.

How does the corporate income tax affect this cutoff? To answer this question, let us show how the two curves in Fig. 2 move when the corporate tax is eliminated. Everything else being the same, the expected value of staying a worker increases (since double taxation is eliminated) and the solid horizontal line shifts up to the dashed line; the expected value of becoming an entrepreneur meanwhile does not change, the upward sloping curve does not move. This results in an increase in the cutoff from $z^*(a,j)$ to $z^{**}(a,j)$. This implies that the minimum level of entrepreneurial ability is decreasing in the corporate tax.[26] As the corporate tax increases, individuals with low levels of entrepreneurial ability will undertake entrepreneurial activity in order to avoid the double taxation of the return on savings.

Similar arguments will be applied to the entrepreneur's (15), so that there is also a minimum level of productivity $z^*(a,j)$ which is a decreasing function of the corporate tax rate.[27]

[26]This qualitative result is consistent with Gravelle and Kotlikoff (1989, 1995).

[27]Because of liquidity constraints, uninsurable business risk and the fact that individuals are born with zero assets, there is also a cutoff in $j^* < 1$, so that entrepreneurship is not an option for young individuals who have very low level assets. For the same reasons and because entrepreneurial incomes are more volatile than workers' (fixed) incomes within a given cohort, there exists a minimum level of wealth required to undertake an entrepreneurial activity.

4. Calibration

To obtain numerical solutions and conduct policy analysis, I need to choose particular values for the parameters of the model economy. I calibrate the model economy to the U.S. economy. In particular, corporate income is taxed twice: once at the corporate level and once at the individual level. The benchmark economy is characterized by the double taxation of corporate income, the entrepreneur's credit constraints, and entrepreneurial risks. The model is calibrated under the assumption that a period is one year. Given the complex nature of the model, analytical solutions cannot be obtained. Appendix B describes the method used to compute stationary equilibria.

4.1. Preferences

The discount factor, β, is set endogenously such that, in equilibrium, the annual after-tax interest rate is 0.04.[28] The relative risk aversion parameter, σ, is set 2.0. This number is in the range of estimates suggested by Auerbach and Kotlikoff (1987) and Prescott (1986). As part of a sensitivity analysis, I also use a higher value of 4.0 for σ.

4.2. Demographic structure

Individuals are born at a real-time age of 21 (model period 1) and they can live a maximum of $J = 55$ years; that is, to a real-time age of 76 years. Agents retire at a real-life age of 65 years (model period $R = 46$).

4.3. Labor abilities

The efficiency units of labor are intended to provide a realistic cross-sectional age distribution of earnings at a point in time. Following Cubeddu (1996), I compile these labor efficiency units using the Current Population Survey (CPS) March demographic file for 1989. The sample includes private sector employees between the ages of 21 and 65 who are not working in the agricultural sector. For each age, I compute per annum mean labor earnings and mean hours worked. Mean wages are calculated by simply dividing mean earnings by mean hours worked. The endowment of efficiency units is determined by dividing the average wage for each age by the average wage of the full sample. Table 1 lists the results of this computation.

4.4. Tax system

A fundamental feature of the U.S. tax system is the taxation of corporate sector equity income at both the firm level, through the corporate income tax, and the

[28]The after-tax interest rate is given by the after-tax marginal product of capital, net of depreciation, in the corporate sector: $(1 - \tau_i)(1 - \tau_c)[F_K(K_c, N_c) - \delta]$.

Table 1
Endowment of efficiency units of labor

Age	Efficiency	Age	Efficiency
21	0.654	44	1.100
22	0.727	45	1.083
23	0.772	46	1.110
24	0.821	47	1.088
25	0.878	48	1.108
26	0.892	49	1.082
27	0.936	50	1.105
28	0.934	51	1.095
29	0.986	52	1.079
30	0.993	53	1.079
31	1.011	54	1.059
32	1.022	55	1.074
33	1.044	56	1.084
34	1.054	57	1.063
35	1.057	58	1.080
36	1.089	59	1.106
37	1.089	60	1.017
38	1.072	61	1.057
39	1.117	62	1.084
40	1.119	63	1.067
41	1.115	64	1.035
42	1.126	65	1.013
43	1.114	66–75	0

Note: CPS March Demographic File for 1989.

personal level, through individual income taxes. In calibrating the corporate tax rate, τ_c, I follow Mendoza et al. (1994), who use national income accounts and government revenue statistics to construct time series for several industrialized countries. I use their average over the 1980s from the estimates for the U.S. economy. The corporate tax is then set at 0.29. In the model, the income tax rate, τ_i, is set endogenously such that the average share of government consumption in output is 0.195. This implies an income tax rate of 0.256. Obviously, this implies that most government revenue comes from personal income taxes.

4.5. Production technology

To calibrate the production technology parameters, it is necessary to adopt a notion of aggregate capital and to determine the percentage of capital employed in the corporate and the non-corporate sectors of production.

Because, in the model economy, the government only consumes, and because services from government-owned capital are excluded from taxation in practice, I abstract from public capital and consider only private tangible assets. I also exclude consumer durables from the measurement of aggregate capital, because (i) they are not taxed in practice and (ii) it is difficult to quantify their market values and the values of their services. Moreover, given the failure to tax owner-occupied housing, I exclude it from the measurement of capital. Following Gravelle and Kotlikoff (1995), I define capital as plants and equipment, inventories, structures, and land at market value.

I assume that the corporate sector includes all firms that are legally organized as corporations and that pay the corporate income tax, while the non-corporate sector consists of unincorporated firms that do not pay the corporate income tax. To obtain the fraction of capital employed in the corporate and non-corporate sectors, I use Table B.6 in Gravelle (1994), which reports the distribution of capital stock by sector and industry. Excluding owner-occupied housing from the measurement of aggregate capital, the fraction of capital employed in the corporate sector is about 0.70.

