TAXES AND VENTURE CAPITAL SUPPORT

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CESIFO WORKING PAPER NO. 1094
CATEGORY 1: PUBLIC FINANCE
DECEMBER 2003

CESifo *Working Paper No. 1094*

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Abstract

In this paper we set up a model of start-up finance under double moral hazard. Entrepreneurs lack own resources and business experience to develop their ideas. Venture capitalists can provide start-up finance and commercial support. The effort put forth by either agent contributes to the firm's success, but is not verifiable. As a result, the market equilibrium is biased towards ine.ciently low venture capital support. The capital gains tax becomes especially harmful, as it further impairs advice and causes a first-order welfare loss. Once the capital gains tax is in place, limitations on loss offset may paradoxically contribute to higher quality of venture capital finance and welfare. Subsidies to physical investment in VC-backed startups are detrimental in our framework.

JEL Classification: D82, G24, H24, H25.

Keywords: venture capital, capital gains taxation, double moral hazard.

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EPRU is financed by the Danish National Research Foundation. We appreciate comments by Jouka Ylä-Liedenpohja and other participants in the European Financial Association 2002 conference in Berlin. We also benefited from discussions we have had with many other colleagues about our work on public policy and venture capital. We are particularly grateful to an anonymous referee for very constructive comments, and to co-editor B.A.Jensen for advice.

1 Introduction

Innovative new firms embody great potential, but also high risks. Typically, entrepreneurs have no finished product yet and cannot show any feedback from the market. Entrepreneurs tend to be technically well trained, but lack a decent track record in business. They cannot offer sufficient collateral when searching for outside finance. In short, they may have great ideas, but lack experience and money. They need informed capital which combines investment finance and managerial expertise. Venture capitalists (VCs), in contrast, possess both money and managerial know-how. They carefully screen new projects, they taylor financial contracts to realign incentives of entrepreneurs with their own interests, and subsequently offer advice and monitoring of the start-ups. There is clear evidence that venture capital in the U.S. effectively promotes the professionalization of young firms. VC-backed firms tend to have a higher chance of survival, are faster in introducing their products to the market, and are more profitable than other new firms. (See the evidence presented in Hellmann and Puri (2000, 2002), Kortum and Lerner (2000), and Kaplan and Stromberg (2002), among others.)

Relatively few studies, Botazzi and DaRin (2001) and Bascha and Walz (2001) among them, have analyzed the involvement of European venture capital in new business creation. They paint a less impressive picture of venture capital in Europe. In particular, Botazzi and DaRin demonstrate lacking performance of VC-backed firms, in that they do not significantly perform better than firms with standard bank finance. Bascha and Walz find that VCs in Germany use considerably less sophisticated financial instruments than their American counterparts. The consensus seems to be that enough capital is raised, but VCs often neglect the intensive coaching of their portfolio firms. Obviously then, public policy should not so much focus on the mere quantity, but rather on the quality of European VC and provide incentives to enhance VC support of new firms.

In this paper, we consider the role of tax policy in shaping incentives for VC support of young firms. We focus on the effects of capital gains taxes and investment subsidies. A key aspect of the analysis is the double moral hazard that results from the need to put in joint effort. While the entrepreneur tends to focus on technological aspects such as product development, the VC draws on her commercial experience and industry knowledge to provide managerial support and to promote the professionalization of the firm. Neither effort is verifiable and contractible. To provide incentives for both parties to supply effort, an equity contract becomes preferable. Still, an inefficiency remains when both parties simultaneously invest effort in the venture, but must share the resulting profits. While each party bears the full cost of her extra effort, marginal gains accrue to all members of the team which impairs the incentives for joint effort.

Within this setting, we examine the effects of introducing a uniform capital gains tax on both entrepreneurs and VCs. Not only does the tax retard entrepreneurship; it results in a first order welfare loss even if the tax is kept small. By cutting into profits, it impairs incentives of VCs to supply managerial inputs which are already too weak at the outset. Further, policy makers frequently call for tax relief on physical investment spending by innovative start-up firms. In our model, an investment subsidy indeed boosts entrepreneurship but, somewhat unexpectedly, results in a welfare loss. Because the subsidy succeeds to boost entrepreneurship, it expands the industry, depresses venture returns and thereby diminishes incentives for VC support. Being already inefficiently low at the outset, a further cut in managerial inputs must deteriorate welfare. A final aspect of taxation of new firms concerns the treatment of losses. Being high-risk undertakings, some firms fail entirely while others register high profits. When a capital gains tax with complete loss offset is in place, a restriction of loss offsets is often thought to hinder entrepreneurship and be detrimental to welfare. We demonstrate, though, that if the extra revenue created by denying full loss offset is used to cut the capital gains tax rate, the combined effect will be welfare improving.

The paper offers two important contributions to the research on venture capital. First, it considers the real effects of venture capital by showing how it helps to expand a small innovative sector of the economy, and second, it offers a formal analysis of how policy affects venture capital support in start-ups. The finance literature now boasts a wealth of contributions on the design of financial contracts in financing entrepreneurial firms (some examples are Black and Gilson (1998), Gompers and Lerner (1999), Kaplan and Stromberg (2000, 2001), Repullo and Suarez (1999), Lülfesmann (1999) and Schmidt (2002)), whereas there is much less work on how venture capital affects entrepreneurship in equilibrium (see, however, Michelacci and Suarez (2002), Inderst and Müller (2003), and Kanniainen and Keuschnigg (2001)). Michelacci and Suarez (2002) and Inderst and Müller (2003) consider the relation between capital market characteristics and start-up activity, and they point out important search inefficiencies as well as contracting and liquidity externalities. They do not, however, analyze in depth the effects of tax and other public policy instruments.

The public finance literature, in turn, contains only little rigorous analysis of public policy in meaningful models of VC backed entrepreneurship. The exceptions are Poterba (1989a,b), Gompers and Lerner (1998) and Gordon (1998) who examine capital gains and differential corporate and personal taxation. Their contributions do not, however, feature detailed modeling of the joint incentives of entrepreneurs and VCs, nor any welfare-based evaluation of tax policy.

This paper continues our previous work on taxation and entrepreneurship. Keuschnigg and Nielsen (2001, 2003) have focused on the effects of taxes, when entrepreneurs are risk averse, and have explored the trade-off between insurance and incentive provision under one-sided moral hazard. This paper is closest to Keuschnigg and Nielsen (2002), where we have considered the case of risk neutrality and have introduced double moral hazard to focus more sharply on the incentives of VC firms in supporting their portfolio companies. The current paper extends these analyses in three important ways: (i) We show how tax and subsidy rules can replicate a budget-breaking third party as introduced by Holmstrom (1982) in order to attain a first best equilibrium. (ii) We analyse the role of loss offset provision in capital gains taxation. More specifically, we show that a policy of tax cut cum base broadening, i.e. restricting loss offsets and using the proceeds to cut the capital gains tax rate, can be welfare improving. And (iii), we analyze more completely the role of investment subsidies. This experiment is important, since most of the real world policies to promote innovative start-up firms subsidize the cost of capital. One of the important insights of the paper is that these subsidies are not performance-related and therefore do not help to strengthen incentives. They effectively reduce welfare if one allows for general equilibrium effects on venture returns. Kanniainen and Keuschnigg (2001, 2003) and Keuschnigg (2002) consider the interaction of incentives for entrepreneurial effort and VC support with the optimal portfolio size of a VC. For simplicity, the current paper abstracts from optimal portfolio choice by restricting to the simpler case of linear effort costs.

We introduce our model in section 2. Section 3 shows how a capital gains tax and other tax-subsidy schemes affect entrepreneurship, VC support, and welfare. Section 4 considers a more narrowly focused policy that offers VC firms a lower tax rate on capital gains but denies full loss offset. Section 5 concludes.

