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Abstract

In recent years, venture capital has increasingly become a factor in the financing of new firms. We examine how the value of mature firms determines the incentives of entrepreneurs to start up new firms and of venture capitalists to finance and advise them. We examine how capital gains taxes as well as subsidies to start-up costs of new firms affect venture capital backed entrepreneurship. We also argue that dividend and capital gains taxes on mature firms have important consequences for start-up firms as well.

Keywords

Taxes, venture capital, entrepreneurship, double moral hazard

JEL Classification

D82, G24, H24, H25

1 Introduction

This paper investigates the potential of taxes and subsidies to affect the creation and success of venture capital backed new firms and the implications for economic welfare. The background for studying these issues is the general interest in entrepreneurship and the conditions for starting new firms. Entrepreneurship and the resulting new firms are important for the wider economy because of the innovation processes going on in these firms and the jobs and value which they create over time. The existence of a wide range of policy initiatives reflects the high level of attention that policy makers and interest groups devote to start-up firms. These programs are specifically intended to promote innovation by encouraging investment in new firms. Many countries offer special tax provisions for small and medium-sized firms. Governments often subsidize lending to new firms or provide direct subsidies to physical capital investment or research and development expenditures. Still, the conditions facing potential entrepreneurs are continually being debated, as is the question of whether politicians could and should do more to stimulate firm creation.

A remarkable feature of the financing of new firms over the last couple of decades is the increasing role of venture capital (VC). Data from the European Private Equity and Venture Capital Association (EVCA) show that total funds raised by venture capital companies as well as their investments have gone up significantly since the beginning of the 1990s.[1] While the stock market collapse in early 2001 affected VC fund raising and investment quite unfavorably, the drop in share prices for young technology firms over the last couple of years did not bring back VC investments anywhere near the much lower levels of ten years ago. Gompers and Lerner (2001) similarly present evidence of the increasing role of VCs. They show (in their Figure 3) that VCs now stand for almost half of all firms sold at IPOs (Initial Public Offerings), in sharp contrast to the situation in the 1980s, where the share of VC-backed companies at IPOs was below 10 per cent.

A further reason to take interest in the increasing role of VCs is that they correspond

[1] The data can be found under www.evca.com.

quite closely to the agents in the literature on financial contracts. VCs and the entrepreneurs whose projects they finance and support, write often rather sophisticated, albeit of necessity still incomplete, contracts. Hart (2001, p. 1088) acknowledges that the VC sector is a good place to look for real-world counterparts of the implicit contracts studied in the theory of financial contracts. According to Hart, the distinguishing feature of VC deals is that the major participants enter a close relationship and are few in number. A rather uncharted territory is how the contracts between entrepreneurs and VCs may be affected by taxes and subsidies that directly target young firm investment. But perhaps taxes on mature firms that are *not* paid by start-ups, may be just as harmful as the much debated capital gains tax on young firms. Taxes on mature firms are capitalized in firm value which defines the price at which VCs and entrepreneurs are able to divest in an initial public offering or a trade sale. Obviously, these venture returns determine the incentives to start a firm and add value in the start-up phase.

Thus we here pose the following question: How do taxes and subsidies affect VC-backed entrepreneurship and welfare? After a closer look at the phenomenon of venture capital in section 2, section 3 sets up a simple two-period model which enables a study of the influence of taxes levied on young or mature firms. Section 4 describes, mainly in graphical terms, the effects of taxes on the demand and supply of entrepreneurs and thus venture capital. In addition, it demonstrates the qualitative effects of the taxes on the success and failure of new firms, on the rate of entrepreneurship and welfare. Section 5 concludes.

2 Venture Capital

In modelling VC backed entrepreneurship it is important to properly capture the nature and role of VC.[2] Gompers and Lerner (2001) define VC firms as independent, profession-

[2]For useful surveys of the VC literature see Gompers and Lerner (1999,2001), Kaplan and Stromberg (2001), and Botazzi and DaRin (2002).

ally managed pools of equity capital invested in high growth companies. VC firms are typically created on the basis of funds raised from banks, pension funds, businesses and private individuals and that are invested over a limited time span of about ten years on average. VCs eventually exit the companies they invest in.

Most importantly, VCs are active investors as opposed to traditional loan financing by banks. VCs concentrate on – and indeed have a comparative advantage in – financing small high growth companies. A target firm is characterized by high potential, but also high risk, as radical innovations are sought. The entrepreneur has a key role as supplier of the basic business idea. Information problems abound: The entrepreneur has superior knowledge about the prospects of further product development and the required effort she needs to put into the start-up. She typically has few assets and can thus offer only limited collateral, if any. Finally, she possesses only limited commercial experience and know-how.

This is where the VC comes in. A VC has the entrepreneurial experience and industry knowledge which the entrepreneur lacks. The VC has access to capital and to networks of managers, customers, and suppliers. This professional expertise enables the VC to support and advice the entrepreneur during the critical first phases of the new company's life.

VCs operate in a cycle. A VC first raises funds from the above-mentioned sources; the funds are available for only a limited time period. Then the VC considers a host of possible projects presented by would-be entrepreneurs, screens and selects a few for investment. In selecting the start-ups, the VC assesses market potential and also the managerial qualifications of the entrepreneur. Once a project is found worthwhile, a financial contract between the VC and the entrepreneur stipulates the type of financial instrument used to infuse capital into the firm and secure repayment. Typically, the instrument is equity-like such as convertible debt, convertible preferreds, or straight equity. The contract may stipulate that capital is made available only in several stages, with further capital injection being conditional on certain performance targets. Finally, the contract specifies control

rights: who can make what decisions under what circumstances.

Once a new firm gets going, the VC monitors its development, establishes key contacts to customers, suppliers and outside professionals who may be hired to the firm. It provides advice to the entrepreneur and the management team and altogether adds value to the start-up. Due to the high risks involved, the fate of new companies differs substantially. The most successful ones can be sold at an IPO; the less successful, but still viable, at a private trade-sale, whereas part of the investments must be written off completely. The exit decision – when to get out of the new firm and in which way – is the final consideration on the part of the VC.

A rather active research area in the US in recent years, the empirical analysis of venture capital has by now provided substantial evidence of the differential effects of VC as compared to standard bank finance. For instance, Hellmann and Puri (2000, 2002) in a couple of studies have examined VC backed firms and compared them to other firms in Silicon Valley, controlling for possible selection effects. They find that VCs generally cause a significant and quantitavely important increase in the probabilities of first market introduction; of hiring a sales or marketing director; of the use of stock option plans for key employees; and of replacing the entrepreneur with an outside CEO. Moreover, VC-backed firms produce more patents and more radical innovations than non-VC-backed firms. Even though VC represents only a small part of financial intermediation, it accounts for a significant part of economy wide innovation. Kortum and Lerner (2000) find that VC backed firms are about three times as effective in R&D as corporate firms. While VCs only stand for some three per cent of total R&D spending, they contribute between eight and fourteen per cent of innovation in the US.