Using the OECD Business Sector Data Base, Poterba (1997) finds that the corporate labor income share is 0.67. Therefore, I set $\theta = 0.33$. The depreciation rate, δ, is set to match the U.S. depreciation–output ratio following the estimate of Stokey and Rebelo (1995), who finds that the depreciation rate is 0.062. Hence, I choose $\delta = 0.062$.

The parameter v determines the degree of returns to scale. I calibrate it endogenously to match the entrepreneurial share of income. Quadrini (2000) documents that entrepreneurs earn 22% of total income. The entrepreneurial share in the current paper should be lower than 22% since I consider only entrepreneurs running unincorporated businesses. I set a target of entrepreneurial income share of 19%.

4.6. Entrepreneurial abilities and productivity shocks

To begin, I must choose some distributions for entrepreneurial abilities and technology shocks. This is a somewhat arbitrary choice, since the units in which entrepreneurial abilities and productivity shocks are measured are only ordinal. For simplicity, I assume that the distribution of entrepreneurial abilities received by workers, $H(z)$, is represented by a discrete approximation, à la Tauchen (1986), to a lognormal distribution with a mean of μ_{w} and a variance of σ_{w}^2. Again, in line with Tauchen (1986), the transition probability function, Ψ, of the productivity shock is a discrete approximation of the stochastic process,

$$\ln z_t = (1-\rho)\mu_{\mathrm{w}} + \rho \ln z_{t-1} + \varepsilon_t \quad \text{with } \varepsilon_t \sim \mathrm{N}(0, \sigma_\varepsilon^2). \tag{21}$$

I assume that the shock, z, takes 31 possible values ($N_z = 31$), evenly spaced in the log scale ranging from $-4\sigma_{\mathrm{w}}$ to $4\sigma_{\mathrm{w}}$. The parameters $(\mu_{\mathrm{w}}, \sigma_{\mathrm{w}}, \sigma_\varepsilon, \rho)$ are set to match the following four targets in equilibrium: (i) the fraction of entrepreneurs in the population, where entrepreneurs are defined as business owners who combine upfront business investments with entrepreneurial abilities to get entrepreneurial profits and operate in the non-corporate sector. Using the 1989 SCF, Gentry and Hubbard (2004) find that 8.7% and 9.5% of the population report active business assets greater than \$5,000 and \$1,000, respectively. They also find that 11.5% of the population report owning active business assets even though these assets might have

Table 2
Calibrated parameters of the benchmark economy

Parameters		Values
Fixed parameters		
σ	Relative risk aversion	2
J	Lifetime	55
R	Retirement	46
θ	Corporate capital income share	0.330
δ	Capital depreciation rate	0.062
τ_c	Corporate income tax rate	0.290
Endogenously calibrated parameters		
τ_i	Income tax rate	0.256
β	Discount factor	0.966
μ_w	Mean of entrepre. ability	0.100
σ_w	Standard deviation of ability	0.126
σ_ε	$N(0, \sigma_\varepsilon^2)$	0.39
ρ	Coefficient of autocorrelation	0.89
v	Degree of return to scale	0.89

zero value. Further, roughly three quarters of businesses are unincorporated (half are sole proprietorships and a quarter are partnerships), a quarter are incorporated. Because, in the model, entrepreneurs have a strictly positive amount of business assets and run unincorporated businesses, I calibrate the number of entrepreneurs in the benchmark economy to be 7.5%;[29] (ii) the fraction of aggregate capital employed in the corporate sector (K_c/K) is about 0.70; (iii) the average annual entry rate into business ownership is about 0.037; and (iv) the average annual exit rate out of business ownership is in the range of 0.242–0.447. The entry rate into and the exit rate out of business ownership are taken from Gentry and Hubbard (2004) and Quadrini (2000). These endogenous parameters ($\mu_w, \sigma_w, \sigma_\varepsilon, \rho$) are listed in Table 2.

4.7. Credit constraints

The proportional intermediation cost, ϕ, charged by financial institutions to entrepreneurs, represents the difference between the interest rate on loans, r_l, and the interest rate on deposits, r_d. Díaz-Giménez et al. (1992) report the average interest rates paid on several types of household borrowing and lending to banks and other intermediaries for selected years. Based on these data, they calibrate the interest rate spread at 5.5%. In the benchmark economy, I set $r_l - r_d = \gamma = 0.055$. To see the role played by financial constraints (i.e., the borrowing limit and the intermediation cost) when evaluating the consequences of corporate taxation, I also consider a case where the borrowing limit in Eq. (6) is eliminated and the intermediation cost becomes $\phi = 0$. In these cases I recalibrate a set of model parameters ($\beta, \tau_i, \mu_w, \sigma_w, \sigma_\varepsilon, \rho, v$) to

[29] See also Cagetti and De Nardi (2006) and Quadrini (2000).

Table 3
Targets and statistics of benchmark economy

	U.S. economy	Benchmark
After-tax interest rate	0.040	0.041
G/Y	0.195	0.195
Entrepreneurs	0.075	0.075
K_c/K	0.700	0.709
Entry rate	0.037	0.036
Exit rate	0.240–0.447	0.390
Entrepr. share of income	0.19	0.185

obtain the same targets. Table 2 reports the fixed and calibrated parameters of the benchmark economy.

5. Quantitative findings

Section 5.1 reports the benchmark results and Section 5.3 describes the implications of eliminating the corporate income tax.

5.1. Benchmark results

In column 3 of Table 3, I report the values of the targets for the benchmark economy. As the table shows, the model replicates most of the targets relatively well except for the exit rate. For instance, the after-tax interest rate is about 4.1% in the model, while it was 4.0% in the U.S. data. The calibrated income tax rate is 0.256. The ratio of corporate tax revenue to GDP is 2.8%, which is consistent with the U.S. data. Given this interest rate, the intermediation cost and the depreciation rate, the implied maximum investment per unit of wealth is $\Delta = 6.45$. The fraction of entrepreneurs exiting entrepreneurship is 0.37. Although this number appears to be relatively high, it is in the range of the estimates reported by Quadrini (1999). It is not too surprising that the exit rate appears to be a bit high since there is no exit cost.

