Bank of Canada Banque du Canada

Working Paper 2002-21 / Document de travail 2002-21

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ISSN 1192-5434

Printed in Canada on recycled paper

Bank of Canada Working Paper 2002-21

August 2002

# Entrepreneurial Risk, Credit Constraints, and the Corporate Income Tax: A Quantitative Exploration

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# Acknowledgements

I am grateful to Jim Davies, Andrés Erosa, and Gustavo Ventura for their very helpful comments and support. I would also like to thank David Andolfatto, Scott Hendry, Ig Horstmann, David Laidler, Kevin Moran, Michael Parkin, Vincenzo Quadrini, John Whalley, Christian Zimmermann, and seminar participants at the University of Western Ontario, the University of Waterloo, the 2000 Canadian Economic Association, the Bank of Canada, and the University of Québec at Montréal for their comments.

## Abstract

This paper describes the positive effect that corporate income tax has on capital formation in the presence of liquidity constraints and uninsurable risk. The author uses a dynamic general-equilibrium model in which individuals choose whether to become entrepreneurs or workers. Workers save by holding corporate equity and therefore are subject to double taxation, as the return on their savings is taxed at both the corporate and personal level. Entrepreneurs, on the other hand, save by investing in their businesses and are taxed only at the personal level. This differential tax treatment results in an increase in capital accumulation because entrepreneurs must save in response to liquidity constraints and uninsurable risk. A calibrated version of the model is used to quantify the consequences of eliminating the corporate income tax. Interestingly, the removal of the corporate income tax decreases capital formation: by eliminating double taxation, the return on workers' savings increases, which in turn reduces the number of entrepreneurs. Consequently, the stock of capital decreases, since entrepreneurs have a higher marginal rate of saving than workers, as they save not only for life-cycle motives but to self-insure against business risk and to start and finance their businesses.

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



## Résumé

Dans cette étude, l'auteur décrit l'effet positif exercé par l'imposition des bénéfices des sociétés sur la formation de capital, dans un contexte de contraintes de liquidité et de risque non assurable. L'auteur utilise un modèle dynamique d'équilibre général dans lequel l'individu choisit de devenir travailleur ou entrepreneur. Les travailleurs investissent leur épargne dans des actifs financiers et sont en conséquence doublement imposés sur le revenu de celle-ci, d'abord au niveau de l'entreprise, ensuite au niveau personnel. Les entrepreneurs, en revanche, investissent leur épargne dans leur entreprise et ne sont donc imposés que sur le plan personnel. La différence de traitement fiscal se traduit par une augmentation de l'accumulation de capital parce que les entrepreneurs doivent se constituer une épargne afin de faire face à des contraintes de liquidité et de risque non assurable. Une version étalonnée du modèle a été utilisée pour quantifier les conséquences de l'élimination de l'impôt sur les bénéfices des sociétés. Il est intéressant de noter que l'élimination de cet impôt diminue la formation de capital. En effet, la suppression de la double imposition permet la hausse du rendement de l'épargne des travailleurs, ce qui fait baisser à son tour le nombre des entrepreneurs. Par voie de conséquence, le stock de capital décroît, car les entrepreneurs ont un taux marginal d'épargne supérieur à celui des travailleurs puisqu'ils doivent épargner non seulement pour des motifs liés au cycle de vie, mais aussi pour s'auto-assurer contre le risque inhérent à l'entreprise dont il leur faut également financer le démarrage et l'activité.

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

# 1 Introduction

Economists have extensively investigated the consequences of differential taxation of corporate and non-corporate capital incomes.[1] They have, however, overlooked two crucial factors affecting the non-corporate sector. First, evidence suggests that entrepreneurs who operate in the non-corporate sector face liquidity constraints. Evans and Jovanovic (1989) and Holtz-Eakin, Joulfaian, and Rosen (1994a,b), among others, suggest that personal wealth has a substantial effect on both the probability of becoming an entrepreneur and on the amount of capital employed in the business. Second, entrepreneurship is risky. Knight (1921) argues that bearing risk is one of the essential characteristics of entrepreneurship and that capital markets provide too little capital to entrepreneurs because of moral hazard and adverse selection problems. Holtz-Eakin, Rozen, and Weathers (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.

These observations raise the following questions. Are borrowing constraints and uninsurable risk faced by entrepreneurs operating in the non-corporate sector important for assessing the consequences of differential taxation of corporate and non-corporate capital incomes? What are the implications of eliminating the corporate tax for capital accumulation, aggregate output, and the allocation of resources between sectors?

In this paper, a dynamic general-equilibrium model of occupational choice with explicit capital constraints and uninsurable entrepreneurial risks is constructed to address the above questions. The model has four features. First, an overlapping generations framework is employed to capture the life-cycle components of entrepreneurship. Within the model, individuals decide during their working lives either to work for someone else and invest in financial assets, or to become entrepreneurs. This results in an endogenously determined non-corporate sector (as entrepreneurship is pursued in that sector).[2] Second, entrepreneurs are borrowing constrained in the model. Hence, there are strong incentives to save to start a business or to implement a larger project for existing businesses. Third, entrepreneurs face idiosyncratic business-income risk and must self-insure by holding assets. Fourth, in addition to the income tax paid by all agents, individuals who are not entrepreneurs (and entrepreneurs with a positive balance after investing in their business) pay a corporate tax on the return to capital.[3]

[1] See Harberger (1962, 1966), Shoven and Whalley (1972), Fullerton et al. (1981), Gordon (1985), and Gravelle and Kotlikoff (1989, 1995). Only Gravelle and Kotlikoff (1989, 1995) use an endogenous non-corporate sector.

[2] In the model economy, I assume that, without loss of generality, entrepreneurs operate firms that are not incorporated. It is true that in the U.S. economy there are small firms that are organized as corporations, but, in general, most small firms are proprietorships.

[3] The corporate income tax imposes a *double taxation* of income: first, corporate earnings are subject to the corporate tax, and then after-tax earnings are either distributed as dividends and taxed at the personal level or retained and potentially taxed as capital gains.

Aside from tax incentives, two important elements determine the choice to undertake an entrepreneurial activity. The first factor is the self-perceived ability to manage a firm, as suggested by Lucas (1978) and Gravelle and Kotlikoff (1989, 1995). The second factor is personal wealth, since entrepreneurs are borrowing constrained and face uninsurable income uncertainty. The present paper differs from the existing research (e.g., Gravelle and Kotlikoff 1989, 1995) in emphasizing two features strongly associated with business ownership: uninsurable risk and liquidity constraints faced by entrepreneurs. This paper's main contribution is to show that in a world with liquidity constraints, uninsurable entrepreneurial risks, and endogenously determined occupations, the elimination of the corporate income tax would have a non-trivial effect on the accumulation of capital and the allocation of capital between the corporate and non-corporate sectors.

In this economy, the corporate tax has two opposing effects on capital formation: it reduces the return on savings, and creates an incentive to become an entrepreneur to avoid the double taxation of corporate capital income. The latter implies a rise in savings because of the presence of liquidity constraints and business risk. Stated differently, the corporate tax introduces increasing returns to savings for constrained entrepreneurs. This paper quantitatively examines the impact of such a trade-off on capital accumulation, output, and the allocation of resources between the corporate and non-corporate sectors.

The model has three main quantitative findings. First, the elimination of the corporate capital income tax has a negative effect on capital formation. For example, in an economy where entrepreneurs are allowed to borrow up to 25 per cent of their wealth, the removal of the corporate tax in a revenue-neutral experiment decreases the aggregate capital stock by 14 per cent. This finding is in direct contrast to the literature built on the earlier work of Summers (1981) and Auerbach and Kotlikoff (1987) on capital taxation in a life-cycle framework. The main force generating this new result is the decrease in the number of entrepreneurs, as they have the highest marginal propensity to save. A reduction in the number of entrepreneurs causes a fall in savings and decreases the aggregate stock of capital. The number of entrepreneurs decreases because, by removing the corporate tax, interest rates increase. An increase in interest rates eliminates the incentive to become an entrepreneur to avoid the double taxation of corporate capital income. Therefore, agents base their entrepreneurial choice on non-tax factors, such as entrepreneurial abilities and savings. Also, a higher interest rate means a higher cost of capital, since entrepreneurs rent capital at the market interest rate. This, in turn, implies a reduction in entrepreneurial profit (even when before-tax wage and interest rates are fixed). The high savings rate of entrepreneurs results from the fact that, in an incomplete capital markets setting, entrepreneurs must save to start a business and to self-insure against business shocks.