So far, there are only very few empirical investigations of European VC. The study by Botazzi and DaRin (2002) leaves the impression that VC is less developed and less sophisticated in Europe than in the US, although the study by Audretsch and Lehmann (2002) arrives at a somewhat more positive result. On the other hand, the US evidence points to the perspective of sharpening the quality of European VC.

Two pieces of evidence indicate the potential importance of tax and subsidy policies in shaping entrepreneurship and activities within VC backed new firms. First, the EVCA recently published the results of a major benchmarking analysis[3], in which it evaluates the environment of new firms and the conditions for entrepreneurship in a series of European countries. The analysis aims at explaining the type of tax and legal environments in which entrepreneurship can flourish, as well as illustrating the current substantial divergence between existing EU member states' tax and legal rules. Among other things, the report focuses on company tax rates in general and especially for small and medium-sized companies (SMEs); capital gains taxes for individuals; tax incentives for individual investors; and fiscal incentives to enhance research and development. The report argues that a favourable tax environment for the VC industry involves lenient tax treatment of capital gains on unquoted investments in growth companies; low company tax rates especially for SMEs; and fiscal R&D incentives.

Second, the theoretical and empirical literature on entrepreneurship demonstrates that taxes should and do matter. Boadway et al. (1991) examine the link between occupational choice, risk and taxes, and Gordon (1998) argues that the personal-corporate tax differential should be important for the creation of innovative new firms. Fuest et al. (2003) argue that differential corporate and personal taxes may be warranted to counter adverse selection problems in new firms' choice between debt and equity financing. Gentry and Hubbard's (2001) empirical analysis demonstrates that the convexity of the tax schedule is important for entrepreneurship. Cullen and Gordon (2003) find that lower personal income taxes in fact reduce entrepreneurship because of the lower tax value of offsetting losses. The work of Carroll, Holtz-Eakin, Rider and Rosen (as surveyed in Rosen (2003)) produces ample evidence that once started, the decisions in new firms regarding employment, capital investment and production are markedly influenced by taxes.

Public finance contributions regarding venture capital as such are so far limited. Gordon (1998) discusses the relation between profit sharing of entrepreneurs and VCs without

[3]See European Private Equity and Venture Capital Association (2003).

incorporating the active role of VCs in new firms. Poterba (1989a,b) as well as Gompers and Lerner (1998) investigate how capital gains taxation affects the demand for VC via entrepreneurs' career choice and the supply of VC in terms of funds raised. Again, none of these accounts for the value-adding capacity of VCs. This active role of VC will be key in our analysis below.

Our own previous work has considered public policy towards venture capital in static models. In Keuschnigg and Nielsen (2003a) we focused on the relationship between moral hazard, risk sharing and income taxes in venture capital contracts, while the effects on venture capital activity of capital gains taxes with full or limited loss offset were dealt with in Keuschnigg and Nielsen (2002, 2003b). Keuschnigg (2002) has analyzed the joint role of a capital gains taxes and start-up subsidies in determining an optimal portfolio of firms in VC financing. Keuschnigg (2003) examines the effects of output subsidies to mature firms with differentiated goods as well as entry subsidies to both entrepreneurs and VCs on the equilibrium level of innovation. In the model below, we widen these perspectives and apply a dynamic model in order to accomodate a full life cycle of firms and relate the tax treatment of both young and mature firms to the incentives for VC backed entrepreneurship.

3 A Model of Young and Mature Firms

3.1 Overview

We consider a two-period equilibrium model of a closed economy with a population of mass one. At the beginning of the first period, the government defines the policy environment. Policy instruments include τ, a capital gains tax on new firms; z, a subsidy to physical investment in start-ups; t^D a tax on dividends on mature firms; and t^G, a capital gains tax on mature firms. Any surplus or deficit in the government budget is paid out or financed with a lump-sum tax or transfer.

Weighing the prospects of entrepreneurship against employment in a traditional sector, individuals decide on occupation; some (E) become entrepreneurs in order to pursue their business ideas, while the remainder ($L = 1 - E$) become workers in the traditional sector. An entrepreneur must first undertake a seed investment to turn her idea into a project and develop a business plan. For this purpose, individual i needs to incur a non-pecuniary investment of h^i. At this stage, individuals are assumed to differ in their basic inventiveness. Some create their project at low cost while others have to put in more effort. Having undertaken the seed investment, an entrepreneur proposes a deal to a VC firm to start up a firm. The contract assigns a share $1 - s$ of possible revenues to the VC; in return, the entrepreneur receives an up-front payment of B, and the VC also covers the necessary physical investment of the start-up, I (reduced to $I(1 - z)$ on account of an investment subsidy z).

After starting up the new firm, the investment is sunk, and both the entrepreneur and the VC put in effort to enhance the likelihood of success. We denote entrepreneurial effort by e and VC advice by a, and the likelihood of success is specified as $p = p(e, a)$. If a venture succeeds, it will be sold to new investors, possibly at an IPO, for a price V. If it fails, the firm will be shut down without any production and revenues whatsoever. When firms successfully mature to production stage, they produce f_1 for the remainder of the first period; in line with the 'new view' of dividend taxation, a part k of this production is retained and invested internally to accumulate capital, while the residual $f_1 - k$ is paid out as dividends to owners.

In the second period, further production $f(k)$ results. Revenues are paid out to owners together with divestment of the undepreciated capital stock k. Workers receive their income in the form of not only wages w, but also a share Π of profits in VC firms plus government transfers T_1 and T_2 in the two periods. Instead of wages, entrepreneurs receive the up-front payment B plus possibly a share sV of the revenue from selling a successful firm. On top of this, they have to pay the capital gains tax on new firms τ, applicable to both the up-front payment and possible venture returns. With income thus determined,

individuals save in the first period to choose optimal life-cycle consumption. Below, we lay out the most essential elements of our model.

3.2 Consumption and Savings

A particularly simple specification of preferences for present and future consumption, X^i and D^i, is given by $U^i = X^i + u\left(D^i\right) - l^i$, where l^i is the effort of agent i, depending on her occupation. Effort of workers is normalized to zero. When consumption is decided, effort on the part of entrepreneurs is already sunk and income depending on success or failure is given. Denoting by y^i discounted individual income, intertemporal consumption follows from

$$U^{*i} = \max\left\{X^i + u\left(D^i\right) - l^i \quad s.t. \quad X^i + \frac{1}{1+r}D^i \leq y^i, \right\} \tag{1}$$

where r is the market rate of interest.