Table 4 lists the distributions of income and wealth for the U.S. and the model economy.[30] In terms of the distribution of income, the model is successful in approximating estimates for the U.S. economy. The income Gini coefficient implied in the model is 0.468, which is close to that observed for the U.S. economy.[31] However, the model is unable to replicate the high concentration of wealth observed in the actual economy. The wealth Gini index takes the value of 0.601, and the top

[30] The concept of income used to report the distribution of income is labor and asset income before taxes plus all transfers.

[31] Among others, Ryscavage (1995), using the data from the CPS for the case of income after transfers and before taxes, reports that the income Gini coefficient was 0.428, 0.428, 0.433, 0.434, and 0.447 for 1990, 1991, 1992, and 1993, respectively. Also, using the PSID data set, Quadrini (2000) finds that the income Gini coefficient for all earners in the period from 1984 to 1989 averaged 0.44.

Table 4
Income and wealth distributions in the benchmark economy and data

	Wealth		Income	
	Gini	Top 30% (%)	Gini	Top 30% (%)
Benchmark	0.601	73.7	0.468	64.1
U.S. economy	0.72–84	86.0	0.440	60.1

Table 5
Percentage of entrepreneurs by age cohort

Age cohort	Data (%)	Benchmark (%)
<35	6.441	0.000
35–40	10.993	1.900
40–45	12.907	8.650
45–50	14.076	10.898
50–55	16.862	14.320
55–60	18.179	14.493
60–65	12.496	11.483
$\geqslant 65$	–	0.000

30% of agents hold 73.7% of total wealth.[32] As the second row of Table 4 shows, these numbers are far from the empirical ones. Even though the implied wealth concentration is not as concentrated as in the actual data, the artificial economy predicts that wealth is less equally distributed than income.[33]

Life-cycle and entrepreneurship: Table 5 shows the fraction of households in an age cohort that is entrepreneurs for both the model and the 2001 SCF data. It is evident from the table that entrepreneurs are older than workers and that the model replicates the hump-shape of entrepreneurship over the life-cycle. The fraction of entrepreneurs under age 35 in the model is zero and subsequently increases with age and then decreases with age when closer to retirement. The reason why the fraction of entrepreneurs for the youngest cohort is zero in the model and not in the data comes from the assumption that newborns start as workers (this assumption was justified by the presence of financial constraints). Consistent with previous studies, entrepreneurship is not an option for younger workers, because they have not had enough time to build up the capital needed to start a business and, with financial

[32] Huggett (1996) is successful in replicating the U.S. wealth Gini index, but only by generating a high fraction of zero and negative wealth-holders, and not by concentrating sufficient assets in the upper tail of the distribution of wealth. Unlike in the current paper, workers in Huggett's model face uninsurable fluctuations in their labor incomes and uncertain lifetime.

[33] It is not surprising to have less concentrated wealth than in the data, since the current model is highly stylized. The model does not consider many important features, such as uninsurable risks in workers' incomes, bequests, education, and uncertain lifetime.

constraints, they have difficulty borrowing sufficient start-up funds. This result is in line with the empirical findings of Evans and Jovanovic (1989) and Evans and Leighton (1989). Erosa (2001) studies how costly financial intermediation affects individuals' decisions to become entrepreneurs. He finds analytically that it is optimal for individuals to start their lives as workers, then switch to being entrepreneurs and back to workers if their net worth is sufficiently low before they retire. Moreover, since younger generations have lower wealth, they will not choose to operate a business, because entrepreneurship involves *uninsurable* idiosyncratic risk.

Given the simplicity of the model, it is interesting to see that the model is able to do a relatively good job for some age groups such as age groups starting from age 40. For example, for the age group 60–65, the number of entrepreneurs is 12.5% in the data while it is about 11.5% in the model. The model is, however, unable to replicate the number of entrepreneurs for the youngest cohorts. As mentioned above, this is not surprising since wealth is needed for entrepreneurial activity and that agents are born with zero assets. One strategy that could contribute to an increase the number of young entrepreneurs is to introduce bequests and inheritances. Parents can transfer businesses to their children or they can transfer them funds that will relax their liquidity constraints. Given the focus of the current paper, the model does not explicitly account for bequests and this is left for future research.[34]

5.2. *Importance of financial constraints and business risk for benchmark results*

I conduct some comparative statics to identify separately the importance of the borrowing limit, the intermediation cost, and the business risk. For ease of comparison, I deviate from the benchmark economy only for a given parameter and leave the other parameters and prices unchanged.

Intermediation cost: I consider three alternative values of $\phi : \phi = 0.0$, and a positive value set below the benchmark ($\phi = 0.05$) and one set above it ($\phi = 0.06$). The first panel of Table 6 presents the results of these experiments. This panel shows that, as the intermediation cost increases, capital accumulation, aggregate output, and the fraction of entrepreneurs decreases and the corporate share of total capital increases. The fraction of entrepreneurs decreases because higher costly external financing reduces the return to entrepreneurship. This reduction in the number of entrepreneurs leads to a fall in aggregate capital and output because of the high savings of entrepreneurs. This result is consistent with Kitao (2006), Li (2002), Meh (2005), and Quadrini (2000).

Borrowing limit: This comparative statistics exercise consists of solving the profit maximization without the borrowing limit given by Eq. (6).[35] This experiment is displayed in the second panel of Table 6. Comparing first and second panels, one can

[34]See Cagetti and De Nardi (2006) who model bequests in an entrepreneurial choice model. Other elements that could contribute to explain entrepreneurship over the life-cycle are, for example, government subsidies (Li, 2002) and human capital (Terajima, 2006).

[35]However, in this experiment the cost of financial intermediation is still present.

