Embargoed until presentation at 1:30 p.m. on Thursday, May 2, 2002

Start-up Financing: Banks vs. Venture Capital

Augustin Landier*
MIT

November 19, 2001

Abstract

I develop a model in which entrepreneurs and investors can hold-up each other once the venture is under way: investors can deny further funding, and entrepreneurs can withdraw from the venture. The entrepreneurs' exit option determines which party needs protection. If the exit option is good, venture capital financing protects the investor through technological monitoring, control rights, and staged financing. If the exit option is bad, bank debt protects the entrepreneur as it involves little technological monitoring, limited control rights, and committed finance. The exit option depends on the legal environment and on the stigma of failure, endogenized in a career concern model. When entrepreneurs can choose project risk, multiple equilibria arise with different financial institutions. Venture capital prevails in the high-risk equilibrium and bank debt in the low-risk equilibrium. The paper investigates why the forms of start-up financing differ across sectors, regions and countries. It offers an explanation for why venture capital has been more prevalent in the US than in Europe. The theory has implications for policy, e.g., regarding the efficiency of non-compete agreements and bankruptcy law.

*Department of Economics, MIT, 50 Memorial Drive, Cambridge MA 02142, USA. Email address: landier@mit.edu.
I thank my advisors Daron Acemoglu, Olivier Blanchard, Denis Gromb and Sendhil Mullainathan. For their useful comments, I am grateful to Manuel Amador, Jessica Cohen, Matthias Dewatripont, Andrew Hertzberg, Bengt Holmstrom, Simon Johnson, David Scharfstein, Antoinette Schoar and Jean Tirole. All remaining errors are mine.

"Value-added VCs are few and far between, especially in Europe. Most European VCs have learned their trade in management buy-outs. They aren't nurturing and every board meeting is about justifying your existence. They are used to sitting across from you and seeing if you're meeting your milestones. Real VCs are about helping you identify your milestones, and then opening up relationships, exploring business models, and being nurturing - that way they get you closer to meeting your milestones. Be very careful with people who are trying to reinvent themselves from private equity to venture capital."

Sonia Lo, founder and CEO of eZoka.com (Financial Times, June 8, 2000).

1 Introduction

Venture capital has emerged as the most common form of financing for high-technology start-ups in the US and is frequently referred to as an important factor in the technological leadership of the US economy. This form of financing differs from standard bank finance in three major dimensions.[1] First, venture capitalists use their high level of expertise to perform technological monitoring and to actively manage the companies they finance. Second, the capital infusions in the firms financed by venture capital are staged in several rounds. Third, venture capitalists usually have extensive control rights (e.g., board rights, voting rights). This form of financing is in contrast with standard bank debt: banks traditionally perform accounting monitoring but no technological monitoring and, outside default, their control is limited to assets used as collateral.

In Europe, the venture capital industry remains small and focusses primarily on financing buyouts rather than on early and expansion-stage financing. Moreover, European venture capitalists are less "hands-on" (they rarely play an active role in the management of the companies they finance) and have less control rights than their American counterparts. Such differences in financing also exist within the US. Saxenian (1994) provides evidence that venture capitalists in Massachusetts are less involved in management and behave more like bankers than in Silicon Valley. In this

[1] An extensive description of venture capital contracts can be found in Kaplan and Stromberg (2001)

paper, I investigate the source of these variations in financing forms. I formalize the idea that these variations are related to differences in the exit option of entrepreneurs, which affect their bargaining power.

Entrepreneurs and investors can hold up each other once the venture is under way: investors can deny further funding, and entrepreneurs can withdraw from the venture. The optimal form of financing balances the terms of bargaining. The entrepreneurs' exit option determines which party needs protection.

If the exit option is bad, the entrepreneur needs to be protected from ex-post appropriation of rents by the investor. This goal is achieved by standard bank debt, as it involves little technological monitoring, limited control rights, and committed finance. Infusing a large amount of cash at the beginning solves two problems. First, the entrepreneur behaves efficiently, maximizing the value of the project, and second, the probability that refinancing is needed is small, relaxing the hold-up problem.

If the exit option is good, the investor needs to be protected. Venture capital financing meets this goal through technological monitoring, control rights, and staged financing. The investor acquires technological expertise, allowing him to perform technological monitoring, which increases the liquidation value of the firm if the entrepreneur withdraws. The optimal initial infusion of cash in this context is smaller, reflecting the trade-off between incentives and the ex-post hold-up. The entrepreneur cannot commit to high repayments. The level of repayments can be decreased by lowering the first cash-infusion. The cost of this form of financing are twofold. First the lower initial infusion decreases the incentives of the entrepreneur to act efficiently. The second cost is the investor's technological expertise. Both costs lower the ex ante value of a given project.

Variations in the outside option of entrepreneurs have two sources. First, they are related to the legal environment. We show how changes in bankruptcy rules affect financial institutions and contracts. Second, and perhaps more interestingly, the outside option depends on the stigma associated with failure in entrepreneurial ventures. This "stigma of failure" is endogenized by formalizing the relationship between a project's risk and the "stigma of failure". The success of a given project depends on luck and ability. Ex ante entrepreneurs do not have information on their ability. The more "normal" it is for a good entrepreneur to fail, the lower the stigma of failure and therefore the stronger the bargaining position of the entrepreneur.

When entrepreneurs can choose between risky high growth projects and safer low-growth projects, two types of equilibria are possible and can coexist under certain conditions. The riskiness of the strategies of other entrepreneurs determines in equilibrium the extent of the stigma of failure and, therefore, affects the trade-off between growth and risk that a given entrepreneur faces. This interaction can lead to multiple equilibria and explain cross-country (e.g. Europe vs. US) or cross-regional differences (e.g. Route 128 vs. Silicon valley) that have been so far described as the result of exogenous differences in corporate culture.

In the *low risk equilibrium*, entrepreneurs choose safe strategies. If their ability is high, they are relatively unlikely to fail. Therefore, the pool of failed entrepreneurs is of relatively low quality, making the stigma of failure high. This reduces the need for expertise on the investor's side because the fear of being forced to default on the debt payment enforces the entrepreneur's discipline. As a consequence, the optimal form of financing looks more like bank debt. In turn, the high stigma of failure makes safe strategies ex ante the most attractive choice.

On the contrary, in the *high-risk equilibrium*, entrepreneurs choose aggressive growth strategies. This means that even entrepreneurs with high ability are likely to fail. Therefore, the pool of failed entrepreneurs is of high quality, leading to a low stigma of failure. This tilts the hold-up problem in a direction favorable to the entrepreneur. Therefore the optimal form of financing looks like venture capital, with high investor expertise and investment staging. The inefficiencies that arise due to the hold-up problem increase the cost of capital. In turn, due to the low stigma of failure, the risky strategy is the most attractive.

Which equilibrium is the most efficient depends on the trade-off between growth and hold-up inefficiencies: if the value of high-risk projects is large enough, it offsets the costs generated by the technological monitoring, and therefore, the high-risk equilibrium is the most efficient one.

