START-UPS, VENTURE CAPITALISTS, AND THE CAPITAL GAINS TAX

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Abstract

A model of start-up finance with double moral hazard is proposed. Entrepreneurs have ideas but lack own resources as well as commercial experience. Venture capitalists provide start-up finance and managerial support. Both types of agents thus jointly contribute to the firm's success, but neither type's effort is verifiable. We find that the market equilibrium is biased towards inefficiently low venture capital support. In this situation, the capital gains tax is particularly harmful. The introduction of a small tax impairs managerial advice and leads to first order welfare losses. Once the tax is in place, limitations on loss off-set may paradoxically contribute to higher quality of venture capital backed entrepreneurship and welfare.

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1 Introduction

Potential entrepreneurs have new ideas but lack own resources as well as commercial experience. The potentially high return of innovative firms is subject to large risks. In the early start-up phase, the product or service is not yet fully developed and the market potential is uncertain. Start-ups require considerable funds to pay for research and development as well as equipment investment which far exceed the entrepreneur's own wealth. They find it difficult, however, to raise outside finance. They cannot offer enough collateral to secure business debt, and they are unable to generate sufficient revenue to pay regular interest. They have no own track record that could be assessed by outside investors. Entrepreneurs usually have technological competence but are managerially inexperienced. The unproven market potential, the technological risks in further product development, and the managerial inexperience of entrepreneurs add up to formidable risks that depend on the quality of the proposed business idea and the entrepreneur's managerial potential. Her superior knowledge about the firm also creates a possibility for opportunistic behavior that puts the investor's money at risk. The informational disadvantage of outside investors is particularly severe in the case of young innovative firms. Assessing the prospects of such firms requires much business competence and own industry experience on the part of the investor which banks do not have. For these reasons, bank finance is difficult to obtain for innovative start-ups.

Venture capitalists (VCs) have money *and* industry experience. Their managerial know-how and industry knowledge establishes a comparative advantage over other financial intermediaries in financing young, innovative firms. Kaplan and Strömberg (2001) describe the main functions of VC financing which consist of screening, contracting and advising. VCs carefully screen and select business plans. They have developed sophisticated financial instruments and contractual arrangements to alleviate the problems resulting from informational asymmetries. They add value by establishing contacts, giving strategic business advice, and generally helping the professionalization of young firms.

This paper focuses on the last function of VC finance which is an important one.[1] Hellmann and Puri (2001) show empirically that VC backed start-ups in Silicon Valley are much faster in introducing stock option plans for high skilled personnel and in hiring a professional sales manager. Also, the presence of a VC makes it more likely that the entrepreneur is replaced by a professional CEO from outside if her lack of managerial abilities turns out to be an impediment to the firm's rapid growth. The VC's influence is particularly strong in the early phase of business development when the informational problems are the largest, but becomes insignificant later on when the firm has successfully matured. In short, VCs add value and raise the likelihood for success by promoting the professionalization of young firms. Hellmann and Puri (2000) show that VC backed firms introduce more radical innovations and pursue more aggressive market strategies compared to other start-ups. For example, once a VC joins the firm and provides finance, the probability of introducing the new product on the market jumps up by a factor of more than three! Rapid market introduction is strategically important because the first firm on the market enjoys a first mover advantage. Kortum and Lerner (2000) show that a Dollar of R&D spending creates more patents and more radical innovations than the same expenditure in other firms. They calculate that VC backed firms account for about 14 percent of industrial innovation in the US in 1998 although they spend only about 3 percent of all R&D funds. This empirical evidence shows that venture capital significantly promotes innovation and business growth.

The success of US style venture capitalism is not easily duplicated, however. Although the volume of funds raised and invested grew dramatically in the late 90s, the market is still much smaller in Europe.[2] More importantly, a recent empirical study by Botazzi and Da Rin (2001) investigates the performance of firms introduced on the technology stock

[1] We abstract from screening and selection problems by assuming uniform quality among entrepreneurs.

[2] VC investments amount to more than one percent of GDP in the US while the share is only about .4 percent in Europe. We do not attempt to explain any differences in US or European VC investing. The incentive problems noted in this paper are expected to apply quite generally. Given the underdeveloped state of the VC sector, the problem should be particularly severe in Europe, however.

markets Euro.nm[3] and finds that VC backed firms have not grown significantly faster and have not performed better than other firms. They conclude that the quality of VC investments in Europe is a more urgent problem than the sheer volume of funds invested. How is it then possible to strengthen the incentives of VCs to support and advise their portfolio companies more intensively? If a firm runs into difficulties, the VC will always want to give advice and exercise control if she can prevent business failure and thereby protect her return payment. However, only if she is able to share in the upside potential of the project, will she feel a keen interest to contribute to the firm's success beyond what is needed for a secure return payment. For this reason, equity finance or equity like instruments like convertible securities are optimal in VC finance.[4]

Not only the entrepreneur but also the financier must simultaneously put up effort to advance the firm's prospects. Since both efforts are largely intangible and not verifiable, the relation between entrepreneur and financier suffers from a double moral hazard. Accordingly, the equity shares must be carefully split to set incentives for both parties. The VC must share in the firm's upside potential to strengthen her incentives to provide managerial advice. The entrepreneur's remaining share must be large enough as well to secure her effort which is deemed critical for the firm's success. With double moral hazard, a natural inefficiency arises. Both parties must share the marginal return while each one bears the entire marginal cost of her extra effort. We find a natural bias towards low managerial support on the part of the VC.[5] It is thus important that policy analysis tar-

[3]These include the Nouveau Marche (Paris), Neuer Markt (Frankfurt), Nieuwe Markt (Amsterdam), Euro.nm Bruxelles and Nuovo Mercato (Milano).

[4]With debt finance, the VC would get a fixed return payment but would not participate in the extra value she creates by advising the entrepreneur in the good state. While convertible securities or at least equity like instruments are predominantly used by US VCs [see Kaplan and Strömberg (2000)], Bascha and Walz (2001) find that about 50 percent of VC finance in Germany relies on debt like instruments. This is probably part of the European problem since debt fails to boost incentives for VC advice.

[5]By the same arguments, the entrepreneur's effort would be underprovided as well. We consider the entrepreneur's input as critical, however, and treat it as discrete (full effort or none). In equilibrium, entrepreneurial effort must be high and cannot be underprovided. The VC's input, in contrast, is assumed variable. This setup makes the model analytically tractable and focuses on the incentives of VCs.

gets the incentives for advice and the quality of VC finance rather than the sheer volume of funds raised and invested.