Table 6
Percentage changes in economic variables and prices after changes in financial constraints and business risk values from the baseline economy

	Capital	Output	K_c/K	Entrepreneurs
Zero intermediation cost	21.942	25.544	−89.248	90.285
Low intermediation cost	12.942	2.544	−51.248	61.285
High intermediation cost	−7.578	−2.782	23.417	−26.764
No borrowing limit	17.710	21.065	−80.038	85.242
Low business risk	15.709	6.518	−20.921	29.052
High business risk	−2.214	0.476	0.768	−13.294
Benchmark economy (values in levels)	2.349	1.258	0.709	0.075

see the results are similar except that the magnitude of the effects are higher in the first panel. Changes in the intermediation cost lead to larger effects than the borrowing limit because a higher intermediation cost not only increases the cost of capital but also makes the borrowing limit tighter. To see that, notice that the borrowing limit per unit of wealth, $\Delta = \frac{1+r_d+\phi}{r_d+\phi+\delta}$, is decreasing in the intermediation cost, ϕ.

Business risk: In this experiment, I consider low and high standard deviations of the business productivity shock: $\sigma_\varepsilon = 0.2$ and 0.44. As the business risk goes down, the importance of the precautionary motive falls but the incentive to become entrepreneurs also increases. As expected the table shows that a drop in business risk raises the number of entrepreneurs and this leads to an increase in aggregate output, capital accumulation, and a decrease in the corporate share of capital.

Overall, Table 6 suggests that the effects of financial constraints (intermediation cost and borrowing limit) on capital accumulation, output, entrepreneurship, and the corporate share of capital are larger than those of business risk on the same statistics. A reason why the effects are relatively small when business risk is reduced is because in the model there are no large losses in business activity since the choice of capital is made after observing the productivity shock.

5.3. The removal of corporate income tax

A revenue-neutral experiment is considered here: that is, I eliminate the corporate tax and adjust the income tax rate such that total government revenues are unchanged across economies.

Before proceeding, it is useful to highlight how the corporate income tax would affect capital accumulation and entrepreneurial activity. In this model, eliminating the corporate income tax has two opposing effects on capital accumulation. First, the removal of the corporate income tax increases the after-tax return on savings and substantially increases capital accumulation. Second, the elimination of the corporate income tax leads to a decrease in capital accumulation. The intuition

Table 7
Aggregate statistics of removing the corporate income tax

	Benchmark	No corporate tax	% Change
Aggregate			
Capital	2.349	2.511	6.9
Output	1.258	1.274	1.3
Non-entrepreneurial labor	0.811	0.842	3.8
Entrepreneurs	0.075	0.059	−21.3
Prices and taxes			
Before-tax wage rate	1.024	1.039	1.5
Before-tax interest rate	0.078	0.074	−5.1
After-corporate-tax interest rate	0.055	0.074	34.5
After-tax interest rate	0.041	0.059	43.9
Corporate tax rate	0.290	0.000	−100
Income tax rate	0.256	0.276	7.8

behind this mechanism is as follows. The increase in after-tax returns on savings that arises from removing the corporate tax eliminates the incentive to become an entrepreneur to avoid the double taxation of corporate capital income. As a result, the fraction of entrepreneurs decreases and this can lead to a decrease in capital formation since entrepreneurs have a higher marginal rate of saving than non-entrepreneurs. The results of the policy experiment presented in Tables 7, 8 and 10 are the net effects of these two opposing forces.[36]

5.3.1. Aggregate effects

Table 7 presents descriptive statistics for the model economy under the policy reform. The switch to an economy without a corporate tax system has a positive effect on capital accumulation and aggregate output, reflecting the fact that the first effect described above (the increase in savings that arises from the after-tax interest rate) dominates the second one (the decrease in savings that stems from the fall in the number of entrepreneurs). The table shows that the removal of the corporate income tax increases the capital stock by 6.9% and aggregate output by 1.3%. However, these numbers are of an order of magnitude smaller than those arrived at in standard models that do not emphasize financial constraints and uninsurable business risk (see Summers, 1981; Auerbach and Kotlikoff, 1987 among others). Entrepreneurs now represent 5.9% of the labor force, down from 7.5% before the tax reform, a

[36]Note that the model is silent in terms of the emergence of the corporate sector. The possibility of selling businesses to the corporate sector, which makes the corporate sector endogenously determined, could bias the predictions of the model. For example, the prospect of being able to sell a business encourages households to become entrepreneurs. This leads to capital accumulation because of costly intermediation and financial constraints. The corporate tax, by reducing the gain of business sale discourages entrepreneurship which in turn would decrease capital accumulation. This new channel via business sale combined with the current channel – i.e., corporate tax encourages entrepreneurship because of double taxation – would have an ambiguous effect on capital accumulation and entrepreneurship.

Table 8
Allocative implications of removing the corporate income tax

	Baseline	No corporate tax	% Changes
Corporate			
Output	0.704	0.789	12.1
Capital	1.665	1.921	15.4
Labor	0.461	0.509	10.4
Capital/total capital	0.709	0.765	7.9
Output/total output	0.560	0.619	10.5
Non-corporate			
Output	0.554	0.485	−12.5
Capital	0.684	0.585	−14.5
Labor	0.350	0.333	−4.9
Entrepreneurs			
Measure of entrepreneurs	0.075	0.059	−21.3
Average capital per firm	11.803	10.901	−7.6
Average labor per firm	6.303	6.214	−1.4
Entry rate	0.037	0.030	−18.9
Exit rate	0.390	0.478	22.7
Fract. of entrepre. with binding borrowing limit (i.e., $k = \Delta a$)	0.387	0.220	−43.2

decrease of 21.3%.[37] The fall in the number of entrepreneurs results from the removal of the double taxation, which increases the after-tax interest rate from 4.1% to 5.9%. A higher after-tax interest rate means that workers earn higher returns on their financial assets, which implies that the incentives to become an entrepreneur because of the corporate tax are eliminated. Everything else being equal, a high interest rate increases the cost of capital for entrepreneurs, which reduces the rewards of entrepreneurship. This reduction in entrepreneurial profits, combined with the uninsurable idiosyncratic risk associated with business ownership, discourages entrepreneurship.