This paper is related to two strands of literature. The first is the career concern literature initiated by Holmstrom (1982, 1999) where managers are concerned by how their reputation will be affected their actions. Second, this paper is related to the large literature on the principal-agent problem in financial contracting. Grossman and Hart (1986) and Hart and Moore (1990) build a theory of incomplete contracting under renegotiation and study how the nature of the hold-up problem affects contracting. Aghion and Bolton (1992) show how the dissociation between control rights and cash-flow rights can decrease inefficiencies due to the *ex post* misalignment of objectives of entrepreneurs and investors. Rajan (1992) considers the trade-off between informed and non-informed finance in a set-up where inefficiencies arise due to the threat of termination of informed creditors. Specifically related to our topic, Gompers (1995) shows empirically that venture capitalists concentrate investment in early-stage and high technology companies where informational asymmetries are highest, and that financing rounds become more frequent when the intangibility of assets is higher. Several papers model the relationship between a venture capitalist and an investor, such as Berglof (1994) or Repullo and Suarez (2000). Hellmann (1998) has a model where control rights protect the investor from hold-up from the entrepreneur. These models do not link investment staging with hold-up and the misalignment between the two parties is due to private benefits (as opposed to endogenous career concerns in our model). The main contribution of my model is to offer a capital market equilibrium perspective to the problem of the conflict between creditors and entrepreneurs: The hold-up and moral-hazard problems to which an entrepreneur is subject depend both on financial institutions and on the choices of other entrepreneurs that prevail in equilibrium. Gromb and Scharfstein (2001) have a model of entrepreneurship where managerial incentives are determined by the career prospects in the event of a project's failure which in turn depends on the type of organization where the project failed (intrapreneurial vs. entrepreneurial). Managers who fail an internal venture can be redeployed by their firms into other jobs which has costs in terms of incentives whereas failed entrepreneurs must seek employment at other firms. Incentive problems depend the organizational choice of firms and, like in my model, on the equilibrium of the labor market. While their focus is on whether projects are done inside or outside large firms, my model focusses on financing institutions and project choice for start-ups.

The paper proceeds as follows. Section 2 describes the benchmark model and solves for the equilibrium. Section 3 endogenizes the stigma of failure. Section 4 discusses the cross-sectorial implications of the model. Section 5 studies the conditions for multiple equilibria to arise and discusses their relative efficiency. Section 6 presents two case studies comparing the level and nature of venture-capital finance in Europe vs. the US and Silicon Valley vs. Route 128 respectively. Section 7 concludes. All mathematical proofs are in the appendix.

2 A Model of Start-up Financing

In this section I present a simple model of start-up finance. The model endogenizes the staging of investment as the solution to an optimal contracting problem. I characterize investors by their level of expertise. Bank finance corresponds to a non-expert investor and a unique infusion of funds. Venture capital corresponds to an expert investor and a positive probability for more than one round of cash infusion to occur.

2.1 Model

The model has four periods, $t = 0, 1, 2, 3$. All agents are risk-neutral. There is no discounting. The main trade-off that we capture is the one between the costs of technological monitoring and the time-inconsistent incentives of the entrepreneur to minimize costs and repay debt.

At $t = 0$, there is a continuum of mass one of wealthless entrepreneurs, each with a project generating a cash-flow V at $t = 3$. Each entrepreneur matches with a competitive investor with whom he enters a contract. The contract specifies a cash injection at $t = 0$, I_0, a final repayment D to the investor, and a level of expertise of the investor $H > 0$. Expertise H has a unit cost γ.The role of the investor's expertise in our model is to affect the terms of bargaining.[2] A higher H increases the

[2] We could assume that H also affects the surplus (V), therefore providing another motive for investor's expertise. We want to isolate the impact of H on the hold-up problem.

firm value to the investor if the entrepreneur leaves, $V(H)$ where $V(H)$ is increasing concave, $V'(0) = +\infty$ and $\lim_{H\to\infty} V(H) < V$. Concretely, H is the effective control of the investor on the project: it represents both the ability of the investor to process technological information relevant for pursuing the project (technological expertise) and the possibility to have access to this information (control rights).

At $t = 1$, the entrepreneur and the investor observe whether the entrepreneur is competent to undertake the project. If he is not (this happens with probability p), the project is liquidated, at a value normalized to zero. If he is competent, the entrepreneur chooses privately a level of effort e, at private cost $e^2/4$.

At $t = 2$, the cost C of the project is revealed. C, which is observable to both the investor and the entrepreneur, but not contractible.C is a random variable, distributed uniformly on $[0, 2C(e)]$, where $C(e)$ is a decreasing, convex function of effort e. We also assume that $-1/C(e)$ is convex and that continuation is efficient for all levels of e. The investment C is spent on the project's execution (if $I_0 < C$, the investor makes the complementary injection $I_1 = C - I_0$), after which a payoff V is produced.

At $t = 3$, the entrepreneur's career goes on. The expectations of the labor market only depend on whether he was successful or not on his first venture. He receives a wage equal to his expected productivity: w_f if he failed and w_s if he succeeded, with $w_s > w_f$. (The next section endogenizes w_f and w_s). We note $\Delta = w_s - w_f$, the stigma of failure.

2.2 First-Best

The first-best levels of effort e and expertise H are determined by the maximization of the surplus:

$$\max_{e,H}(1-p)[V - C(e) - e^2/2] - \gamma H$$

Therefore, the first-best levels are:

$$\begin{cases} H^\star &= 0 \\ e^\star &= -C'(e^\star) \end{cases}$$

The optimal level of expertise is zero, reflecting the fact that H is costly and does not increase the surplus in the absence of market inefficiencies. The wages w_s and w_f have no impact on the first-best values of effort and expertise. This won't be the case any more in the presence of contracting inefficiencies.

2.3 Hold-up

We now depart from the first-best world by introducing a contract incompleteness: we assume that each party can hold-up the other at $t = 2$. The investor can force renegotiation when more cash needs to be infused at $t = 2$, and the entrepreneur can always force renegotiation by threatening to quit the project. We assume symmetric Nash-bargaining.

If the investor does not inject the cash required for the project at $t = 2$, the project stops and the entrepreneur gets w_f, namely the wage of a failed entrepreneur[3]. The value functions of the entrepreneur (E), and of the investor (I), when renegotiation occurs are:

$$\begin{cases} E &= w_f + \frac{1}{2}(V + w_s - V(H) - w_f) \\ I &= V(H) + \frac{1}{2}(V + w_s - V(H) - w_f) \end{cases}$$

Remark that $E + I = V + w_s$, which is the surplus from continuation and that the terms of bargaining do not depend on how much cash has to be reinjected. In what follows, we call $\Delta = w_s - w_f$, the "stigma of failure". We can rewrite the outcome of the bargaining as follows:

$$\begin{cases} E &= w_s + \frac{1}{2}(V - V(H) - \Delta) \\ I &= V(H) + \frac{1}{2}(V - V(H) + \Delta) \end{cases}$$

This shows that, ceteris paribus, an increase of the stigma of failure (Δ), improves the bargaining position of the investor. When Δ is large, the main problem tends to be investor's ability to appropriate rents ex post if he has the power to do so. Conversely, for a small Δ, the main problem tends to be the entrepreneur's threat to leave the firm.

[3] To be precise, we assume that the market only observes if the project has been successfully completed or not, i.e. if V has been produced. The market has no information on the reasons why V "did not happen".

There is an asymmetry between these two commitment problems. The threat of rent appropriation by the investor can be remedied by injecting more cash (or equivalently offering a deeper line of credit) at the beginning, which reduces the states of the world where the entrepreneur has to ask for further funding. Absent default, the investor does not have control and can not threat the entrepreneur. Such a solution, however, does not exist for the entrepreneur's commitment problem.