Ownership of VC firms is broadly dispersed over the population. VC profits are thus divided equally and give rise to an income Π per capita. Agents are also entitled to a present value of lump-sum per capita transfers T, or incur a tax liability if negative. At the end of period 1, a worker has wealth (present value of income) $y^i = w + T + \Pi$, a successful entrepreneur $y^i = sV + B + T + \Pi$, while a less fortunate one is left with $y^i = B + T + \Pi$ only. Since preferences are assumed separable, the necessary condition is $u'\left(D\right) = 1/\left(1+r\right)$, so that all agents demand the same amount of second period consumption. Note here that $D'\left(r\right) > 0$.

Desired intertemporal consumption is attained by an appropriate amount of savings S. Since second period consumption is the same for all, savings must be identical as well. Indirect utility follows from substituting out X^i in (1),

$$U^{*i} = y^i - l^i + C\left(r\right), \quad C\left(r\right) \equiv u\left(D\right) - D/\left(1+r\right). \tag{2}$$

Welfare of an individual agent equals life-time wealth adjusted for effort cost plus consumer surplus C which, by construction, is uniform across agents.

3.3 Mature Firm Value and Investment

A mature firm is assumed to pay net of tax dividends of $\chi_1 = \left(1-t^D\right)(f_1-k)$ and $\chi_2 = \left(1-t^D\right)(f(k)+k)$, where f_1 is a fixed amount of first period production and $f(k)$ is a standard production function. This definition of dividends assumes internal investment finance ($f_1 > k$) and thus adopts the new view of dividend taxation. At IPO, the value V of a mature firm reflects the present value of the net dividend flow χ_1 and χ_2. Paying out a dividend χ_1 at the end of period one leaves a value V_2 at the beginning of period 2. In period 2, another dividend of χ_2 is paid out, leaving a value of $V_3 = 0$ at the end of the period, when the world ends. Therefore, from the date of IPO to the end of period 2, dividend payments of mature firms run down their value to zero on account of dividend payments and thereby produce negative capital gains. It is assumed that the tax code allows for full tax rebates.

Taking account of capital gains taxes, no-arbitrage conditions nail down firm values V and V_2 in capital market equilibrium,

$$0 = \chi_1 + \left(1-t^G\right)(V_2 - V), \quad rV_2 = \chi_2 - \left(1-t^G\right)V_2. \tag{3}$$

The first equation states that the sum of dividends and (negative) capital gains must be zero in the latter part of the first period. During the second period, the dividends and net-of-tax capital loss from owning shares in mature firms must add up to a rate of return that matches the interest r from an alternative investment of V_2. Substituting the dividend definitions in these no-arbitrage conditions yields

$$V_2 = \left[\left(1-t^D\right)(f+k)/\left(1-t^G\right)\right]/(1+\rho), \quad V = \left(1-t^D\right)(f_1-k)/\left(1-t^G\right) + V_2, \tag{4}$$

where $\rho \equiv r/\left(1-t^G\right)$ is the discount rate or cost of equity. Thus, the mature firm's investment problem is to maximize

$$V = \frac{1-t^D}{1-t^G}\left[f_1 - k + \frac{f(k)+k}{1+\rho}\right], \tag{5}$$

yielding

$$f'(k) = \rho = r/\left(1-t^G\right) \quad \Rightarrow \quad \frac{dk}{dr} < 0, \quad \frac{dk}{dt^G} < 0, \quad \frac{dk}{dt^D} = 0. \tag{6}$$

The effects of taxes on mature firm investment clearly reflects the 'new view' of dividend taxation. When investment is internally financed, as it mostly is with mature firms, the dividend tax is neutral. More investment reduces dividends today, with corresponding savings in the dividend tax, but raises dividends and dividend taxes due tomorrow. The dividend tax thus reduces costs and returns of investment proportionally and is neutral to investment. Since the capital gains tax raises the cost of capital, it reduces mature firm investment.

Using the envelope theorem, the effects of taxes on mature firm value are

$$\begin{array}{lrcl} (a) & \frac{dV}{dr} & = & -\frac{V_2}{(1-t^G)(1+\rho)} < 0, \\ (b) & \frac{dV}{dt^D} & = & -\frac{V}{1-t^D} < 0, \\ (c) & \frac{dV}{dt^G} & = & \frac{V}{1-t^G} + \rho\frac{dV}{dr} = \frac{V+\rho\cdot(V-V_2)}{(1-t^G)(1+\rho)} > 0. \end{array} \tag{7}$$

Firm value is at a maximum at the IPO date and is subsequently run down to zero on account of dividend payments, $V > V_2 > V_3 = 0$. Hence, mature firms generate capital losses leading to tax rebates. Therefore, the first term in (7.c) stands for the increase in firm value on account of higher tax rebates, when the capital gains tax is increased. The second term is the reduction in firm value resulting from the fact that the tax raises the discount rate. As the last equality shows, the tax rebates (in our model) dominate over the discount rate effect.[4]

3.4 VC Financed Start-ups

The simplest possible production structure in the first period is the following. Both entrepreneurial and traditional firms produce the same good. Traditional firms produce output with a Ricardian technology, where one worker produces one unit of output, giving

[4]This last result may, however, reflect our simple two-period formulation and may not come out as strong in fully intertemporal models. In McGee's (1998) extension of Sinn's (1990) model of young and mature firms with infinite planning horizon, the effect of the capital gains tax on firm value is zero in a steady state. This follows from evaluating McGee's equations (2-3) in a steady state with $VN = 0$, and differentiating with respect to the capital gains tax rate denoted by c in that paper.

an aggregate output of L units. The ensuing wage equals one in equilibrium. Each entrepreneurial firm, if it has successfully completed the start-up phase, produces f_1 units of the same good. Agents can opt for entrepreneurship or else choose employment in a traditional firm. The occupational choice decision of individuals involves comparing utility in (2) from entrepreneurship and employment, respectively.

