Product Market Competition and the Financing of New Ventures
ONLINE SUPPLEMENT

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1 Extensions and Robustness Checks

In order to illustrate key insights about the bank/VC financing tradeoff, and about the impact of product market competition on that tradeoff, in the simplest and most intuitive way, in the main model we have made some strong assumptions. In this online supplement we relax some of these assumptions. Importantly, while the analytics may change slightly (we refer the reader to the appendix for details), the main results of the model continue to hold.

1.1 Another Way to Measure Competition: Number of Competitors

As discussed above, the effects of competition on the financing tradeoff described in the main model hold under competitive settings such as Hotelling line, Salop circle, CES utility framework, logit framework, or Cournot-to-Bertrand switch. One common measure of competition that we have not mentioned so far is the number of competitors in the market. Consider for example a slightly different version of our model, in which the venture, rather than facing only one high cost \( \sigma \) entrant in the second period, faces \( n - 1 \) such entrants in a Cournot oligopoly.

In such a setting, competition still reduces the symmetric profit \( (d\Pi^s(\theta)/d\theta < 0) \) as in the main model. However, competition does not necessarily increase the profit differential \( \Pi^h(\theta) - \Pi^s(\theta) \) for all values of \( n \); and indeed may decrease it when \( n \) is large. Thus, Lemma 1 in the main text does not hold for all values of \( n \) under Cournot oligopoly.

Despite this difference and its analytical implications, we show in the appendix (Section 2.1.1) that the key results of our model still hold in this setting. In particular, while an increase in competition may decrease the profit differential \( \Pi^h(\theta) - \Pi^s(\theta) \) and in turn the upside of bank financing over VC financing, in that case it will decrease the downside of bank financing even more, so that overall the impact on the appeal of bank financing relative to VC financing remains positive. \(^1\)

1.2 First-Period Competition and Predatory Behavior Under Bank Financing

In the main model, we focused on the effects of competition in the second period of our model - on what could be interpreted as the long-run effects of competition. But how would the short run effects of competition - i.e. the effects of competition in the first period - affect the financing tradeoff? This

\(^1\) Another common model of competition that we have not mentioned so far is the differentiated Cournot duopoly with \( p(q_i, q_j) = a - q_i - \theta q_j \), where the degree of substitutability between products \( \theta \) captures the intensity of product market competition. This setting is similar to the \( n \)-firm homogeneous Cournot setting in that although Lemma 1 does not always hold, the results of the model regarding competition continue to obtain (see Section 2.1.2 in the appendix): competition increases the domain of venture risk over which bank financing is optimal, and the overall appeal of bank financing over VC financing.
is the question we address in this extension. To that end, we examine the case where rival \( m \) enters in the first period rather than in the second period. Rival \( m \) is “deep-pocketed” - i.e. does not need outside capital to enter the market - and as in the main model has a marginal cost of production \( c \).

In order to keep our measure of competition as consistent as possible with the measure used in the main model, we assume that products are differentiated in the first period, and measure competition \( \theta \) as the degree of homogeneity across products. Moreover, we assume that a unique consumer or group of consumers purchases one unit of the product from either \( e \) or \( m \) at the end of the first period. This coincides with some of the demand specifications we considered in the main model - e.g. Hotelling line, Salop circle, logit - where expected demand can be interpreted as the probability of selling the product and of making a positive profit. Thus in this section we endogenize what we called venture risk in the main model: here \( R_1 (p_{1i}, p_{1im}, \theta), i = vc, b \), is the probability that \( m \) - rather than \( e \) - sells in the first period given venture price \( p_{1i} \) and rival price \( p_{1im} \). Conversely, \( 1 - R_1 (p_{1i}, p_{1im}, \theta) \) captures \( e \)'s probability of selling (her expected demand) in the first period.

In the second period, again a unique consumer or group of consumers purchases one unit of the product from either \( e \) or \( m \). However, in order to keep the analysis simple and focus our attention on first-period competition, we assume that in the second period products become perfectly homogeneous and rival ventures compete à la Bertrand. This assumption is not unrealistic: early on in the product lifecycle, as rival firms open up a new market, products are likely to be more differentiated than later on in the lifecycle, when rivals eliminate idiosyncratic production glitches and learn what consumers like, and when accordingly products tend to become more homogeneous. Without loss of generality, we also assume that the venture can be operated in the second period without the entrepreneur, but at a higher marginal cost \( c_L > \overline{c} \), for example if another manager, less efficient than the entrepreneur or the rival, is hired.\(^2\) (We also normalize the venture liquidation value \( L \) to zero.)