2.4 The Optimal Contract

We look for the optimal contract. In addition to the hold-up assumption, we assume that entrepreneurs cannot credibly pledge the future incomes that they will get at $t = 3$ from the labor-market. We also assume perfect accounting monitoring: the entrepreneur cannot divert cash injected by the investor outside the firm until the completion of the project. This implies that when the entrepreneur is incompetent, the investor gets all his investment I_0 back because the entrepreneur does not have any bargaining power[4]: he cannot steal money and if he leaves, the investor gets everything back. Last, we assume that continuation is always efficient at $t = 2$. Therefore it is not possible for the investor to commit to terminate the project.

Each time an additional injection of cash is needed, i.e. $I_0 > C$, the sharing of the payoff is determined by the Nash-bargaining solution. The reason is that for any other sharing rule, one of the two parties would find it attractive to renegotiate. It follows that the only case where the sharing rule can be different from the bargaining solution is the case where the first injection of cash can cover the costs ($I_0 > C$) and the entrepreneur prefers to repay his debt rather than renegotiate ($w_s + V + I_0 - C - D > E$). In this case, the investor would like to renegotiate but cannot force renegotiation, since the survival of the firm does not rely on him injecting more cash.

When E is low enough, it is possible to implement the first-best by a simple debt contract: the investor does not invest in expertise, ($H = 0$), an injection of $I_0 = 2C(e^\star)$ is made at the beginning. As long as the repayment level $D^\star$ required

[4] We could alternatively assume that the entrepreneur can threaten to burn the cash inside the firm and can therefore extract $\Delta/2$. This would however lead to a mechanical relation between the risk of the project and inefficiency.

for the investor to break even is such that

$$w_s + V - D^\star > E, \tag{1}$$

the entrepreneur prefers to repay his debt for any value of $C < 2C(e^\star)$. For this reason, the fear of having to ask for more money plays the role of a discipline device which induces the first-best level of effort. Assuming, that the entrepreneur always repay his debt, the break-even condition writes simply: $D^\star = 2C(e^\star)$. In turn, equation 1 rewrites :

$$w_s - w_f > 4C(e^\star) - V \tag{2}$$

Remark that for any $\epsilon \geq 0$, all contracts of the form $I_0 = C(e^\star) + \epsilon$, $D = D^\star + \epsilon$ have the same properties. In term of payoffs and of incentives, only the difference $I_0 - D$ matters. In what follows, when several contracts are optimal, we pick the one than minimizes I_0 and D, a convention that makes comparisons possible[5].

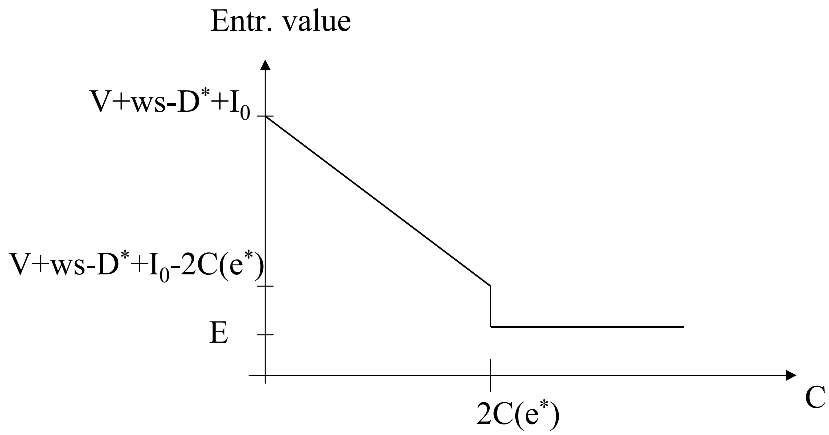
In brief, when the stigma of failure is high enough, the first-best is implemented. The investor does not invest in technological expertise and the fear of failure is sufficient for the entrepreneur to commit to repay his debt and perform optimal effort. This type of lending has the essential characteristics of bank finance.

Proposition 1 *There exists a threshold value $\Delta^\star = 4C(e^\star) - V$ such that for $w_s - w_f > \Delta^\star$:*

- *Investor does not have technological expertise: $H = 0$.*
- *The optimal contract consists of an initial injection of cash $I_0 = 2C(e^\star)$.*
- *There is no renegotiation.*
- *First best effort, $e^\star$, is implemented.*

[5] Such a contract would be the optimal contract for an arbitrary small opportunity cost of injecting money at $t = 0$ rather than $t = 2$.

- *There is no need for a second-stage injection of cash.*



Consider now what happens when the stigma of failure becomes small, i.e. $w_s - w_f$ just below $\Delta^\star$. Implementing the first-best becomes impossible because the condition that the entrepreneur does not find it attractive to renegotiate for $C < 2C(e^\star)$ is now incompatible with the break-even condition. There are two tools that can be used ex ante to solve the commitment problem of the entrepreneur. First, the investor can decrease I_0, which has only a second-order impact on the surplus (through a first-order decrease in effort) but relaxes the budget constraint to the first-order. He can also acquire technological expertise ex ante. Since $V'(0) = +\infty$, both tools are used at the optimum contract. We let the formal proof for the appendix and try to go further with an intuitive derivation of the optimal contract. Decreasing I_0 decreases incentives to perform effort and leads to a level of effort $e < e^\star$, since the excess of cash that the entrepreneur can try to keep is smaller. The positive relationship between effort and I_0 (which constitutes the incentive compatibility constraint) is:[6]

$$I_0 = 2\sqrt{-\frac{C(e)^2}{C'(e)}e}.$$

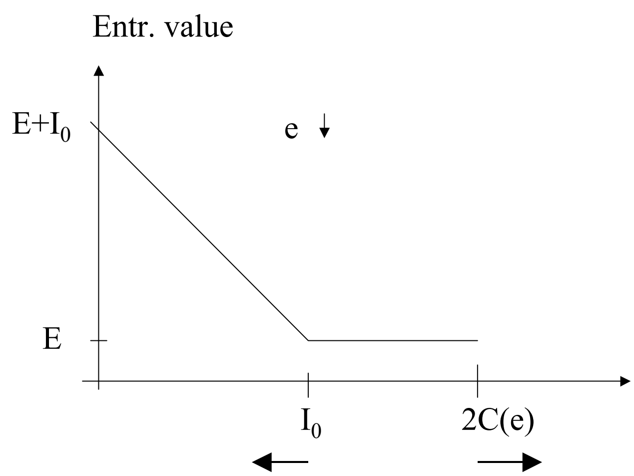
Therefore, a larger I_0 also means a larger average cost, $C(e) > C(e^\star)$. Since $I_0 < 2C(e^\star)$, this implies that with a positive probability $(1 - I_0/2C(e))$, the entrepreneur does not have sufficient cash from the first injection to pursue the project and has to

[6] Remark that $e^\star$ is solution of this equation for $I_0 = 2C(e^\star)$.

negotiate for a second cash-injection. When this occurs, the sharing rule is determined by the terms of bargaining. Now, when the realization of C is smaller than I_0, as I show in appendix, at the optimal contract, the entrepreneur repays his debt[7].