An entrepreneur's expected surplus is the difference in utility in these two alternatives, and must in particular take account of various effort costs. First, seed investment is interpreted as a non-pecuniary private research effort which is required to prepare a business plan. Agents are taken to be distributed uniformly in the unit interval with respect to research ability and associated effort cost, $h^i = h \cdot i$. Once this effort is sunk, all start-up firms are assumed to be of uniform quality which cuts out any issues of adverse selection and helps to concentrate on the double moral hazard in VC backed firms.[5]

A start-up succeeds with probability p, leaving a value of V, and fails with $1 - p$, leaving nothing. By the law of large numbers with independent risks, the number of mature firms becomes $N = pE$. The success probability $p = p(e, a)$ is concave in joint effort with decreasing returns to effort and is specified as

$$p = p(e, a) = e^{\epsilon} a^{\alpha}, \quad \epsilon + \alpha < 1. \tag{8}$$

VCs and entrepreneurs share expected firm value according to the following contractual

[5] We thus follow the finance literature in modeling the VC's value added by making the firm's success jointly depend on the entrepreneur's and VC's effort, subject to a double moral hazard. See Casamatta (2003), Inderst and Mueller (2003), Repullo and Suarez (1999), and Schmidt (2003) for an incomplete list. This is not to deny that selection effects are important, but only helps to focus on the value added role of VCs. See, however, Ueda (2003) on project selection of VCs. Selection problems are discussed in the literature originating with DeMeza and Webb (1987) and Stiglitz and Weiss (1981), see De Meza (2002) for a recent discussion. Fuest et al. (2003) study the relation between selection problems and corporate vs. personal taxes.

arrangement:

$$\begin{aligned} \pi^E &= (1-\tau)\left[spV + B\right], \\ \pi^F &= (1-\tau)\left[(1-s)\,pV - B - (1-z)\,I\right], \\ \pi^G &= \tau\left[pV - (1-z)\,I\right] - zI, \\ \pi &= \pi^E + \pi^F + \pi^G = pV - I. \end{aligned} \tag{9}$$

Recall that τ stands for the uniform capital gains tax on VCs and entrepreneurs, z is a subsidy to start-up capital cost, π^E, π^F, π^G are the expected incomes accruing to the entrepreneur, the VC and the government. The governments surplus corresponds to the *net* tax revenue extracted from the project, or the net subsidy injected. Note that VC funds are owned households. The share of aggregate VC surplus per capita is denoted by Π and fulfils $\Pi = \pi^F E$.

Let effort costs of the entrepreneur and the VC be given by βe and γa, respectively. In assuming competitive VCs, we allocate all bargaining power to the entrepreneur. Accordingly, the VC's surplus per venture, $\Omega^F \equiv \pi^F - \gamma a$, is squeezed to zero. Define the entrepreneur's profit net of effort cost as $\Omega^E \equiv \pi^E - \beta e$ which is uniform by our symmetry assumption. An entrepreneur's surplus from incurring the seed investment and starting a business is then $\Omega^E - h^i - w$, as she must also take account of foregone wage income and seed investment costs.[6] Having sunk $w + h^i$, the entrepreneur is left to maximize her remaining surplus subject to the VC choosing to participate and subject to optimal effort choice of both parties *after* the contract is signed. The problem is

$$\Omega^E = \max_{s,B} (1-\tau)\left[p\left(e,a\right)sV + B\right] - \beta e \qquad s.t. \tag{10}$$

$$PC^F : \Omega^F = (1-\tau)\left[p\left(e,a\right)(1-s)\,V - B - (1-z)\,I\right] - \gamma a \geq 0, \tag{i}$$

$$IC^E : \Omega^E_e = p_e\left(e,a\right)(1-\tau)\,sV - \beta = 0, \tag{ii}$$

$$IC^F : \Omega^F_a = p_a\left(e,a\right)(1-\tau)\,(1-s)\,V - \gamma = 0. \tag{iii}$$

[6] The entrepreneur's surplus reflects her occupational choice and, thereby, her willingness to start a firm. When comparing expected welfare of the two career alternatives, all terms common to all occupations such as $\Pi + T$ and consumer surplus C fall out. Therefore, $\Omega^E - h^i - w$ gives the true utility differential between occupations.

At effort stage, where the agreed profit share s is already fixed, optimal levels of efforts are determined by the two incentive compatibility constraints. Figure 1 illustrates the simultaneous choice of effort, using the functional form for $p(e,a)$ above. Both reaction curves $e(a)$ and $a(e)$ are positively sloped, implying that entrepreneurial effort and VC advice are strategic complements.

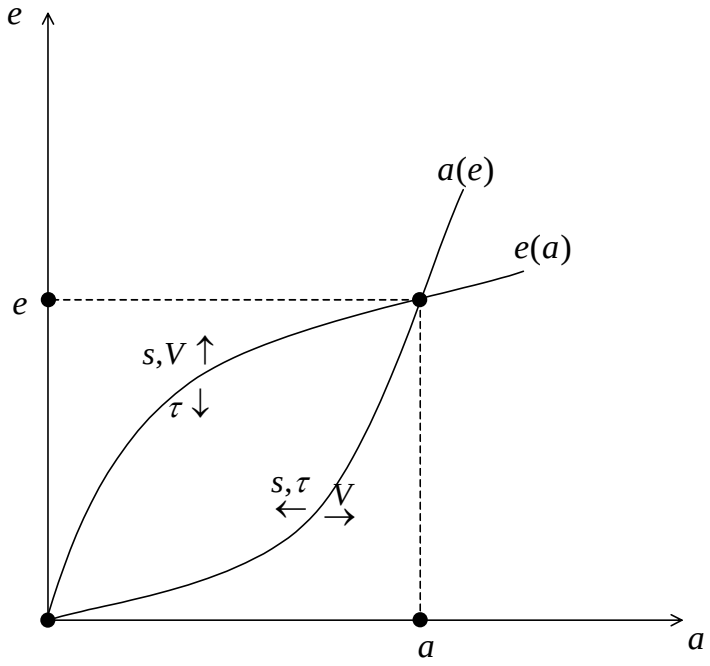

Figure 1: Effort and Advice

Anticipating effort choices, the entrepreneur proposes a deal such that the VC is willing to finance the investment expenditure and support the project with advice. She offers a share $1-s$ in the firm at a total price covering the start-up cost plus an upfront payment of B. The entrepreneur can thus raise her own expected profit by keeping either a larger share s or demanding a higher upfront payment B by asking for a price in excess of start-up cost $(1-z)\,I$. Note a fundamental difference between the two instruments s and B. Claiming a higher s reduces the VC's share and destroys her incentives to add value, while the upfront payment B does not. The latter merely redistributes lump-sum across the two parties. The entrepreneur will therefore first choose s to maximize joint surplus. Having found this Pareto optimal share s, she then requests a maximum upfront payment