The second important finding is that the magnitude of the change in the capital stock (in absolute value) decreases as liquidity constraints and business risks become less severe. For instance, the decrease in the capital stock implied by the complete elimination of corporate income taxation is more than three times larger in an economy where entrepreneurs can borrow up to 25 per cent of their wealth than in an economy that allows business owners to borrow up to 75 per cent of their wealth. In the presence of tight borrowing constraints and entrepreneurial risks, savings will be higher than in a world with less binding borrowing constraints. As a result, the removal of the corporate tax will lead to a larger reduction in the capital stock in an economy with a more binding liquidity constraint than in an economy with a looser liquidity constraint.

Third, the removal of the corporate income tax (that is, the elimination of the differential taxation of corporate and non-corporate capital incomes) increases the fraction of total capital employed in the corporate sector. This result parallels findings provided by the vast literature that studied the consequences of corporate taxation (Harberger 1962; Gravelle and Kotlikoff 1989, 1995; U.S. Department of the Treasury 1992). In this paper, however, while the corporate share of total capital increases, the absolute level of corporate capital decreases after the corporate tax is eliminated. This decrease is due to the reduction of the aggregate stock of capital following the removal of the corporate tax. This finding is consistent with that by Feldstein and Slemrod (1980), who show that, in the presence of progressive personal income taxation, the introduction of a corporate income tax system could have a positive effect on corporate capital. However, Feldstein and Slemrod's analysis is limited to the allocation of a given capital stock.

This paper is organized as follows. Section 2 describes the major features of the model, and section 3 the calibration procedure. Section 4 describes the results and demonstrates the importance of liquidity constraints and business risk in examining the corporate income tax. It also discusses empirical evidence regarding liquidity constraints and business risk, and comments briefly on the efficiency effects of the corporate income tax. Section 5 summarizes the paper and presents the main conclusions.

# 2 Model Economy

The model economy builds on work done by Gravelle and Kotlikoff (1989, 1995), Li (1997), Erosa (2001), and Meh (2001). Its key features are as follows: (i) the model is 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 labour income; (iv) agents cannot borrow for consumption; (v) entrepreneurs can borrow capital to finance their business, but up to a fraction of their wealth, and the amount of capital rented cannot be diverted for other purposes; and, (vi) corporate and non-corporate sectors coexist and produce an identical good.

## 2.1 Preferences and occupation

### 2.1.1 *Preferences*

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

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

where $\beta$ is the intertemporal discount factor, $\sigma$ is the coefficient of relative risk aversion, and $c_j$ is the non-negative consumption at age $j$.

### 2.1.2 *Endowment and occupation*

In each period, age-$j$ individuals are endowed with $\varepsilon_j$ units of labour efficiency. This endowment of labour efficiency is the same within a cohort, but it is different between cohorts. At the mandatory age of retirement, $R+1$, and thereafter, the endowment of efficiency units of labour is zero.[4] Individuals of age below $R-1$ decide between two occupations in the next period: wage work and entrepreneurship. Whereas workers supply their efficiency units of labour inelastically to the market in return for the common wage rate, $w$, entrepreneurs use their entire labour efficiency to manage a single firm and receive the 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.[5]

### 2.1.3 *Information*

At the beginning of each period, workers and entrepreneurs realize idiosyncratic technological shocks from a finite set, $\mathcal{Z}=\left\{z^1,...,z^{N_z}\right\}$. The technological shocks received by workers (which can be interpreted as entrepreneurial ideas) are independently and identically distributed according to the cumulative distribution function, $H(z)$, with a probability density function, $h(z)$. In contrast, the uninsurable idiosyncratic technology shock faced by entrepreneurs follows a finite-state first-order Markov process, with conditional transition probabilities given by

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

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

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

where $z'$, $z \in \mathcal{Z}$.

The technology shock received by a worker does not affect their income.[6] In particular, the shock constitutes an imperfect signal about the next period's business quality in the event that the worker decides to become a business owner. A better entrepreneurial idea received by a worker at the beginning of the period implies a better distribution of the next period's technology shock, in the sense of first-order stochastic dominance.

In contrast with workers, technology shocks that entrepreneurs observe affect their entrepreneurial income. Further, fluctuations in entrepreneurs' incomes are not insurable, because idiosyncratic technology shocks are not verifiable by a third party. Finally, technological shocks are 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.

## 2.2 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.[7] 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 skill, and primarily reliant on personal wealth to operate, but they face greater difficulties in insuring and diversifying entrepreneurial risk.[8] The above assumptions are consistent with the work of Fazzari, Hubbard, and Petersen (1988), Gertler and Gilchrist (1994), and Gilchrist and Himmelberg (1994).

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

[7] 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 that Gravelle and Kotlikoff (1989, 1995) describes suggests that corporations coexist with non-corporate firms in every two-digit industry and in most of the three-digit ones.

[8] 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 tax. He investigates the importance of business ownership in explaining the high concentration of wealth in the U.S. economy.

### 2.2.1 *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 labour efficiency inputs, respectively, and $\theta$ denotes the corporate capital income share. Capital used in the corporate sector is assumed to depreciate geometrically at a rate of $\delta$.

### 2.2.2 *Non-corporate sector*

The non-corporate sector consists of a set of small firms run by entrepreneurs who finance their businesses either by 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 labour. 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,

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

where $0 < \nu < 1$ determines the degree of returns to scale and $B$ is a scalar. Note that $1 - \nu$ represents the share of output retained as rents by entrepreneurs.[9] 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.

## 2.3 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

[9] In other words, $\nu$ is the share of output that goes to non-entrepreneurial inputs, such as capital and labour.

asset portfolios, individuals are indifferent between corporate capital equity and deposits at financial intermediaries. 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, $a$.

Financial institutions collect deposits from individuals by paying an interest rate, $r_d$, and make loans to corporations and to entrepreneurs who need funds to finance their businesses. The interest rate on loans (to entrepreneurs and corporations) is identical to the interest on deposits.[10]

In this paper, loans are provided only for entrepreneurship. I assume that entrepreneurs cannot use the funds borrowed from intermediaries for purposes other than investments. I also assume that there is no intertemporal borrowing ($a' \geq 0$). As Evans and Jovanovic (1989) suggest, an entrepreneur can rent capital ($k_l$ units of capital) up to an amount that is proportional to their wealth, $a$, where the factor of proportionality is common to everyone and is denoted by $\gamma$. Furthermore, entrepreneurs cannot default on their loan (this assumption does not appear to be unreasonable, because most loans are collateralized in practice).[11] Empirically, Evans and Jovanovic (1989) and others document that small businesses are restricted in the amount of loans they can get from financial institutions. For example, they find that a person cannot, on average, use more that 1.5 times their initial asset for starting a new venture.[12] This evidence suggests that small businesses and new firms are liquidity-constrained. Given this result, the entrepreneur faces the constraint[13]

$$0 \leq k \leq (1+\gamma)a, \tag{5}$$

where the coefficient of proportionality, $\gamma$, satisfies $\gamma \geq 0$. The maximum amount of capital entrepreneurs can invest in their own business is equal to $(1+\gamma)a$.

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

[11]The borrowing constraint can arise endogenously as a feature of an optimal lending contract in environments characterized by asymmetric information and enforcement problems (e.g., Bernanke and Gertler 1989 and Albuquerque and Hopenhayn 1998). The imposition of an exogenous borrowing constraint is motivated by the need to keep the model tractable.

[12]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."

[13]I will show later that unconstrained entrepreneurs are indifferent between borrowing capital from the capital mutual funds or using their own wealth to finance the firm. I assume for simplicity that they will finance first with their own assets and then resort to financial intermediaries for the capital needed.