Proposition 2 *For $w_s - w_f < \Delta^\star$, optimal contracting results in:*

- *A positive level of technological expertise H,*
- *A first injection $I_0 < C(e^\star)$. Effort is second-best, $e^{\star\star} < e^\star$.*
- *There is a positive probability that a second injection I_1 occurs.*
- *The cost of capital for a given project is higher than when $w_s - w_f < \Delta^\star$, reflecting undereffort and the cost of expertise.*



As the stigma of failure, $w_s - w_f$, decreases, effort decreases and expertise H increases. The probability that a second cash injection is needed is now $1 - \frac{I_0}{C(e^{\star\star})}$ which increases. The level of the first cash injection decreases and the average level of the second one, $\frac{C(e^{\star\star})-C^\star}{2}$ increases. The total expected level of cash needed to finance the venture, $\gamma H + C(e^{\star\star})$, increases, due to the inefficient underprovision of effort. The loss in efficiency due to the hold-up friction is $L = \gamma H + (1-p)(C(e^{\star\star}) - C(e^\star))$.

[7] The repayment D is equal to what would occur in case of renegotiation (but the investor does not have to make a complementary cash injection).

Proposition 3 *In the second-best region ($\Delta < \Delta^\star$), as the stigma of failure $\Delta = w_s - w_f$ decreases:*

- *The level of technological expertise of investor increases.*
- *Effort decreases : The lower the stigma of failure, the more stringent the incentive constraint is.*
- *The probability that a second-stage investment occurs increases as the level of effort decreases. This probability is:* $1 - (-e^{\star\star}/C'(e^{\star\star}))^{1/2}$.
- *The initial cash injection decreases, the average second cash-injection increases, the total amount of cash needed increases.*
- *The loss in efficiency with regard to the first best is decreasing with Δ and increasing with the cost of technological expertise H.*

This benchmark model captures the main intuition of the paper:

As long as the stigma of failure $(w_s - w_f)$ is "high enough" simple debt contracts are the optimal mode of financing. The investor does not need to acquire technological expertise: the fear to be forced to raise new funding operates as a discipline device and forces entrepreneurs to choose the first-best effort. In turn, the investor has no power to exercise a threat on the entrepreneur as long as he repays his debt. This kind of financing has the characteristics of bank debt.

Conversely, when the stigma of failure is low, the entrepreneur cannot commit not to trigger renegotiation. This leads to a loss in efficiency that is partly solved by having the investor acquire technological expertise. This expertise, by alleviating the hold-up threat of the entrepreneur, rebalances the terms of bargaining. This improvement in the efficiency of the terms of bargaining represents the "value-enhancement" of venture-capital as a style of financing in our model. It however has costs, simply those of high-skilled technological expertise. The model shows that an endogenous staging of capital injection in two rounds occurs.

Proposition 4 *A testable prediction of the model is the following:*

Ceteris paribus, the higher the stigma of failure, the higher the ratio of second-stage infusion over first-stage infusion.

3 Value Enhancing Investors

In our model, the value enhancement of investor's expertise lies exclusively in the resolution of a hold-up problem. As a consequence, whenever bank debt is possible, it is also first-best efficient. This feature is not essential to the model. For example, when the technological knowledge of the investor adds value to the project (e.g., if the payoff is an increasing function of H, $V(H)$) it might be first-best to have a positive level of H and a large stigma of failure would lead to a level of technological monitoring lower than H. In this case, the relationship between efficiency and stigma might be non-monotonic. Venture capitalists are known to add value to the ventures they finance, e.g. by helping to hire appropriate managements, or using their network to help the entrepreneur to obtaining contracts.

4 The Stigma of Failure

The framework we have developed allows us to clarify the link between the stigma of failure and the nature of financial institutions and contracts. The determinants of the stigma can be both exogenous (institutions) or endogenous (informational).

4.1 Exogenous Stigma

Assume that bankruptcy rules or liquidation rules are the determinants of the stigma: $w_s = w$, $w_f = w - \Delta$. We assume that Δ is pure waste for society (think to Δ as the time it takes for the entrepreneur to be discharged and able to go on with his career). We can use our model to describe how Δ affects financial contracts and what level of Δ is efficient. There is a trade-off between the disciplining effect of Δ and its cost for society. A higher Δ alleviates the commitment problem of the entrepreneur but diminishes the expected surplus by $p\Delta$.

Proposition 5 • *There exists a threshold $p^\star < 1$ such that for $p < p^\star$, the optimal bankruptcy cost Δ is positive and decreases with p.*

- *Investor's expertise and the probability of second-stage financing decrease weakly with Δ (strictly decrease for $p < p^\star$).*

The first point shows that bankruptcy rules are an effective way to give bargaining-power to the investor and that the riskier the sector, the more distortionnary it is. The second point shows that softer bankruptcy rules ask for an investor with higher technological monitoring. Even though bankruptcy rules vary across countries, they are not the only component of the stigma of failure. As it is shown in the last section, a crucial component of the stigma of failure is the endogenous competent resulting from the market's inference about the ability of a failed entrepreneur.

4.2 Endogenous Stigma

We now extend our model so as to endogenize the stigma of failure, $w_s - w_f$ in a simple career-concern set-up.[8]

Assume that there are two types of entrepreneurs: Good types (G) –in proportion θ– and bad types (B). Initially, the types are unknown to everyone, including the entrepreneurs. The type of an entrepreneur matters for two distinct reasons: it affects the probability of being competent on the entrepreneurial project and the entrepreneur's productivity on the labor-market. High (low) types have a probability p_G ($p_B = 1$) to be incompetent to finish their project and therefore, the ex ante probability for an entrepreneur to fail on a project is $p = \theta p_G + (1 - \theta)$. The wage w will reflect inference conditional on the history of the entrepreneur (competent or not). Bad types have a productivity normalized to zero on the labor market, while high types have productivity y.

[8] This formalization is related to Landier (2001).

Inference on productivity:

Since there is a proportion θ of good types in the population, the probability that a "fired" entrepreneur is of high type is:

$$\pi_f = \frac{\theta p_G}{\theta p_G + (1-\theta)}.$$

Since bad entrepreneurs never succeed, the probability that a "successful" entrepreneur is of the good type is one: $\pi_s = 1$.

The wage on the labor-market is competitive and therefore equal to the expected of the entrepreneur conditional on the available information. The wage is therefore $w_s = \pi_s y$ if the entrepreneur has been replaced and $w_f = (1-\pi_f)y$ if he has successfully completed his project.

The stigma of failure is:

Proposition 6 *The "stigma of failure" is a decreasing function of p_G and therefore of p:*

$$w_s - w_f = \frac{1-\theta}{\theta p_G + (1-\theta)} = \frac{1-\theta}{p}.$$

We use this career concern structure in two contexts: first we want to study how sectorial characteristics impact the "style of financing". Second, we show how complementarities between the strategies chosen by entrepreneurs might lead to multiple equilibria and therefore to differences in lending styles in a given sector of similar economies.

5 Start-up Finance and Sector Characteristics

In this section, we do comparative statics with regard to p_G the probability that a good entrepreneur fails. When p_G goes through $[0,1]$, the ex ante risk of failure $p = \theta p_G + (1-\theta)$ goes through $[1-\theta, 1]$. p can be seen as an index of sectors, a higher p meaning a riskier sector. The payoff in case of success in sector p is $V(p)$ and the cost function is $C(p,e)$. As before, there are good and bad entrepreneurs. Bad entrepreneurs always fail and good entrepreneurs fail with probability $p_G(p) = 1 - \frac{1-p}{\theta}$, which is increasing with sector-risk p. We assume that entrepreneurs are randomly affected across sectors, justifying the fact that θ is constant across sectors.