B that allows the VC no more than to break even.[7] In this way, the entrepreneur acquires the entire joint surplus $\Omega = \Omega^E + \Omega^F$. Substituting B from (10.i) into (10) yields the entrepreneur's problem for choosing s, anticipating the incentive effects for later stage effort e and a as determined by (10.ii-iii) and illustrated in Figure 1:

$$\Omega \underset{+}{\left[\underset{+}{V}, \underset{-}{\tau}, \underset{+}{z} \right]} = \max_{s} (1-\tau) \left[p(e,a) V - (1-z) I \right] - \gamma a - \beta e \quad \text{s.t. (10.ii-iii).} \tag{11}$$

The entrepreneur first realizes a capital gain B when selling a stake to the VC at a price in excess of start-up cost, and a possible additional gain sV at IPO. With a symmetric capital gains tax on both entrepreneurs and VCs, the Pareto optimal profit share s becomes independent of taxes and of venture returns V. We can thus take s as a fixed constant, beyond the influence of policy.[8]

The joint surplus derived from the project must be sufficiently large to compensate entrepreneurs for any foregone outside opportunity $w = 1$, and an initial effort cost $h^i = h \cdot i$ during the seed phase prior to VC finance. Entry of entrepreneurs occurs as long as $\Omega - w - h \cdot i > 0$, until the marginal entrepreneur just breaks even. The free entry condition is, thus,

$$\Omega \underset{+}{\left[\underset{+}{V}, \underset{-}{\tau}, \underset{+}{z} \right]} = w + hE. \tag{12}$$

Figure 2 illustrates the relation between venture returns and the number of entrepreneurs. A higher venture return V, consisting of a higher IPO value of a maturing firm, raises the returns to start-up activity and leads more agents to choose an entrepreneurial career. Already now, we can anticipate that a higher dividend tax, while harmless for mature firm investment as predicted by the new view, may seriously impair start-up investment. In reducing the IPO value of a mature firm, it reduces venture returns and thereby depresses

[7] This corresponds to the Pareto frontier in Inderst and Mueller (2003).

[8] In Keuschnigg and Nielsen (2002) we show, though, that differential capital gains taxes on entrepreneurs and VCs, or a different tax treatment of the upfront payment B, can change the privately optimal equity share s, leading to more complicated comparative statics.

start-up activity. This will be confirmed more rigorously below.

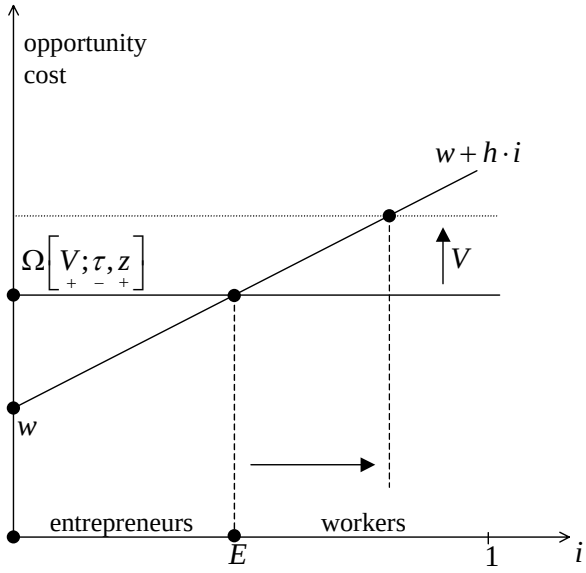

Figure 2: The Start-up Decision

3.5 Equilibrium

We now derive equilibrium venture returns V by equating the demand and supply of new firms. The demand for entrepreneurship reflects the demand for second period goods which requires a sufficiently large number $N = pE$ of mature firms,

$$D = (f(k) + k) \cdot pE. \tag{13}$$

The success rate of start-ups is $p(V, \tau)$ since efforts e, a are obviously functions of venture returns and the capital gains tax on new firms (viz. 10.ii-iii) and Figure 1. By (6), mature firm investment and output is a function of the interest rate which, in turn, is uniquely related to the price V of successful new firms as in (5). Total differentiation of (5) allows us to solve for the interest rate,

$$\frac{V_2}{1-t^G}\frac{dr}{1+\rho} = -dV - \frac{V}{1-t^D}dt^D + \frac{(1+\rho)V - \rho V_2}{(1-t^G)(1+\rho)}dt^G, \quad r\left[\underset{-}{V};\underset{-}{t^D},\underset{+}{t^G}\right]. \tag{14}$$

The supply per firm, $f(k) + k$, and total market demand D both depend on the interest rate. Knowing the interest rate compatible with any given firm value, $r(V)$, we can thus

derive the demand for entrepreneurs by inverting the second period equilibrium condition in (13),

$$E^D \underset{- \; - \; + \; +}{\left[V; t^D, t^G, \tau\right]} = \frac{1}{p\left(V, \tau\right)} \cdot \frac{D\left(r\right)}{f\left(k\left(r\right)\right) + k\left(r\right)}. \tag{15}$$

The demand for start-up entrepreneurship is downward sloping in venture returns V,

$$\frac{dE^D}{dV} = -\frac{E}{p}\frac{dp}{dV} + \left[\frac{E}{D}D'\left(r\right) - \frac{E}{f+k}\left(1+f'\right)k'\left(r\right)\right] \cdot r'\left(V\right) < 0. \tag{16}$$

Since $dp/dV > 0$, $D' > 0$, $k' < 0$, and $r' < 0$, all components contribute to the negative impact of venture returns on the demand for start-up entrepreneurship. There are two effects. First, a higher firm value elicits more effort and raises the success probability. Other things equal, fewer start-ups E are needed, when a larger fraction of them matures to production stage. Second, higher firm value reflects a lower interest rate. For any given success rate, this depresses demand for second period output but raises investment and output of mature firms. Consequently, fewer mature firms and thus fewer start-ups are needed to accomodate demand. For both reasons, demand for start-up entrepreneurs diminishes with venture returns as the downward sloping demand schedule in Figure 3 illustrates.

The supply schedule for new firms is upward sloping. Since an increase in venture returns raises the entrepreneur's surplus Ω, ever more entrepreneurs find it worthwhile to incur the seed investment h^i as illustrated in Figure 2. More formally, the free entry condition (12) yields

$$E^S \underset{+ \; - \; +}{\left[V; \tau, z\right]}, \quad dE^S/dV = \frac{1}{h} \cdot \frac{\partial \Omega}{\partial V} > 0. \tag{17}$$

Equating demand and supply for entrepreneurship, $E^D = E^S$, yields the equilibrium

number of new firms, the IPO price V and, in turn, the interest rate r. Figure 3 illustrates.