One can easily verify that the optimal contracts in this extension remain the same as in the main model: a simple debt contract under bank financing and an equity-type contract under VC financing. We determine the optimal financing choice in the appendix (Section 2.2), and derive two primary results.

First, the financing tradeoff remains very similar to the financing tradeoff presented in the main model. Indeed, as in the main model, the upside of bank financing comes from generating a greater second-period continuation surplus than VC financing \((V_b > V_{vc})\), and a downside of bank financing

\(^2\)This last assumption merely allows us to pin down the rival’s second period profit in case of venture default under bank financing (see below).
comes from possible inefficient liquidation (with probability $R_{1b}$) - an expected cost of $R_{1b}V_b$. In this extension, however, bank financing has an additional downside: Rival $m$ has a predatory incentive to lower the first-period price to reduce $e$’s probability of selling in that period, because failure to sell would lead $e$ to default and would generate value $V_{bm}$ for $m$ in the form of expected profit in the second period. This illustrates the possibility of predatory behavior by a deep-pocketed rival in the case of debt financing, as discussed in Bolton and Scharfstein (1990). At the same time, $e$ has an extra incentive to lower the price to sell in the first period, in order to avoid the very default that $m$ is trying to instigate, and to obtain additional payoff $V_b$ in the second period. Thus the additional downside of bank financing here, $\left[(1 - R_{1vc}) (p_{1vc} - \bar{c}) - (1 - R_{1b}) (p_{1b} - \bar{c})\right]$, comes from lower equilibrium prices in the first period, leading to a lower first-period expected profit than under VC financing (where predation is absent). All in all, $e$ will choose bank financing over VC financing iff the continuation surplus upside more than offsets the inefficient liquidation and predatory pricing downsides.

Importantly, the size of $m$’s gain $V_{bm}$ from predation relative to the size of $e$’s gain $V_b$ from default avoidance under bank financing plays a key role in this extension. In particular, if $V_{bm} \geq V_b$, $m$ has more to gain from predation than $e$ does from default avoidance, and equilibrium first-period prices will reflect this, leading to a high venture risk $R_{1b}$ under bank financing. This in turn implies relatively large inefficient liquidation and predatory pricing downsides, and indeed we show that when $V_{bm} \geq V_b$ these downsides always dominate the upside and bank financing is never optimal. Only when $V_b > V_{bm}$ is there an effective tradeoff between the two financing options.

The second key result is that competition in the first period has a similar effect on the financing tradeoff as competition in the second period did in the main model: it increases the appeal of bank financing over VC financing. To see this, note that under VC financing, competition affects both $e$ and $m$’s first-period expected profits, $(1 - R_{1vc}) (p_{1vc} - \bar{c})$ and $R_{1vc} (p_{1vcm} - \bar{c})$, respectively; with both $e$ and $m$ facing identical marginal cost $\bar{c}$. Under bank financing, competition affects not only $e$ and $m$’s first-period expected profits, $(1 - R_{1b}) (p_{1b} - \bar{c})$ and $R_{1b} (p_{1bm} - \bar{c})$, but also their expected second-period gains from first-period success, $(1 - R_{1b}) V_b$ and $R_{1b} V_{bm}$, respectively. For both $e$ and $m$, the sum of these two factors can be treated simply as “adjusted” expected profits $(1 - R_{1b}) (p_{1b} - \bar{c} + V_b)$ and $R_{1b} (p_{1bm} - \bar{c} + V_{bm})$ where $V_b$ and $V_{bm}$ are interpreted as negative marginal costs. In the interesting case where $V_b > V_{bm}$,\(^3\) competition affects an expected profit function whereby $e$ has an effective

\(^3\)As discussed above, when $V_{bm} \geq V_b$ the payoff from bank financing is always smaller than that from VC financing, and hence $e$ chooses VC financing regardless of the degree of competition. One could show, however, that the difference between these payoffs does shrink with competition, which effectively increases the infra-marginal appeal of bank financing.
marginal cost advantage $V_b - V_{bm}$ over $m$.