## 2.4 Government

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

## 2.5 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 technology shock, $z$;
- after observing the productivity shock, $z$, entrepreneurs rent capital, $k$, hire labour 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. In particular, age-$j$ workers below $R$ receive an idiosyncratic technology shock (entrepreneurial idea), $z$, and entrepreneurs of age $j$ below $R+1$ observe an idiosyncratic technology shock.[14] 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 labour efficiency to hire. Production in the corporate and non-corporate sectors then takes place, and the corporate tax rate, $\tau_c$, 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,

[14] At age $R$, workers do not receive any technology shock, since at age $R+1$ they will be retired. Entrepreneurs still receive technology shocks at age $R$.

and depreciation. Consumers then pay taxes, $\tau_i$, 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 technology shock.

### 2.5.1 *Entrepreneurial net income*

An entrepreneur observes the technology shock before choosing capital and labour inputs (there is no adjustment cost in capital and labour inputs). As a result, those inputs are chosen by solving an intratemporal profit maximization problem. Given $z$ and $a$, the entrepreneurial net income of an age-$j$ entrepreneur is given by the following expression

$$
\begin{aligned}
& (1+(1-\tau_i)r_d)(a-k_s)+ \\
& f(z,k_s+k_l,n)-wn-(r_d+\delta)k_l+(1-\delta)k_s- \\
& \tau_i\left[f(z,k_s+k_l,n)-wn-(r_d+\delta)k_l-\delta k_s\right] \\
\text{with } 0 \leq\ & k_s \leq a,\ 0 \leq k_l \leq \gamma a,\ \text{and } \overline{N} \geq n \geq 0.
\end{aligned} \tag{6}
$$

The first term in expression (6) is the after-tax return on the entrepreneur's deposits, $(a-k_s)$, at financial intermediaries.[15] The second term is the residual output after factor payments plus the non-depreciated part of the entrepreneur's own capital invested in the firm, $(1-\delta)\,k_s$. The tax paid on entrepreneurial income is the third term. As noted earlier, the government deducts only the depreciation of $k_s$, and it does not do so regarding the return the agent would have got if $k_s$ were deposited at financial intermediaries.[16]

After rearranging expression (6), the entrepreneur's net income becomes

$$
\begin{aligned}
& (1+(1-\tau_i)r_d)a+ \\
& (1-\tau_i)\left[f(z,k_s+k_l,n)-wn-(r_d+\delta)(k_l+k_s)\right], \\
\text{with } 0 \leq\ & k_s \leq a,\ 0 \leq k_l \leq \gamma a,\ \text{and } \overline{N} \geq n \geq 0.
\end{aligned} \tag{7}
$$

Define $\pi(z,a)$ as the adjusted entrepreneurial profit for given $z$ and $a$.[17] The entrepreneur chooses $k_s, k_l$, and $n$ to maximize their net income (which is equivalent to maximizing the

[15] 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 $a-k_s$.

[16] The opportunity of cost of $k_s$ is $(r_d+\delta)k_s$.

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

adjusted business income) by taking $w$, $r_d$, $z$, and $a$ as given. The adjusted profit maximization problem is as follows:

$$\begin{aligned}\pi(z,a) &= \max_{\{k_s,k_l,n\}}\{f(z,k_s+k_l,n)-wn-(r_d+\delta)(k_l+k_s)\}, \quad (8)\\ &\quad \text{subject to}\\ 0 &\leq k_s \leq a, \text{ and } 0 \leq k_l \leq \gamma a.\\ \overline{N} &\geq n \geq 0, \text{with } f(z,k,n) \text{ defined in expression (4).}\end{aligned}$$

Solving this problem shows that unconstrained individuals are indifferent between renting capital from intermediaries and using personal wealth to operate their business.[18] Thus, for simplicity, I assume that entrepreneurs will always first invest their own assets and then resort to financial intermediaries for loans. Consequently, an entrepreneur cares only about the total amount of capital invested, $k_s + k_l$, which is denoted by $k$. If $k > a$, the entrepreneur is a net borrower, and $k - a$ is the amount they must repay at the end of the period; if $k \leq a$, the entrepreneur self-finances entirely and makes a deposit of $a - k$ at the capital mutual fund. Therefore, the static profit maximization becomes

$$\pi(z,a) = \max\{f(z,k,n)-wn-(r_d+\delta)k\}, \quad (9)$$

subject to

$$0 \leq k \leq (1+\gamma)a, \quad (10)$$

$$\overline{N} \geq n \geq 0, \text{with } f(z,k,n) \text{ defined in expression (4).} \quad (11)$$

The first-order conditions are given by

$$\nu\theta zBk^{\nu\theta-1}n^{\nu-\nu\theta} \geq (r_d+\delta) \text{ with equality if } k < (1+\gamma)a, \quad (12)$$

$$(\nu-\nu\theta)zBk^{\nu\theta}n^{\nu-\nu\theta-1} = w. \quad (13)$$

If the entrepreneur is unconstrained ($k < (1+\gamma)a$), then the optimal capital input is given by

$$k^u(z) = \left[\frac{zB\alpha\left(\frac{(r_d+\delta)(\nu-\nu\theta)}{w\theta\nu}\right)^{\nu-\nu\theta}}{r_d+\delta}\right]^{\frac{1}{1-\nu}}. \quad (14)$$

[18] Intuitively, an unconstrained individual is indifferent between self-financing and borrowing, since (i) loans and deposits have the same interest rate, and (ii) the choice of capital input is made after the observation of the shock.

Thus, the decision rules of capital and labour inputs are given, respectively, by[19]

$$k(z,a) = \begin{cases} k^u(z), & \text{if } a > \frac{k^u(z)}{1+\gamma} \\ (1+\gamma)a, & \text{if } a \leq \frac{k^u(z)}{1+\gamma} \end{cases} \tag{15}$$

$$n(z,a) = \left[\frac{(\nu-\nu\theta)zBk(z,a)^{\nu\theta}}{w}\right]^{\frac{1}{1-(\nu-\nu\theta)}}. \tag{16}$$

## 2.6 The individual's decision problem

In this paper, I consider only stationary equilibriums 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 $V^w(z,a,j)$ to be the value function of an age-$j$ worker whose current period technology shock (or entrepreneurial idea) is $z$ and beginning-of-period net asset holdings are $a$. Similarly, define $V^e(z,a,j)$ as the value function of an age-$j$ entrepreneur whose beginning-of-period technology shock is $z$ and net asset holdings are $a$. Notice that, at age $R+1$ and thereafter, for a given age, $j$, the value functions $V^w(z,a,j)$ and $V^e(z,a,j)$ are identical for every $z \in \mathcal{Z}$. Therefore, I assume that a retired person is a worker (with zero labour efficiency). The household's decision is described in recursive language in which, after the terminal period, $J$, the value function is set to zero: $V^w(z,a,J+1) \equiv 0$.

## 2.7 The entrepreneur's problem

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

$$V^e(z,a,j) = \max_{\{a',e'\}} \{u(c) + \beta \max\{\sum_{z'\in\mathcal{Z}} h(z')V^w(z',a',j+1), \sum_{z'\in\mathcal{Z}} \Psi(z',z)V^e(z',a',j+1)\}\}, \tag{17}$$

subject to

$$c = (1+(1-\tau_i)r_d)a + (1-\tau_i)\pi(z,a) - a' \tag{18}$$

$$e' \in \{0,1\} \tag{19}$$

$$a', c \geq 0. \tag{20}$$

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

Entrepreneurs choose a non-negative amount of consumption, $c$, and the next period's risk-free asset holding, $a'$, 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.[20] In addition, entrepreneurs choose the next period's occupation, $e'$, which takes the value of 1 if the worker decides to be an entrepreneur, and zero otherwise. The expected value of continuing to be an entrepreneur for an age-$j$ entrepreneur in the next period (at age $j+1 \leq R$), conditional on the beginning of the next period's asset, $a'$, and current technology shock, $z$, is given by $\sum_{z' \in \mathcal{Z}} \Psi(z', z) V^e(z', a', j+1)$; 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, $a'$, is $\sum_{z' \in \mathcal{Z}} h(z') V^w(z', a', j+1)$. 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 1; otherwise, it equals zero. The function, $\pi$, in the budget constraint is the net tax business profit defined in equation (9).