Table 8 reports the allocative effects of the tax reform. The table suggests that the elimination of the corporate tax leads to a shift in the capital stock from non-corporate to corporate production. The fraction of total capital employed in the corporate sector increases by 7.9%, while the share of corporate output in total output increases by 10.5%. Again, while the signs of these effects are in line with previous studies by Harberger (1962), Fullerton et al. (1981), and Gravelle and Kotlikoff (1989, 1995), among others, their magnitudes are much smaller.[38] For

[37]In a recent paper, Chari et al. (2004) study the effects of capital gains taxation in an entrepreneurial choice model with incomplete markets. In their partial-equilibrium model, they find a welfare gain of 0.15% from eliminating capital gain taxation. In the current model (which is a general equilibrium), output increases by 1.3% after eliminating corporate taxation. Kitao (2006) also finds that a low capital income tax reduces entrepreneurial output by about 2%. Recall that in the current paper a lower corporate tax corresponds to a lower tax on capital.

[38]See Gravelle (1994, Chapter 4) for a survey of the previous literature.

Table 9
Percentage of entrepreneurs by age after removing the corporate tax

Age cohort	Benchmark	No corporate tax
<35	0.000	0.000
35–40	1.900	0.000
40–45	8.650	0.000
45–50	10.898	6.745
50–55	14.320	9.443
55–60	14.493	9.228
60–65	11.483	9.218
⩾65	0.000	0.000

example, Gravelle and Kotlikoff (1995) find that the Tax Reform Act of 1986 – which considerably altered the differentials between taxes on corporate and non-corporate capital – increased the fraction of capital used in the corporate sector by 30%. Recall though that Gravelle and Kotlikoff (1995) do not account for liquidity constraints and business risk. The small allocative effects found in the current study are consistent with Gordon (1985). In an extension of the Harberger-type model, Gordon (1985) shows that in the presence of uncertainty, the double taxation of corporate income can leave corporate investment incentives, and individual savings incentives, basically unchanged. Gordon also shows that in some plausible situations, such taxes could even lead to an efficiency gain. The explanation for his findings is that, while investors given taxes receive a lower expected return, they also bear less risk when they invest and these two effects are largely offsetting.[39]

Table 9 describes how the fraction of entrepreneurs by age changes after the removal of the corporate tax. It can be seen from the table that the fraction of entrepreneurs diminishes for all age groups. Without the corporate tax, individuals choose to become entrepreneurs much later in life. For example, the fraction of individuals of age between 35 and 45 choosing entrepreneurship becomes zero from a positive number before the reform.

5.3.2. Distributional effects

Table 10, which reports the distributional implications of eliminating the corporate income tax, shows that wealth inequality, as measured by the Gini index, decreases by 0.029 percentage points from 0.601 to 0.572. Moreover, the fraction of total wealth owned by the top 30% of wealth-holders also falls by 2.8 percentage points from 73.7%. This is a surprising result, since one of the objections to the removal of the corporate tax is its negative impact on the cross-sectional distribution of wealth.

A chief element contributing to the reduction in the overall wealth inequality is the decrease in the disparity between the groups of entrepreneurs and non-

[39]Notice, however, that the current study is very much different from Gordon (1985). The return of corporate income is certain in my model, while it is uncertain in Gordon (1985).

Table 10
Distributional features of removing the corporate income tax

	Benchmark	No corporate tax
wealth Gini	0.601	0.572
Top 30% of wealth holders (%)	73.7	70.9
Ratio of mean of entrepre. wealth to mean of wealth of the rest of population	3.9	2.5
Ratio of median of entrepre. wealth to median of wealth of the rest of population	7.0	6.1

entrepreneurs.[40] Table 10 shows that the ratio of the *median* of entrepreneurial wealth to the *median* of non-entrepreneurial wealth decreases from 7.0 to 6.1.[41] The intuition behind this decrease in disparity is that the elimination of the double taxation of corporate income increases the after-tax returns on savings from 4.1% to 5.9%, and therefore leads to an increase in the savings of (young) workers, which reduces the number of zero wealth-holders. At the same time, the rise in savings increases the pre-tax wage rate, which in turn reduces the profits of entrepreneurs, decreasing entrepreneurial savings.

Furthermore, wealth inequality among entrepreneurs also decreases slightly. Removing the double taxation of corporate income leads least productive entrepreneurs to exit entrepreneurship; those staying and/or becoming entrepreneurs are mostly higher quality. This result has two opposing effects on the overall incentives to save faced by an entrepreneur. On the one hand, the higher the quality of the entrepreneur, the less risky is his/her business, thus reducing the incentive to save for precautionary motives. On the other hand, higher quality of entrepreneurs also implies a higher optimal size of business, and therefore, a higher probability that the liquidity constraints bind, increasing the incentives to save. These two effects largely offset each other and inequality within the group of entrepreneurs decreases only slightly.

Finally, the large increase in the after-tax interest rate has an important effect on the savings of workers, particularly those of low-income workers. For example, the fraction of agents with zero assets has decreased by 28%.

6. Importance of liquidity constraints and business risk for policy experiment

This section examines the importance of liquidity constraints and business risk in analyzing the effects of eliminating the corporate income tax, and shows that accounting for these two elements changes the impacts of switching to an economy without a corporate income tax system.

[40]To understand this result, recall that the elimination of the corporate income tax reduces the number of entrepreneurs.

[41]The ratio of *mean* entrepreneurial wealth to *mean* non-entrepreneurial wealth falls from 3.9 to 2.5.

To quantify the effects of the policy reform, a version of the model that abstracts from both financial constraints (i.e., the borrowing limit and the intermediation cost) and business risk are considered. Without financial constraints, the borrowing limit is eliminated and the intermediation cost $\phi = 0$. When business risk is eliminated the entrepreneurial ability, z, drawn from the distribution H, constitutes a *perfect* signal about the next period's business quality in the event that the agent decides to become a business owner. Consequently, the transition probability matrix, Ψ, is an identity matrix, which implies that only the parameters $(\beta, \tau_i, \mu_{\mathrm{w}}, \sigma_{\mathrm{w}}, v)$ have to be calibrated to match the benchmark targets (without the entry rate into and exit rate from entrepreneurship).