Thus the difference between $e$’s “adjusted” expected profit under bank financing and her expected profit under VC financing represents the value of gaining an effective cost advantage $V_b - V_{bm}$ over rival $m$. And we have already shown in Lemma 1 in the main model that competition raises the value of gaining a cost advantage. Competition thus increases the appeal of bank financing relative to VC financing, and a threshold degree of competition $\theta_{\text{pred}} \in [\theta_{\text{min}}, \theta_{\text{max}}]$ exists such that bank financing is optimal if $\theta > \theta_{\text{pred}}$, and VC financing is optimal for other values of $\theta$.

In sum, when we focus on first-period competition instead of second-period competition, we continue to obtain qualitatively similar results as in the main model. Bank financing effectively yields a cost advantage over the rival (here in the first period rather than in the second period), and competition, by raising the value of this cost advantage, increases the appeal of bank financing relative to VC financing.

### 1.3 Effort by the Venture Capitalist

It is often argued that a key difference between bank financing and VC financing is that - unlike bankers - venture capitalists provide not only cash, but also a number of value-creating services (Bygrave and Timmons, 1992). Indeed, as shown in the empirical literature, these services include mentoring (MacMillan, Kulow, and Khoylian, 1988), strategic planning and help obtaining additional financing (Gorman and Salhman, 1989; Erhlich, De Noble, Moore and Weaver, 1994), help recruiting key managers (Hellmann and Puri, 2002), facilitating the development of cooperative strategies such as licensing and strategic alliances (Gans, Hsu, and Stern, 2002; Hsu, 2006), speeding-up the time to bring products to market (Hellmann and Puri, 2000), and providing certification of startup quality to less informed outsiders (Meggison and Weiss, 1991; Stuart, Hoang and Hybels, 1999; Hsu, 2004).

To capture value-creating services provided by the venture capitalist, here we assume that the venture capitalist can make an effort at the beginning of the second period to help and advise the entrepreneur in her attempt to generate a cost-reducing innovation. Formally, the venture capitalist’s effort $\gamma t$ increases the probability of successful innovation in the second period, and that probability is assumed to be the sum of the entrepreneur’s effort and the venture capitalist’s effort: $\Pr (c = c) = \gamma + \gamma t$. His cost of effort is $K t (\gamma t) = \frac{k t}{2} \gamma t^2$. Moreover, we also assume that the venture capitalist can still manage the venture even without the entrepreneur, generating second period surplus $V_t (\theta)$. 

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over VC financing.
We show in the appendix (Section 2.3) that under these assumptions, while the analysis becomes more complicated due to the double-side moral hazard problem emerging under VC financing, the results remain qualitatively similar to those of the main model. Two main cases emerge:

When the entrepreneur is relatively efficient compared to the venture capitalist (marginal cost of effort $k$ low enough relative to $k^t$: $k/k^t < \lambda/(2 - \lambda)$), the results of the main model continue to hold. That is, there exists a threshold level of venture risk such that bank financing is preferred for firms with venture risk below that threshold, and VC financing is preferred otherwise. Moreover, competition strictly increases the appeal of bank financing over VC financing: the threshold level of venture risk rises with competition, thus increasing the domain of venture risk over which bank financing is optimal.

When the venture capitalist is relatively efficient compared to the entrepreneur ($k^t$ low enough relative to $k$: $k/k^t \geq \lambda/(2 - \lambda)$), two issues emerge. First, conditional on choosing VC financing, the optimal contract may call for financier control in both periods and regardless of the state of the world. This maximizes the venture capitalist’s effort incentives and thus takes advantage of his relative efficiency; and the entrepreneur can extract this value created through a date 0 monetary transfer from the venture capitalist stipulated in the initial contract. Importantly, the entrepreneur, anticipating no future payoffs in ex post bargaining, exits the venture after receiving payment from the financier - an outcome corresponding more closely to selling the venture to the venture capitalist than to VC financing as we understand it elsewhere in the model. Second, dealing with a venture capitalist strictly dominates dealing with a bank in that case, regardless of the degree of competition. To see this, consider the financing tradeoff described in (5) in the main text, with the entrepreneur choosing bank financing if and only if $[V_b(\theta) - Vt(\theta)] - R_1 [V_b(\theta) - L] \geq 0$. In this scenario the venture capitalist’s efficiency leads to a greater probability of gaining a cost advantage, and in turn to a greater continuation surplus, under VC financing than under bank financing: $\gamma_{vc}(\theta) + \gamma^t(\theta) > \gamma_b(\theta)$ yields $Vt(\theta) > V_b(\theta)$. Obviously, in this case there is no upside from bank financing, and two downsides: inefficient liquidation (as in the main model), and a lower continuation surplus. Thus, there is no financing choice for the entrepreneur in this less interesting case; and the impacts of risk and competition on financing are null.