VC investments have been the subject of a considerable literature in finance.[6] This research stresses corporate governance perspectives and investigates the financial instruments that are optimally used in the relationship between entrepreneurs and financiers. The academic literature, however, has largely failed to provide a rigorous analysis of taxation and public policy towards venture capital-based entrepreneurial activity. The exceptions are Gordon (1998) and Poterba (1989a,b). Their analysis discusses the effects of taxes on the supply of funds and the entrepreneur's occupational choice decision while they do not explicitly consider the VC's productive role in supporting and advising start-up firms. Poterba emphasized that the capital gains tax mainly encourages entrepreneurs to start a firm and, thereby, increases the demand for funds while it has only a minor effect on the supply of funds. The findings of Gompers and Lerner (1998) are largely in the same vein. With these exceptions, we know of little other work besides our own previous efforts. In Keuschnigg and Nielsen (2001a), we examined the effects of government services for information and education of entrepreneurs as well as specialized infrastructure. Keuschnigg and Nielsen (2001b) considered the effects of tax policy on entrepreneurial activity and welfare when only entrepreneurs but not VCs are subject to moral hazard.

This paper importantly extends the previous analysis by including a double moral hazard problem relating to the joint effort of both entrepreneurs and financiers. While the entrepreneur is technologically competent but lacks commercial experience, the VC can help with business contacts and managerial know-how. But she will not automatically incur the required effort unless she is given strong incentives by sharing in the upside potential of the firm. With this extension, the VC's effort and the quality of VC finance

[6] Gompers and Lerner (1999, 2001) summarize the literature. Recent theoretical contributions include, among others, Repullo and Suarez (1999) and Schmidt (2001). Our model borrows important elements such as double moral hazard. It importantly extends these papers by investigating the implications of double moral hazard for start-up activity and the quality of VC finance in industry equilibrium and by adding policy analysis.

tend to be inefficiently low compared to what would be socially optimal. It is then natural to inquire if any policy initiatives such as cutting the capital gains tax rate or restricting loss offsets for VC firms would serve to boost the quality in VC finance.[7]

In our paper we ask how tax policy, and in particular the capital gains tax, affects the formation of young and innovative firms. We consider the implications of taxes for start-up activity and welfare in general equilibrium with a large traditional sector and a small sector of VC backed start-up firms. The analysis relates to the entrepreneur's tendency to give up a job in the traditional industry and start a business, but also addresses the incentives of VCs to provide managerial support. Apart from capital gains taxation, we examine various other tax and subsidy schemes which are intended to strengthen incentives of VCs to provide more managerial support. We propose a narrowly focused, revenue neutral policy that cuts the capital gains tax rate for VC funds but restricts loss offsets. If the VC cannot offset losses from unsuccessful firms against the profits of successful ones, she will be punished for "allowing" businesses to fail. The imperfect loss offset provision should therefore make the VC advise more intensively to prevent business failure. At the same time, the lower tax rate on capital gains strengthens the incentives for advice in the good state. We find that this revenue neutral policy helps to alleviate the underinvestment on the part of the VC and therefore turns out to be welfare enhancing.

Our main findings are as follows: The introduction of capital gains taxation discourages managerial advice, retards entrepreneurship, and causes a first order welfare loss. Both a tax on entrepreneurship and a tax on physical start-up investment raise managerial advice and welfare. By restricting entrepreneurship and industry output, these policies boost the equilibrium price and, thereby, the private incentives to advise which yields the desired welfare gain. A more direct welfare enhancing policy to stimulate VC advice would be a subsidy to their revenues. Furthermore, once a positive capital gains tax is in place, a cut in the tax rate financed by restricting the loss offset provision also

[7]The paper by Keuschnigg (2002) discusses similar issues in a richer, but considerably more difficult framework. Taxation is shown to affect both the extent of advice per firm as well as the optimal number of firms in a VC's company portfolio. The paper points to a separate distortion in the size of VC portfolios.

improves the quality of VC activity and welfare. All in all, the double moral hazard problem in financing start-ups casts doubts on the use of capital gains taxes vis-a-vis start-up firms and delivers a surprising rationale for limitations of loss offset. These findings are grounded in the fact that the VC industry is not able to solve the incentive problems that are due to double moral hazard and lead to inefficiently low advice. In analyzing the sensitivity of our results, we find that, in principle, a market solution to this problem could be found but no such institution seems to exist in reality. It turns out that our proposed optimal tax subsidy mechanism mimicks the workings of such a hypothetical institution and, thereby, achieves the first best outcome.

We now introduce the 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 mass one of agents. Individuals may have a business idea and start a firm in the entrepreneurial sector, or else they prefer a safe job in the traditional sector. An occupational choice decision splits the population into L workers and E entrepreneurs,

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

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 for traditional goods by X^D and for innovative goods by D, market clearing requires

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

Entrepreneurs lack both resources and commercial experience to develop their business idea. They team up with a VC who has managerial know-how and money to pay for the start-up cost. Given a fixed number N of VC firms, each one is involved in funding and advising E/N start-ups on average.[8] The expected output P 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 managerial 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 $\pi^F E = \int_0^1 \Pi^i di$ in the aggregate where $\Pi^i = \Pi$ 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 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 $Q = (1-z)I + B$, which covers the entire start-up cost plus an up-front payment B.[9] With this deal, the entrepreneur's

[8] We do not explicitly determine an optimal number of portfolio companies per VC as is done in Kanniainen and Keuschnigg (2001 a,b). Average portfolio size is implicitly determined in equilibrium.

[9] One might argue that entrepreneurs are asked to sell their tradable shares in VC firms at a price equal to Π to pay for start-up cost $(1 - z)I$. The VC is left to pay $(1 - z)I - \Pi$ plus a lump-sum $\tilde{B}$, or

expected income or capital gains amount to $sPV + B$. In the presence of taxes, the entrepreneur must pay a capital gains tax on the initial deal, $\tau^E (Q - (1-z)I) = \tau^E B$, 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

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

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 expects a profit, or capital gain, of π^F per firm. With taxes and subsidies,

$$\pi^F = \left(1 - \tau^F\right)(1-s)\,PV - \left(1 - \psi\tau^F\right) Q, \tag{5}$$

where τ^F is the capital gains tax applied to the VC. The parameter $\psi \equiv P + (1-P)\,\xi$ relates to imperfect loss offset. Gains from successful start-ups are fully taxed whereas only a part $0 \leq \xi \leq 1$ qualifies for a tax deduction if the firm fails. With full loss offset, $\xi = \psi = 1$, whereas limited loss offset is indicated by $\xi, \psi < 1$. Given that a VC generates expected, net of tax gains of π^F per project, total capital gains of a VC add up to $\pi^F \cdot E/N$.

The government assumes a limited role only. Ignoring the provision of public goods, it raises taxes to pay for various subsidies. The government budget constraint is

$$\tau^E (sPV + B)\,E + \tau^F \left[(1-s)\,PV - \psi Q\right] E = S^E E + S^L L + zIE. \tag{6}$$

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

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

$Q = (1-z)I - \Pi + \tilde{B}$ in total. This would only lead to a redefinition of the advance payment, $B = \tilde{B} - \Pi$. The same goes with any initial wealth that the entrepreneur might be able to put up as a collateral.