2 The Economy

2.1 Overview

Consider a simple economy with a large number of agents, N. Individuals may have a business idea and start a firm in the entrepreneurial sector, or else they take a safe job in the traditional sector. An occupational choice decision splits the population into L workers and E entrepreneurs,

$$N = L + E. \tag{1}$$

Two goods are supplied. One unit of labor yields one unit of the traditional good which is assumed to be the *numeraire*. The unit input-output coefficient fixes the wage rate at $w = 1$, and aggregate output amounts to L. The innovative good pays a relative price V. Its production is inherently risky. An entrepreneur who puts in high effort, is able to produce one good with probability $P > 0$, but nothing with probability $1 - P$. By the law of large numbers, a fraction P of entrepreneurs succeeds, yielding an aggregate supply of the innovative good equal to $P \cdot E$. Denoting demand per individual for traditional goods by X^D and for innovative goods by D, market clearing requires

$$ND = P \cdot E, \qquad NX^D = L. \tag{2}$$

Entrepreneurs lack both resources and commercial experience to develop their business idea. They team up with a VC that has managerial know-how and money to pay for the start-up cost. Given a fixed number F of VC firms, each one is involved in funding and advising E/F start-ups on average.[1] The output from the start-up is the result of a joint effort by the entrepreneur who contributes her technological know-how, and the VC who supports the venture with advice. A VC generates a net of tax profit π^F per project. All start-up firms are assumed symmetric. Dividends are distributed among households, giving $\pi^F E = N\Pi$ in the aggregate, where Π is a uniform dividend per household from equally distributed ownership of VC firms.

Disposable income y^i of an agent depends on her occupation. Taking account of the price normalization $w = 1$, and denoting a possible wage subsidy by S^L ($S^L < 0$ indicating a wage tax), income of a worker amounts to $1 + S^L + \Pi$. Income from start-up firms is divided between entrepreneurs and VCs. Since a firm produces one unit of the innovative good, its value is V if it is successful, and zero if it fails. A start-up firm thus generates an expected capital gain of $PV - (1 - z)I$ over the private start-up cost. Physical investment I uses the traditional good and is possibly subsidized by government at a rate z. Since the entrepreneur has no other income or wealth, she cannot pay for the investment expenditure. She thus sells a share $1 - s$ to a VC for a price $(1 - z)I + B$, which covers the entire start-up cost plus an up-front payment B. With this deal, the

[1] We do not explicitly determine an optimal number of portfolio companies per VC as is done in Kanniainen and Keuschnigg (2001, 2003). Average portfolio size is implicitly determined in equilibrium. Moreover, VCs are modelled as “atomless” which keeps the analysis simple without changing the results. This is verified by the analysis of Keuschnigg (2003), where VCs are modeled as real persons with alternative job opportunities.

entrepreneur's expected income or capital gain amounts to $sPV + B$. In the presence of taxes, the entrepreneur must pay a capital gains tax on the initial deal, $\tau^E B$, plus a tax upon realization of her remaining share, $\tau^E sPV$ in expected value. Taking account of a potential lump-sum subsidy S^E to entrepreneurs, they derive (on top of the profits from the VC sector Π) an expected disposable income from the firm of

$$\pi^E = \left(1 - \tau^E\right)(sPV + B) + S^E. \tag{3}$$

Summing up and taking into account that the venture may succeed or fail, per capita income of agent i is

$$y^i = \begin{cases} 1 + S^L + \Pi & \text{worker,} \\ \left(1 - \tau^E\right)(sV + B) + S^E + \Pi & \text{successful entrepreneur,} \\ \left(1 - \tau^E\right) B + S^E + \Pi & \text{unsuccessful entrepreneur.} \end{cases} \tag{4}$$

A VC faces a tax on capital gains at rate τ^F. If the venture is successful, the VC's net income or capital gains, $\left(1 - \tau^F\right)(1 - s)V - ((1 - z)I + B)$, is fully taxed. However, if the venture fails, we assume that only a part $0 \leq \xi \leq 1$ of the resulting loss $(1 - z)I + B$ qualifies for deduction against the tax. Full loss offset corresponds to $\xi = 1$, whereas limited loss offset implies $\xi < 1$. With probability of success P, the VC can thus deduct all initial outlays $(1 - z)I + B$ against the tax. With probability $1 - P$, only a share ξ of the initial outlays are tax deductible. Hence, the effective degree of tax deductibility is measured by the parameter $\psi \equiv P + (1 - P)\xi$.[2] Utilizing this, the VC's expected profit or capital gain π^F per firm becomes $P\left(1 - \tau^F\right)[(1 - s)V - (1 - z)I - B] - (1 - P)(1 - \tau^F \xi)[(1 - z)I + B]$, or

$$\pi^F = \left(1 - \tau^F\right)(1 - s)PV - \left(1 - \psi\tau^F\right)[(1 - z)I + B]. \tag{5}$$

The government assumes a limited role only. Ignoring the provision of public goods,

[2] Clearly, $\psi < 1$ with imperfect loss offset, and $\psi = 1$ with full loss offset. Note that we implicitly assume that a VC finances a portfolio of firms. Free entry in VC finance, as we later assume, means that a given number of VC firms finance more portfolio companies each.

it raises taxes to pay for various subsidies. The government budget constraint is

$$\tau^E (sPV + B) E + \tau^F [(1-s) PV - \psi ((1-z) I + B)] E = S^E E + S^L L + zIE. \quad (6)$$

Now use equations (1) and (3)–(6) to write aggregate disposable income Y as

$$Y = (\pi^E + \Pi) E + \left(1 + S^L + \Pi\right) L = L + (PV - I) E. \quad (7)$$

Agents spend disposable income to buy quantities D and X of innovative and traditional goods, respectively. Equating spending $Y = N(VD + X)$ with income in (7), we have

$$V (ND - PE) + \left(NX^D - L\right) = 0, \qquad X^D = X + IE/N. \quad (8)$$

Total demand NX^D for the traditional good stems from households' consumption X per individual and from investment I per project in the entrepreneurial sector. Walras' Law holds: market clearing $ND = PE$ for innovative goods also implies equilibrium in the traditional sector, $NX^D = L$.

2.2 Private Decision Making

Having made an occupational choice, workers and entrepreneurs supply effort and spend on goods. VC firms finance and advise start-ups and distribute profits to households. Starting an entrepreneurial firm requires a joint effort by the entrepreneur and the VC. The entrepreneur contributes her technological knowledge, the VC firm helps with managerial and market expertise. Both parties are assumed to incur intangible effort costs that are not verifiable and cannot be contracted upon. Their relationship is subject to double moral hazard as in Repullo and Suarez (1999), Lülfesmann (1999), Casamatta (2002), Schmidt (2002) and Inderst and Müller (2003), for example. The inputs of the two parties are required simultaneously, and that of the entrepreneur is assumed to be critical for the success of the start-up. This feature results from the entrepreneur's effort being discrete, $e \in \{0, 1\}$, giving effort costs $l(e) \in \{0, \beta\}$. The VC also adds value to the firm in terms of advice a which is taken to be continuous. In doing so the VC incurs an intangible cost of effort which is assumed to be linear, $l(a) = a$. The success probability of the start-up is specified as

$$P = e \cdot p\left(a\right), \quad p\left(a\right) = a^{1-\theta} / \left(1-\theta\right), \quad 0 < \theta < 1. \tag{9}$$

In sum, the entrepreneur's expected profit income π^E in (3) depends on her own as well as the VC's effort which jointly determine the success probability as in (9). The same goes for the VC's income π^F in (5).

The venture capital cycle involves the following sequence of events. 1. The government sets tax policy, i.e. $\tau^E, \tau^F, \xi, z, S^E$, and S^L; 2. The VC buys an equity stake $1-s$ at a price $(1-z)I + B$; 3. Potential entrepreneurs accept or reject the deal (occupational choice); 4. VCs and entrepreneurs simultaneously supply efforts e, a subject to double moral hazard; 5. Nature resolves risk and, thus, determines outcome; 6. Agents choose consumption conditional on their income. As usual, the model is solved backwards.