Assumption 1 *Riskier sectors have higher payoffs in case of success:*

If $p < p'$, $V_p < V_{p'}$ and $V_p(H) < V_{p'}(H)$ for all $H > 0$.

Failing in a low-risk sector is more informative than failing in a high-risk sector: to fail in a low-risk sector, "you really have to be bad". As a consequence, the "stigma of failure" decreases with the sector index p :

Lemma 1

- *A failed entrepreneur is more likely to be of high type in a riskier sector.*
- *The stigma of failure, $\Delta(p) = w_s^p - w_f^p = (\frac{1-\theta}{p})y$, decreases with the index p.*

Now, we want to compare the ways of financing (contracts and institutions) in these sectors. To do so, we need a normalization assumption. Specifically, we make the following homogeneity assumption:

Assumption 2

- *$(1-p)C(p,e)$ and $(1-p)V(p)$ are independent on p and the private cost for project p is $\frac{e^2}{2(1-p)}$.*
- *$\Delta^\star(1-\theta) = 4C(1-\theta, e^\star) - V(1-\theta)$ is positive.*

Under these assumptions, the level of first-best effort does not depend on p and $\Delta^\star(p) = \frac{\Delta^\star(0)}{1-p}$ increases with p.

Therefore, $\Delta(p) - \Delta^\star(p)$ decreases with p, implying that the incentive constraint becomes more stringent. As a consequence, assuming that sectors are financed with the optimal institution , the following is true when we move towards more risky sectors (higher p) :

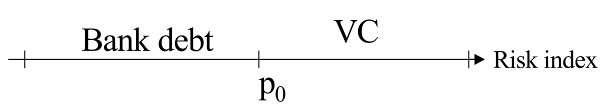
Proposition 7 *When p increases:*

- *The level of technological expertise $H_p^\star$ is higher and the level of effort diminishes (weakly).*
- *The cost of capital increases, due to the higher level of expertise required from the investor.*
- *The level of the first cash injection decreases and the probability of a second cash injection to occur increases. The expected level of this second cash injection increases as well, while the first cash injection decreases.*

Moreover, if we assume that $y > \Delta^\star(1-\theta)$, the less risky project ($p = 0$) can be financed by "bank debt" (i.e. with $H = 0$) while the most risky is in the second-best region, where renegotiation occurs with positive probability, we have:

Proposition 8 *There exists a cut-off sector p_0 such that:*

- *If $p < p_0$, sector p is financed by an investor without expertise ($H_p^\star = 0$) and a simple debt contract. In other words, traditional bank lending prevail in these sectors.*
- *If $p > p_0$, sector p is financed by an investor with expertise $H_p^\star > 0$, increasing in p. This type of financing has the characteristics of venture capital (e.g. staging in two rounds).*



6 Growth Strategies and Multiple Equilibria.

So far our model explains why different sorts of institutions and financial contracts might emerge to finance entrepreneurship in different sectors. It does not however explain why venture capital would succeed in certain economies but fail to become an important source of start-up funding in otherwise similar economies.[9] The explanation we propose is based on multiple equilibria: Assume that entrepreneurs within a given sector can choose different development strategies. They can choose aggressive business plans leading to "big hits" but likely to fail or they can choose more secure growth strategies, leading to smaller but more certain payoffs. Two equilibria can exist.

- In a "high-risk" equilibrium, entrepreneurs choose "high-risk" strategies for their project (meaning the probability for the entrepreneur to be incompetent is high). Therefore the stigma of failure is low which ensures that low-risk strategies do not look attractive.

- Conversely, in a "low-risk" equilibrium, the fact that all entrepreneurs choose low-risk strategies makes the stigma of failure high. Therefore, "high-risk" strategies are unattractive.

We now formalize this idea. The set-up is as in section one, except for the fact that the entrepreneur now chooses irreversibly at time zero among two possible strategies (or business plans) for the project: a risky one (p_2, V_2) and a low-risk one (p_1, V_1). This choice is observable by the investor but cannot be credibly signaled to the labor market once the entrepreneur has failed.

There are two potential pure strategy equilibria in our model: one where entrepreneurs all choose the low-risk strategy and one where they all choose the high-risk strategy.

We note $\Delta_1^\star = 4C_1(e_1^\star) - V_1$, $\Delta_2^\star = 4C_2(e_2^\star) - V_2$. The stigma of failure Δ is determined in each potential equilibrium by $\Delta_i = \frac{1-\theta}{p_i}$, therefore $\Delta_1 > \Delta_2$: the stigma of failure is higher in a low-risk than in a high-risk equilibrium..

For both types of projects, we note $B_i = (1-p_i)(V_i - C_i(e_i^\star) - e_i^{\star 2}/2)$, the expected first-best value generated by project i.

[9] More exactly, the only explanation it gives is that when the cost of technological expertise, γ, is too high, the commitment problem cannot be resolved.

We note $L_i(\Delta) = (1-p_i)(C_i(e_i(\Delta)) - C_i(e_i^\star) + (e_i(\Delta)^2 - e_i^{\star 2})/2) + \gamma H_i(\Delta)$ the efficiency loss in equilibrium i. L_i is a decreasing function of Δ.

The condition for project i to be preferred to project j in equilibrium (i) is that:

$$-p_i\Delta_i + (B_i - L_i(\Delta_i)) > -p_j\Delta_i + (B_j - L_j(\Delta_i))$$

Proposition 9

- *The low-risk equilibrium exists if*

$$\Delta_1 > \frac{B_2 - B_1}{p_2 - p_1} + \frac{L_1(\Delta_1) - L_2(\Delta_1)}{p_2 - p_1}.$$

- *The high-risk equilibrium ("high-risk") exists if*

$$\Delta_2 < \frac{B_2 - B_1}{p_2 - p_1} + \frac{L_1(\Delta_2) - L_2(\Delta_2)}{p_2 - p_1}.$$

- *Therefore, the condition for the two equilibria to coexist is that:*

$$\Delta_2 + \frac{L_2(\Delta_2) - L_1(\Delta_2)}{p_2 - p_1} < \frac{B_2 - B_1}{p_2 - p_1} < \Delta_1 + \frac{L_2(\Delta_1) - L_1(\Delta_1)}{p_2 - p_1}$$

To perform welfare analysis, since the investor makes zero profit, we have to compare the ex ante value of a project in each equilibrium, i.e.

$$W_i = B_i - L_i(\Delta_i)$$

The last expression rewrites:

$$\Delta_2 + \frac{L_1(\Delta_1) - L_1(\Delta_2)}{p_2 - p_1} < \frac{W_2 - W_1}{p_2 - p_1} < \Delta_1 + \frac{L_2(\Delta_1) - L_2(\Delta_2)}{p_2 - p_1}$$

Using this criterion, we can discuss the coexistence and the relative efficiency of the equilibria:

Proposition 10

- *The high-risk and low-risk equilibria can coexist.*
- *Depending on parameters, each equilibrium can be more efficient than the other.*

- *The high-risk equilibrium is the most efficient if the difference in the value of the projects exceeds the higher costs of financing, i.e.,*

$$B_2 - B_1 > L_2(\Delta_2) - L_1(\Delta_1),$$

To summarize, we compare the two regimes of entrepreneurship in the case where the difference in stigmas in the two equilibria is large enough such that $\Delta_1 < \Delta_1^\star$ and $\Delta_2 > \Delta_2^\star$ (a condition under which the coexistence result still holds).