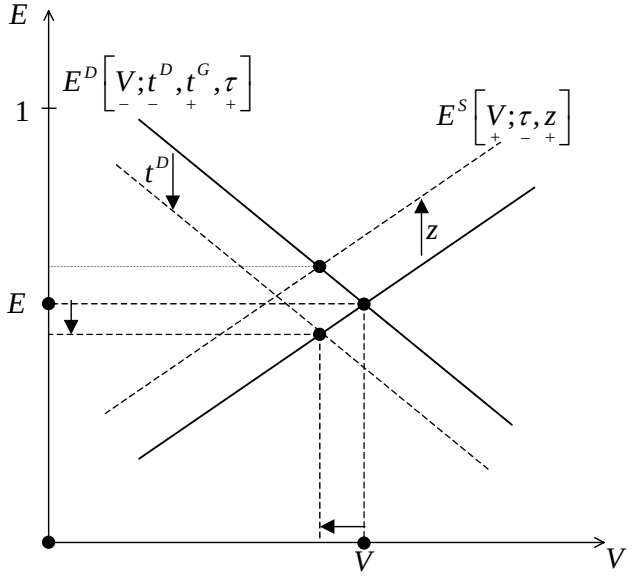

Figure 3: Equilibrium Venture Returns

With risk neutrality and no distributional concerns, welfare is the sum of individual utilities and reflects efficiency. Utility in (2) includes monetary profits $\Pi = \pi^F E$ from ownership of VC firms. Since these profits are merely a compensation for intangible VC effort costs $\gamma a E$, we must subtract them from our welfare measure. The welfare criterion is thus given by

$$U^* = \int_0^E U^{*i} di + U^{*L} L - \gamma a E. \tag{18}$$

Noting the symmetry after the seed investment effort helps to simplify. Utility of a worker is $U^{*L} = w + \Pi + T + C$. Referring to (12) and noting symmetry after the seed phase, utility of an entrepreneur is $U^{*i} = U^{*E} + h^E - h^i$. Utility of a low cost entrepreneur is equal to utility of the marginal entrepreneur plus a rent reflecting her cost advantage in generating a business idea. Since the marginal entrepreneur is indifferent with respect to occupational choice, $U^{*E} = U^{*L}$, and noting $E + L = 1$ as well as the participation constraint of VCs, $\pi^F = \gamma a$, we can compute a simple welfare formula,

$$U^* = w + T + C(r) + \int_0^E \left(h^E - h^i\right) di, \qquad C'(r) = D/(1+r)^2. \tag{19}$$

The last term reflects entrepreneurial rent of low cost entrepreneurs. Further, consumer rent from second period consumption increases with the interest rate.

Now take the differential of (19) and use the definition of V_2; the goods market equilibrium (13); equations (17), (11) and (14) plus government balanced budget constraints. The general expression for welfare changes from deviations from a zero-tax initial situation can then be obtained:

$$dU^* = (p_e V - \beta)\, Ede + (p_a V - \gamma)\, Eda. \tag{20}$$

The coefficients in (20) would be zero if effort and advice were chosen at their first best levels which follow from maximizing the joint surplus in (11) *without* incentive constraints. Since efforts are assumed not observable and not verifiable, neither the entrepreneur nor the VC are able to commit to first best effort but will choose their inputs according to the incentive constraints (10.ii-iii). Since both agents must share the return on their effort within the team, but must fully bear their own cost, entrepreneurial effort and VC advice are too low in the private equilibrium.[9] Thus, even small taxes can give rise to first order welfare changes. Comparing with (10.ii-iii), the round brackets in (20) are both found to be positive. They reflect the excess of social over private returns to effort and advice. Since privately chosen effort tends to be underprovided in the presence of double moral hazard, any policy that boosts effort and advice must yield first order welfare gains.

It must be emphasized, however, that the VC industry has developed its own special contractual instruments to alleviate such problems: the use of control rights, staged capital infusions conditional on the firm reaching predefined milestones, and the use of convertible securities. An analysis of these financing practices would require a more dynamic and difficult modeling of the relationship between entrepreneurs and VCs. Indeed, Schmidt (2003) has shown that convertible securities can go a long way to allocate the right incentives at the right time to the right party. However, Schmidt also acknowledges that the incentive problem resulting from double moral hazard never fully disappears as long as entrepreneurial effort must be expended *at the same time* as VC advice. Given the fact that most business failures can be traced in one form or the other to entrepreneurial

[9] Such incentive problems in teams have been first analyzed by Holmstrom (1982).

management mistakes, it seems that the entrepreneurs' effort and due diligence is required in each stage of business development.

4 The Effects of Taxes

As mentioned in the Introduction, a recent EVCA benchmarking paper (cfr. EVCA (2003)) has investigated the business climate for VC financed new firms in Europe, assessing among other things the levels of corporate income taxes, especially for small and medium-sized firms, capital income taxes for investment in new firms, and fiscal subsidies to investment in start-ups. Clearly, the VC industry regards several taxes as possible obstacles to VC financed start-up activity. It also seems to suggest that subsidies to loans or to physical investments in new firms would be desirable. We will now demonstrate that these measures may affect VC backed start-up activity quite differently. We further argue that a limited focus on the taxation of small firms cuts too short. The taxation of mature firms might be as important for start-ups as the direct taxation of new firms. Sinn (1991) and McGee (1998) already anticipate that dividend taxation can impair start-up investment even though it is neutral with respect to mature firm investment under the 'new view'. The key mechanism is that these taxes are capitalized in mature firm value and thereby reduce venture returns.

The model set up in the previous section is well suited to study how selected taxes and subsidies affect the joint efforts of entrepreneurs and VCs in new firms, the success probability of these, the level of entrepreneurship, venture returns, and welfare. While we can analyze the comparative static effects more generally, we restrict our analysis to small deviations from an untaxed market equilibrium and thereby avoid complicated tax base effects. Table 1 provides an overview of the main results. We emphasize intuitive explanations of the main insights concerning the effects of dividend taxation, capital gains taxation, and subsidies to start-up investment.[10]

[10]For a more formal analysis of the proposed policy experiments, we refer the reader to a separate

Table 1: Effects of Tax Policy

Type of tax	k	E	V	e	a	U^*
mature firms						
dividend tax t^D	+	−	−	−	−	−
capital gains tax t^G	−	+	+	+	+	+
young firms						
capital gains tax τ	+	±	+	−	−	−
start-up cost subsidy z	−	+	−	−	−	−
self-financing $z, \tau < 0$	−	±	−	+	+	+

4.1 Dividend Taxation

The immediate effect of an increase in the dividend tax on mature firms is to reduce firm value. To see how this shifts demand for start-up firms E^D for any given firm value as in Figure 3, observe that the tax capitalization must be accompanied by an offsetting *reduction* in the interest rate to keep V constant (see (14)) which boosts mature firm investment. A lower interest rate impairs demand for second period output, but strengthens investment and output per firm. Consequently, fewer firms are needed to satisfy demand. For any given V, the demand schedule shifts down in Figure 3 while the supply schedule is unaffected. To eliminate the resulting excess supply of goods in period 2, the interest rate must now rise again to create more demand and to reduce supply, thereby partly reversing the initial reduction. A rising interest rate reduces firm values. As can be inferred from Figure 1, lower venture returns discourage joint efforts (the reaction curves shift and give a new intersection within the lens). The success probability declines and joint project surplus falls. Lower venture returns V thereby diminish the incentives to start a business, as Figure 2 demonstrates.