2.2.1 Preferences and Demand

For simplicity, agents are endowed with separable preferences over consumption and effort cost. We normalize the worker's effort to zero, $l^i = 0$ if $i \in L$. In contrast, the entrepreneur's effort $e \in \{0, 1\}$ is discrete and gives rise to low or high effort cost, $l^i \in \{0, \beta\}$ with $\beta > 0$ for $i \in E$. Consumption demand for the two goods is decided only *after* effort has been expended and individual income y^i has been determined. At that stage, consumers maximize utility net of a *given* effort level that was previously sunk,

$$U^{i*} = \max_{D^i, X^i} \left\{ u\left(D^i\right) + X^i - l^i \quad s.t. \quad X^i + VD^i \leq y^i \right\}. \tag{10}$$

Utility is assumed separable which eliminates income effects. In our simple general equilibrium framework, we can therefore separately solve for equilibrium in the entrepreneurial sector much like in a partial equilibrium model. Since subutility $u\left(D^i\right)$ is identical for all agents and satisfies $u'\left(D^i\right) > 0 > u''\left(D^i\right)$, demand for the innovative good is the same for everyone, $D^i = D$. It will be convenient to adopt the isoelastic specification

$u(D) = \phi^{1/\eta} \cdot D^{1-1/\eta} / (1 - 1/\eta)$ which yields

$$u'\left(D^i\right) = V, \qquad D = \phi V^{-\eta}. \tag{11}$$

Demand for the traditional good then follows from the budget, $X^i = y^i - VD$, and reflects the individuals' different incomes. Substituting back into the utility function, we obtain indirect utility (conditional on effort)

$$U^{i*} = y^i - l^i + CS, \qquad CS = u(D) - VD. \tag{12}$$

Consumer surplus associated with consumption of innovative goods, denoted by CS, may also be obtained by integrating the inverse demand from (10),

$$CS = \int_0^{D(V)} D^{-1}(z)\, dz - VD(V), \tag{13}$$

where $D^{-1}(z) = u'(z)$ is marginal utility from the z'th unit of the good. Since agents consume the same quantity D independent of income, CS is likewise the same for all.

2.2.2 Effort Choice

Funding and advising entrepreneurial firms must be sufficiently profitable; otherwise VCs would close down operations. To break even, the expected capital gains net of taxes must cover not only the effective price paid for the equity stake, but also the VC's intangible effort cost. The VC's problem consists of structuring the deal, i.e. proposing to buy a stake $1 - s$ for a price $(1 - z)I + B$, and subsequently offering a level of support a to maximize the surplus $\pi^F - a$.[3] Using (5), we have

$$\Omega = \max_{s,B,a} \left\{ \left(1 - \tau^F\right)(1 - s) \cdot ep(a) \cdot V - \left(1 - \psi \cdot \tau^F\right) Q - a \right\} \tag{14}$$

subject to participation and incentive compatibility constraints,

$$PC^E \;:\; \pi^E - \beta = \left(1 - \tau^E\right)[p(a)\, sV + B] + S^E - \beta \geq 1 + S^L, \tag{i}$$

$$IC^E \;:\; \left(1 - \tau^E\right) p(a)\, sV - \beta \geq 0, \tag{ii}$$

$$IC^F \;:\; \max_a \left\{ \left(1 - \tau^F\right) ep(a)(1 - s)V - \left(1 - \psi(e, a, \xi)\, \tau^F\right)[(1 - z)I + B] - a \right\}. \tag{iii}$$

[3]As we later introduce a zero-profit constraint for VCs, it is actually not restrictive to assume that the VC has all the bargaining power.

A value $\psi = 1$ implies perfect loss offset. With incomplete loss offset, however, the tax variable $\psi(e, a, \xi) = ep(a) + (1 - ep(a))\xi$ depends on the entrepreneur's effort, the VC's advice, and the share of losses ξ that qualifies for a tax deduction. With $\xi < 1$, the government fully participates in the capital gains, but only partly shares in the losses from unsuccessful investments. This raises the effective tax burden on VCs. With imperfect loss offset, the VC may reduce the effective tax load by raising ψ, i.e. advising more intensively and making losses less likely.

Following the principle of backward induction, we now turn to effort choice. Anticipating how effort affects income and utility, the VC and entrepreneur simultaneously choose effort. At this stage, B, s, and V plus policy parameters are all fixed. According to (12), expected utility of an entrepreneur conditional on effort is $\pi^E - l(e) + \Pi + CS$ with π^E given by (3) and (9). The entrepreneur's choice of effort $e \in \{0, 1\}$ is determined by the incentive constraint IC^E in (14.ii) which compares utility from high effort with utility from low effort. Income terms that do not depend on effort cancel from both sides of the inequality, leaving only $\left(1 - \tau^E\right) sep(a) V - l(e)$ to be maximized. High effort gives $l = \beta$ and $P = p(a)$ while low effort results in $l = 0$ and $P = 0$. If the incentive constraint IC^E in (14.ii) is satisfied, the entrepreneur will expend high effort indeed. Her willingness to expend effort increases with her profit share s, while a higher capital gains tax τ^E reduces the return to effort.

The VC chooses managerial effort to maximize the remaining part of income in (14.iii). The first order condition is

$$\Omega' = ep'(a) \cdot \left[\left(1 - \tau^F\right)(1 - s) V + (1 - \xi)\tau^F Q\right] - 1 = 0. \tag{15}$$

The second order condition $\Omega'' < 0$ is fulfilled by the concavity of $p(a)$. Note first that the VC would never want to waste any managerial effort ($a = 0$) if the entrepreneur shirks ($e = 0$). Efforts are complements. Given high entrepreneurial effort, the marginal benefits of advice in (15) are twofold. First, the VC obtains the return on its shares with a higher probability. Second, more advice lowers the probability that the portfolio company fails, and thereby allows the VC to avoid the extra tax cost due to imperfect loss offset. With full loss offset, $\xi = 1$, the government participates equally in gains and losses, and the extra benefit of reducing the overall tax bill from the VC portfolio vanishes. Note also that, for a given tax rate, a limitation of loss offset, i.e. a reduction of ξ, strengthens the incentives for advice. Taxation then punishes the VC more severely when she allows the business to fail. A smaller capital gains tax and a larger equity stake $1 - s$ similarly strengthen the VC's consulting incentives.

2.2.3 The Equity Contract

The next step backwards is to the entrepreneur's occupational choice which is reflected in the participation constraint PC^E in (14.i). According to (12), expected indirect utility from entrepreneurship is $\pi^E + \Pi - \beta + CS$, while utility from a worker's salary is $1 + S^L + \Pi + CS$. Since the terms Π and CS are the same for both occupations, they cancel from the participation constraint, giving rise to (14.i). If the venture contract is sufficiently generous, i.e. if it includes a large upfront payment B and leaves a large residual share s, agents will find it attractive to give up a safe job and start a firm.

The last step to be solved is the VC's proposal for a contract. In specifying the contract terms by means of choosing s and B, the VC must anticipate how the proposal affects the entrepreneur's willingness to accept the deal, and how it determines the entrepreneur's and her own incentives to expend effort, once the firm is started and the initial investment costs are sunk. Since by assumption the entrepreneur possesses no own wealth, the equity injection by the VC must at least cover the start-up cost $(1 - z)I$. Apart from that, the VC obviously wants to obtain a large stake $1 - s$ at a small price Q (leaving a small share s to the entrepreneur). Starting from a situation of high effort $e = 1$, and anticipating how efforts respond to variations in profit sharing, the VC cuts the entrepreneur's share to boost her own profits, $d\Omega/ds = -\left(1 - \tau^F\right) p\left(a\right) V < 0$. Note that the effect of s on Ω via a disappears due to the envelope theorem on account of (15). The VC cuts s until IC^E becomes tight. A further reduction would destroy all profits as the entrepreneur starts shirking. Consequently, IC^F and IC^E jointly determine advice plus the minimum profit share s that induces high effort by the entrepreneur.