With financial constraints and business risk eliminated individuals save *only* for retirement. This implies that savings are very sensitive to changes in the after-tax interest rate. Furthermore, in the absence of business risk and financial constraints, individuals can easily avoid the corporate tax by becoming entrepreneurs since personal wealth does not play a key role in business formation.

The first line of Table 11 shows that the aggregate and allocative effects of removing the corporate tax are substantially *smaller* in the model economy with financial constraints and business risk than when financial constraints and business risk have been ignored. In the absence of financial constraints and business risk (that is, when the intermediation cost is zero and the borrowing limit is not binding) doing away with the corporate tax increases aggregate capital stock and output by 22.5% and 9.2%, respectively, while in the presence of financial constraints and business risk the same variables increase by only 6.9% and 1.3%, respectively. Furthermore, in the absence of financial constraints and business risk, the removal of the corporate tax leads to an increase in the corporate share of total capital of 51.1% and a decrease in the fraction of entrepreneurs of 43.9%, while in the presence of these two characteristics of entrepreneurship, the corporate share of total capital increases by only 7.9% and the fraction of entrepreneurs decreases by only 21.3%. Again, these significant differences in the effects of the tax reform arise because without financial constraints and business risk it is easy to avoid the corporate tax.

It is also useful to understand separately the importance of financial constraints (i.e., the borrowing limit and the intermediation cost) and business risk in determining the results of the tax reform. The borrowing limit and the

Table 11
Importance of financial constraints and business risk for capital accumulation, output, corporate capital share and number of entrepreneurs (change in %)

	Capital	Output	K_{c}/K	Entrepre.
No limit, no cost, no risk	22.5	9.2	51.1	−43.9
No limit and no cost	18.1	6.3	48.5	−36.6
No borrowing limit ($k < \Delta a$)	12.3	3.5	35.2	−28.3
No intermediation cost ($\phi = 0$)	15.3	5.3	40.2	−34.2
No business risk	10.3	3.0	20.4	−25.6
Benchmark economy	6.9	1.3	7.9	−21.3

intermediation cost lead agents to have higher savings in order to start a business and/or to increase the size of business investment. Recall that a change in the intermediation cost also affects the borrowing limit. For example, a decrease in the intermediation cost leads to a rise in $\Delta = \frac{1+r_d+\phi}{r_d+\phi+\delta}$, the maximum investment that be made from one unit of wealth. The presence of business risk leads to higher saving (precautionary savings) because of the lack of insurance markets against idiosyncratic business risk.

The second and third lines of Table 11 report the tax reform results when financial constraints and business risk are separately analyzed. Comparing the second and third lines, one can see that tax reform has more effects when there is no borrowing limit and zero intermediation cost than when there is no business risk. This suggests that the precautionary saving induced by business risk is not very large in this model and that the savings coming from financial constraints are much larger. This is because there are no large losses in businesses and the choice of business investment is made after observing the productivity shock. The second line of the table also shows that the tax reform effects are larger without intermediation than without the borrowing limit. This comes from the fact the intermediation cost affects also the borrowing limit.

These results indicate that business risk and financial constraints are crucial for quantifying the effects of the elimination of the corporate income tax.

7. Sensitivity analysis

This section examines how important is the degree of risk aversion for the results in the previous sections. To do so, I consider two versions of an economy with higher risk aversion: (i) one economy with liquidity constraints and business risk and (ii) another economy without liquidity constraints and business risk.

Table 12 reports the results for higher risk aversion, $\sigma = 4$, which is the same value used by Gravelle and Kotlikoff (1995). Surprisingly, eliminating the corporate tax now has a negative effect on capital accumulation and output in the presence of liquidity constraints and business risks. Specifically, the capital stock decreases by 16.8% and output by 5.3%. To understand this result, notice that when agents are more risk-averse, they care more about consumption smoothing. As a result, they save more for precautionary motives. In particular, agents who decide to become or remain entrepreneurs have to accumulate enough assets to self-insure against the fluctuation in entrepreneurial profits.[42] The decrease in the number of entrepreneurs leads to a decrease in capital accumulation since entrepreneurs have the highest propensity to save. This decrease in entrepreneurial savings overturns the general increase in savings resulting from the rise in the after-tax interest rate.[43]

[42]The importance of entrepreneurial precautionary saving is consistent with findings from the data. Specifically, Kennickell and Lusardi (2001) show that business owners have a much stronger precautionary saving motive than non-entrepreneurs. According to their estimates, a large part of precautionary saving in the economy is accounted for by entrepreneurs.

[43]Notice that the economy without financial constraints and business risk when $\sigma = 4$ is a simple case of the model in Gravelle and Kotlikoff (1995), who investigate the efficiency gains from the Tax Reform Act

Table 12
Changes in economic variables after removing the corporate income tax in the absence of liquidity constraints and business risk (when $\sigma = 4.0$)

	Business risk and liquidity constraint (%)	No business risk and no liquidity constraint (%)
Capital	−16.8	12.1
Output	−5.3	6.3
K_c/K	10.4	20.1
Entrepreneurs	−31.5	−43.3

The negative effect of eliminating the double taxation of corporate income on the capital accumulation has also been found by other researchers. Cassou and Lansing (2004) in a human capital-based endogenous growth model find that 'the elimination of double taxation of business income can actually reduce long-run growth when combined with full investment expenses... Doing away with double taxation forces the government to replace this revenue using a higher post-reform tax rate. A higher post-reform tax rate is harmful for growth because it discourages labor effort and time devoted to human capital accumulation' (p. 2). Feldstein and Slemrod (1980), in a static economy with a progressive personal income tax, the elimination of the corporate tax system could actually lead to a decrease in the corporate of share of total capital if under the corporate income tax system, retained earnings are not subject to the personal tax and dividends are taxed twice. When risk aversion is high, the removal of the corporate tax increases wealth inequality in the model economy with liquidity constraints and business risks, though the size of the increase is insignificant. The Gini coefficient of wealth increases from 0.601 to 0.607. This is because the fall in the pre-tax wage rate decreases the income of workers, while entrepreneurial profits increase.