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

$$V(D - PE) + \left(X^D - L\right) = 0, \qquad X^D = X + IE. \tag{8}$$

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

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 a double moral hazard as in Schmidt (2001), Repullo and Suarez (1999) and Lülfesmann (1999), for example. Different from these authors we assume, however, that both inputs are always required simultaneously and that the entrepreneur's effort is critical for the success of the start-up. The second 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 managerial advice a which is taken to be continuous. The success probability of the start-up is specified as

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

With $e \in \{0, 1\}$, the entrepreneur's effort is critical. The firm can never succeed without it. The VC, however, adds further value to the firm but to a variable extent only. 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; 2. The VC buys an equity stake $1-s$ at a price Q; 3. Potential entrepreneurs accept or reject the deal, i.e. agents choose their occupation; 4. VCs and entrepreneurs simultaneously supply effort (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. Figure 1 illustrates the sequence of events:

τ^i, S^i	$1-s, Q$	$i \in \{L, E\}$	e, a	nature	income
■	■	■	■	■	■
policy	deal	occup.	efforts	risk	consumpt.

Figure 1: Sequence of Events

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 $i \in E$. Finally, when advising start-ups, VC firms also incur intangible cost of managerial effort which is assumed to be linear, $l^i = a$. Consumption demand is decided only *after* effort has been expended and individual income y^i has been determined. At that stage, consumers maximize utility for a *given* effort level. In general, agents choose demand for the two goods to maximize utility net of the disutility of effort,

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

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 just as in a partial equilibrium model.[10] Since subutility $u\left(D^i\right)$ is identical for

[10] See Green, Whinston and MasCollel (1995, chapters 3, 10 and 15) on the general equilibrium foundation of partial equilibrium modeling.

all agents and satisfies $u'(D^i) > 0 > u''(D^i)$, demand for the innovative good is the same for everyone, $D^i = D$. It will be convenient to adopt the isoelastic specification $u(D) = \phi^{1/\eta} \frac{D^{1-1/\eta}}{1-1/\eta}$ 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 income. 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 intantible effort cost. The VC's problem consists of structuring the deal, i.e. proposing to buy a stake $1 - s$ for a price Q, and subsequently offering a level of managerial support a to maximize $\pi^F - a$. Using (5), we have

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

subject to participation and incentive compatibility constraints,

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

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

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

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 qualify 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. 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 along Figure 1, we now turn to effort choice. Anticipating how effort affects income and utility, the VC and entrepreneur simultaneously choose effort. At this stage, Q, 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 benefits of high 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

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 in Figure 1 turns 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 in Figure 1 is the VC's proposal for a contract. In specifying the contract terms, 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 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 $Q = B + (1 - z) I$ 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 price Q, or the capital gain $B = Q - (1 - z)I$, which just makes entrepreneurs accept the proposed deal,

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

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 Q 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 managerial 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, zero profit 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 $D = p(a) E$. The remaining part of the population picks up safe jobs in the traditional manufacturing sector.

2.2.5 Welfare

For an evaluation of policy initiatives, we need to state 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 managerial effort costs, we must subtract them from profits.[11] Adding up indirect utilities of agents, subtracting managerial effort costs, and using $\Pi = \pi^F E = aE$ by the zero profit condition, the welfare measure becomes

$$U^* = U^{*E} \cdot E + U^{*L} \cdot L - aE = 1 + S^L + CS. \tag{18}$$

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. Denoting by R net tax revenue or government surplus per firm, $R = \tau^E (sPV + B) + \tau^F [(1-s) PV - Q] - zI - S^E + S^L$.[12] Adding the VC's surplus Ω, the joint surplus per venture is $\Phi = \Omega + \left(\pi^E - \beta - 1 - S^L\right) + R$, or

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

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

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

[11] VCs are modeled as "atomless" agents and, thus, do not show up in the resource constraint. At the cost of a considerable increase in complexity but with no interesting new insight, we could have treated VCs as real persons. In this case, the subtraction of their effort cost would have been obvious.

[12] 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 also keep the loss offset parameters ψ, ξ at unity in this section.

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

Proposition 1 ***(Efficiency)*** *(a) In the untaxed equilibrium, managerial 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 managerial support. Since the entrepreneur's effort is assumed critical, it must be kept at unity and therefore cannot be underprovided.[13] The government can, in principle, induce the efficient level of managerial 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.

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 tax is paid *before* any effort is expended, it is not harmful since it is already sunk when the VC finally chooses the level of advice. The revenue subsidy is given *after* effort is chosen. Anticipating a larger return on account of the subsidy, she is keen to

[13] With double moral hazard, entrepreneurial effort would be similarly discouraged by profit sharing, if it were variable. It seems rather descriptive to us that the entrepreneur's effort is critical, leaving less leeway for variations of effort. In any case, this paper primarily focuses on the role of VCs.

increase managerial support.[14] Setting other policy parameters to zero, the optimal and self-financing policy is given by (21) and

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

Note that this policy will release 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). The square bracket indicates the wedge between the VC's optimal marginal return $p'V$ and what it 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,[15] $da/d\tau^F < 0$, 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.

How robust is this bias towards low managerial effort and inferior quality of VC finance? Our assumption that the financier and entrepreneur jointly determine the success probability and must simultaneously exercise effort, is important. Schmidt (2001), for example, assumes sequential efforts where in a first phase only the entrepreneur's effort is

[14]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.

[15]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.3-4).

required. In a second stage, the entrepreneur's effort is not necessary any longer. At this later stage, the further increase in the value of the firm depends exclusively on the VC's managerial input. With this sequential effort choice, Schmidt (2001) is able to explain the use of convertible debt. In particular, the use of convertible securities may actually serve to attain a first best outcome.[16] While convertible debt is certainly a more flexible financial instrument and may allow parties to attain a superior outcome than straight equity finance, the first best result in Schmidt (2001) hinges critically on the fact that efforts are never required simultaneously, but only sequentially. Different from Schmidt, we stress the fact that the entrepreneur's effort is critical throughout the company's life. In reality, most businesses failures are ultimately due to some entrepreneurial management mistake. When the joint efforts of entrepreneur and financier overlap and are required simultaneously, the possible advantage of convertible securities relative to (mixed) equity contracts is reduced. In this case, the basic inefficiency noted above emerges again.

Nevertheless, one might wonder whether the highly sophisticated VC industry couldn't 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. However, contracting with a third party might solve this commitment problem.[17] Since only the VC's effort is continuously variable in our setting, an efficient solution must make the VC the full residual claimant on the project outcome. The key idea for efficient contracting is that the VC irrevocably gives up already at the contracting stage the expected amount X 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

[16] Critical for the possibility of a first best outcome is his assumption that entrepreneurs exclusively supply effort in a first phase, VCs exclusively supply effort in a second phase, and efforts never are required simultaneously.

[17] The proposed mechanism reflects ideas in the literature on moral hazard in teams, cfr. Holmstrom (1982), and McAfee and McMillan (1991). Competitive intermediaries were also shown to solve contractual problems in the labor market 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.

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.

Proposition 2 ***(Competitive Intermediaries)*** *Suppose there exist competitive market intermediaries who accept an advance payment* $X \geq p(a)\, sV$ *against the promise to pay out the agreed profit share* sV *to the entrepreneur once the project is completed.*
(a) VC investments are first best.
(b) The optimal policy (21-22) replicates the transactions with the intermediary.