Given a and s, we find that the VC cuts the price $B+(1-z)\,I$ to raise her own profits. She will always have to pay for $(1-z)\,I$, but she may offer a smaller upfront payment B. However, PC^E prevents a too low price, as otherwise entrepreneurs would not want to start a firm at all. As IC^E in (14.ii) must hold with equality, PC^E in (14.i) gives the minimum upfront payment B which makes entrepreneurs accept the proposed deal,[4]

$$B = \left(1 + S^L - S^E\right) / \left(1 - \tau^E\right). \tag{16}$$

2.2.4 Industry Equilibrium

The efforts of entrepreneurs and VCs, $e = 1$ and a; the success probability $P = p\,(a)$; and the contract parameters s and B are now all determined. With E projects or start-up entrepreneurs, industry supply becomes $p\,(a)\,E$. The induced effort levels and supply depend parametrically on project value, or market price V, for the innovative good. We assume a competitive VC sector where firms compete down profits from VC investments until they just suffice to cover the managerial effort cost of advice. In other words, VC firms must generate positive monetary profits to compensate for the intangible effort cost of advice. This yields the "zero profit" condition $\Omega = \pi^F - a = 0$ as yet another equilibrium condition, or

$$\pi^F = a. \tag{17}$$

A variation in the competitive venture return V, of course, feeds back to the level of advice and profit shares. It is thus determined jointly by the free entry condition together with the other conditions relating to the venture contract and the level of advice. The equilibrium number of entrepreneurs then follows from demand (11) and the market clearing condition $ND = p\,(a)\,E$. The remaining part of the population picks up safe jobs in the traditional sector.

[4] In an untaxed equilibrium, $B = 1$. We shall only look at values of subsidies so that $1 + S^L > S^E$ always holds. In consequence, B is always positive, and the participation constraint is never slack.

2.2.5 Welfare

For an evaluation of policy initiatives we need a welfare measure. By the participation constraint in (14.i), indirect utility in (12) will be equal for workers and entrepreneurs, $U^{*E} = U^{*L}$. Household income includes positive monetary profits from ownership of VC firms. Since these profits are merely a compensation for intangible effort costs, we must subtract them from profits. Adding up indirect utilities of agents, subtracting VC effort costs, and using $N\Pi = \pi^F E = aE$ by the zero profit condition, the welfare measure becomes

$$U^* = U^{*E}E + U^{*L}L - aE = \left(1 + S^L + CS\right) N. \tag{18}$$

2.3 Efficiency

Agents maximize each their own surplus, taking the actions of others as given. Private decisions of entrepreneurs and VCs may not achieve the efficient solution which would maximize the joint surplus of each start-up project. The surplus of entrepreneurs is expected net profits minus effort cost minus foregone wages, $\pi^E - \beta - 1 - S^L$, which is zero by the participation constraint. The surplus per venture of the VC is Ω in (14), while net tax revenue or government surplus per firm amounts to $\tau^E\left(sPV + B\right) + \tau^F\left[(1-s)\,PV - (1-z)I - B\right] - zI - S^E + S^L$.[5] Adding these surpluses of the three parties we obtain the joint surplus per venture, denoted by Φ:

$$\Phi = e \cdot \left[p\left(a\right)V - \beta\right] - a - I - 1. \tag{19}$$

Quite obviously, the optimal effort levels that maximize joint surplus are $e^* = 1$ and

$$p'\left(a^*\right)V = 1, \tag{20}$$

which compares with (15), i.e. $(1-s)\cdot p'\left(a\right)\left(1-\tau^F\right)V = 1$.

[5] When one more entrepreneur is recruited from the pool of workers, the government pays S^E instead of S^L, yielding a net reduction of the surplus equal to $-\left(S^E - S^L\right)$. We keep the loss offset parameters ψ, ξ at unity in this section.

Proposition 1 ***(Efficiency)*** *(a) In the untaxed equilibrium, advice is too low,* $a < a^*$*.* *(b) The optimal revenue subsidy to induce the first best level of advice is*

$$\left(1-\tau^{F*}\right)(1-s^*) = 1 \qquad \Rightarrow \qquad \tau^{F*} = \frac{-s^*}{1-s^*} < 0. \tag{21}$$

Proof. (a) Comparing (20) with the untaxed version of (15), i.e. $(1-s) \cdot p'(a) V = 1$, implies $a < a^*$. (b) Conditions (20) and (15) yield $a = a^*$ only if (21) holds. ■

In the absence of taxes, the private level of advice is smaller than the efficient one because the financier gets only a part $1-s$ of the full social return $p'(a) V$ from her extra effort. The need to share profits with the entrepreneur to enlist her critical effort impairs the incentive of the VC. The market equilibrium is therefore biased towards an inefficiently low level of support. Since the entrepreneur's effort is assumed critical, it must be kept at unity and therefore cannot be underprovided.[6] The government can, in principle, induce the efficient level of support. It needs to strengthen the marginal private return on advice by subsidizing VC revenues at the rate given in (21). With this policy, private incentives in (15) are aligned to yield, for any given price V, the socially optimal level of advice a^*. Knowing a^*, IC^E in (14.ii), $s^* p(a^*) V = \beta$, then implies an optimal profit share $s^* = s(a^*)$, again conditional on V. In essence, our result on the optimal revenue subsidy implies that the government can play the role of a budget-breaking third party that was introduced by Holmstrom (1982) as a means to obtain a first best equilibrium.

Since the 'capital gains subsidy' boosts VC profits, the government could impose a tax on start-up investment $z^* < 0$ which must be paid out of the VC's pockets, since the entrepreneur has no own resources. The rationale for this policy is that the VC herself, rather than the general tax payer, would pay the revenue subsidy that she receives. Since the start-up tax is paid *before* any effort is expended, it is not performance-related and therefore not harmful when the VC finally chooses the level of advice. The revenue subsidy, in contrast, is given only *after* effort is chosen, and only in case of success. Anticipating

[6] As demonstrated in our companion paper, Keuschnigg and Nielsen (2002), entrepreneurial effort would be similarly discouraged by profit sharing, if it were continuous.

a larger return to effort on account of the subsidy, the VC is keen to increase support.[7] Setting other policy parameters to zero, an optimal and self-financing policy is given by (21) and

$$z^* I = \tau^{F*} \left[(1 - s^*) \, p^* V - (1 - z) I - B \right], \qquad B = 1, \tag{22}$$

Note that this policy induces general equilibrium effects that will affect the innovative goods price and, therefore, venture returns. The V appearing in (22) will be different from the value holding at $\tau^F = 0$.

Another way of verifying this line of argument is to check how a marginal introduction of a subsidy affects joint surplus in (19),

$$\frac{d\Phi}{d\tau^F} = \left[p'(a) \, V - 1 \right] \frac{da}{d\tau^F} = \left[1 - (1 - s) \left(1 - \tau^F \right) \right] p'(a) \, V \frac{da}{d\tau^F}, \tag{23}$$

where the second equality uses (15) (with $\xi = 1$). The square bracket indicates the wedge between the VC's optimal marginal return $p'V$ and what she receives via the privately agreed profit share plus the tax subsidy, $(1 - s) \left(1 - \tau^F \right) p'V$. In the untaxed state, $\tau^F = 0$, this wedge amounts to $sp'V$ which is the external benefit of the VC's effort, i.e. the positive spillover to the entrepreneur . Since a tax reduces advice,[8] $da/d\tau^F < 0$, introducing a small *subsidy* strengthens advice, and thereby yields a first order increase in joint surplus. When the subsidy is eventually raised up to its optimal level listed in (21), the first order gain in joint surplus vanishes.

One might wonder whether the highly sophisticated VC industry could not come up with its own market-based solution to this basic inefficiency. The problem results from the fact that VCs cannot commit to the efficient levels of advice when they rely on the usual equity-like contracts. In principle, as stressed by Holmstrom (1982) in the framework

[7] The scheme basically solves a commitment or time consistency problem. When the VC contracts with the entrepreneur, she cannot commit to the mutually beneficial level of advice because this level is privately not optimal anymore, when the effort actually has to be expended.