Proposition 11 *Compared to the low-risk equilibrium, the high-risk equilibrium is characterized by:*

- *investors with more technological expertise.*
- *a higher probability of second-stage financing, with this probability being zero in the low-risk equilibrium.*
- *a higher probability for the entrepreneur to fail.*
- *a lower stigma of failure* $(w_s - w_f)$*.*
- *a higher cost of capital.*

Proposition 12

- *An increase in* V_2 *increases the efficiency and the likelihood of the high-risk equilibrium.*
- *An increase in the cost of technological expertise reduces the efficiency and the likelihood of the high-risk equilibrium.*

The first point illustrates that when there are large returns to risky strategies, the high-risk equilibrium tends to be both more likely and more efficient. This is likely to be the case in high-tech sectors. The picture that emerges from this proposition is broadly the one of Europe vs. the US:

- In Europe, young firms tend to have strategies that are not very aggressive. This leads to few "firings" of entrepreneurs and a high-stigma of failure (you have to be a bad manager to fail a conservative strategy), which in turn makes aggressive strategies too risky to be attractive. Financing does not require financial expertise of the investor: the stigma of failure plays the role of a discipline device, making simple debt contracts possible.

- On the contrary, in the US entrepreneurs choose risky, more aggressive strategies, that make them more likely to be unsuccessful. For this reason, the stigma of failure is low (having failed does not reveal much about your ability). This in turn creates a hold-up problem, leading to:

  - Acquisition of expertise from the investor to rebalance the terms of bargaining.
  - Staging of the investment in two rounds.
  - A higher cost of project's financing, reflecting the cost of investor's skills and the moral hazard problem (undereffort).

A quotation of Eric Benhamou, a french entrepreneur who emigrated to Silicon Valley and is currently the CEO of 3Com summarizes this link between strategy choice and the stigma of failure:

> *"As a student at Stanford, I realized how naive I had been to believe I could start a business in France.[...]in France, you keep all your life the stigma of a failure. Here [in Silicon Valley] it is the mark of your entrepreneurial spirit. In France, it is common practice to give up on growth in order to limit risk. Here, when you start a venture, your goal is to become number one of your sector".*

7 New Ventures: Europe vs. the US.

7.1 Financing

Venture Capital has played a prominent role in the technological leadership of the US[10]. More than 70% of firms in the personal computer industries have been venture-capital backed. Giant companies such as Cisco, Cray, Genentech, Lotus, Apple and Microsoft got started with venture capital.

In 1999, the US venture capital industry raises more than three times more capital than the rest of the world taken together. The development of Venture Capital funds in Europe has grown recently. However, it is difficult to draw a line between private equity and venture capital. If we aggregate the two, we find that about $99.4 billion of private equity and VC was invested in North America ($97.1 raised) in 1999, which amounts to 1.01% of GDP, whereas only $26.8 billion was invested in Europe ($27.1 bil. raised), i.e. 0.3% of the European GDP. While European countries have an increasing amount of venture capital under management, most of it is dedicated to buyouts of mature companies rather than seed or start-up financing. About 13% of financing went to seed and start-up in Europe against more than 30% in the US. Restricting oneself to the high tech industry makes this opposition even more striking: 26% in Europe against 80% in the US.

Characteristics of venture-capital contracts in the US include staging of investment and a high level of control rights. The replacement of the founder of the company by a manager who is more able to accomplish the project occurs with high probability. Moreover, venture capitalists spend a large amount of time learning about the technological aspects of the project of the firm both pre and post first-state financing. In our model, this intensity of technological monitoring –requiring a high level of expertise on the investor's side– and the staging of cash infusions are endogenous features of venture-capital as a lending technology.

European venture capitalists are traditionally less "hands on" and less strategi-

[10] Venture capital rivals in-house R&D as a major source of funding for innovation: as reported by M.Mandel, based on a report of the NVCA, "in the first quarter of 2000, Venture Capital equaled one-third of all money spent on R&D compared to 3% in the 80s".

cally involved than their American counterparts. In the context of our model, this means that they perform less technological monitoring. Sapienza, Manigart and Vermeir (1996) provide empirical evidence that French venture capitalists spend much less effort than their American counterparts in monitoring the firms they finance. They describe French venture capitalists as closer to bank managers than value-added investors.

Historically, early-stage venture-capital funds in Europe have produced relatively low rates of return (as compared to buyout funds, for example). Investment appears to be less high-tech in Europe. For example, in Europe, less than 20% of all venture capital investment was in high tech in 1998 compared with more than 60% for the US. Compared to the US, European venture capital devotes a much larger percentage of venture financing goes to manufacturing rather than High-tech.

7.2 The Stigma of Failure: Some Empirical Evidence

To quantify the "stigma of failure", I use wage information in labor market data. Two studies based on US data, Evans and Leighton (1989) and Hamilton (2000), establish that American entrepreneurs returning to employment earn slightly higher wages than other workers with similar characteristics.[11]

To my knowledge, no such study exists for France. I run my own regressions, using Enquête-Emploi, an annual survey of 1/300 of the French population. I find that French entrepreneurs returning to paid employment earn significantly lower wages than other workers. To control for transitions between self-employment and employment, I construct a sequence of two-year panel data. Given year t and $t+1$, I know the employment status of each individual for both years: employed, self-employed, unemployed or out of the labor force. I also know the wage w_t of employees, but not

[11] Evans and Leighton (1989), relies on the National Longitudinal Survey of Young Men (1966-1981) and finds that "workers who fail at self-employment return to wage work at roughly the same wages they would have received had they not tried self-employment". Each additional year of self-employment experience increases the mean wages of males aged 29-39 by 4.5%, as compared with an increase of 3.1% for an extra year of wage experience. Hamilton (2000) uses the Survey of Income and Program Participation (1984) and finds that "entrepreneurs returning to paid employment actually earn a higher wage than employees with the same observed characteristics".

the income of the self-employed. Given this restriction, I run the following regression[12] in order to "estimate" the stigma of failure is:

$$\ln(w_{t+1}) = X'_{t+1}\beta + \alpha SE_t + \epsilon,$$

where X_{t+1} is the vector of observable characteristics of employed individuals in year $t+1$, and SE_t, a dummy variable equal to 1 if the individual is self-employed in year t. The coefficient α estimates the percentage wage premium for individuals who made the transition from self-employment in year t to employment in year $t+1$. I run this regression from 1990 to 2000. I find that in contrast to what prevails in the US, self-employed who become employees earn significantly less than other employees. The wage discount is -13% on average over the period.

This wage discount can reflect that leaving self-employment is a bad signal to the labor-market. Alternatively, however, it could reflect a selection effect, i.e., self-employed are of a relatively low type with regard to the rest of the population, in a way that the market but not the econometrician observes. To control for this effect, I run the following regression on all paid employees of period t:

$$\ln(w_t) = X'_t\beta + \delta SE_{t+1} + \epsilon,$$

where SE_{t+1} is a dummy variable equal to 1 if the individual has become self-employed at time $t+1$. The coefficient δ estimates whether workers who make the transition from paid employment to self-employment have relatively low wages vis-a-vis the rest of the population[13]. It turns out that it is not the case: δ is only -0.017 on average over the period and insignificant for most years. This confirm that the discount α is not due to selection and thus can be interpreted as a proxy for the stigma of failure. This estimation allows us to conclude that the wage discount α captures mostly the "stigma of failure".