Proof. (a) In prefunding the entrepreneur's profit share in advance by paying X to the intermediary, the VC can claim the entire return of the project ex post. The entrepreneur receives her incentive income $p(a)\, sV$ from the intermediary. In the absence of taxes, the VC's problem becomes $\max\{p(a)\, V - (X + B + I) - a\}$ subject to PC^E : $p(a)\, sV + B - \beta \geq 1$, $PC^I : X \geq p(a)\, sV$, $IC^E : p(a)\, sV - \beta \geq 0$, and

$$IC^F : p'(a)\, V = 1, \tag{24}$$

where PC^I is the participation constraint of the intermediary. Since the entrepreneur's income is prefunded ex ante, X (like B and I) is sunk at effort stage. Since the entrepreneur gets her income from the intermediary, the VC is full residual claimant on the extra value added of her managerial input. Consequently, the level of managerial advice in (24) coincides with the first best level noted in (20) which proves part (a). With free entry of competitive intermediaries and entrepreneurs, the VC raises her own profits by proposing a minimum profit share s and advance payment X such that both PC^I and IC^E become binding. She also cuts the upfront payment B to a minimum such that PC^E becomes binding, $B = 1$. If VCs are left with any profits, they will fund more projects until venture returns V fall to the zero profit level.
(b) We return to problem (14), set τ^F and z as in (21-22), and allow full loss offset. All other taxes are zero. Write $\Omega = pV - (spV + B + I) - a + \left[zI + \tau^F Q\right] - \left[\tau^F (1 - s)\, pV\right]$

in (14). Since the square brackets sum up to zero on account of (22), this expression is identical to the objective stated in part (a) if evaluated at the first best solution. The constraints PC^E and IC^E are identical as well. Leaving out all sunk costs, we rewrite IC^F in (14.iii) as $pV - a - \left[\tau^F (1-s) pV + spV\right]$. Since the square bracket is zero by the policy (21), the incentive constraint collapses to $\max pV - a$, giving the same condition as in (24). As $z, \tau^F < 0$, the policy effectively takes a tax $\left[zI + \tau^F Q\right]$ before effort is chosen and pays it back to the VC as a subsidy $\left[\tau^F (1-s) pV\right]$ after effort is chosen. The scale of this operation is such that the subsidy just suffices to pay the entrepreneur's expected profit share. Subsituting (21) yields $\left[\tau^F (1-s) pV + spV\right] = 0$ which makes the VC the full residual claimant on her value added contribution. She is left to maximize $p(a) V - a$, which induces her to choose the first best level of advice. ■

For whatever reason, such institutions seem not to exist in practice. For example, we find no hints for such solutions 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. When we analyze the capital gains tax in the next section, we will, however, calculate the same experiment with efficient contracting in appendix D. This will assure ourselves that the results are virtually identical in all respects except for the welfare results. The differing welfare implications of tax policy are now well understood in the light of propositions 1 and 2.

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 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, $\psi = \xi = 1$, and that the start-up subsidy are set to zero, $z = 0$, in the initial equilibrium. Other policy parameters may be positive initially. 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 $\psi = 1$. 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 and the VC's entry decision 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.3). With the lack of managerial 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.3). 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 managerial 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.4).[18] 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, $\hat{\Omega} = -spV\hat{s} - [(1-s)\,pV - Q]\,\hat{\tau}$, see (A.5).[19] With the prospect of sizeable losses from their portfolio investments, VCs will fund fewer start-ups. Furthermore, the lack of managerial 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.9), venture returns increase in zero profit equilibrium by

$$\hat{V} = \left[1 - \theta + \frac{\theta B + sI}{Q}\right]\hat{\tau} = \left[1 - (\theta - s)\,\frac{I}{Q}\right]\hat{\tau} > 0. \tag{25}$$

Although higher venture returns would otherwise encourage more intensive advice, the direct tax effect works to reduce it and dominates in (A.4) to retard the equilibrium level of managerial support,

$$\hat{a} = \frac{1}{\theta - s}\left(\hat{V} - \hat{\tau}\right) = -\frac{I}{Q}\hat{\tau} < 0. \tag{26}$$

The capital gains tax inflates the costs of VC backed investment. To break even, the equilibrium price must increase as noted in (25) which chokes off demand for the innovative good. The size of the entrepreneurial sector shrinks. Since start-ups obtain less managerial 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 (25) and (26) into (A.11). The capital gains tax retards entrepreneurship as

[18] By (A.4), we always have $\theta - s > 0$.

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

long as the demand elasticity η is not too low,[20]

$$\hat{E} = -\left\{(\eta - 1)\left[1 - (\theta - s)\, I/Q\right] + \left[1 - (1 - s)\, I/Q\right]\right\}\hat{\tau} < 0 \quad \Leftrightarrow \quad \eta > \eta^*, \tag{27}$$

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

Since transfers boost disposable income, the welfare effect depends on the amount of revenues 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 $S = \tau\left(pV - I\right)E$ in the present case, the tax raises revenues in the amount of

$$\left(pV - I\right)E\hat{\tau} = \hat{S}. \tag{28}$$

Substitute (25) and (28) into (A.12). Using (A.1c) and (27), we get

$$\hat{U}^* = \hat{S} - pVE \cdot \hat{V} = (1 - \theta)\, spVE \cdot \hat{a} < 0. \tag{29}$$

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 managerial 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 managerial support. Since she must share the increase in revenues while bearing all the cost of her effort, the VC provides less managerial support than would be socially optimal. Any policy that discourages advice even more, is bound to inflict first order welfare losses.

[20] 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 3 ***(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 (25) to (29). ■

In appendix D, we consider the same experiment in the "efficient venture capital model" as in proposition 2. The uniform capital gains tax has qualitatively identical effects, except for welfare. Not surprisingly, when we start from an efficient equilibrium, the marginal welfare effect of a small tax is zero to the first order.

3.2 Welfare Increasing Policies

This subsection briefly investigates two policy scenarios which succeed to improve welfare. They shed some light on the mechanisms triggered by public policy. The following subsection will orientate tax policy more directly towards the basic inefficiency in VC support. First, we consider a policy of subsidizing workers and taxing entrepreneurs, i.e. $S^L > 0 > S^E$.[21] The policy makes the entrepreneur's outside option more attractive. To make her willing to start a firm, she must receive a larger up-front payment B, see (16). The deal becomes more expensive for the VC. To prevent losses, the equilibrium price must increase. Higher venture returns finally induce the VC to advise more intensively which works to alleviate the market distortion. For this reason, the policy should boost welfare although the higher price at the same time reduces consumer surplus. This can be stated more rigorously:

[21] Since agents are assumed risk neutral, occupational choice equates the expected income of workers and entrepreneurs, net of effort cost. Hence, this policy cannot be viewed as redistributive taxation. If we included risk aversion, so that expected income of entrepreneurs would exceed that of workers by a risk premium, the policy would appear redistributive. For a discussion of redistributive (progressive) taxation in a model of entrepreneurship and moral hazard, see Keuschnigg and Nielsen (2001c).