[8] That the tax reduces advice is obvious from (15). Since this tightens IC^E in (14.ii), the VC must raise the entrepreneur's share s to avoid loosing her effort. With a smaller share for herself, she will want to advise even less. Later on we fully take account of this interdependency, see (A.2-3) in the appendix.

of moral hazard in teams, contracting with a third party might solve this commitment problem.[9] Since only the VC's effort is continuously variable in our setting, an efficient solution will have to make the VC the full residual claimant on the project outcome. The key idea for such efficient contracting is that the VC irrevocably gives up already at the contracting stage an expected amount $X = psV$ of bonus money that must be promised to the entrepreneur to enlist her effort. It is important that this money is transferred to a third party, an outside intermediary. When it comes to the effort stage, the VC can rely on the third party to reward the entrepreneur's effort. Since the entrepreneur's share in profits is already prefunded, the VC can claim 100 percent of the extra project income resulting from her advice, as is required for efficiency.

For whatever reasons, such institutions seem not to exist in practice. For example, we find no hints of such arrangements in the analysis of VC contracts by Kaplan and Strömberg (2000). While VCs apparently assure themselves of far-reaching control rights and use convertible instruments to participate more in the upside potential of their portfolio companies, they seemingly do not come close to being full residual claimants. For this reason, we do not follow the "efficient venture capital model" for the rest of this paper, but rather stay with our basic profit sharing framework.[10]

3 Taxation of Venture Capital

This section turns to a general equilibrium and welfare analysis of alternative tax experiments. We are particularly interested in how taxes affect the equilibrium number of

[9] In addition to Holmstrom (1982), we may also refer to McAfee and McMillan (1991). Further, competitive intermediaries were shown to solve contractual problems in the labor market as well where anonymous matching and ex post bargaining can lead to inefficient ex ante investments of firms and workers; see Masters (1998) for such an analysis.

[10] If entrepreneurial effort were continuous, it would also be inefficiently provided. Contracting with a third party to solve for this inefficiency would be precluded by the assumption that the entrepreneur possesses no wealth at the outset. This observation constitutes an additional reason for staying with our basic profit sharing framework and the inefficiency it implies.

start-ups and how they affect the involvement of VCs in their portfolio companies. The comparative static analysis below uses 'hats' primarily to denote percentage changes. For instance, $\hat{a} \equiv da/a$, gives the deviation da relative to the value a in the initial equilibrium position with zero profits. Further, we define relative changes in tax rates as $\hat{\tau}^j \equiv d\tau^j / (1 - \tau^j)$. To allow for zero initial values of subsidies, we also define $\hat{S}^i \equiv dS^i$. We assume that full loss offset is allowed in this section, $\psi = \xi = 1$, and that the start-up subsidy is set to zero, $z = 0$, in the initial equilibrium. Appendix A lists some restrictions that must hold in the initial zero profit equilibrium, and that are useful in signing comparative static effects. Appendix B calculates various comparative static effects from policy changes that will be extensively referred to in the following subsections.

3.1 Uniform Capital Gains Tax

Policy makers and business practitioners often state that a capital gains tax is particularly harmful to VC activity and the creation of innovative young firms. What are then the effects, in our framework, on the equilibrium number of start-ups and the quality of VC finance? As a first experiment, we consider the introduction of a uniform tax on entrepreneurs and VCs with full loss offset. Hence, $\tau^E = \tau^F = \tau$, starting from values of zero, and $\xi = 1$. To isolate the tax effects, we assume that revenues are distributed by a uniform transfer to entrepreneurs and workers, $S^E = S^L = S$. This transfer neither affects occupational choice (see 14.i), nor the VC's incentives to advise, nor her profits. The subsidy thereby leaves the competitive price of innovative goods unaffected. The up-front payment to entrepreneurs is $B = 1$ by (16) in the untaxed equilibrium. We conjecture that a uniform capital gains tax will discourage VC support and thereby diminish welfare.

The immediate effect of the capital gains tax is that it impairs the VC's incentives to expend effort in advising the firm, $\hat{a} = -\hat{\tau}/\theta$ by (A.2) in the appendix. With the lack of support, success becomes more uncertain. The entrepreneur thus requests a higher profit share to compensate for her own critical effort. This comes on top of the fact that the tax itself diminishes the entrepreneur's effort which is secured only with a higher profit share, $\hat{s} = \hat{\tau} - (1-\theta)\,\hat{a}$, see (A.2). Having to cede a higher equity stake to the entrepreneur further weakens the VC's incentives. Taking account of this interaction, the VC cuts back support by $\hat{a} = -\hat{\tau}/\,(\theta - s) < 0$, and raises the entrepreneur's equity share by $\hat{s} = \hat{\tau}\,(1-s)\,/\,(\theta - s)$, see (A.3).[11] The capital gains tax erodes profits from VC investments directly, but also by the need to cede a larger share to the entrepreneur to secure her critical contribution, $\hat{\Omega} = -spV\hat{s} - [(1-s)\,pV - (1-z)I - B]\,\hat{\tau}$, see (A.4).[12] With the prospect of sizeable losses from their portfolio investments, VCs will fund fewer start-ups. Furthermore, the lack of support results in higher risks and a larger rate of business failure. Eventually, the supply contraction must raise the price of the innovative good, or venture returns, by enough to restore profitability. According to (A.8), venture returns increase in zero profit equilibrium by

$$\hat{V} = \left[1 - \theta + \frac{\theta B + sI}{1+I}\right]\hat{\tau} = \left[1 - (\theta - s)\,\frac{I}{1+I}\right]\hat{\tau} > 0. \tag{24}$$

Although higher venture returns would otherwise encourage more intensive advice, the direct tax effect works to reduce it and dominates in (A.3) to retard the equilibrium level of support,

$$\hat{a} = \frac{1}{\theta - s}\left(\hat{V} - \hat{\tau}\right) = -\frac{I}{1+I}\hat{\tau} < 0. \tag{25}$$

The capital gains tax inflates the cost of VC backed investment. To break even, the equilibrium price must increase as noted in (24) which chokes off demand for the innovative good. The size of the entrepreneurial sector shrinks. Since start-ups obtain less support, fewer of them will succeed and mature to production stage. This latter effect works to increase entrepreneurship, since a larger number of start-ups is required to accommodate any given level of demand when the failure rate is high. Substitute (24) and (25) into (A.10). The capital gains tax retards entrepreneurship as long as the demand elasticity η

[11] By (A.3), we always have $\theta - s > 0$.

[12] The square bracket is positive by (A.1c).

is not too low,[13]

$$\hat{E} = -\left\{(\eta - 1)\left[1 - \frac{(\theta - s)\, I}{1 + I}\right] + \left[1 - \frac{(1 - s)\, I}{1 + I}\right]\right\}\hat{\tau} < 0 \quad \Leftrightarrow \quad \eta > \eta^*, \tag{26}$$

where $1 > \eta^* = \frac{(1-\theta)I}{1+I+(1-\theta+s)I} > 0$. Consider as a benchmark a demand elasticity of unity which implies a smaller rate of entrepreneurship, $\hat{E} = -\left[1 - (1-s)\, I/(1+I)\right]\hat{\tau} < 0$. The capital gains tax always reduces the size of the innovative sector. It also discourages entrepreneurship, except for a very low demand elasticity.

Since transfers boost disposable income, the welfare effect depends on the amount of revenue that the tax raises. Starting from an untaxed equilibrium, there will be no tax base effects. By the government budget constraint in (6), equal to $NS = \tau\,(pV - I)\,E$ in the present case, the tax raises revenues in the amount of

$$(pV - I)\, E\hat{\tau} = N\hat{S}. \tag{27}$$

Substitute (24) and (27) into (A.11). Using (A.1c) and (26), we get

$$\hat{U}^* = N\hat{S} - pVE \cdot \hat{V} = (1 - \theta)\, spVE \cdot \hat{a} < 0. \tag{28}$$

The uniform capital gains tax raises the price of innovative goods and thereby reduces welfare on account of a loss in consumer surplus. This loss is not fully compensated by the increase in disposable income when the tax revenue is distributed to households. The first order welfare effect is strictly negative in the neighborhood of the untaxed equilibrium and is in fact proportional to the reduction of support. This welfare result confirms the efficiency analysis in section 2.3, where we argued that the double moral hazard causes the VC to provide an inefficiently low level of support. Since she must share the increase in revenues while bearing all the cost of her effort, the VC provides less support than would be socially optimal. Any policy that discourages advice even more, is bound to inflict first order welfare losses.