According to Figure 3, the new equilibrium thus features less start-up entrepreneurship and lower venture returns which, in turn, are detrimental to joint effort and the success

mathematical appendix in Keuschnigg and Nielsen (2003c).

probability. The net effect on the interest rate is negative, giving rise to higher mature firm investment as reported in the first line of Table 1. This is purely an equilibrium effect, since the tax was shown to be neutral in partial equilibrium, see (6). The key impact on welfare derives from the fact that the dividend tax is capitalized into the value of mature firms which discourages joint efforts. Since entrepreneurial effort and VC advice are already too low in market equilibrium, the introduction of a small dividend tax imposes a negative welfare effect to the first order (cfr. (20) above). To state it more provocatively, the dividend tax mostly harms those firms which actually do not pay any dividends! We summarize:

Proposition 1 ***(Dividend Tax)*** *(a) A higher dividend tax reduces firm value and start-up entrepreneurship. (b) The reduction in firm value impairs incentives for entrepreneurial effort and advice and reduces the success probability. (c) Introducing a small dividend tax on mature firms entails a first order welfare loss.*

4.2 Capital Gains Taxation

The immediate effect of a capital gains tax on young firms, given venture returns V, is to subtract from returns to effort and advice. As can be deduced from Figure 1, the tax therefore discourages joint effort. Further, the tax directly reduces the expected capital gain from starting a firm. Both effects subtract from the entrepreneur's surplus and thereby lead to exit. The supply schedule shifts down in Figure 3 (not drawn). On the other hand, in discouraging effort, the tax also reduces the success probability which shifts up the demand curve. With a lower success rate, more entrepreneurs are required to satisfy any given demand.

To reestablish equilibrium, venture returns must increase. The change in the number of start-up entrepreneurs, however, is ambiguous. Since higher firm values must be supported by a lower interest rate (see again (14)), investment per mature firm expands

in equilibrium. While the tax discourages joint effort for any given return V, the equilibrium increase in mature firm value sharpens incentives for effort. However, it is easily shown that this price adjustment cannot dominate over the direct tax effect, implying lower effort and VC support in equilibrium and, hence, a lower success rate as well.[11] By (20), the reduction in entrepreneurial effort and VC support leads to a welfare loss. We summarize:

Proposition 2 ***(Capital Gains Tax on Start-up Firms)*** *(a) A capital gains tax raises firm value. The effect on start-up entrepreneurship is ambiguous. (b) The tax impairs incentives for effort and advice and reduces the success probability. (c) Introducing a capital gains tax on start-up firms entails a first order welfare loss.*

A corollary of this proposition is, of course, that a small negative capital gains tax – or revenue subsidy – for young firms will raise efforts in start-ups and improve welfare. However, a possible tax break in capital gains taxation must be limited to young VC backed firms only. Table 1 shows that in our framework a capital gains tax on mature firms at rate t^G, being capitalized in a higher value of these firms, will raise venture returns and hence welfare.[12] Conversely, a capital gains tax relief to mature firms will be detrimental to entrepreneurial efforts and VC advice and will lower welfare.[13] A general cut in the capital gains tax is therefore not nearly as powerful in targeting efforts and welfare as is a selective tax break (revenue subsidy) to young VC backed firms exclusively.[14]

[11] Again, we refer to the mathematical appendix in Keuschnigg and Nielsen (2003c).

[12] Note that dividend payments of mature firms reduce their value down to zero in our two period framework, leading to negative capital gains throughout their life. Allowing for full tax rebates, the capital gains tax thereby boosts firm value.

[13] Throughout, we treat mature firm investment in accordance with the 'new view'. This requires that the tax treatment of retentions be no harsher than the tax treatment of dividends. Strictly speaking, an increase from a zero-tax initial situation in the capital gains tax on mature firms would conflict with this underlying assumption. On the other hand, a negative capital gains tax on mature firms would reinforce the 'new view'.

[14] Our result very much reflects the ambiguous simulation results of McGee (1998) with respect to capital gains taxation.

4.3 A Subsidy to Start-up Investment Cost

Most real world policies to encourage business formation allow for interest subsidies, loan guarantees to facilitate access to cheaper bank loans, or direct subsidies to investment spending. All these measures subsidize the cost of capital and are largely unrelated to firm performance. They can thus be understood as a subsidy to the cost of start-up investment, captured by z in our model. The only direct effect of an increase in the investment subsidy is to raise the entrepreneur's surplus from starting the firm, see (11) and (17), and thereby to encourage entry. There are no other direct effects on effort and advice or on the demand for start-up firms. In Figure 3, the subsidy thus shifts up the supply schedule and leads to a new equilibrium with more entrepreneurs and lower venture returns. The adjustment mechanism is well known by now. Since lower firm value reflects a higher interest rate, the subsidy retards mature firm investment, see Table 1.

The undesirable side effect of start-up subsidies is that they impair incentives for entrepreneurial effort and VC advice. The success probability correspondingly declines. The more successful these subsidies are in stimulating entry, the more likely should be the decline in venture returns, and the stronger the negative welfare consequences. Note, however, that this welfare loss results from a general equilibrium effect rather than any direct impact. In a small open economy with a fixed real interest rate, mature firm value should remain constant. In this case, efforts would be unaffected, and the subsidy would only produce increased entry. Since the entry margin is not distorted, the subsidy would entail a zero welfare effect in this case.

We have thus established, for a closed economy:

Proposition 3 ***(Capital Subsidy to Start-ups)*** *(a) A subsidy to start-up capital cost expands entrepreneurship and reduces venture returns. (b) The subsidy impairs incentives for effort and advice and reduces the success probability. (c) Introducing a small subsidy to start-up cost entails a first order welfare loss.*

As a corollary, a *tax* on start-up capital cost could raise welfare, if the general equilibrium effects are noticeable. This can be compared to DeMeza and Webb (1987) who argue, for entirely different reasons, that entrepreneurial entry should be discouraged.