All in all, however, it is still the case that risk and competition have weakly negative and positive effects, respectively, on the appeal bank financing relative to VC financing: the results are still consistent with those of the main model.

\footnote{For interesting recent analysis of double-sided moral hazard in VC contracting, see e.g. Renucci (2000), Cassamatta (2003), Repullo and Suarez (2004), Hellmann (2006), and Bettignies (2008). See also the related work of Dessi (2005) and Cestone (2013).}
We end this extension with two remarks. First, let us return to the case of the efficient venture capitalist \((k/k' \geq \lambda/(2 - \lambda))\) and consider the effects of competition on the two downsides of bank financing. On the one hand, the downside associated with inefficient liquidation and the resulting foregone profit \(R_1[V_b(\theta) - L]\) likely decreases with competition, as discussed in Section 5.2 in the main text. On the other hand, the downside associated with a lower continuation surplus, \(V_I(\theta) - V_b(\theta)\), increases with competition. As in the main model, competition increases in the value of a cost advantage, but here the impact of this increase on the continuation surplus is greater under VC financing, where the probability of gaining such a cost advantage \((\gamma_{vc}(\theta) + \gamma_I(\theta) > \gamma_b(\theta))\), is greater. Indeed, if the latter effect dominates the former, the overall downside from bank financing would increase with competition. As discussed above, in our model this has no impact on the equilibrium financing choice, because bank financing remains a strictly dominated strategy no matter what, and the optimality of VC financing is unaffected by competition.

But suppose we introduce an additional, exogenous upside \(H\) of bank financing relative to VC financing. In particular, \(H\) could represent a greater opportunity cost of investment for a venture capitalist than for a bank. This difference would be reflected in the difference in surplus that the entrepreneur can extract at date 0 - she would prefer bank financing iff: \([V_b(\theta) - V_I(\theta)] - R_1[V_b(\theta) - L] + H \geq 0\). Thus, consider the possibility that a) the venture capitalist is sufficiently efficient relative to the entrepreneur \((k/k' \geq \lambda/(2 - \lambda))\) leading to \(V_I(\theta) \geq V_b(\theta)\), b) the demand and other parametric specifications are such that competition unambiguously decreases the downsides from bank financing \([V_b(\theta) - V_I(\theta)] - R_1[V_b(\theta) - L]\), and c) the exogenous difference in opportunity costs of investment is greater than the two bank financing downsides evaluated at \(\theta_{min}\) \((H > [V_I(\theta_{min}) - V_b(\theta_{min})] + R_1[V_b(\theta_{min}) - L])\). In that case, as in the main model there would exist a threshold level of venture risk such that ventures with a risk level below that threshold are bank financed while others are VC-financed; but here competition would reduce this threshold level of venture risk, unlike in the main model where competition increases it.

While we cannot completely rule out this possibility, there are several mitigating factors to consider here. First, even without introducing \(H\), this extension already takes into account the differential opportunity costs of investment between venture capitalists and banks. Indeed, in the case of a bank financing this opportunity cost is \(I\), while in the case of VC financing it is \(I + K_I(\gamma_I(\theta))\), where \(K_I(\gamma_I(\theta))\) is the opportunity cost of the venture capitalist’s expertise and value-adding investments. Opportunity costs \(I\) cancel each other out, but \(K_I(\gamma_I(\theta))\) is embedded in the financing tradeoff as part
of $V_t(\theta)$; and hence the strict dominance of VC financing in this extension holds even when the extra opportunity cost of VC value-adding services is taken into account. Thus, if $H$ were to be introduced, it would have to capture an opportunity cost differential other than the extra cost $K_t(\gamma_t(\theta))$; or an altogether different exogenous upside from bank financing that remains to be defined. Second, if such an additional factor $H$ were to be identified, it would unlikely be entirely exogenous to the other elements of the model, and these interactions with other modeling elements ought to be fully fleshed out.\footnote{For example, if $H$ were to capture opportunity costs of VC value-added investments not included in $K_t(\gamma_t(\theta))$, then these costs would likely depend on $\gamma_t(\theta)$, which depends on the degree of competition; and the impact of competition on the financing tradeoff should in turn reflect these effects.} Third, even if $H$ were completely exogenous, it would have to be very large (greater than the two bank financing downsides), which in turn would limit the feasibility of VC financing under certain conditions, especially at high levels of competition when profits are likely to be low. All in all, to convincingly introduce an additional upside to bank financing is beyond the scope of this extension, but certainly a promising avenue for research which we look forward to taking up in future work.