8. Conclusion

This paper has shown that in the presence of liquidity constraints and uninsurable idiosyncratic business risk, removing the corporate tax has different implications than those suggested by the standard models of corporate taxation. The size of the effects of the tax reform on capital accumulation, aggregate output, entrepreneurial activity, and the allocation of capital are significantly reduced and may even change signs for some plausible situations. Furthermore, the cross-sectional distribution of wealth becomes less concentrated. These findings suggest that allowing for liquidity

(*footnote continued*)
of 1986. Specifically, the difference is that their 55-year overlapping generations model contains 11 industries (goods) and several types of capital. The model economy without liquidity constraints and business risk is a special case of Gravelle and Kotlikoff (1995) since the former model economy has corporate and non-corporate sectors which produce a single good using a homogeneous capital input. In such a model, (i) the corporate income tax provides incentives to become entrepreneurs since these individuals pay only the personal income tax and (ii) the corporate income tax discourages capital formation as the corporate tax reduces after-tax returns on savings.

constraints and business risk could change the consequences of the corporate income tax as the removal of such a tax could result in a decrease in capital accumulation and aggregate output.

It is worth noting that this study focuses on a particular, so far largely ignored, channel through which the corporate income tax system affects the economy. To isolate this channel I have necessarily abstracted from several issues that are important in a more complete discussion of corporate taxation. Some of these issues are discussed below.

Although I have not dealt explicitly with the efficiency aspects of the corporate income tax, this paper implies that evaluating the welfare implications of the corporate income tax should involve considerations that have previously been ignored. In past studies of the efficiency effects of the corporate income tax, the welfare cost reflects distortions such as inter-industry, within-industry, and intertemporal distortions.[44] However, intertemporal distortions in past studies capture only one side of the story, that is, the negative impact of the corporate tax on savings as it reduces the return to savings. In this model, the introduction of a corporate tax system could increase capital accumulation (even though the corporate tax reduces the return to savings) when liquidity constraints and idiosyncratic business risks are present. A full evaluation of the welfare loss (or gain) that stems from the imposition of a corporate tax requires an assessment of the positive impact of the corporate tax on savings in addition to the production inefficiency generated by the misallocation of resources between corporate and non-corporate sectors. This issue is left for future research.

Another avenue of future research is to endogenize the decision to incorporate a business. By double taxing corporate income but not non-corporate income, corporate taxes can play a crucial role in a firm's choice of organizational form. Gordon and Mackie-Mason (1997) and Cullen and Gordon (2006), among others, show that this margin is important to investigate differential taxation of corporate and non-corporate income.[45]

Finally, the model can be extended to study the effects of corporate income taxation in an open economy environment where capital is perfectly mobile. For example, Gravelle and Smetters (2001) show that open economy considerations are important for analyzing the economic effects of corporate income taxation.

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[44] See Gravelle (1994, Chapter 4) for a discussion of the distortions generated by the corporate income tax.

[45] Using cross-sectional data on organizational form across states from the Census of Retail Trade, Goolsbee (2002) finds a significant impact of the taxation of corporate relative to personal income on the share of economic activity that is done by corporations.

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Appendix A. Definition of a stationary equilibrium

A stationary equilibrium for a given set of policy arrangements, $\Omega = \{\tau_c, \tau_i, G\}$, is a collection of value functions for workers (including retirees) and entrepreneurs $\{V^w(z,a,j), V^e(z,a,j)\}$; policy functions for workers and entrepreneurs $(a^w, e^w, c^w)(z,a,j)$ and $(a^e, c^e, e^e, k, n)(z,a,j)$; age-dependent invariant distributions of workers (and retirees) and entrepreneurs $(\mu_j^w(z,a),\ \mu_j^e(z,a))$; aggregate capital and labor demands in the corporate sector $\{K_c, N_c\}$; and prices (w, r_d), such that:

1. For given prices, V^w and V^e satisfy workers' and entrepreneurs' (19) and (15), respectively. $(a^w, e^w, c^w)(z,a,j)$ and $(a^e, c^e, e^e, k, n)(z,a,j)$ are optimal decision rules.
2. Corporate and intermediation sectors make zero profits and prices are competitive:

$$w = (1-\theta)\left(\frac{K_c}{N_c}\right)^{\theta}, \tag{22}$$

$$r_d = (1-\tau_c)\left[\theta\left(\frac{K_c}{N_c}\right)^{\theta-1} - \delta\right]. \tag{23}$$

3. Capital and labor markets clear:

$$\sum_j \sum_z \left\{\int_a k(z,a,j)\mu_j^e(z,a)\,\mathrm{d}a\right\} + K_c = \sum_j \sum_z \left\{\int_a a\mu_j^e(z,a)\,\mathrm{d}a\right\} + \sum_j \sum_z \left\{\int_a a\mu_j^w(z,a)\,\mathrm{d}a\right\}, \tag{24}$$

$$\sum_j \sum_z \left\{\int_a n(z,a,j)\mu_j^e(z,a)\,\mathrm{d}a\right\} + N_c = \sum_j \sum_z \left\{\int_a \varepsilon(j)\mu_j^w(z,a)\,\mathrm{d}a\right\}. \tag{25}$$

4. The government budget is balanced:

$$G = \tau_c\left(\frac{r_d}{1-\tau_c}\right)K_c + \tau_i\left[\sum_j\sum_z\left\{\int_a (r_d a + w\varepsilon(j))\mu_j^w(z,a)\,\mathrm{d}a\right\}\right] + \tau_i\left[\sum_j\sum_z\left\{\int_a (r_d a + \pi(z,a,j))\mu_j^e(z,a)\,\mathrm{d}a\right\}\right]. \tag{26}$$