In summary, the picture that emerges from these empirical results confirms that the French and US labor markets react differently to the termination of entrepreneurial activity. In contrast with the US labor market, the French labor market penalizes heavily those who quit self-employment for employment.

[12] on the set of individuals employed in year t.

[13] before making the transition and controlling by observable characteristics.

7.3 Route 128 vs. Silicon Valley

Saxenian (1994) describes how Silicon Valley and Route 128 –two regions that had similar innovative advantages in the early 1980's– evolved differently. Route 128 lost its competitive edge, generating three times less jobs in the high tech industry between 1975 and 1990 than Silicon Valley. Saxenian shows how this divergence is related to different social norms concerning job mobility and failure. While Route 128 has a conservative culture, valuing safer projects and careers, Silicon Valley has created an environment that encourages risk and accepts failure. "There is little embarrassment or shame associated with business failure. In fact, the list of individuals who failed, even repeatedly, only to succeed later was well-known in the region." The different performance of the two regions is reflected in the levels of venture capital investment. For example, in 1981, 38% of the US venture capital went to California, but only 12% to Massachusetts based companies. Interestingly, the nature of venture-capital itself has been different in the two regions. Saxenian gives the following quote from a top executive of DEC who became a consultant in Silicon Valley: "There is no real venture capital in Massachussets. The venture capital community is a bunch of very conservative bankers. They are radically different from the venture capitalists in Silicon Valley." This picture matches the multiple equilibria characteristic of the model.

8 Conclusion

This paper presents a model of entrepreneurial finance, where the outside option of entrepreneurs in case of failure determines the staging of investment in different rounds and the choice of a monitoring technology. I show how, in turn, the outside option depends on the industry parameters, on the legal environment and on the coordination of agents. I describe how these different styles of financing relate to bank debt vs. venture capital. If agents can choose between aggressive or safe growth strategies, I show that two equilibria can arise with different efficiency consequences. In a low-risk equilibrium, entrepreneurs choose safe projects, failure is highly stigmatized and, therefore, the optimal style of financing is bank debt. In a high-risk equilibrium, entrepreneurs choose riskier projects. In this equilibrium, failure is not stigmatized and the optimal form of financing requires intense technological monitoring and investment staging, features which are characteristic of venture capital. The theory explains why similar economies might be in different entrepreneurial regimes, characterized by different growth strategies and different financial institutions.

References

[1] Acemoglu Daron, Credit Market Imperfections and Persistent Unemployment, MIT working paper (2000)

[2] Acs, Z.J. and Audretsch, D.B., Innovation and Small Firms, MIT Press, 1990.

[3] Admati, Anan, and Paul Pfeiderer [1994], 'Robust Financial Contracting and the Role of Venture Capitalists,' Journal of Finance, 49 (2) 371-402.

[4] Philippe Aghion, Patrick Bolton, "An Incomplete Contracts Approach to Financial Contracting", The Review of Economic Studies, Vol. 59, No. 3. (Jul., 1992), pp. 473-494.

[5] Philippe Aghion, Jean Tirole,"Formal and Real Authority in Organizations", The Journal of Political Economy, Vol. 105, No. 1. (Feb., 1997), pp. 1-29.

[6] Audretsch, D.B., 1991, New-firm survival and the technological Regime, Review of Economics and Statistics 73, 441-450.

[7] Audretsch, D.B., Innovation, Growth and Survival, International Journal of Industrial Organization 13, 1995.

[8] Baker, M., Career Concerns and staged investment: evidence from the venture capital industry, HBS mimeo, july 2000

[9] Becker R. and Hellmann, T., The Genesis of Venture Capital: Lessons from the German Experience, Stanford University, Graduate School of Business, Working Paper 1705

[10] Bergemann, Dirk, and Hulrich Hege [1998], 'Venture Capital Financing, Moral Hazard and Learning,' Journal of Banking and Finance, 22 (2), 703-735.

[11] Berglof, E., A Control Theory of Venture Capital Finance, Journal of Law, Economics and Organization, 10, 1994.

[12] Bidhe, Amar, The Origin and Evolution of New Businesses, Oxford Univ Press (2000)

[13] Boot, A.W.A., Why hang on to losers?Divestitures and Takeovers. Journal of Finance, september 1992.

[14] Blanchflower, D.G., and Oswald, A.J., What makes an entrepreneur?, Journal of Labor Economics, 1998, vol. 16, issue 1, pages 26-60.

[15] Cornelli, Francesca, and OvedYosha [1998], 'Stage Financing and the Role of ConvertibleDebt,' mimeo, London Business School

[16] M. Dewatripont, E. Maskin, "Credit and Efficiency in Centralized and Decentralized Economies", The Review of Economic Studies, Vol. 62, No. 4. (Oct., 1995), pp. 541-555.

[17] Abstract

[18] Diamond, D.W., Reputation Acquisition in Debt Markets, The Journal of Political Economy, Vol. 97, No. 4. (Aug., 1989), pp. 828-862

[19] Evans, David S. and Linda S. Leighton, Some empirical Aspects of Entrepreneurship, AER (june 1989): 462-83.

[20] European Commission, Fostering Entrepreneurship in Europe: Priorities for the future.

[21] Friedman, E. and Johnson, S. , Tunneling and propping, MIT mimeo, 2000.

[22] Gale, Douglas, and Martin Hellwig [1985], 'Incentive-Compatible Debt Contracts: The One-Period Problem,' Review of Economic Studies, 52 (3), 647-63.

[23] Global Entrepreneurship monitor, Kaufmann center for entrepreneurship, 2001.

[24] Gertner R.H., Scharfstein D.S., and J. C. Stein, Internal versus external capital markets, The Quaterly Journal of Economics, 1994

[25] Gompers, Paul A., Optimal Investment, Monitoring, and the Stages of Venture Capital, Journal of Finance 50 (1995): 1461-1489.

[26] Gompers, P. and Josh Lerner, The Venture Capital Cycle, MIT Press 1999.

[27] Gompers, Paul, and Josh Lerner [2001] 'The Venture Capital Revolution,' Journal of Economic Perspectives, 15 (2), 145-68.

[28] Gromb and Scharfstein, Entrepreneurship in Equilibrium, MIT mimeo 2001.

[29] Grossman, S. J., and Hart, O. D., The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration, 1986, JPE

[30] Hamilton, Barton H., Does Entrepreneurship pay? An empirical Analysis of the Returns to Self-Employment, Journal of Political Economy, 2000, vol 108, no 3.

[31] Hart, O. and Moore, J., Property Rights and the Nature of the Firm, Journal of Political Economy, (98), 1990.

[32] Hart, Oliver, and John Moore [1998], 'Default and Renegotiation: A Dynamic Model of Debt,' Quarterly Journal of Economics, 113 (1), 1-41.

[33] Hellmann, T., The Allocation of Control Rights in Venture Capital Contracts, The Rand Journal of Economics, Vol. 29, 1, 57-76, Spring 1998

[34] Hellmann, T. and M. Puri, How Venture Capital and the professionalization of Start-up Firms: Empirical Evidence, GSB Research Paper #1661, September 2000.