Our other final remark in this extension concerns a possible complementarity between efforts. Note that in this extension the venture capitalist and the entrepreneur, while both increasing the probability of innovation, exert independent efforts that do not directly affect one another. One could argue instead that in practice venture capitalists and entrepreneurs may have complementary roles, in that an increase in one agent’s effort may raise the net marginal benefit of the other agent’s effort. We examine this case of complementary efforts in the appendix and show that results and intuitions are qualitatively the same as in the case of independent efforts discussed above.

1.4 Verifiable Profits under VC Financing

In the main model we argued that a key difference between bank financing and VC financing comes from venture capitalists ability - due to their expertise, social networks, financial resources, etc. - to extract rents from the entrepreneur in \textit{ex post} bargaining, even under entrepreneur control. Another key difference between the two types of financing may come from venture capitalists’ superior ability to verify venture cash flows, relative to banks who do not the same expertise about the venture. To examine this possibility, in this extension we assume that second period\footnote{As in the main model, we assume for simplicity that venture capitalists’ ability to use their expertise either in \textit{ex post} bargaining or to verify cash flows requires them to be familiar with the venture and hence is effective only in the second period.} cash flows under VC financing are verifiable with probability $\delta \in [0, 1]$, while with probability $(1 - \delta)$ cash flows remain unverifiable as in the main model. Bank financing remains unchanged.
As discussed in the appendix (Section 2.4), the optimal contract in that case is such that whenever cash flows turn out to be verifiable, $e$ retains 100% of the cash flows rights, minus a fixed payment $z$ to the venture capitalist. The entrepreneur thus has first-best incentives, generating the first-best continuation surplus $V_{FB}(\theta) = V_b(\theta)$ in the second period. When cash flows turn out to remain unverifiable the outcome of the main model prevail, with the entrepreneur and the venture capitalist obtaining shares $(1 - \lambda)$ and $\lambda$ of realized profit, respectively, yielding continuation surplus $V_{vc}(\theta)$ in the second period.

We show that the main results of the model continue to hold in this environment: First, there exists a threshold level of venture risk $R_{1}^{ver} (\theta, \delta) \in [0, R_{max})$ for all $\delta \in [0, 1]$ and $\theta \in [\theta_{min}, \theta_{max}]$, such that below that threshold bank financing is optimal, while above that threshold VC financing is optimal. Second, competition continues to have a strictly positive impact on this threshold: $\partial R_{1}^{ver} (\theta, \delta) / \partial \theta > 0$. In other words, competition continues to increase the appeal of bank financing over VC financing.

Two additional results emerge from this extension. First, the venture capitalist’s payoff now includes both debt-type (a fixed payment $z$, with probability $\delta$) and equity-type (a fraction $\lambda$ of profit, with probability $1 - \delta$) elements, much like the preferred securities observed in VC contracts in practice. Second, this extension allows us to examine the impact of the verifiability of cash flows $\delta$ on the relative appeal of bank financing, which is negative: $\partial R_{1}^{ver} (\theta, \delta) / \partial \delta < 0$. This is because as mentioned above cash flow verifiability enables $e$ to retain 100% of cash flow rights, leading to a more efficient outcome under VC financing, all the while having no impact under bank financing.

1.5 Staged Financing

Suppose that, instead of a single investment $I$ being required at the beginnings of period 1, two investments $I_1$ and $I_2$ are required at the beginning of periods 1 and 2, respectively. We show in the appendix (Section 2.5) that if we replace regularity condition (1) in the main text by an “adapted” regularity condition $I_1 + I_2 \leq \lambda_{min} \Pi_1^s (\theta_{max})$ to reflect these changes in investment requirements, the main results and intuitions of the paper continue to hold.

Specifically, we show that there exists a threshold level of venture risk $R_{1}^{st} (\theta) \in (0, R_{max})$ for all $\theta \in [\theta_{min}, \theta_{max}]$, such that below that threshold bank financing is optimal, while above that threshold VC financing is optimal. Second, competition continues to have a strictly positive impact on the appeal of bank financing relative to VC financing: $\partial R_{1}^{st} (\theta) / \partial \theta > 0$. 