5. Invariant distributions, $\{\mu_j^w(z,a), \mu_j^e(z,a)\}$, are consistent with individuals' optimal behavior. The distribution of individual states across age 1 agents is such that μ_1^w is entirely determined by $h(\cdot)$ and μ_1^e is zero, since all agents start as workers with zero assets. For $j = 1,\ldots,J-1$,

$$\mu_{j+1}^w(\mathcal{S}_z,\mathcal{S}_a) = \sum_{z'\in\mathcal{S}_z}\int_{a'\in\mathcal{S}_a}\sum_{j,z}\left\{\int_a I^{ww}(a,z,j)P^w(z,j)\mu_j^w(z,a)\,\mathrm{d}a\right\}\mathrm{d}a' + \sum_{z'\in\mathcal{S}_z}\int_{a'\in\mathcal{S}_a}\sum_{j,z}\left\{\int_a I^{ew}(a,z,j)P^w(z,j)\mu_j^e(z,a)\,\mathrm{d}a\right\}\mathrm{d}a', \tag{27}$$

$$\mu_{j+1}^e(\mathcal{S}_z,\mathcal{S}_a) = \sum_{z'\in\mathcal{S}_z}\int_{a'\in\mathcal{S}_a}\sum_{j,z}\left\{\int_a I^{we}(a,z,j)P^e(z,z',j)\mu_j^w(z,a)\,\mathrm{d}a\right\}\mathrm{d}a' + \sum_{z'\in\mathcal{S}_z}\int_{a'\in\mathcal{S}_a}\sum_{j,z}\left\{\int_a I^{ee}(a,z,j)P^e(z,z',j)\mu_j^e(z,a)\,\mathrm{d}a\right\}\mathrm{d}a', \tag{28}$$

where

$$I^{ww}(a,z,j) = \begin{cases} 1 & \text{if } a^w(z,a,j)\in S_a \text{ and } e^w(z,a,j) = W, \\ 0 & \text{otherwise,}\end{cases} \tag{29}$$

$$I^{ew}(a,z,j) = \begin{cases} 1 & \text{if } a^e(z,a,j)\in S_a \text{ and } e^e(z,a,j) = W \text{ and } j<R, \\ 0 & \text{otherwise,}\end{cases} \tag{30}$$

$$I^{we}(a,z,j) = \begin{cases} 1 & \text{if } a^w(z,a,j)\in S_a \text{ and } e^w(z,a,j) = E, \\ 0 & \text{otherwise,}\end{cases} \tag{31}$$

$$I^{ee}(a,z,j) = \begin{cases} 1 & \text{if } a^e(z,a,j)\in S_a \text{ and } e^e(z,a,j) = E, \\ 0 & \text{otherwise,}\end{cases} \tag{32}$$

$$P^w(z,j) = \begin{cases} h(z) & \text{if } j\leqslant R-1, \\ 1 & \text{otherwise,}\end{cases} \tag{33}$$

$$P^{\mathrm{e}}(z,z',j)=\begin{cases}\Psi(z',z) & \text{if } j\leqslant R-1,\\ 1 & \text{otherwise,}\end{cases} \tag{34}$$

for $j=1,\ldots,J-1$ and for all $(\mathscr{S}_z,\mathscr{S}_a)\in\mathscr{B}(\mathscr{Z}\times\mathscr{R}^+)$, where $\mathscr{B}(\mathscr{Z}\times\mathscr{R}^+)$ is the Borel σ-algebra on $\mathscr{Z}\times\mathscr{R}^+$.

Appendix B. Computation of stationary equilibria

This appendix describes the algorithm used to compute stationary equilibria for given parameter values and a corporate tax rate, τ_{c}. In the benchmark economy, government consumption equals tax revenue.

1. Guess the capital labor ratio in the corporate sector. In the policy experiment case, guess the income tax rate, τ_i.
2. Compute factor prices: $r_{\mathrm{d}}=(1-\tau_{\mathrm{c}})\left[\theta\left(\frac{K_{\mathrm{c}}}{N_{\mathrm{c}}}\right)^{\theta-1}-\delta\right]$ and $w=(1-\theta)\left(\frac{K_{\mathrm{c}}}{N_{\mathrm{c}}}\right)^{\theta}$.
3. Calculate optimal decision rules by solving the problems of workers and entrepreneurs.
4. Compute the capital labor ratio in the corporate sector by using market clearing (24) and (25). In the policy experiment case, calculate the income tax rate, such that the government budget constraint is satisfied.
5. If the guessed values from step 1 are equal to the implied values in step 4, then the stationary equilibrium is found. Otherwise, guess new values and repeat the above steps.

To implement this algorithm, the space of assets is discretized with 501 possible values. The lower bound of the grid is zero and the upper bound, $\bar{a}$, is determined such that in the steady-state equilibrium it is never chosen by individuals. The distance between gridpoints increases with asset levels. More precisely, the grid is derived from the equation $a_{\mathrm{s}}=\lambda(s-1)^2$, where $s\in\{0,\ldots,501\}$ and $\lambda=\bar{a}/500^2$. To determine the policy function of assets, a bisection method is used to bracket the maximum over the grid of assets, and then the asset decision rule is obtained by applying a Golden Search procedure, as implemented by Press et al. (1994). To undertake this process, value functions off gridpoints are given by linear interpolation of value functions at gridpoints.

Although the invariant distribution requires the computation of probability measures μ_j^{w} and μ_j^{e} for $j=1,\ldots,J$, I perform an equivalent aggregation process by simulating the behavior of a large number of agents. Equilibria are computed by simulating shock histories and consequent decision rules of 10,000 agents per cohort in steady-state equilibrium. When current assets fall outside gridpoints, decision rules of assets are obtained by linear interpolation of values at grid points. Because occupation is discrete, I assume that when current asset holdings are between two values of gridpoints the occupation decision rule is given by the occupation implied by the lowest value of the two gridpoints. This assumption stems from the fact that wealth plays an important role in business formation. Note that higher numbers of agents do not affect the statistics of the model economies.

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