## 2.8 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, $V^w(z, a, J+1) \equiv 0$.

$$
\begin{aligned}
V^w(z, a, j) &= \max_{\{a', e'\}} \{u(c) + \beta \max\{\sum_{z' \in \mathcal{Z}} h(z') V^w(z', a', j+1), \\
&\quad \sum_{z' \in \mathcal{Z}} \Psi(z', z) V^e(z', a', j+1)\}\},
\end{aligned}
\tag{21}
$$

subject to

$$
\begin{aligned}
c &= (1 - \tau_i) w \varepsilon(j) + (1 + (1 - \tau_i) r_d) a - a' \\
e' &\in \{0, 1\} \\
c, a' &\geq 0.
\end{aligned}
\tag{22}
$$

Workers and retired agents choose a non-negative consumption, $c$, and the next period's risk-free asset holding, $a'$, which is restricted to be non-negative. Workers also choose the next period's ($j+1 \geq R$) occupation, $e'$. At any point in time, a worker's resources come from the return on the asset holding, $a$, and labour efficiency endowment, $\varepsilon(j)$. Asset holdings pay an

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

after-corporate-tax risk-free rate of interest, $r_d$, and labour receives a real wage, $w$. Labour income and return to capital are taxed at a rate of $\tau_i$. The only source of income for retired individuals is the after-tax return on wealth. Appendix A defines a steady-state equilibrium.

# 3 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 equity 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 equity, 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 equilibriums.

## 3.1 Preferences

The discount factor, $\beta$, is set endogenously such that, in equilibrium, the annual after-tax interest rate is 0.04.[21] The value of the intertemporal elasticity of substitution, $1/\sigma$, follows the estimates reviewed by Auerbach and Kotlikoff (1987) and Prescott (1986). Following Gravelle and Kotlikoff (1995), I choose a value of 0.25; in other words, $\sigma = 4$. As part of a sensitivity analysis, I also use 2.0 and 5.0 for $\sigma$.

## 3.2 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 $R + 1 = 46$).

## 3.3 Labour abilities

The efficiency units of labour are intended to provide a realistic cross-sectional age distribution of earnings at a point in time. Following Cubeddu (1996), I compile these labour 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 labour earnings and mean hours worked. Mean wages are calculated by simply dividing mean earnings by mean hours

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

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.

## 3.4 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 at the personal level, through individual income taxes. In calibrating the corporate tax rate, $\tau_c$, I follow Mendoza, Razin, and Tesar (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, $\tau_i$, is set such that the average share of government consumption in output is 0.195. This implies an income tax rate of 0.196. Obviously, this implies that most government revenue comes from personal income taxes.

## 3.5 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 labour income share is 0.67. Therefore, I set $\theta = 0.33$. The depreciation rate, $\delta$, 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, $\nu$, determines the degree of returns to scale. Similar to Basu and Fernald (1997), who find that this parameter is close to 1, I choose a value of 0.97. Given the values of $\nu$ and $\theta = 0.33$, the capital income share in the non-corporate sector is about 0.3201.[22]

### 3.6 Entrepreneurial ideas and technological shocks

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

$$\ln z_t = (1-\rho)\mu_w + \rho \ln z_{t-1} + \epsilon_t, \text{ with } \epsilon_t \sim N(0, \sigma_\epsilon^2). \tag{23}$$

I assume that the shock, $z$, takes seven possible values ($N_z = 7$), evenly spaced in the log scale ranging from -4$\sigma_w$ to 4$\sigma_w$. The parameters $(\mu_w, \sigma_w, \sigma_\epsilon, \rho)$ are set to match the following four targets in equilibrium: (i) the share of entrepreneurs in the labour force is about 0.08 (e.g., see Gollin 1996), (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 self-employment is about 0.029, and (iv) the average annual exit rate out of self-employment is 0.18. The entry rate into and the exit rate out of self-employment are taken from Quadrini (2000), who computeds the rates by using the Panel Study of Income Dynamics (PSID) data.[23] These endogenous parameters $(\mu_w, \sigma_w, \sigma_\epsilon, \rho)$ are listed in Table 2.

### 3.7 Credit constraints

Evans and Jovanovic (1989) find that a person cannot borrow *more* than 50 per cent of their assets for starting a business. I choose, however, the credit constraint parameter $\gamma = 0.25$

[22] In models without credit constraints on entrepreneurs, the capital income share should be $\nu\theta$, which is about 0.33. In my model, however, $\nu\theta$ is the share of capital in the income of unconstrained entrepreneurs only. A constrained entrepreneur spends $(r_d+\delta)(1+\gamma)a$ on capital and gets $zB\left(k^\theta n^{1-\theta}\right)^\nu$ in output. This yields a capital income share of $\frac{(r_d+\delta)(1+\gamma)a}{zB\left\{[(1+\gamma)a]^\theta n^{1-\theta}\right\}^\nu}$. However, since for constrained individuals the condition $zB\nu\theta\left\{[(1+\gamma)a]^{\nu\theta-1} n(a)^{\nu-\nu\theta}\right\} > r_d+\delta$ is satisfied, the capital income share is less than $\nu\theta$. As a result, the empirical share of capital exceeds $\nu\theta$ for the constrained entrepreneurs. Therefore, the estimate of $\nu\theta$ should be less than 0.33.

[23] Gollin (1996) computes the measure of entrepreneurs by using data from the International Labour Organization (1993). The labour force is defined as employers and own-account workers, employees, unpaid family workers, members of producer cooperatives, and persons not classifiable by status. Entrepreneurs consist of employers and own-account workers, who are unincorporated.

in the benchmark economy. To see the role played by credit constraints in evaluating the consequences of corporate taxation, I also consider higher values of $\gamma$; that is, $\gamma = 0.50$ and $\gamma = 0.75$.[24] For each value of $\gamma$, I recalibrate a set of model parameters $(\beta, \tau_i, \mu_w, \sigma_w, \sigma_\epsilon, \rho)$ to obtain the same targets. Table 2 reports the calibrated parameters of the benchmark economy.

# 4 Quantitative Findings

Section 4.1 reports the benchmark results, where entrepreneurs can borrow only up to 25 per cent of their net worth. Section 4.2 describes the implications of eliminating the corporate income tax when the credit constraint is set at 0.25. Section 4.3 describes the extent to which liquidity constraints and business risks matter in assessing the implications of eliminating the double taxation on corporate capital income. Section 4.4 reports on a sensitivity analysis, and section 4.5 discusses the research results.

## 4.1 Benchmark results

**Targets:** In column 3 of Table 3, I report the values of the targets for the benchmark economy when $\gamma = 0.25$. As the table shows, the model replicates most of the targets relatively well. For instance, the after-tax interest rate is about 3.9 per cent in the model, while it was 4 per cent in the U.S. data. The calibrated income tax rate is 0.196.

**Distribution of wealth and income:** Table 4 lists the distributions of income and wealth for the United States and the model economies when $\gamma = 0.25$.[25] 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 0.458, which is close to that observed for the U.S. economy.[26] 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 20 per cent and 30 per cent of agents hold, respectively, 57.4 per cent and 75.2 per cent of the total wealth.[27] As the second row of Table 4 shows, these numbers are far from the empirical

[24] Because the results are similar in both cases, I present the analysis only for $\gamma = 0.75$.

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

[26] 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.

[27] Hugget (1996) is successful in replicating the wealth Gini index. However, he fails to replicate the concentration of wealth. Unlike in the current paper, workers in Hugget's model face uninsurable fluctuations in their labour incomes.

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.[28]

**Life-cycle and entrepreneurship:** Table 5 shows how entrepreneurial activities are distributed over the life cycle. It is evident that entrepreneurs are older than workers. The measure of entrepreneurs for under age 36 is zero and subsequently increases with age. 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 liquidity 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 risk. This finding contrasts with that of Miller (1984), who argues that individuals choose riskier occupations, such as entrepreneurship, when they are younger.