[13] If η is near zero, the price increase would have almost no effect on demand. In this case, a smaller survival rate on account of less advice implies a higher start-up rate to accommodate demand.

Proposition 2 ***(Capital Gains Tax)*** *The capital gains tax discourages managerial advice, raises venture returns, and retards entrepreneurship. Although tax-financed transfers boost disposable income, a small tax results in first order welfare losses on account of a loss in consumer surplus.*

Proof. See equations (24) to (28). ■

3.2 A Subsidy to Investment

This subsection briefly investigates another policy scenario which, perhaps surprisingly, happens to harm welfare. Like the previous experiment it sheds some light on the mechanisms triggered by public policy, the key again being how the experiment affects the basic inefficiency in VC support.

The policy consists in offering a subsidy to physical investment I, i.e. $z > 0$, and financing the subsidy by a uniform lump sum tax $S < 0$ (negative transfer) on workers and entrepreneurs. This policy avoids influencing the entrepreneur's outside option, and in addition it also makes the deal less expensive by decreasing the total start-up investment cost. The investment subsidy allows venture returns to fall until VCs again break even on their investments. The lower price of innovative goods unfortunately discourages support which deteriorates welfare in the face of an already inefficiently low level of VC involvement in the market equilibrium. But entrepreneurship will be stimulated on account of both the increase in demand following the price decline and the drop in the survival probability associated with the cut in VC support. We state our results as:

Proposition 3 ***(Subsidizing Start-up Investment)*** *A small subsidy on start-up investment $\hat{z} > 0$ that is financed by a uniform lump sum tax $\hat{S} < 0$, lowers venture returns and advice, stimulates entrepreneurship, but decreases welfare to the first order.*

Proof. By (6), $NS = -zIE$, so a small subsidy starting from $z = 0$ is financed by transfers of $N\hat{S} = -IE\hat{z} < 0$. The upfront payment $B = 1$ in (16) remains unchanged.

By (A.8) and (A.9), venture returns and advice drop by $\hat{V} = -(\theta - s) I\hat{z}/(1+I)$ and $\hat{a} = -I\hat{z}/(1+I)$. Substitute into (A.10) to get $\hat{E} = [(\theta - s)\eta + 1 - \theta] I\hat{z}/(1+I)$. Substituting $\hat{V}$ and $\hat{S}$ into (A.11) and using (A.lc) yields $\hat{U}^* = -EI\hat{z}(1-\theta)s/[(1-s)\theta] < 0$, which is again proportional to $\hat{a}$. ■

Most of actual policy initiatives to promote business creation involve some form of subsidy to the cost of capital. Such policies come out rather unfavorable in our framework. Since they are not performance-related, they are not useful in strengthening incentives for entrepreneurial effort and VC support. Quite to the contrary; since they stimulate entry, they tend to reduce venture returns and for this reason impair incentives for effort. Since VC support is inefficiently low in the untaxed equilibrium, this negative feedback effect imposes a first order welfare loss.[14]

Finally, an obvious temptation after our two policy experiments is to combine them in the following way: Levy a negative capital gains tax and finance the implied revenue subsidy by a tax, not a subsidy, on physical investment of VC-backed start-ups. It should be clear from propositions 2 and 3 that this combined policy of a 'self-financed revenue subsidy to start-ups' has the potential to raise welfare. While the revenue subsidy directly boosts incentives for effort, the start-up tax can affect incentives only indirectly via the induced equilibrium price effect. The net effect is almost surely to strengthen VC advice which must raise welfare when advice is too low in the untaxed equilibrium.

4 Tax Cut Cum Loss Offset Restriction

The policy proposal just mentioned of a self-financed revenue subsidy to start-ups may be unrealistic although it is specifically targeted at the problem of inadequate quality of

[14] Actual policy, however, might be motivated in part by the expectation of positive spillover effects from entry of innovative entrepreneurial firms in the output market. In this case, the investment subsidy might have a more constructive role to play, with the positive externality effect partly or fully offsetting the negative incentive effect.

VC finance and, at the same time, does not put a net burden on the general tax payer. Furthermore, most countries do apply a capital gains *tax* or they subject capital gains to the general income tax. The previous analysis revealed that the capital gains tax is particularly harmful because it exacerbates a preexisting market distortion. We now suggest another targeted and self-financed policy initiative that should yield welfare gains. Suppose a positive capital gains tax with full loss offset is in place. We propose to cut the tax rate on VC funds τ^F while at the same time restricting loss offset (reducing ξ and hence ψ below unity), so that the combined policy change is revenue neutral. In this way, VCs pay themselves for the tax cut they receive, without putting a burden on the general budget. The proposal exploits the fact that VC investments are inherently risky and VC funds always end up registering losses in some firms and substantial revenues in others. By raising the tax cost of business failure, the loss offset restriction punishes financiers for lack of advice and for letting companies fail. The lower capital gains tax boosts the marginal benefit of advice. Hence, the policy of tax cut cum loss offset restriction gives a double kick as both elements encourage advice.

To be more precise, suppose that VCs are subject to a capital gains tax with full loss offset, $\tau^F > 0$ and $\xi = 1$, while $\tau^E = 0$.[15] The tax finances a uniform subsidy to workers and entrepreneurs, $S > 0$, which is kept constant. The policy proposal broadens the tax base by limiting loss offset, $\hat{\xi} < 0$, and uses the additional revenues to cut the tax rate, $\hat{\tau}^F < 0$. The reform is revenue neutral without any burden to the general tax payer. Since we start from a taxed equilibrium, we have to take account of tax base effects which complicates the analysis relative to the experiments in section 3.

To follow the effects of the policy, we begin by considering the impact on advice in

[15] In reality, the scenario would start with a uniform capital gains tax $\tau^F = \tau^E > 0$ and then stimulate advice with a selective tax break to VCs only. Having $\tau^E > 0$ would, however, introduce additional tax base effects and considerably complicate the analysis without fundamentally altering the analysis. Similarly, a cut in a uniform capital gains tax on both entrepreneurs and VCs, financed by restricting loss offset, will generate the same qualitative effects on key variables as the ones we derive below. In the experiment, we also set $z = 0$, while $S^E = S^L = S$.

(A.3). Both the tax cut and the loss offset restriction boost advice which also allows for a lower equity share to the entrepreneur on account of lower survival risk. In (A.4), we find that both the tax cut and the reduction of the entrepreneur's share boost VC profits while the loss offset restriction erodes profits. If the net effect on profits is positive, which will depend on the relative size of the shocks to τ^F and ξ, the rents in VC investing attract additional activity and expands aggregate supply until venture returns, i.e. the prices of innovative goods, are competed down to the break-even level stated in (A.8). Lower prices expand the innovative sector. When a larger fraction of start-ups is successful on account of more intensive support, fewer firms need to be started to satisfy any given level of demand. It is thus unclear, a priori, whether the policy raises the number of entrepreneurs or not. All these equilibrium adjustments affect the tax base and determine the extent of the tax cut that can be financed with the loss offset restriction. After several calculations in Appendix C, we find

$$\hat{\tau}^F = \frac{\tau^F}{1-\tau^F} \frac{(1-p)\frac{\theta}{1-\theta} + \tau^F \left[\theta - \eta(\theta - s) + \eta(1-s)p\theta\right]}{1-\tau^F + \tau^F(1-\eta)(1-\theta)} \hat{\xi}. \tag{29}$$

As a benchmark case, consider a price elasticity of demand for the innovative good equal to unity, $\eta = 1$. In this case, the coefficient is unambiguously positive. The loss offset restriction $\hat{\xi} < 0$ indeed allows to finance a cut in the capital gains tax, $\hat{\tau}^F < 0$. In principle, however, an ambiguity might emerge if the initial tax rate is very high and the demand elasticity is considerably different from unity.