Proposition 4 ***(Taxing Entrepreneurship)*** *A small (specific) tax on entrepreneurship that finances a transfer to workers ($\hat{S}^L > 0 > \hat{S}^E$), raises venture returns and managerial advice, impairs entrepreneurship, and boosts welfare to the first order.*

Proof. By the government budget in (6), $S^L L + S^E E = 0$, a small subsidy to workers requires a tax on entrepreneurs equal to $\hat{S}^E = -\hat{S}^L \cdot (1-E)/E$, giving $\hat{S}^E - \hat{S}^L = -\hat{S}^L/E$. In raising the entrepreneur's outside option, the policy makes the deal more expensive to the VC. Substitute into (A.8) and get $\hat{Q} = \hat{B} \cdot B/Q = \hat{S}^L/(QE)$. By (A.9,10), equilibrium venture returns and advice increase, $\hat{V} = \hat{S}^L \cdot (\theta - s)/(QE)$ and $\hat{a} = \hat{S}^L/(QE)$. Substituting into (A.11) gives $\hat{E} = -\hat{S}^L \cdot [(\theta - s)\eta + 1 - \theta]/(QE)$. Substituting $\hat{V}$ into (A.12) and using (A.lc) yields the welfare effect, $\hat{U}^* = \hat{S}^L \cdot (1-\theta)\, s/[(1-s)\theta] > 0$, which is proportional to $\hat{a}$. ■

The second policy is to tax I, i.e. $z < 0$, and use the proceeds for a uniform subsidy S to workers and entrepreneurs. This policy avoids to raise the entrepreneur's outside option but it also makes the deal more expensive by increasing the total start-up investment cost. Again, venture returns must increase to allow VCs to break even on their investments. The higher price then attracts more managerial support which boosts welfare in face of the inefficiently low level of VC involvement in the market equilibrium. We state:

Proposition 5 ***(Taxing Start-up Investment)*** *A small tax on start-up investment $\hat{z} < 0$ that finances a uniform transfer $\hat{S} > 0$, raises venture returns and managerial advice, impairs entrepreneurship, but raises welfare to the first order.*

Proof. By (6), $S = -zIE$, a small tax starting from $z = 0$ pays for transfers of $\hat{S} = -IE\hat{z} = QE\hat{Q} > 0$. The last equality holds because the policy raises the total equity cost to the VC by $\hat{Q} = -\hat{z} \cdot I/Q$. The upfront payment $B = 1$ in (16) remains unchanged. By (A.9) and (A.10), venture returns and advice increase by $\hat{V} = (\theta - s)\,\hat{Q}$ and $\hat{a} = \hat{Q}$. Substitute into (A.11) to get $\hat{E} = -[(\theta - s)\eta + 1 - \theta]\,\hat{Q}$. Substituting $\hat{V}$ and $\hat{S} = QE\hat{Q}$ into (A.12) and using (A.lc) yields the welfare effect, $\hat{U}^* = \frac{(1-\theta)s}{(1-s)\theta} EQ \cdot \hat{Q} > 0$, which is again proportional to $\hat{a}$. ■

3.3 Low Cost Subsidies to Venture Capitalists

The fact that managerial effort cost is intangible and not verifyable, excludes the possibility of encouraging advice by subsidizing managerial cost. This leaves only a revenue subsidy, or negative capital gains tax, $\tau^F < 0$, to directly address the lack of managerial support. Revenue subsidies tend to be expensive, though. To limit the cost to the tax payer, we would like the VCs to pay themselves for the subsidy. The preceding analysis revealed that a tax $z < 0$ on start-up investment I does not harm the VC's incentives because the tax is already sunk when it comes to decide on advice. Since the entrepreneur has no own wealth, it is always the VC who must shoulder the tax. Hence, the policy can be made self-financing by forcing the VCs to pay for their own subsidy.

We state the comparative static effects, allowing for non-zero initial values of τ^F and z. The government budget constraint in (6) now reads $\tau^F [(1-s)\, pV - Q] = zI$ or, by (A.1c) $zI = \tau^F Q\,(1-\theta)/\theta$. Log-linearizing, and using (A.1e), we have

$$(1-z)\, I\hat{z} = a\hat{\tau}^F + zI\hat{Q} \quad \Rightarrow \quad \hat{Q} = -\frac{a}{Q+zI}\hat{\tau}^F. \tag{30}$$

According to (16), the upfront payment remains unchanged at $B = 1$. Eliminating $\hat{z}$ by using (A.8), $\hat{Q} = -\hat{z}\,(1-z)\, I/Q$, we get the second equation. It indicates the VC's cost increase $\hat{Q}$ that results from the combined effects of the investment tax and revenue subsidy (or capital gains tax cut).

By (A.4), we find that the tax cut $\hat{\tau}^F < 0$ boosts advice and, thereby, allows the VC to squeeze the entrepreneur's profit share. However, the increased profits from a higher share of the VC come at the expense of an inflated equity cost $\hat{Q}$. It turns out that the net effect of the policy is positive. The emerging rents in VC financing attract new investments that compete down venture returns to the break even level. To see this, substitute (30) into (A.7) to get $\hat{V} = (1-\theta)\,\hat{\tau}^F + (\theta - s)\,\hat{Q} = \left[(1-\theta) - (\theta - s)\,\frac{a}{Q+zI}\right]\hat{\tau}^F$. To sign the square bracket, we use the government budget $zI = \tau^F Q\,(1-\theta)/\theta$ in the denominator, and replace a by (A.1e). After expanding $\theta - s = 1 - s - (1-\theta)$ and some further

manipulations, we have

$$\hat{V} = \frac{(1-\theta)\left[1-(1-s)\left(1-\tau^F\right)\right]}{\theta+(1-\theta)\tau^F}\hat{\tau}^F. \tag{31}$$

Importantly, the effect on the price is zero, if the optimal subsidy as stated in (21) is in place. With a smaller subsidy, or when a capital gains tax is in place, the square bracket is unambiguously positive. In this case, a tax cut, or an increase in the subsidy, $\hat{\tau}^F < 0$, reduces the price of innovative goods.

The main intention of the subsidy is to promote the professionalization of young firms by getting experienced financiers more involved in their portfolio companies. Indeed, the subsidy directly enhances managerial support in (A.3) which is then felt in higher survival chances. Accordingly, entrepreneurs request a smaller profit share to compensate for their own critical input, leaving a larger share to the VC which reinforces incentives for even more advice. The erosion of competitive venture returns noted in (31), on the other hand, works in the opposite direction. Using (A.8) and evaluating (A.10), and making use of (30), the policy is seen to boost advice by

$$\hat{a} = \hat{Q} - \hat{\tau}^F = -\frac{a+Q+zI}{Q+zI}\hat{\tau}^F = -\frac{1}{\theta+(1-\theta)\tau^F}\hat{\tau}^F, \tag{32}$$

where the last equality replaces a by (A.1e) and uses the public budget $zI = \tau^F Q(1-\theta)/\theta$.