**A Comparative statics analysis:** Table 6 shows the impact of changes in the liquidity constraint under the assumption that taxes and before-tax factor prices remain constant at their benchmark levels. An increase in $\gamma$ implies that business investments become less dependent on personal wealth. The capital market conditions represented by $\gamma$ have significant effects on capital accumulation and output. In particular, an increase in $\gamma$ from 0.25 to 0.75 increases the capital stock and total output by 24.8 and 37.9 per cent, respectively. Since before-tax factor prices are fixed, the increase in the capital stock comes mostly from the fact that the number of entrepreneurs is also increasing. As $\gamma$ increases, the average size of businesses (in terms of labour and capital) increases, and, as a result, entrepreneurial profits also rise. Since entrepreneurs have a higher marginal propensity to save, the capital stock increases. Two main factors contribute to the higher accumulation pattern of entrepreneurs: the incentive to save to (i) undertake an entrepreneurial activity, and (ii) implement a larger project in the presence of credit constraints and uninsurable entrepreneurial risk. When agents make the occupational choices, they know with certainty the income they would earn as workers. However, if they decide to become entrepreneurs, their income depends on the realization of the shocks, which are unknown when the occupational choice is made. Therefore, in becoming entrepreneurs, the agents face higher income uncertainty, inducing them to save more for

[28] 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.

precautionary reasons.[29]

Production also increases because, in the presence of credit constraints, some agents do not decide to become entrepreneurs, even though they have the best entrepreneurial ideas. If they do decide to become entrepreneurs, individuals who are constrained will operate with a suboptimal amount of capital. Therefore, relaxing the liquidity constraint allows those agents to become entrepreneurs and implement good ideas, which, in turn, implies an increase in production efficiency.

The third row of Table 6 indicates that an increase in $\gamma$ reduces the fraction of both the aggregate capital employed in the corporate sector and the percentage of total output produced by corporations. This result is intuitive, since in the presence of less tight liquidity constraints it becomes easier to avoid the corporate capital income tax. Hence, for constrained individuals the corporate tax is neutral, since they cannot avoid the double taxation of corporate income by becoming entrepreneurs. This result is consistent with Stiglitz (1973).

## 4.2 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. Tables 7, 8, and 9 summarize the results of the policy experiment.

**Aggregate effects:** Table 7 lists descriptive statistics for the model economy under the policy reform. The switch to an economy without a corporate tax system has a deleterious effect on capital accumulation. As the first row of Table 7 shows, the removal of the corporate income tax decreases the capital stock by almost 14 per cent. This surprising result is mainly owing to the sizable decrease in the number of entrepreneurs (from 7.3 to 5.1 per cent of the population), because in the model they have the highest marginal propensity to save. Business owners have a high marginal propensity to save because they do so not only for retirement but also to start a business and to self-insure against entrepreneurial risk. The fall in the number of entrepreneurs results from the elimination of the double taxation, which increases the after-tax interest rate from 4.0 to 7.0 per cent. 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. The fall in the number of entrepreneurs and the capital stock also generates a decrease in total output by about 5 per cent. Thus, complete removal of the corporate tax has a negative impact on

[29] Like workers, entrepreneurs also save to provide for old-age consumption.

production efficiency.

Table 7 also shows that the decrease in the number of entrepreneurs leads to a rise in non-entrepreneurial labour, which in turn implies a decrease in the wage rate. This decrease in the wage rate increases average labour input per business by about 21 per cent.

Table 8 reports the allocative implications of eliminating the corporate income tax. Interestingly, the fraction of total capital employed in the corporate sector increases by about 9 per cent when the corporate tax is removed. The corporate share of total output also increases from 55.5 to 63.8 per cent. These findings are consistent with previous studies by Harberger (1962) and Gravelle and Kotlikoff (1989, 1995). However, the absolute level of corporate capital after the elimination of the corporate tax is smaller than prior to its elimination, owing to the fall in the aggregate stock of capital after the corporate tax is eliminated. This finding is consistent with Feldstein and Slemrod (1980), who demonstrate that, in the presence of progressive income taxation, the introduction of a corporate income tax system could have a positive effect on corporate capital.[30]

Another important result is that the complete removal of the corporate tax reduces steady-state aggregate consumption. However, this experiment compares steady states and ignores the transition dynamics. To make an accurate normative statement about the desirability of either tax system, I would have to take into account the transition paths from one steady state to the other as well (see Auerbach and Kotlikoff 1987).

The elimination of the corporate tax is equivalent to a cut in the overall average capital income tax rate. Therefore, the numerical findings in the current paper suggest that cutting capital income tax and replacing it with a single higher income tax rate decreases capital accumulation and aggregate output. This result contradicts the findings of Summers (1981) and Auerbach and Kotlikoff (1987), among others.[31]

**Distributional effects:** Table 9 reports the distributional implications of eliminating the corporate income tax. I find that the elimination of the double taxation of corporate capital income has virtually no effect on wealth inequality. The wealth Gini coefficient increases by less than 1 percentage point, and the fraction of total wealth owned by the top 20 per cent of wealth holders increases from 57.4 to 58.2 per cent.

[30] Notice that, because the model of Feldstein and Slemrod is static, the aggregate capital stock is fixed. Consequently, a decrease (an increase) in corporate capital is equivalent to a decrease (an increase) in the corporate share of total capital. This equivalence does not necessarily hold in the current paper, since the model is dynamic and the aggregate capital is not fixed.

[31] İmrohoroğlu (1998) studies the quantitative impact of eliminating capital income taxation on capital accumulation and steady-state welfare in an economy populated by overlapping generations facing idiosyncratic earnings risk, borrowing constraints, and life-span uncertainty. He finds that the capital income tax that maximizes the steady-state welfare is positive. His result is due to the fact that in an incomplete markets setting, the increase in the wage tax to offset the revenue loss from the decrease in the capital income tax rate reduces an individual's ability to self-insure against shocks.

Similarly, the removal of the double taxation of corporate income increases the concentration of income only slightly. As the second panel of the table shows, the income Gini increases from 0.458 to 0.464. This increase in the income Gini index is due to the fall in the wage rate. More precisely, the decrease in the wage rate, while reducing workers' incomes, increases entrepreneurial profits, and this in turn implies a greater inequality between workers and entrepreneurs.

## 4.3 Importance of liquidity constraints and business risk

In examining the importance of credit constraints and business risk to the quantitative impact of removing corporate taxation, I consider two alternative economies: one in which business formation depends relatively less on personal wealth ($\gamma = 0.75$), and one where business risk is completely eliminated. Each economy is recalibrated to the same targets as in the benchmark economy.

**Importance of liquidity constraints:** To quantify the effects of the corporate tax in an economy with less rigid credit constraints, I calibrate the model to the same targets as in the previous exercise. The new calibrated income tax rate in this case is 0.203.

As Table 10 shows, the negative effects of eliminating the corporate income tax on capital accumulation decreases as the liquidity constraint becomes less binding. In particular, the decrease in the aggregate capital stock is 14 and 4 per cent, if the tightness of the liquidity constraints are 0.25 and 0.75, respectively. Stated differently, the reduction in the stock of capital in an economy where entrepreneurs can borrow up to 25 per cent of their personal wealth is more than three times larger than in an economy that allows business owners to borrow up to 75 per cent of their personal wealth. To understand this result, I consider two economies that have no corporate tax but differ in the tightness of the liquidity constraint. *Ceteris paribus*, in the absence of the corporate tax, an economy with tighter liquidity constraints will have more capital than an economy with looser liquidity constraints. The main factor generating this result is that the tighter the borrowing constraint, the more people save to set up a business or to implement a larger project. The introduction of the corporate income tax provides incentives for individuals to become entrepreneurs to avoid the low return on savings implied by the double taxation on corporate capital income. As a result, introducing the corporate income tax system into an economy with a tight liquidity constraint will increase capital accumulation more than in an economy with a looser liquidity constraint. The same conclusion applies to other variables, such as aggregate output and aggregate consumption.

This finding suggests that liquidity constraints are important in assessing the effects of corporate tax elimination. This paper also suggests that as the liquidity constraint becomes less binding, the prediction of the removal of the corporate tax in this model becomes more consistent with the findings in Summers (1981), Harberger (1962), and Gravelle and Kotlikoff (1995).