We have now established the relative size of the policy shocks and may substitute (29) into (A.8) to obtain the equilibrium price effect. Collecting terms and noting that all terms proportional to $\eta\tau^F$ cancel out, we eventually get

$$\hat{V} = \frac{\tau^F}{1-\tau^F} \frac{\left[s + (1-s)\theta\tau^F\right](1-p\theta)}{1-\tau^F + \tau^F(1-\eta)(1-\theta)} \hat{\xi}. \tag{30}$$

Again, the denominator is positive for $1 = \eta$. An ambiguity could emerge in the unlikely case where an excessively large demand elasticity would coincide with a large initial tax rate. We conclude that the net result of the tax cut cum loss offset restriction on the price of innovative goods is negative which verifies our discussion prior to (29).

Less attractive venture returns will weaken the incentives of VCs to provide support. However, the policy's direct impact in (A.3) is for more advice. Substituting (29) into (A.9), we get the equilibrium response in advice,

$$\hat{a} = -\frac{\tau^F}{1-\tau^F} \frac{(1-p)\frac{\theta}{1-\theta} + 1 - \tau^F \eta (1-s)(1-p\theta)}{1-\tau^F + \tau^F (1-\eta)(1-\theta)} \hat{\xi}. \tag{31}$$

Again, the numerator is positive for $\eta = 1$ since $(1-s)(1-p\theta)$ is smaller than one. It seems inconceivable that the demand elasticity and the tax rate could ever be so large that the last term would dominate the first two terms in the numerator. The policy initiative thus stimulates equilibrium advice which was its main intention in the first place.

We have so far recorded a larger innovative sector on account of a lower competitive goods price, as well as a larger survival rate on account of more intensive VC involvement in start-ups. Substituting (29) into (A.15), we find that fewer firms need to be started to supply the larger market since more of these start-ups make it to the production stage,

$$\hat{E} = \frac{\left[1 - \eta \left(s + (1-s)\tau^F\right)\right](1-p\theta)}{1-\tau^F + \tau^F (1-\eta)(1-\theta)} \frac{\tau^F}{1-\tau^F} \hat{\xi}. \tag{32}$$

Again, the effect is unambiguous, provided that η and τ^F are not too large.

Proposition 4 ***(Tax Cut Cum Loss Offset Restriction)*** *Restricting loss offset and cutting the capital gains tax rate boosts advice, impairs entrepreneurship, lowers the price, and raises welfare.*

Proof. Use $\hat{\xi} < 0$ in equations (30) to (32). Refer to (A.11) for the welfare effect where transfers are kept constant, $\hat{S}^L = \hat{S}^E = 0$. The welfare gain reflects an increased consumer surplus from innovative goods. ■

5 Conclusions

The recent years witnessed increased interest in and awareness of the role of venture capital in promoting entrepreneurship and start-up investment. The ups and downs of the stock markets notwithstanding, new firms hold considerable promise for developing new ideas that will eventually translate into new jobs. Apart from the lack of own resources, the commercial inexperience of would-be entrepreneurs is a major barrier to the creation and growth of new firms. While entrepreneurs tend to be technically well trained, they often lack the managerial know-how to turn their new firms into veritable growth companies. Venture capital can importantly add value by promoting the professionalization of young firms. Empirical evidence in the U.S. clearly points to the potential value-added of venture capital. New firms that are backed by venture capital are less likely to fail, grow more quickly and end up more profitable than other ventures. By way of contrast, the few studies that have investigated the recent development of European venture capital, have failed to uncover similar evidence. Although there is reason to expect a similar growth enhancing role of venture capital as in the U.S., the conditions for a successful operation of venture capital in Europe must be improved.

This paper emphasized an inefficiency in venture capital support when the joint inputs of entrepreneurs and venture capitalists in start-up firms are simultaneously supplied and are non-verifiable and not contractible in nature. When the marginal cost of extra effort is fully private, but venture capitalists must share with entrepreneurs the return on this increased engagement, incentives for advisory effort must suffer. The capital gains tax aggravates this inefficiency. It not only retards entrepreneurship but also leads to a first-order welfare loss. However, once a capital gains tax is in place, there is scope for reducing the inefficiency. Instead of conceding full loss offset, as is often demanded, one could actually contemplate to restrict it. The revenue so generated could be used to lower the capital gains tax rate. The package would deliver a double kick to venture capitalists: On one hand, the lower tax would stimulate advice directly; on the other hand, the limited loss offset would punish VCs for letting some businesses fail.

Another initiative often advocated by policy makers is to stimulate the volume of capital raised and the number of start-ups by such measures as interest subsidies, credit guarantees or direct investment tax credits. In our framework, however, a subsidy to physical investment of start-up firms is detrimental to welfare although it succeeds to boost entrepreneurship. Because it is successful in expanding the innovative sector by raising the number of start-ups, it eventually erodes venture returns which, in turn, impairs the venture capitalists' incentives for support. The investment subsidy thus aggrevates a preexisting distortion with respect to advice. In fact, an investment tax would be called for.

We do not wish to claim that our insights are easily transformed into practical tax policy. Making sure that loss offset will indeed be restricted could be difficult, if incorporated venture capital companies can offset losses with gains within the company. Similarly, potentially desirable cuts in capital gains taxes or taxes on physical investment in start-ups would not be easy to target. But the central message remains that capital gains taxes undermine the quality of venture capital and are particularly harmful to innovative new firms for reasons that have not previously been highlighted.

Appendix

To conserve space, we throughout the Appendix use the notation $Q \equiv (1-z)I + B$ for the VC's initial outlays or equity price.

A. Equilibrium Restrictions

A zero profit equilibrium with full loss offset, $\psi = \xi = 1$, and $z = 0$, fulfills[16]

$$
\begin{array}{llll}
(a) & (9) & ap' = (1-\theta)\, p, & \\
(b) & (15)\ IC^F & a = \left(1-\tau^F\right)(1-\theta)(1-s)\, pV, & \\
(c) & (14)\ \Omega = 0 & Q = (1-s)\, pV\theta, & \\
(d) & (14.ii)\ IC^E & \beta = \left(1-\tau^E\right) spV, & \\
(e) & (b)\,/\,(c) & a = \left(1-\tau^F\right) \frac{1-\theta}{\theta} Q, & \\
(f) & (d)\,/\,(c) & \frac{s}{1-s} = \frac{\beta\theta}{(1-\tau^E)Q}. &
\end{array}
\tag{A.1}
$$

B. Comparative Statics

Appendix B prepares the comparative static effects of the policy scenarios given in sections 3 and 4. In all cases it is assumed that full loss offset is in place initially, $\psi = \xi = 1$. We also use the functional form noted in (9), giving $\hat{p} = (1-\theta)\,\hat{a}$ and $\hat{p}' = -\theta\hat{a}$.

Advice and Profit Share: As noted in section 2.2.3, the incentive constraints (14.ii) and (15) simultaneously determine a and s. Log-linearization yields

$$
\begin{aligned}
IC^E: &\quad \hat{s} = \hat{\tau}^E - \hat{V} - (1-\theta)\,\hat{a}, \\
IC^F: &\quad \theta\hat{a} = \hat{V} - \hat{\tau}^F - \tfrac{s}{1-s}\hat{s} - \tfrac{\tau^F}{1-\tau^F}\theta p\hat{\xi},
\end{aligned}
\tag{A.2}
$$

Use (15) which is $p'(a)\left(1-\tau^F\right)(1-s)\,V = 1$ with full loss offset, and (A.1c), to simplify the coefficient of $\hat{\xi}$. Restricting loss offset, $\hat{\xi} < 0$, thus raises advice, ceteris paribus.