Entrepreneurship responds to accommodate increased demand on account of a lower goods price. On the other hand, the policy raises survival rates such that fewer start-ups are needed to supply a given quantity. Substituting (31) and (32) into (A.11) yields

$$\hat{E} = \frac{\left(1-\eta\left[1-(1-s)\left(1-\tau^F\right)\right]\right)(1-\theta)}{\theta+\tau^F(1-\theta)}\hat{\tau}^F. \tag{33}$$

Irrespective of the demand elasticity, entrepreneurship unambiguously falls, if the optimal subsidy is in place which makes the square bracket zero (note $\hat{\tau}^F < 0$). Otherwise, the demand elasticity must not exceed unity too much to keep the positive sign. The critical upper boundary is $1/\left[1-(1-s)\left(1-\tau^F\right)\right] > \eta$, which is not very restrictive, even in the untaxed position (where $1/s > \eta$ is needed). We conclude that the policy, if introduced

from an untaxed state, expands the size of the innovative sector (as measured by the aggregate level of demand and supply) but retards entrepreneurship.

The ultimate interest in the policy proposal which gives a revenue subsidy to VCs but taxes start-up investment to pay for it, is its potential to raise welfare. By (A.12) and (31), the welfare effect of the policy is

$$dU^* = -pVE \cdot \hat{V} \gtrless 0 \quad \Leftrightarrow \quad 1 \gtrless (1-s)\left(1-\tau^F\right). \tag{34}$$

Note that the policy involves a subsidy, i.e. a reduction of the tax rate τ^F below zero. If we start from an untaxed position, for example, then the policy lowers the price and thereby raises consumer surplus which yields a welfare gain. If the optimal policy is already in place, a further increase in the revenue subsidy entails a zero first order welfare effect.

Proposition 6 ***(Self-financed Revenue Subsidy to VC Firms)*** *A small revenue subsidy to VC firms, $\hat{\tau}^F < 0$, financed with a tax on start-up investment cost, $\hat{z} < 0$, reduces venture returns, encourages advice, retards entrepreneurship, and boosts welfare. Starting from an equilibrium with an optimal subsidy in place, $(1-s)\left(1-\tau^F\right) = 1$, the effects on venture returns and on welfare are reduced to zero.*

Proof. See equations (31) to (34). ■

4 Tax Cut Cum Loss Offset Restriction

The previous policy proposal of a self-financed revenue subsidy may be unrealistic although it is specifically targeted at the problem of inadequate quality of 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 propose yet another targeted and self-financed policy initiative that should yield considerable 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, ψ below unity) such that the combined policy change is revenue neutral. Again, 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.

Suppose that VCs are subject to a capital gains tax with full loss offset, $\tau^F > 0$ and $\xi = 1$, while $\tau^E = 0$.[22] 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. To follow the effects of the policy, we follow the steps in Figure 1 and consider the impact on advice in (A.4). 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.5), 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.9). Lower prices expand the innovative sector. When a larger fraction of start-ups

[22] 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. Since τ^E would remain constant anyway, nothing interesting is lost if we set $\tau^E = 0$. We also set $z = 0$, while $S^E = S^L = S$.

are successful on account of more intensive managerial 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

$$\hat{\tau}^F = \frac{\tau^F}{1-\tau^F} \frac{(1-p)\frac{\theta}{1-\theta} + \tau^F \left[\theta - \eta\left(\theta - s\right) + \eta\left(1-s\right)p\theta\right]}{1-\tau^F + \tau^F\left(1-\eta\right)\left(1-\theta\right)} \hat{\xi}. \tag{35}$$

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 (39) into (A.9) to obtain the equilibrium price effect. Collecting terms and noting that all terms proportional to $\eta\tau^F$ cancel out, we eventually get

$$\hat{V} = \frac{\tau^F}{1-\tau^F} \frac{\left[s + \left(1-s\right)\theta\tau^F\right]\left(1-p\theta\right)}{1-\tau^F + \tau^F\left(1-\eta\right)\left(1-\theta\right)} \hat{\xi}. \tag{36}$$

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 (35).

Less attractive venture returns will weaken the incentives of VCs to provide managerial support. However, the policy's direct impact in (A.4) is for more advice. Substituting (35) into (A.10), we get the equilibrium response in advice,

$$\hat{a} = -\frac{\tau^F}{1-\tau^F} \frac{(1-p)\frac{\theta}{1-\theta} + 1 - \tau^F\eta\left(1-s\right)\left(1-p\theta\right)}{1-\tau^F + \tau^F\left(1-\eta\right)\left(1-\theta\right)} \hat{\xi}. \tag{37}$$

Again, the numerator is positive for $\eta = 1$ since $\left(1-s\right)\left(1-p\theta\right)$ 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 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 with start-ups. Substituting (35) into (A.16), 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,

$$\hat{E} = \frac{\left[1 - \eta\left(s + (1-s)\,\tau^F\right)\right](1 - p\theta)}{1 - \tau^F + \tau^F(1-\eta)(1-\theta)} \frac{\tau^F}{1-\tau^F}\hat{\xi}. \tag{38}$$

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

Proposition 7 ***(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 (36) to (38). Refer to (A.12) for the welfare effect where transfers are kept constant, $\hat{S}^L = 0$. The welfare gain reflects an increased consumer surplus from innovative goods. ■

5 Conclusions

America's thriving venture capital sector is often considered an important source of the country's competitiveness in innovative industries. Judging from several influential policy documents, policy makers in Europe and many other countries increasingly recognize that venture capital can importantly contribute to the professionalization and growth of young innovative firms and thereby to sustained innovation and growth in the economy at large. It seems, however, that the American role model of venture capitalism is not easily transferred to other countries. Despite the strong recent growth of the volume of funds raised and invested in Europe, there are several signs that these investments are often not as productive as expected. It seems that among all firms recently launched on Europe's high

technology stock markets, venture capital backed firms have not significantly performed better than other firms. The quality of venture capital investments thus seems a more urgent problem than the sheer volume invested.

This argument can also be given a theoretical foundation. Venture capitalists provide more than finance, they also add value to young firms. Therefore, the entrepreneur and the financier jointly contribute to the firm's success. Entrepreneurs contribute the technological idea or innovation but tend to be commercially inexperienced in their early business career. The venture capitalist has money and managerial know-how. She can importantly contribute to the professionalization of the young firm. Their relationship is subject to a double moral hazard, however, since none of these efforts are verifiable and contractible. For this reason, not only the entrepreneur but also the financier need high powered financial incentives which makes equity (or equity like instruments such as convertible securities) the preferred mode of finance. When returns must be shared but each partner must bear the entire intangible cost of her own input, then effort is underprovided. In our framework, we have considered the entrepreneur's input as critical, it is either all or nothing. In equilibrium, it cannot be underprovided. The venture capitalist's involvement in the firm is a matter of gradual adjustment. When she increases her managerial support, she bears the entire marginal cost but must share with the entrepreneur the extra returns. In our framework, the market equilibrium therefore suffers from a bias towards inefficiently low managerial support by venture capitalists. Policy should thus primarily address the quality of venture capital finance.