**Importance of business risk:** To determine the role played by the risk associated with businesses, I consider an economy identical to the benchmark one, except that business risk is eliminated. Specifically, the entrepreneurial idea, $z$, 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, $\Psi$, is an identity matrix, which implies that only the parameters $(\beta, \tau_i, \mu_w, \sigma_w)$ have to be calibrated to match the same targets as in the benchmark (without the entry rate into and exit rate from entrepreneurship).

When business ownership is not risky, precautionary motives are eliminated, and individuals who become entrepreneurs save mainly because of the liquidity constraints. Hence, it is intuitive to expect that the amount of wealth that entrepreneurs hold might be low when there is no business risk. Table 11 reports changes in aggregate capital and output when entrepreneurial risk is eliminated. The table shows that in the absence of business risk, complete elimination of the corporate tax decreases aggregate capital stock by 6 per cent, while in the presence of entrepreneurial risk the decrease is about 14 per cent. This result indicates that business risk accounts for a large portion of the decrease in the capital stock when the corporate income tax is eliminated.

## 4.4 Sensitivity analysis

Section 4.3 suggests that the degree of risk aversion might be important since precautionary savings play significant roles in understanding the results. Therefore, I conduct some experiments with higher ($\sigma = 5.0$) and lower ($\sigma = 2.0$) coefficients of relative risk aversion. The model is recalibrated to match the same targets of the benchmark economy. I also conduct an experiment in a small open economy to determine the sensitivity of the numerical findings of section 4.3 to the assumption of a closed economy.

**Higher risk aversion:** The first column of Table 12 shows the results. The elimination of the corporate income tax has a much greater negative effect on capital accumulation than the results shown in Table 7. In particular, capital stock decreases by 27 per cent and output is reduced by more than 10 per cent. The intuition behind this result is attributed to the precautionary saving. When individuals are more risk-averse, agents who decide to become entrepreneurs (because of the corporate tax) have to accumulate enough assets to self-insure against the high fluctuation in entrepreneurial profits.

**Lower risk aversion:** The second column of Table 12 reports the results for lower risk aversion. Surprisingly, eliminating the corporate tax now has a positive effect on capital accumulation and output, even though the number of entrepreneurs still falls. Specifically, the capital stock increases by 7 per cent and output by 1.6 per cent. To understand this new result, notice that when agents are less risk-averse, they care less about consumption smoothing. As a result, they save less for precautionary motives. Therefore, savings are more sensitive to changes in the after-tax interest rate. Consequently, the increase in savings that results from eliminating the corporate income tax outweighs the decrease in entrepreneurial savings. To further understand this result, I consider the effects of the corporate tax in an economy where the relative risk-aversion coefficient is still set at 2.0, but the liquidity constraint is severe and $\gamma$ takes the value of 0.05. In this way, a person who decides to become or continues to be an entrepreneur has to rely more on self-financing and can borrow only up to 5 per cent of their wealth. Table 13 shows the result of this experiment: capital stock and output decrease after the corporate tax is removed. Thus, this research shows that as long as the liquidity constraint is severe enough and the risk associated with business ownership is high enough, eliminating the corporate tax has a negative impact on capital accumulation. Stated differently, in the presence of tight liquidity constraints and high business risk, the corporate tax has a positive effect on aggregate capital stock and output.

**Small open economy:** Table 14 summarizes the findings of eliminating the corporate tax in a partial equilibrium version of the model. To approximate the behaviour of a small open economy, the before-tax interest rate and the wage rate are fixed at their benchmark values. The quantitative effects of completely eliminating the corporate income tax are stronger in the small open economy than in the closed economy assumption and the general-equilibrium analysis of Tables 7, 8, and 9. Total capital decreases by 20 per cent instead of 14 per cent, and total output drops by 9 per cent instead of 5 per cent. This result is explained by the 63 per cent fall in the number of entrepreneurs. The decrease in the number of entrepreneurs is higher in the small open economy than in the closed economy because in addition to the high interest rate that results from eliminating the corporate tax, the opportunity cost of entrepreneurship–the wage rate–is higher (as it is held constant).[32] Moreover, the signs of the different effects are maintained except for average labour demand per business, which now falls by about 1 per cent.

Table 14 suggests that the elimination of the corporate tax substantially increases the fraction of aggregate capital stock used by corporations. The share of corporate capital rises

[32] The opportunity cost of becoming an entrepreneur (that is, the foregone wage income) is lower in a closed economy than in a small open economy. Consequently, there is a smaller decrease in the number of entrepreneurs in a general-equilibrium framework than in a partial equilibrium analysis, which holds the before-tax wage rate constant.

from 0.77 to 0.91. The source of this result is the decrease in both the number of entrepreneurs and the average entrepreneurial business size. For example, the average capital per business decreases by 17 per cent.

Table 14 also shows that, similar to the general-equilibrium analysis, eliminating the double taxation of corporate capital income has almost no effect on the distribution of assets. Wealth inequality measured by the Gini coefficient increases from 0.601 to 0.605. In the partial equilibrium model, however, removing the corporate income tax leads to a decrease in income inequality. Indeed, the income Gini coefficient drops from 0.451 to 0.430. Income is more equally distributed after the tax reform in the partial equilibrium setting, because the income of the remaining entrepreneurs is low, since the wage rate is constant and the rental rate of capital increases. Therefore, even though the number of entrepreneurs decreases, they do not have a higher fraction of total income.

## 4.5 Discussion

In this paper, I have argued that if liquidity constraints and risks associated with business ownership are severe enough, the corporate tax has a positive impact on capital accumulation and output. By reducing the returns on savings, the corporate tax provides incentives for individuals to become entrepreneurs, as they would then pay only the personal income tax. However, because of capital market imperfections, potential entrepreneurs must accumulate the necessary assets to start a business. This latter mechanism may lead to an increase in capital accumulation under plausible parameter values. By raising the aggregate capital stock, the corporate income tax could actually increase the amount of capital employed in the corporate sector. However, in the numerical analysis, the aggregate capital stock increases more than corporate capital, so that the corporate share of total capital decreases after a rise in the corporate income tax. To the best of my knowledge, this paper is the first to investigate the effects of the corporate income tax on savings decisions, and the allocations of resources between corporate and non-corporate sectors in the presence of liquidity constraints and uninsurable entrepreneurial risks.[33]

It is clear that my results are driven by the assumption of capital market imperfections. As a result, one may wonder whether liquidity constraints and business risks exist empirically. Many economists have argued extensively that capital constraints play an important role in business creation. Evans and Jovanovic (1989), Evans and Leighton (1989), and Holtz-Eakin, Joulfaian, and Rosen (1994a,b) investigate the links between entry into entrepreneurship and wealth. They find that there is a positive correlation between an individual's personal wealth and the probability that an individual becomes an entrepreneur. Ando (1985) finds that most

[33]The increase in the absolute level of corporate capital after a rise in the corporate tax rate is similar to the findings of Feldstein and Slemrod (1980). However, their model is a static one, so they are missing the effect of the corporate tax on savings decisions.

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 per cent of the firms in their sample reached the maximum amount of their commitment size. These findings suggest that new businesses are liquidity constrained and that the amount of capital available to them is limited to business owners' personal wealth.

I have also assumed 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 document that business ownership is risky.[34] Holtz-Eakin, Rozen, and Weathers (2000) find that households entering self-employment experience more upward and downward mobility in income distribution than households that continue to work for someone else. Borjas (1999) reports that the standard deviation of log weekly income is higher among the self-employed than among paid workers. This evidence suggests that entrepreneurship entails more variable payoffs than continuing to work for someone else.

In this paper, I consider only business risks; it would be interesting to also account for uninsurable fluctuations in labour earnings when studying the effects of the corporate tax on capital formation. I believe that this modification would not change the results in the current study as long as entrepreneurial incomes are more variable than labour earnings.