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1.6 “Mixed Strategies” in Control Allocation

For simplicity, in the main model we focused on “pure strategy” contracts where an allocation of control was assigned with probability 0 or 1 (though possibly contingent on debt repayment or default as under bank financing). We now allow for mixed strategies in control allocations.

As shown in the appendix (Section 2.6), allowing for randomizations across control allocations has no effect under VC financing. Under bank financing, mixed strategies allow debt contracts whereby e retains control with probability $\beta_D$ if she repays the debt, and with probability $\beta_0$ if she does not. The optimal debt contract - much as in Bolton and Scharfstein (1996) - yields $\beta_D = 1$, effectively the same as in our main model. Indeed, the only difference with the main model is that e retains control over the venture with probability $\beta_0 > 0$ when she defaults on debt repayment (in the main model we had $\beta_0 = 0$).

Nevertheless, the main results of the model continue to hold, specifically, a) there exists a threshold level of venture risk $R_{1, max} (\theta) \in (0, R_{\text{max}})$ for all $\theta \in [\theta_{\text{min}}, \theta_{\text{max}}]$), such that below that threshold bank financing is optimal, while above that threshold VC financing is optimal; and b) competition continues to have a strictly positive impact on the appeal of bank financing relative to VC financing: $\partial R_{1, max} (\theta) / \partial \theta > 0$.

1.7 Entrant with either Low or High Marginal Cost of Production

In our main model, we have assumed that the entrant enters with a high cost of production $\bar{c}$. In this section we relax this assumption by allowing the entrant to enter with a low cost. More precisely, the entrant’s cost is $c$ with probability $\alpha$, and $\bar{c}$ with probability $1 - \alpha$. The venture generates an expected profit $\bar{\Pi}^b (\theta, \alpha) = \alpha \Pi (\bar{c}, c, \theta) + (1 - \alpha) \Pi (c, \bar{c}, \theta)$ if the venture successfully innovates, and $\bar{\Pi}^s (\theta, \alpha) = \alpha \Pi (\bar{c}, c, \theta) + (1 - \alpha) \Pi (c, \bar{c}, \theta)$ otherwise. Using the same logic as in the main model, we can express the continuation surplus under financing type $j = b, vc$ as $\bar{V}_j (\theta, \alpha) = \bar{\Pi}^b (\theta, \alpha) + \bar{\gamma}_j (\theta) [\bar{\Pi}^b (\theta, \alpha) - \bar{\Pi}^s (\theta, \alpha)] - k [\bar{\gamma}_j (\theta)]^2 / 2$, with $\bar{\gamma}_b (\theta) = [\bar{\Pi}^b (\theta, \alpha) - \bar{\Pi}^s (\theta, \alpha)] / k$ and $\bar{\gamma}_{vc} (\theta) = (1 - \lambda) [\bar{\Pi}^b (\theta, \alpha) - \bar{\Pi}^s (\theta, \alpha)] / k$.

Then there exists a threshold level of venture risk $\bar{R}_{1} (\theta) = 1 - \bar{V}_{vc} (\theta, \alpha) / \bar{V}_b (\theta, \alpha)$ such that bank financing is preferred for firms with venture risk below that threshold, and VC financing is preferred otherwise. As shown in the appendix (Section 2.7), as in the main model competition increases the threshold level of venture risk $\bar{R}_{1} (\theta)$, thus increasing the domain of venture risk over which bank financing is optimal.
1.8 Two competing ventures

Throughout the model we have assumed away any competition in the first period and in entrepreneurial efforts between the venture and the entrant. In this section we study a setting with two ventures, each composed of an entrepreneur $e_i$ and a financier $f_i$ ($i = 1, 2$), who is either a banker of venture capitalist.

At date 0, $e_i$ makes a contractual offer to $f_i$ and decides whether or not to manage the venture in the first period at cost $e$. At date 1, with probability $1 - R_1$, venture 1 generates monopoly profit $\Pi_1$ while venture 2 sells nothing and makes zero profit. With probability $R_1$, venture 2 generates monopoly profit $\Pi_1$ while venture 1 sells nothing and makes zero profit. At the beginning of the second period, if $e_i$ is still involved in the venture at that point, she exerts an effort $\gamma_i = \{\gamma_i, \gamma_j\}$ to potentially reduce her second period marginal cost: $c_i(\gamma) = c$ and $c_i(\gamma) = \gamma$. At date 2, under $e_i$’s management, the venture generates expected duopoly profit $\Pi(c_i(\gamma_i), c_j(\gamma_j), \theta)$ if both entrepreneurs are still involved in the ventures, and monopoly profit $\Pi(c_i(\gamma_i))$ if $f_j$ took control of venture $j$ at date 1 (which happens if $f_j$ is a bank and $e_j$ defaulted at date 1).