4.4 A Self-financing Policy

The fact that a start-up subsidy and the capital gains tax both reduce welfare suggests the following strategy. Impose a tax $z < 0$ on start-up investment cost and use the proceeds to finance a narrow tax break $\tau < 0$ on capital gains to young VC backed firms. Since the entrepreneur is wealth constrained, the start-up tax must be paid by the VC who should have no difficulty in raising capital. Being self-financed, the policy provides a *net* tax or subsidy equal to zero. The government budget constraint with all other taxes at zero reads $\tau (pV - (1-z) I) E = zIE$ in this case. A small start-up tax thus finances a cut in the capital gains tax rate by $(pV - I) d\tau = Idz$.

We first investigate the direct impact for a given value V. The direct effects on entrepreneurial surplus from the investment tax and from the revenue subsidy exactly cancel out on account of revenue neutrality. However, the tax break on τ strengthens incentives, thereby boosting joint effort, see Figure 1, and increases the success rate as well. As a result, the project surplus increases and encourages entry of entrepreneurial firms. The supply schedule in Figure 3 shifts up. At the same time, the tax cut τ reduces the demand for entrepreneurship, for any given V, because it makes start-ups more successful by inducing more effort, see (15). Fewer firms are needed to satisfy goods demand if more of them mature to the production stage. The demand schedule shifts down. Drawing this scenario in Figure 3 clearly shows that venture returns start to fall, thereby stimulating demand but discouraging supply of entrepreneurs. The equilibrium effect on entrepreneurship remains ambiguous. The reduction in firm value reflects a higher interest rate which is detrimental to mature firm investment, see Table 1.

Although the diminished venture returns work to erode entrepreneurial effort and VC advice, this adjustment does not dominate the stimulating impact of the tax cut. It is

easily shown that net venture returns $(1-\tau)V$ increase. Accordingly, the self-financing policy stimulates joint effort in equilibrium as well. Again from (20), this brings about an improvement in welfare.[15] We summarize:

Proposition 4 ***(Self-financing Policy)*** *(a) A capital gains tax cut financed with a tax on start-up capital cost reduces venture returns while the effect on entrepreneurship is ambiguous. (b) Since the value of mature firms net of the capital gains tax increases, the policy encourages effort, advice and the success probability. (c) A small policy change entails a first order welfare gain.*

This important proposition implies that potential incentive problems in VC financed start-up firms do not justify any big subsidies to the VC industry. Since the proposed policy is self-financing, the net subsidy per project is zero! Our framework essentially implies that public policy should not aim at more, but at more successful VC backed firms. This conforms quite well with the conclusions of Bottazzi and Da Rin (2002) about VC in Europe. They argue that in Europe VC has expanded quite impressively over the last decade, but the impact on firm performance seemingly remained rather limited. If anything, this calls for a policy that sharpens incentives for more entrepreneurial effort and more active VC involvement. In our framework, the entry margin is undistorted, but the double moral hazard between entrepreneurs and VCs works to erode incentives for value creating effort.

5 Conclusions

The creation of young entrepreneurial firms has been in the spotlight of policy makers and economists. New firms are considered an important source for new jobs, innovation and growth. Since VC is associated often with the most successful of the new firms and many

[15] Note that the policy would work even better in an open economy where any adjustment in the interest rate and mature firm value is limited.

of today's leading technology companies have started out with VC support, VC backed start-up activity catches particular interest. As a consequence, policy makers and industry representatives have been much concerned whether the conditions for VC financing and starting up new firms are appropriate, see European Commission (1998, 2000, 2003) or EVCA (2003). The decision to embark on an entrepreneurial career and to allocate funds to start-up investing depends on many factors. This paper argues that tax policy holds an important potential to affect not only the number, but also the success and growth of VC financed new firms.

In practice, the policy initiatives intended to stimulate VC backed start-up activity mostly allow for various subsidies to the cost of capital such as subsidized loans, credit guarantees to facilitate access to cheap bank loans, favorable depreciation rules, or direct subsidies to R&D and start-up investment spending. In the realm of taxes proper, the capital gains tax is usually considered as particularly damaging to VC activity. The main policy conclusions of this paper are that a tax relief on capital gains is more beneficial than a subsidy to start-up cost. While a subsidy on start-up cost is clearly effective in encouraging entry, it is not performance-related and therefore ill-suited to strengthen incentives. A tax relief, in contrast, succeeds to strengthen incentives for value-creating effort and thereby makes firms more successful. Another lesson is that looking at taxes directly levied on young firms cuts too short in fully defining the tax environment for start-up investment. The average tax burden on mature firms is capitalized in firm value and thereby reduces venture returns which drive the discrete investment choice by start-up firms. This is most clearly demonstrated by the dividend tax. According to the 'new view', the dividend tax is fully neutral with respect to capital accumulation of mature firms. However, it clearly reduces firm value on account of tax capitalization and thereby discourages start-up entrepreneurship as part of the economy-wide investment. By reducing venture returns, it also discourages effort and VC support and thereby contributes to a higher rate of business failure. To put it more provocatively, the dividend tax harms mostly those firms which actually don't pay the tax.

On the normative front, the model proposed in this paper identifies a market distortion in VC backed start-up investment and thereby justifies, in principle, some form of government action. However, what is required in our model is not more firms, but more successful ones. The appropriate policy thus is not simply to throw more money at start-ups, but instead to restructure tax and subsidy policies to make them more performance related. This could be achieved by reducing the existing subsidies to start-up capital cost which are largely unrelated to success, and channel the resulting budget savings towards selective tax cuts for young, VC backed firms, where the incentive problems from double moral hazard are the largest. This should strengthen the incentives for entrepreneurial effort and closer VC involvement in start-up firms.

Future research on the taxation of young, venture capital backed firms might address a number of extensions. First, one might consider more formally the innovative spillovers of start-up firms and what they imply for innovation in new firms compared to innovation in established firms. As Boadway and Tremblay (2003) argue in their survey, such knowledge spillovers do not necessarily justify entry subsidies because of a business stealing effect. On the other hand, the empirical literature seems to suggest that young VC backed firms are more effective in R&D and pursue more radical innovations than established ones. Second, the influence of taxes on the specific contractual arrangements typically used in VC financing is a rather unexplored area. To what extent is the VC industry able to fully overcome the incentive problems in VC backed start-ups by using control rights, convertibles, staging etc. in addition to cash flow rights? What is the influence of taxes on contractual arrangements and investment decisions with such richer forms of financial contracting? Finally, it would be fruitful to consider the coexistence and interaction of bank and VC financing of start-ups. This research might possibly emphasize the way in which banks and VCs select projects, and how this affects the value creating activity of VCs in the subsequent start-up phase.

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