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 inter-industry distortions, within-industry distortions, and intertemporal distortions. However, intertemporal distortions in past studies capture only one side of the story: 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 corporate tax reduces the return to savings), as long as liquidity constraints and idiosyncratic business risks are severe enough. 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 efficiency generated by the misallocation of resources between corporate and non-corporate sectors.

Without a better understanding of the nature and source of the liquidity constraints, the welfare implications of the corporate income tax in an incomplete capital markets setting are unclear (e.g., see Krueger and Perri 1999). This welfare analysis with an endogenous borrowing constraint is left for future research.

[34]See Gentry and Hubbard (2000) for a review of the literature.

## 5 Conclusion

This paper has investigated the consequences of eliminating the corporate capital income tax in a general-equilibrium model of occupational choice, in which the non-corporate sector is subject to liquidity constraints and uninsurable entrepreneurial risks. In this economy, the corporate tax provides individuals with incentives to become entrepreneurs, as it reduces the return on financial assets. Because, in the presence of liquidity constraints and business risks, personal wealth plays a critical role in business formation, the corporate income tax may have a positive impact on asset accumulation.

Under a wide range of parameter configurations, I have found that the complete elimination of the corporate income tax is harmful to capital accumulation, production, and aggregate consumption. The negative effects of eliminating the corporate income tax on the economy decrease as borrowing constraints and risks associated with business ownership become less severe. Hence, the findings in this paper are similar to those of Summers (1981), Auerbach and Kotlikoff (1987), and Gravelle and Kotlikoff (1995), among others, when liquidity constraints are not binding and the risk of failure associated with business ownership is low. I have also found that eliminating the corporate income tax may actually reduce the amount of capital used in the corporate sector. This surprising result is mainly owing to the decrease in the aggregate stock of capital brought about by the corporate tax reform. However, the fraction of aggregate capital employed in the corporate sector increases when the corporate tax is removed.

Furthermore, within the model, the corporate tax encourages entrepreneurial risk-taking. On the one hand, the corporate tax provides agents with incentives to become entrepreneurs to avoid the double taxation of corporate capital income. On the other hand, entrepreneurship is a risky business and business owners must bear the risk of failure.[35]

[35] Domar and Musgrave (1944) were the first to study the link between taxation and risk-taking.

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Table 1: Endowment of Efficiency Units of Labour

| 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.

Table 2: Calibrated Parameters of the Benchmark Economy

| Parameters | | Values |
|---|---|---|
| $\sigma$ | Relative risk aversion | 4 |
| $J$ | Lifetime | 55 |
| $R$ | Retirement | 45 |
| $\theta$ | Corporate capital income share | 0.330 |
| $\nu$ | Degree of return to scale | 0.970 |
| $\delta$ | Capital depreciation rate | 0.062 |
| $\tau_c$ | Corporate income tax rate | 0.290 |
| $\tau_i$ | Income tax rate | 0.196 |
| $\beta$ | Discount factor | 0.961 |
| $\mu_w$ | Mean of ideas | 0.208 |
| $\sigma_w$ | Standard deviation of ideas | 0.124 |
| $\sigma_\epsilon$ | N(0,$\sigma_\epsilon^2$) | 0.065 |
| $\rho$ | Coefficient of autocorrelation | 0.809 |

Table 3: Targets and Statistics of Benchmark Economy

| | U.S. economy | Benchmark |
|---|---|---|
| After-tax interest rate | 0.040 | 0.0398 |
| $G/Y$ | 0.195 | 0.1960 |
| Entrepreneurs | 0.080 | 0.073 |
| $K_c/K$ | 0.700 | 0.767 |
| Entry rate | 0.029 | 0.026 |
| Exit rate | 0.170 | 0.165 |

Table 4: Income and Wealth Distributions in the Benchmark Economy and Data

| | **Wealth** | | | **Income** | | |
|---|---|---|---|---|---|---|
| | Gini | Top 20% | Top 30% | Gini | Top 20% | Top 30% |
| | | (%) | (%) | | (%) | (%) |
| Baseline | 0.601 | 57.4 | 75.2 | 0.458 | 47.3 | 63.2 |
| U.S. economy | 0.72-0.84 | 76.0 | 86.0 | 0.440 | 47.0 | 60.1 |

Table 5: Measure (in Percentage) of Entrepreneurs by Age

| Age | Benchmark | No corporate tax |
|---|---|---|
| Less than 54 | 0.0 | 0.0 |
| 54 | 0.0 | 6.2 |
| 55 | 0.0 | 9.9 |
| 56 | 5.9 | 11.9 |
| 57 | 9.3 | 13.4 |
| 58 | 11.4 | 14.2 |
| 59 | 14.4 | 15.0 |
| 60 | 17.8 | 16.5 |
| 61 | 20.8 | 19.1 |
| 62 | 49.0 | 21.5 |
| 63 | 60.7 | 24.3 |
| 64 | 65.4 | 27.6 |
| 65 | 68.9 | 30.2 |
| 21-75 | 7.2 | 4.7 |

Table 6: Comparative Statistics With Respect to $\gamma$

| | $\gamma = 0.25$ | $\gamma = 0.50$ | $\gamma = 0.75$ |
|---|---|---|---|
| Capital stock | 2.387 | 2.706 | 2.957 |
| Output | 1.300 | 1.351 | 1.770 |
| Corporate capital/Total capital | 0.767 | 0.626 | 0.542 |
| Corporate output/Total output | 0.555 | 0.257 | 0.268 |
| Entrepreneurs | 0.073 | 0.098 | 0.099 |
| Average capital per business | 8.938 | 11.877 | 15.817 |
| Average labour per business | 5.612 | 7.280 | 9.399 |
| Personal capital/Business capital (%) | 0.800 | 0.667 | 0.572 |

Table 7: Aggregate Statistics of Removing the Corporate Income Tax

| | Benchmark | No corporate tax | % change |
|---|---|---|---|
| **Aggregate** | | | |
| Capital | 2.387 | 2.056 | -13.9 |
| Output | 1.300 | 1.238 | -4.8 |
| Consumption | 0.897 | 0.855 | -4.7 |
| Non-entrepreneurial labour | 0.814 | 0.838 | 2.9 |
| Entrepreneurs | 0.073 | 0.051 | -30.1 |
| | | | |
| **Prices and taxes** | | | |
| Before-tax wage rate | 1.055 | 0.979 | -7.2 |
| Before-tax interest rate | 0.069 | 0.091 | 31.9 |
| After-corporate-tax interest rate | 0.049 | 0.091 | 85.7 |
| After-tax interest rate | 0.039 | 0.070 | 79.5 |
| Corporate tax rate | 0.290 | 0.000 | |
| Income tax rate | 0.196 | 0.230 | 17.3 |

Table 8: Allocative Implications of Removing the Corporate Income Tax

| | Baseline | No corporate tax | % changes |
|---|---|---|---|
| **Corporate** | | | |
| Output | 0.722 | 0.789 | 9.3 |
| Capital | 1.820 | 1.709 | -6.1 |
| Labour | 0.458 | 0.540 | 17.9 |
| Capital/Total capital | 0.767 | 0.831 | 8.3 |
| Output/Total output | 0.555 | 0.638 | 15.0 |
| **Non-corporate** | | | |
| Output | 0.578 | 0.448 | -22.5 |
| Capital | 0.568 | 0.347 | -38.9 |
| Labour | 0.356 | 0.298 | -16.3 |
| **Entrepreneurs** | | | |
| Measure of entrepreneurs | 0.073 | 0.051 | -30.1 |
| Average capital per firm | 8.938 | 7.901 | -11.6 |
| Average labour per firm | 5.612 | 6.785 | 20.9 |
| Entry rate | 0.026 | 0.018 | -30.8 |
| Exit rate | 0.165 | 0.229 | 38.8 |
| Personal cap./Business | 0.800 | 0.800 | -0.0 |

Table 9: Distributional Features of Removing the Corporate Income Tax

| | Wealth | | | Income | | |
|---|---|---|---|---|---|---|
| | Gini | Top 20% | Top 30% | Gini | Top 20% | Top 30% |
| | | (%) | (%) | | (%) | (%) |
| Benchmark | 0.601 | 57.4 | 75.2 | 0.458 | 47.3 | 63.2 |
| No corporate tax | 0.607 | 58.2 | 75.5 | 0.464 | 48.6 | 63.7 |