[35] Hellmann, T. and M. Puri, "The Interaction between Product Market and Financing Strategy: The Role of Venture Capital", Review of Financial Studies, Winter 2000, Vol. 13, No. 4, pp. 959-984

[36] Holmstrom, B. Managerial Incentive Problems: A Dynamic Perspective. in Essays in Economics and Management in Honor of Lars Wahlbeck, Helsinki: Swedish School of Economics, 1982.

[37] Holmstrom, B., Managerial Incentive Problems: A Dynamic Perspective, Review of Economic Studies, January 1999.

[38] Kaplan S., and Stromberg P., Financial contracting theory meets the real world: An empirical analysis of venture capital contracts, Chicago GSB Working Paper, sept. 2001.

[39] Kaplan S., and Stromberg P., Venture Capitalists As Principals: Contracting, Screening, and Monitoring (forthcoming, American Economic Review, AEA Papers & Proceedings).

[40] Landier, A., Entrepreneurship and the Stigma of Failure, Working Paper, MIT, 2001.

[41] Rajan R.G. , Insiders and Outsiders: the Choice between Informed and Arm's-length Debt, The Journal of Finance, vol 47, september1992.

[42] Repullo, Rafael, and Javier Suarez [2000], 'Venture Capital Finance: A Security Design Approach,' CEPR Discussion Paper 2097.

[43] Sahlman, W. A., The Structure and Governance of Venture Capital Organizations, Journal of Financial Economics, 27, 1990.

[44] Sapienza, Harry, Sophie Manigart, and Wim Vermeier [1996], 'Venture Capitalist Governance and Value Added in Four Countries,' Journal of Business Venturing, 11, pp. 439-69.

[45] Winter, S.G., 1984, Schumpeterian Competition in Alternative Technological Regimes, Journal of Economic Behavior and Organization 5, 287-320.

[46] Zwiebel, J., 1995, Corporate conservatism and relative compensation, Journal of Political Economy 103, 1-25

9 Appendix

Proof of prop. 1:

Take H as given.

Effort is chosen such as to maximize :

$$\max_e \int_0^{2C(e)} \max(V + I_0 - D + w_s - C, E) \frac{dC}{2C(e)} - e^2/2.$$

Remark that only $I_0 - D$ is relevant for incentives. When several contracts are optimal, we select the one that minimizes I_0. This contract would be dominant for an arbitrarily small opportunity cost of injecting money at the beginning.

Let $C^\star$ be such that $V + I_0 - D + w_s - C^\star = E$.

- First assume that the optimization problem leads to a level of effort $e^{\star\star}$ such that $C^\star > C(e^{\star\star})$. That means that the entrepreneur will never find it attractive to trigger renegotiation, and therefore, his maximization problem rewrites:

$$\max_e (V + I_0 - D + w_s) - C(e) - e^2/2$$

which is the first-best program. Therefore, $e^{\star\star} = e^\star$. The contract that minimizes the level of D is an initial injection $I_0 = 2C(e^\star)$ and a level of debt $D^\star$ determined by the break-even condition of the investor:

$$(1-p)D^\star = 2(1-p)C(e^\star) + \gamma H$$

It follows that, as long as $D^\star = 2C(e^\star) + \frac{\gamma H}{1-p}$ verifies :

$$V - D^\star + w_s > E = w_f + \frac{1}{2}(V + w_s - V(H) - w_f).$$

i.e.

$$(w_s - w_f) > 4C(e^\star) + 2\frac{\gamma H}{1-p} - (V + V(H)) = \Delta^\star,$$

then an initial injection $I_0 = 2C(e^\star)$ leads to the implementation of the first best effort $e^\star$.

Remark that in this region, higher bargaining power of the investor does not lead to inefficient outcomes, since as long as he repays his debt, the investor cannot hod-up the entrepreneur. In this region, the optimal level of H is zero, which is also the first-best level. Therefore, the threshold is:

$$\Delta^\star = 4C(e^\star) - V.$$

- Consider $(w_s - w_f)$ just below $\Delta^\star$? The level of effort $e^{\star\star}$ is now such that $C^\star < C(e^{\star\star})$, so that the optimization problem rewrites:

$$\max_e \left(\frac{C^\star}{2C(e)}\right)(E + C^\star) + \left(1 - \frac{C^\star}{2C(e)}\right)E - e^2/2$$

$$\max_e \left(\frac{C^{\star 2}}{C(e)}\right) - e^2 = U(e)$$

U is concave and $U\prime(e) = -\left(\frac{C^\star}{C(e)}\right)^2 C'(e) - 2e$

The first order condition writes:

$$f(e^{\star\star}) = -2\frac{C(e^{\star\star})^2}{C'(e^{\star\star})}e^{\star\star} = C^{\star 2}$$

The function f increases with $e^{\star\star}$ (from the assumption that $1/C(e)$ is concave). Therefore, $e^{\star\star}$ decreases with $C^\star$.

Remark that for $C^\star = C(e^\star)$, the solution is $e^{\star\star} = e^\star$ since $e^\star = -C'(e^\star)$. Since we look for the contract that minimizes I_0, at the margin, the entrepreneur is just able to cover his costs, namely $I_0 = C^\star$.

The second-best choice of effort and technological expertise is determined by the maximization of the ex-ante surplus,

$$\max_{e,H} -C(e) - e^2/2 - \gamma H$$

under the following constraints:

1. Threshold condition 1:

$$V - D + w_s = E.$$

2. Threshold condition 2:

$$I_0 = C^\star$$

3. Break-even condition:

$$\frac{C^\star}{2C(e)}(D-I) + I \geq C^\star + (1 - \frac{C^\star}{2C(e)})(\frac{2C(e)-C^\star}{2}) + \frac{\gamma H}{1-p}.$$

Remark that $D - I = 0$[14], so this rewrites:

$$V + w_s - E \geq C^\star + (1 - \frac{C^\star}{2C(e)})(\frac{2C(e)-C^\star}{2}) + \frac{\gamma H}{1-p}.$$

i.e.,

$$C^\star + (1 - \frac{C^\star}{2C(e)})(\frac{2C(e)-C^\star}{2}) + \frac{\gamma H}{1-p} \leq \frac{\Delta + V + V(H)}{2}.$$

i.e.,

$$C^\star + (1 - \frac{C^\star}{C(e)})(\frac{C(e)-C^\star}{2}) + \frac{\gamma H}{1-p} + 2C(e^\star) \leq \frac{\Delta - \Delta^\star + V(H)}{2}.$$

4. Incentive constraint:

$$-2\frac{C(e)^2}{C'(e)}e = C^{\star 2}$$

Since by assumption, even for $e = 0$, continuation is efficient, and since $[\frac{\partial}{\partial e}(e^2/2)](e = 0) = 0$, there is an interior solution. It is solution of the reduced-form problem:

$$\max_{e,H} -C(e) - e^2/2 - \gamma H$$

such that:

$$\begin{cases} C^\star + (1 - \frac{C^\star}{C(e)})(\frac{C(e)-C^\star}{2}) + \frac{\gamma H}{1-p} + 2C(e^\star) \leq \frac{\Delta-\Delta^\star+V(H)}{2}. \\ -2\frac{C(e)^2}{C'(e)}e = C^{\star 2} \end{cases} \tag{3}$$

[14] This is another way to write threshold contition one.