This paper considered the role of tax policy to promote the quality of venture capital finance. The major problem is that managerial effort cost is largely intangible and not verifiable which excludes the possibility of directly subsidizing effort cost to induce more involvement in portfolio companies. One is left with the capital gains tax as a prime candidate for reform. This tax is indeed widely considered to be a major obstacle but its role in shaping venture capital incentives has not been addressed in the public finance literature. We found, indeed, that even a small capital gains tax involves a first order

welfare loss because it exacerbates a preexisting market distortion and further diminishes incentives to provide managerial support. Therefore, the capital gains tax could indeed be a major impediment to the development of a high quality venture capital industry that significantly adds value to young innovative firms. However, one can go further than merely proposing a cut in the tax rate at the cost of the general tax payer. Apart from narrowly limiting the tax break to apply to venture capital funds only, one may also make it essentially self-financed by imposing a tax on start-up investment cost of venture capital backed firms. Since the increased start-up cost must be largely financed out of the financier's pocket, it makes venture capitalists pay themselves for the capital gains tax break. Since the tax on start-up cost is already sunk when it comes to decide on managerial support, it does not impair incentives while the capital gains tax cut boosts incentives for advice. The policy thus sharpens incentives for stronger venture capital involvement. Another tax incentive for more venture capital support is a tax cut that is self-financed by a limitation in loss offsets which broadens the tax base. This proposal strengthens marginal returns to advice on two fronts: it rewards success on account of the tax cut and makes business failure more costly by denying full loss offset.

We conclude that tax policy indeed holds interesting options to sharpen incentives and to promote more quality in venture capital finance. It would be very important though to test empirically whether such tax incentives are indeed effective in raising managerial support. One might find some measures of venture capital involvement such as number of visits to portfolio companies, time allocated to consulting activities, number of portfolio firms per advisor etc. and test whether there is a significant influence of tax variables.

Appendix

A. Equilibrium Restrictions

A zero profit equilibrium with full loss offset, $\psi = \xi = 1$, and $z = 0$, fulfills[23]

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

With incomplete loss offset, $\psi, \xi < 0$, these restrictions are [set $\xi = \psi = 1$ to get (A.1)]

$$\begin{array}{lll} (b') & (15)\ IC^F & a = (1-\theta)\left(1-\tau^F\right)(1-s)\, pV + (1-\theta)\,(1-\xi)\,\tau^F pQ, \\ (c') & (14)\ \Omega = 0 & \left(1-\tau^F\right)(1-s)\, pV\theta = Q\left[1-\psi\tau^F + (1-\theta)\,(1-\xi)\, p\tau^F\right], \\ (e') & (b)\,/\,(c) & a = \left(1-\xi\tau^F\right)\frac{1-\theta}{\theta} Q, \\ (f') & (d)\,/\,(c) & \frac{s}{1-s} = \frac{\left(1-\tau^F\right)\theta\beta}{(1-\tau^E)[1-\xi\tau^F-\theta(1-\xi)p\tau^F]Q}. \end{array} \tag{A.2}$$

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 $\hat{p}' = -\theta\hat{a}$.

Managerial 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

$$\begin{array}{ll} IC^E: & \hat{s} = \hat{\tau}^E - \hat{V} - (1-\theta)\,\hat{a}, \\ IC^F: & \theta\hat{a} = \hat{V} - \hat{\tau}^F - \frac{s}{1-s}\hat{s} - \frac{\tau^F}{1-\tau^F}\theta p\hat{\xi}, \end{array} \tag{A.3}$$

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

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.3) for the equilibrium adjustment of $\hat{a}$ and $\hat{s}$ gives

$$\begin{array}{l}\hat{a}=\frac{1}{\theta-s}\left[\hat{V}-(1-s)\,\hat{\tau}^F-s\hat{\tau}^E-\frac{\tau^F}{1-\tau^F}(1-s)\,\theta p\hat{\xi}\right], \qquad \theta-s>0,\\ \hat{s}=\frac{1-s}{\theta-s}\left[(1-\theta)\,\hat{\tau}^F+\theta\hat{\tau}^E-\hat{V}+\frac{\tau^F}{1-\tau^F}(1-\theta)\,\theta p\hat{\xi}\right].\end{array} \tag{A.4}$$

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.3). The VC 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.3). 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 $\hat{\Omega}=d\Omega$]

$$\frac{\hat{\Omega}}{1-\tau^F}=(1-s)\,pV\hat{V}-spV\hat{s}-[(1-s)\,pV-Q]\,\hat{\tau}^F-Q\hat{Q}+\frac{\tau^F(1-p)\,Q}{1-\tau^F}\hat{\xi}. \tag{A.5}$$

Substitute $\hat{s}$ from (A.4), 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,

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

Rearranging yields

$$\hat{V} = (1-\theta)\,\hat{\tau}^F + s\hat{\tau}^E + (\theta - s)\,\hat{Q} + \tau^F \frac{(1-s)\,p\theta - (\theta - s)}{1-\tau^F}\hat{\xi}. \tag{A.7}$$

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

$$\hat{B} = \hat{\tau}^E + \frac{\hat{S}^L - \hat{S}^E}{(1-\tau^E)\,B}, \qquad \hat{Q} = \frac{B}{Q}\hat{B} - \frac{(1-z)\,I}{Q}\hat{z}, \tag{A.8}$$

which also affects VC profits and competitive returns V. Substituting into (A.7), we have

$$\begin{array}{rcl} \hat{V} & = & (1-\theta)\,\hat{\tau}^F + \frac{\theta B + s(1-z)I}{Q}\hat{\tau}^E + \frac{\theta - s}{(1-\tau^E)Q}\left(\hat{S}^L - \hat{S}^E\right) \\ & - & \frac{(\theta-s)(1-z)I}{Q}\hat{z} + \frac{\tau^F}{1-\tau^F}\left[(1-s)\,p\theta - (\theta - s)\right]\hat{\xi}. \end{array} \tag{A.9}$$

The competitive price adjustment feeds back into advice and profit sharing. Substituting (A.9) into (A.4), we get profit sharing and advice in zero profit equilibrium

$$\begin{array}{rcl} \hat{a} & = & \frac{B}{Q}\hat{\tau}^E - \hat{\tau}^F + \frac{\hat{S}^L - \hat{S}^E}{(1-\tau^E)Q} - \frac{(1-z)I}{Q}\hat{z} - \frac{\tau^F}{1-\tau^F}\hat{\xi}, \\ \frac{1}{1-s}\hat{s} & = & \frac{(1-z)I}{Q}\hat{\tau}^E - \frac{\hat{S}^L - \hat{S}^E}{(1-\tau^E)Q} + \frac{(1-z)I}{Q}\hat{z} + \frac{\tau^F(1-p\theta)}{1-\tau^F}\hat{\xi}. \end{array} \tag{A.10}$$