Solving the system (A.2) for the equilibrium adjustment of $\hat{a}$ and $\hat{s}$ gives

$$
\begin{aligned}
\hat{a} &= \tfrac{1}{\theta-s}\left[\hat{V} - (1-s)\,\hat{\tau}^F - s\hat{\tau}^E - \tfrac{\tau^F}{1-\tau^F}(1-s)\,\theta p\hat{\xi}\right], \qquad \theta - s > 0, \\
\hat{s} &= \tfrac{1-s}{\theta-s}\left[(1-\theta)\,\hat{\tau}^F + \theta\hat{\tau}^E - \hat{V} + \tfrac{\tau^F}{1-\tau^F}(1-\theta)\,\theta p\hat{\xi}\right].
\end{aligned}
\tag{A.3}
$$

To sign $\theta - s$, suppose a increases, for example, because loss offset is restricted. With a higher success rate, entrepreneurs require a lower share s by IC^E in (A.2). The VC

[16] Multiply (15) by a and use (A.1a) to get (A.1b). Replace a by (A.1b) in (14) to get (A.1c) for $\Omega = 0$.

correspondingly obtains a higher share $1-s$ which further strengthens her incentives to advise. This cycle converges if $\theta - s > 0$. This interdependency gives rise to interesting cross-properties. The loss offset restriction, for example, does not directly affect the entrepreneur's incentives in (A.2). However, since it discourages the VC's advice, the success rate declines. With a smaller survival chance, the entrepreneur must receive a larger profit share to prevent shirking. Furthermore, raising the tax rate τ^E does not directly affect the VC. However, when the entrepreneur's reward for high effort is taxed, the VC must again cede a higher profit share to prevent shirking. This diminishes the VC's own stake and, in turn, her incentives to give advice.

Zero Profit Equilibrium: Although policy influences advice, the envelope theorem prevents, on account of (15), that a variation of a affects profits. This is not the case with respect to the share s which is imposed on the VC by the entrepreneur's IC^E in (14.ii). Accordingly, VC profits in (14) change by [note $\hat{\psi} = (1-p)\hat{\xi}$, and $\hat{\Omega} = d\Omega$]

$$\frac{\hat{\Omega}}{1-\tau^F} = (1-s)\,pV\hat{V} - spV\hat{s} - [(1-s)\,pV - Q]\,\hat{\tau}^F - Q\hat{Q} + \frac{\tau^F(1-p)\,Q}{1-\tau^F}\hat{\xi}. \tag{A.4}$$

Substitute $\hat{s}$ from (A.3), collect terms, set $\hat{\Omega} = 0$, and get the equilibrium price that results from free entry competing profits down to zero. Use (A.1c) to simplify coefficients,

$$\frac{Q}{\theta-s}\hat{V} = \frac{1-\theta}{\theta-s}Q\hat{\tau}^F + \frac{s}{\theta-s}Q\hat{\tau}^E + Q\hat{Q} + \frac{\tau^F\left[\frac{(1-\theta)sp}{\theta-s} - (1-p)\right]}{1-\tau^F}Q\hat{\xi}. \tag{A.5}$$

Rearranging yields

$$\hat{V} = (1-\theta)\,\hat{\tau}^F + s\hat{\tau}^E + (\theta-s)\,\hat{Q} + \tau^F\frac{(1-s)\,p\theta - (\theta-s)}{1-\tau^F}\hat{\xi}. \tag{A.6}$$

Reflecting the entrepreneur's outside option, the upfront payment in (16) changes by

$$\hat{B} = \hat{\tau}^E + \frac{\hat{S}^L - \hat{S}^E}{(1-\tau^E)\,B}, \qquad \hat{Q} = \frac{B}{Q}\hat{B} - \frac{(1-z)\,I}{Q}\hat{z}, \tag{A.7}$$

which also affects VC profits and competitive returns V. Substituting into (A.6), we have

$$\begin{aligned}\hat{V} \;&=\; (1-\theta)\,\hat{\tau}^F + \tfrac{\theta B + s(1-z)I}{Q}\hat{\tau}^E + \tfrac{\theta-s}{(1-\tau^E)Q}\left(\hat{S}^L - \hat{S}^E\right) \\ &-\; \tfrac{(\theta-s)(1-z)I}{Q}\hat{z} + \tfrac{\tau^F}{1-\tau^F}\left[(1-s)\,p\theta - (\theta-s)\right]\hat{\xi}.\end{aligned} \tag{A.8}$$

The competitive price adjustment feeds back into advice and profit sharing. Substituting (A.8) into (A.3), we get profit sharing and advice in zero profit equilibrium

$$\begin{aligned} \hat{a} &= \tfrac{B}{Q}\hat{\tau}^E - \hat{\tau}^F + \tfrac{\hat{S}^L - \hat{S}^E}{(1-\tau^E)Q} - \tfrac{(1-z)I}{Q}\hat{z} - \tfrac{\tau^F}{1-\tau^F}\hat{\xi}, \\ \tfrac{1}{1-s}\hat{s} &= \tfrac{(1-z)I}{Q}\hat{\tau}^E - \tfrac{\hat{S}^L - \hat{S}^E}{(1-\tau^E)Q} + \tfrac{(1-z)I}{Q}\hat{z} + \tfrac{\tau^F(1-p\theta)}{1-\tau^F}\hat{\xi}. \end{aligned} \tag{A.9}$$

The competitive price generates demand according to (11) which attracts an equilibrium number of entrepreneurs to clear the market for innovative goods as in (2). A policy shock thus changes entrepreneurship by

$$\hat{E} = -\eta\hat{V} - (1-\theta)\,\hat{a}. \tag{A.10}$$

Finally, the effect on welfare results from (18) and reflects disposable income and consumer surplus from consumption of innovative goods. By (13), $dCS = -DdV$. Using $ND = pE$, we obtain from (18)

$$dU^* \equiv \hat{U}^* = N\hat{S}^L - pVE \cdot \hat{V}. \tag{A.11}$$

C. Tax Cut Cum Loss Offset Restriction

This Appendix calculates the effects resulting from a capital gains tax cut financed with a loss offset restriction. The scenario starts from a situation where a capital gains tax τ^F on VCs with full loss offset finances uniform transfers $S = S^L = S^E$ that is kept constant. Other policy instruments are set to zero, $\tau^E = z = 0$. With this scenario, the equity price $Q = 1 + I$ also remains constant. The government budget in (6) simplifies to

$$\tau^F\left[(1-s)\,pV - \psi Q\right]E = NS, \qquad \psi = p + (1-p)\,\xi. \tag{A.12}$$

Multiply the budget (A.12) by $\left(1-\tau^F\right)\frac{\theta}{Q}$, substitute the zero profit condition (A.2c') and use the definition of ψ to get

$$\left(1-\tau^F\right)\frac{\theta NS}{Q} = \tau^F\left[1 - \theta\psi - (1-\theta)\,\xi\tau^F\right]E. \tag{A.13}$$

Full loss offset would result in $NS = \tau^F \frac{1-\theta}{\theta} QE$. Next, take the differential and evaluate the coefficients at the position $\psi = \xi = 1$. Also use $\hat{\psi} = (1-p)\,\hat{\xi}$ at $\xi = 1$,

$$\begin{aligned} -\tfrac{\theta NS}{Q}\hat{\tau}^F = \; & (1-\theta)\left[E\left(1-\tau^F\right)\hat{\tau}^F + \tau^F E\hat{E}\right] \\ & -\tfrac{\tau^F}{1-\tau^F}E\left[\theta\,(1-p)\,\hat{\xi} + (1-\theta)\left(\tau^F\hat{\xi} + \left(1-\tau^F\right)\hat{\tau}^F\right)\right]. \end{aligned}$$

Now replace NS by (A.13) at $\psi = 1$ and cancel terms to obtain

$$\hat{\tau}^F = \frac{\tau^F}{1-\tau^F}\left[\frac{\theta\,(1-p) + (1-\theta)\,\tau^F}{(1-\theta)\left(1-\tau^F\right)}\hat{\xi} - \hat{E}\right]. \tag{A.14}$$

With the loss offset restriction $\hat{\xi} < 0$ being exogenous, the effects on the tax rate $\hat{\tau}^F$, advice $\hat{a}$, venture returns $\hat{V}$, and number of start-ups $\hat{E}$ are simultaneously determined by the system (A.8), (A.9), (A.10), and (A.14), where all other policy parameters except $\hat{\tau}^F$ and $\hat{\xi}$ are set to zero. Substituting (A.8) and (A.9) into (A.10) yields

$$\hat{E} = (1-\eta)\,(1-\theta)\,\hat{\tau}^F + \frac{\tau^F}{1-\tau^F}\left[(1-\theta) - \eta\,(1-s)\,p\theta + \eta\,(\theta - s)\right]\hat{\xi}, \tag{A.15}$$

which we substitute into (A.14) to get (29) in the text.

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