Table 10: Changes in Economic Variables After Removing the Corporate Income Tax by $\gamma$

| | $\gamma = 0.25$ | $\gamma = 0.75$ |
|---|---|---|
| | (%) | (%) |
| Capital | -13.9 | -3.6 |
| Output | -4.8 | -1.3 |
| $K_c/K$ | 8.3 | 6.2 |
| Entrepreneurs | -30.1 | -9.2 |

Table 11: Changes in Economic Variables After Removing the Corporate Income Tax in the Absence of Business Risk

| | Business risk and liquidity constraint | No business risk and liquidity constraint |
|---|---|---|
| | (%) | (%) |
| Capital | -13.9 | -5.9 |
| Output | -4.8 | -1.9 |
| $K_c/K$ | 8.3 | 2.4 |
| Entrepreneurs | -30.1 | -8.2 |

Table 12: Changes in Economic Variables After Removing the Corporate Income Tax for Lower and Higher Risk Aversion

| | Higher risk aversion ($\sigma$=5.0) | Lower risk aversion ($\sigma$=2.0) |
|---|---|---|
| | % | % |
| Capital | -26.8 | 7.0 |
| Output | -10.3 | 1.6 |
| $K_c/K$ | 6.6 | 7.6 |
| Entrepreneurs | -34.4 | -26.8 |

Table 13: Changes in Economic Variables After Removing the Corporate Income Tax when $\sigma = 2.0$ and $\gamma = 0.05$

| | (%) |
|---|---|
| Capital | -0.2 |
| Output | -0.7 |
| $K_c/K$ | 8.9 |
| Entrepreneurs | -42.6 |

Table 14: Partial Equilibrium Results After Removing the Corporate Income Tax ($\gamma = 0.25$)

| | Baseline | No corporate tax | % changes |
|---|---|---|---|
| **Aggregate** | | | |
| Capital stock | 2.387 | 1.918 | -19.6 |
| Output | 1.300 | 1.188 | -8.6 |
| **Sectors** | | | |
| Corporate output | 0.721 | 0.970 | 34.5 |
| Non-corporate output | 0.578 | 0.217 | -62.5 |
| Corporate capital/Total capital | 0.767 | 0.907 | 18.3 |
| Corporate output/Total output | 0.555 | 0.817 | 47.2 |
| **Non-corporate** | | | |
| Entrepreneurs | 0.073 | 0.027 | -63.0 |
| Average capital per business | 8.938 | 7.495 | -16.1 |
| Average labour per business | 5.612 | 5.653 | 0.7 |
| **Distribution** | | | |
| Wealth Gini index | 0.601 | 0.605 | 0.7 |
| Income Gini index | 0.458 | 0.430 | -6.1 |
| **Income tax rate** | 0.196 | 0.232 | 18.4 |

## 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 distribution of workers (and retirees) and entrepreneurs, $(\mu_j^w(z,a), \mu_j^e(z,a))$; aggregate capital and labour 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' problems (21) and (17), 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:

$$w = (1-\theta)\left(\frac{K_c}{N_c}\right)^{\theta}, \tag{24}$$

$$r_d = (1-\tau_c)\left[\theta\left(\frac{K_c}{N_c}\right)^{\theta-1} - \delta\right]. \tag{25}$$

3. Capital and labour markets clear:

$$\sum_j \sum_z \left\{\int_a k(z,a,j)\,\mu_j^e(z,a)\,da\right\} + K_c = \sum_j \sum_z \left\{\int_a a\mu_j^e(z,a)\,da\right\} + \sum_j \sum_z \left\{\int_a a\mu_j^w(z,a)\,da\right\}, \tag{26}$$

$$\sum_j \sum_z \left\{\int_a n(z,a,j)\,\mu_j^e(z,a)\,da\right\} + N_c = \sum_j \sum_z \left\{\int_a \varepsilon(j)\mu_j^w(z,a)\,da\right\}. \tag{27}$$

4. The government budget is balanced:

$$G = \tau_c\left(\frac{r_d}{1-\tau_c}\right)K_c + \tau_i\left[\sum_j \sum_z \left\{\int_a (r_d a + w\varepsilon(j))\mu_j^w(z,a)\,da\right\}\right] + \tau_i\left[\sum_j \sum_z \left\{\int_a (r_d a + \pi(z,a,j))\mu_j^e(z,a)\,da\right\}\right]. \tag{28}$$

5. Invariant distributions, $\{\mu_j^w(z,a), \mu_j^e(z,a)\}$, are consistent with individuals' optimal behaviour. The distribution of individual states across age 1 agents is such that $\mu_1^w$ is entirely determined by $h(\cdot)$ and $\mu_1^e$ is zero, since all agents start as workers with zero assets. For $j = 1, ..., J-1$,

$$\begin{aligned}
\mu_{j+1}^w(\mathcal{S}_z, \mathcal{S}_a) &= \sum_{z' \in \mathcal{S}_z} \int_{a' \in \mathcal{S}_a} \\
&\sum_{j,z} \left\{ \int_a I^{ww}(a,z,j) P^w(z,j) \mu_j^w(z,a)\, da \right\} da' + \\
&\sum_{z' \in \mathcal{S}_z} \int_{a' \in \mathcal{S}_a} \\
&\sum_{j,z} \left\{ \int_a I^{ew}(a,z,j) P^w(z,j) \mu_j^e(z,a)\, da \right\} da',
\end{aligned} \tag{29}$$

$$\begin{aligned}
\mu_{j+1}^e(\mathcal{S}_z, \mathcal{S}_a) &= \sum_{z' \in \mathcal{S}_z} \int_{a' \in \mathcal{S}_a} \\
&\sum_{j,z} \left\{ \int_a I^{we}(a,z,j) P^e(z,z',j) \mu_j^w(z,a)\, da \right\} da' + \\
&\sum_{z' \in \mathcal{S}_z} \int_{a' \in \mathcal{S}_a} \\
&\sum_{j,z} \left\{ \int_a I^{ee}(a,z,j) P^e(z,z',j) \mu_j^e(z,a)\, da \right\} da',
\end{aligned} \tag{30}$$

where

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

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

$$I^{we}(a,z,j) = \begin{cases} 1, & \text{if } a^w(z,a,j) \in S_a \text{ and } e^w(z,a,j) = 1 \\ 0, & \text{otherwise,} \end{cases} \tag{33}$$

$$I^{ee}(a,z,j) = \begin{cases} 1, & \text{if } a^e(z,a,j) \in S_a \text{ and } e^e(z,a,j) = 1 \\ 0, & \text{otherwise,} \end{cases} \tag{34}$$

$$P^w(z,j) = \begin{cases} h(z), & \text{if } j \leq R-1 \\ 1, & \text{otherwise,} \end{cases} \tag{35}$$

$$P^e(z,z',j) = \begin{cases} \Psi(z',z), & \text{if } j \leq R-1 \\ 1, & \text{otherwise,} \end{cases} \tag{36}$$

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

# Appendix B: Computation of Stationary Equilibriums

This appendix describes the algorithm used to compute stationary equilibriums for given parameter values and a corporate tax rate, $\tau_c$. In the benchmark economy, the government consumption equals the tax collection.

1. Guess the capital labour ratio in the corporate sector. In the policy experiment case, guess the income tax rate, $\tau_i$.

2. Compute factor prices: $r_d = (1-\tau_c)\left[\theta\left(\frac{K_c}{N_c}\right)^{\theta-1} - \delta\right]$ and $w = (1-\theta)\left(\frac{K_c}{N_c}\right)^{\theta}$.

3. Calculate optimal decision rules by solving the problems of workers and entrepreneurs.

4. Compute the capital labour ratio in the corporate sector by using market clearing conditions (26) and (27). 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 $a_s = \lambda(s-1)^2$, where $s \in \{0, ..., 501\}$ 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 $\mu_j^w$ and $\mu_j^e$ for $j = 1, ..., J$, I perform an equivalent aggregation process by simulating the behaviour of a large number of agents. Equilibriums 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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