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

$$\hat{E} = -\eta\hat{V} - (1-\theta)\,\hat{a}. \tag{A.11}$$

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 $D = pE$, we obtain from (18)

$$dU^* \equiv \hat{U}^* = \hat{S}^L - pVE \cdot \hat{V}. \tag{A.12}$$

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

$$\tau^F \left[(1-s)\, pV - \psi Q \right] E = S, \qquad \psi = p + (1-p)\, \xi. \tag{A.13}$$

(A.2) gives the modified equilibrium restrictions that take account of the loss offset parameters $\psi \neq 1$ and $\xi \neq 1$. Multiply the budget (A.13) by $\left(1-\tau^F\right) \frac{\theta}{Q}$, substitute the zero profit condition (A.2c') and use the definition of ψ to get

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

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

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

Now replace S by (A.14) at $\psi = 1$ and cancel terms to obtain

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

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.9), (A.10), (A.11), and (A.15), where all other policy parameters except $\hat{\tau}^F$ and $\hat{\xi}$ are set to zero. Substituting (A.9) and (A.10) into (A.11) yields

$$\hat{E} = (1-\eta)\, (1-\theta)\, \hat{\tau}^F + \frac{\tau^F}{1-\tau^F} \left[(1-\theta) - \eta\, (1-s)\, p\theta + \eta\, (\theta - s) \right] \hat{\xi}, \tag{A.16}$$

which we substitute into (A.15) to get (35) in the text.

D. Efficient Contracting

This appendix calculates the comparative static effects of a uniform capital gains tax under the efficient venture capital model of proposition 2. The scenario includes full loss

offset and refunds tax revenues as uniform transfers. The VC's program is

$$\begin{aligned}
\Omega &= \max\left\{(1-\tau)\left[p\left(a\right)V-\left(X+B+I\right)\right]-a\right\} && \text{(A.17)}\\
PC^{E} &: (1-\tau)\left(p\left(a\right)sV+B\right)-\beta\geq 1, && \text{(i)}\\
IC^{E} &: (1-\tau)\,p\left(a\right)sV-\beta\geq 0, && \text{(ii)}\\
IC^{F} &: (1-\tau)\,p'\left(a\right)V=1, && \text{(iii)}\\
PC^{I} &: X\geq p\left(a\right)sV. && \text{(iv)}
\end{aligned}$$

Two aspects of the efficient VC model are important. First, the VC must transfer X to the intermediary *prior* to the effort stage so that this amount is sunk when she later on decides upon her managerial contribution. Second, the payment must be to a *third* party, our market intermediary.[24]

The solution is described in the proof of proposition 2. The following comparative static analysis will show that the first order welfare effect of introducing a small tax is zero which verifies our claim that the market outcome is first best. Furthermore, we will learn that the positive effects of taxation are robust to this change in VC contracting. Only the welfare implications are different. The analysis now follows the solution by backwards induction. From (A.17),

$$\hat{a}=\left(\hat{V}-\hat{\tau}\right)/\theta,\qquad \hat{X}=\hat{\tau},\qquad \hat{B}=\hat{\tau}. \tag{A.18}$$

The first equation reflects condition (iii). The second combines (ii) and (iv), $X=\beta/\left(1-\tau\right)$, and takes the log-linear approximation. With all constrainst binding, condition (i) reduces to $(1-\tau)\,B=1$, giving the third result.

[24] Alternatively, the VC could deposit an amount $\tilde{X}=sV$ at contract stage so that she can pay out of this reserve a bonus money to a successful entrepreneur. She would keep the deposit in case of failure. The VC's expected cost is $-\tilde{X}+(1-p)\,\tilde{X}=-p\left(a\right)\tilde{X}$. When suppressing the tax, the VC's problem would consist of $\max p\left(a\right)\left(V-\tilde{X}\right)-\left(B+I\right)-a$ subject to $PC^{E}:p\left(a\right)\tilde{X}+B-\beta\geq 1$, $IC^{E}:p\left(a\right)\tilde{X}-\beta\geq 0$ and $IC^{F}:p'\left(a\right)\left(V-\tilde{X}\right)=1$. As is evident from IC^{F}, this would not give the efficient solution. In raising advice, the VC would have to use her deposit more often to pay bonus money which subtracts from her profits. This shows that only the possibility to contract with a third party allows the VC to give up *irrevocably* the bonus money *prior* to the effort stage and commit to the efficient level of advice.

With free entry of competitive VCs, venture returns V adjust to eliminate excess profits. The equilibrium price allows no more than break even. Multiply (A.17iii) with a and use (9) to get $(1-\tau)(1-\theta)pV = a$. Substituting this into $\Omega = 0$, and using $Q = B + I$ yields the zero profit condition

$$p(a)V\theta = X + Q \qquad \Leftrightarrow \qquad (\theta - s)\,p(a)\,V = Q, \tag{A.19}$$

where the second version replaces X by (A.17iv). Taking the logarithmic differential yields $(1-\theta)\hat{a} + \hat{V} = \frac{X}{X+Q}\hat{X} + \frac{B}{X+Q}\hat{B}$. Using (A.18), we get

$$\hat{V} = \left[1 - \theta\frac{I}{X+Q}\right] \cdot \hat{\tau} > 0, \tag{A.20}$$

which is formally identical to (25) since $\theta I/(X+Q) = (\theta - s)\,I/Q$ by (A.19).

Any change in equilibrium venture returns feeds back on the incentives to advise. Substituting (A.20) into (A.18) reveals the net effect

$$\hat{a} = -\frac{I}{X+Q}\hat{\tau}, \tag{A.21}$$

which is qualitatively the same as in (26) but is quantitatively somewhat smaller.

From the market clearing condition $D = p(a)\,E$ and (11), we get $\hat{E} + (1-\theta)\,\hat{a} + \eta\hat{V} = 0$ or, upon substituting (A.20-21),

$$\hat{E} = -\left\{(\eta - 1)\left[1 - \frac{\theta I}{X+Q}\right] + \left[1 - \frac{I}{X+Q}\right]\right\}\hat{\tau}. \tag{A.22}$$

Both square brackets are positive. As in (27), the tax reduces entrepreneurship, except possibly for an overly small demand elasticity η. By the same arguments as in (A.20) the first square bracket is identical to the first one in (27). The second bracket is slightly different, reflecting a different magnitude of the equilibrium response in advice.

In our present scenario, the government budget in (6) reduces to $\tau(pV - I)\,E = S$. Differentiating, we recover (28), i.e. $(pV - I)\,E\hat{\tau} = \hat{S}$. Apart from the increase in transfers, welfare in (A.12) depends on the equilibrium price effect noted in (A.20). By (A.19), it is also written as $\hat{V} = \frac{pV-I}{pV}\hat{\tau}$. Inserting $\hat{V}$ and $\hat{S}$ into (A.12), we find

$$\hat{U}^* = \hat{S} - pVE \cdot \hat{V} = 0. \tag{A.23}$$

Except for welfare, all other comparative static effects of the capital gains tax remain the same, at least in qualitative terms. When VCs are able to enter into binding agreements with outside market intermediaries, they can overcome the inefficiency in advice. Not surprisingly, the first order welfare effect of a small tax is reduced to zero.

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