Since the marginal impact of $e_i$’s effort on expected profit is positive and the share of expected profit extracted by $e_i$ under bank financing is higher than under VC financing, incentives to exert effort should vary accordingly. Therefore we focus on parameter values such that $\gamma$ is a dominant strategy under bank financing and $\gamma$ is a dominant strategy under VC financing – which is consistent with the results from the main model.8

Within this context, we show that when her rival chooses VC financing, there exists a threshold level of venture risk $R_{1,vc}^*$ such that the $e_1$’s optimal financing choice is bank financing if $R_1 \leq R_{1,vc}^*(\theta)$, and VC financing otherwise. Similarly, when her rival chooses bank financing, there exists a threshold level of venture risk $R_{1,b}^*$ such that the $e_1$’s optimal financing choice is bank financing if $R_1 \leq R_{1,b}^*(\theta)$, and VC financing otherwise. We show in the appendix (Section 2.8) that similarly to the main model, competition increases the threshold level of venture risk below which $e_1$ ’s optimal financing choice is bank financing, when $e_2$ chooses VC financing or bank financing $(dR_{1,j}^*(\theta)/d\theta \geq 0 \forall j = b, vc.)$.

Moreover, we derive the industry equilibrium in financing choice and see how it is affected by competition. When $e_2$ chooses financing type $j = b, vc$, $e_1$ prefers bank financing over VC financing iff

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8In this section we “simplify” the model to a discrete choice of efforts in order to have clear results from the Nash equilibrium.

8As in the previous section we use the following notation: $\Pi(c, \gamma, \theta) = \Pi^b(\theta)$, $\Pi(c, \gamma, \theta) = \Pi^*(\theta)$, $\Pi(c, \gamma, \theta) = \Pi^\theta(\theta)$, and $\Pi(c, \gamma, \theta) = \Pi^*(\theta)$. As shown in the appendix, we focus on the range of parameter values such that $(1 - \lambda)(\Pi^b(\theta) - \Pi^\theta(\theta)) \leq K \leq (\Pi^b(\theta) - \Pi^\theta(\theta))$, and $(1 - \lambda)(\Pi(c) - \Pi(\pi)) \leq K \leq (\Pi(c) - \Pi(\pi))$. 

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Since (as shown in section A.3 in the main text) is positive, by showing that difference between the two effects, measured as \( dV_{b}(n) - dV_{vc}(n) \) - \( dV_{b} \) \( R_{1}^{*} \) (\( \theta \)) > \( 1 - R_{1} \). For \( \epsilon_{2} \), the “risk” of the venture is \( 1 - R_{1} \), so when \( \epsilon_{1} \) chooses financing type \( j = b, vc \), \( \epsilon_{2} \) prefers bank financing over VC financing iff \( R_{1}^{*} (\theta) > 1 - R_{1} \).

Therefore, there exists an equilibrium where both entrepreneurs choose VC financing if \( R_{1} \in [R_{1,vc}^{*} (\theta), 1 - R_{1,vc}^{*} (\theta)] \); there exists an equilibrium where both entrepreneurs choose bank financing if \( R_{1} \in [1 - R_{1,b}^{*} (\theta), R_{1,b}^{*} (\theta)] \); there exists an equilibrium where one entrepreneur chooses VC financing and the other chooses bank financing if \( R_{1} \leq \min \{R_{1,vc}^{*} (\theta), 1 - R_{1,b}^{*} (\theta)\} \) or \( R_{1} \geq \max \{R_{1,b}^{*} (\theta), 1 - R_{1,vc}^{*} (\theta)\} \). Recall that \( R_{1,b}^{*} (\theta) \) and \( R_{1,vc}^{*} (\theta) \) are increasing functions of \( \theta \). Therefore, when competition is weak (\( \theta \) is small), both \( R_{1,b}^{*} (\theta) \) and \( R_{1,vc}^{*} (\theta) \) are small, so the only possible equilibrium is one where both entrepreneurs choose VC financing. Conversely, if competition is strong (\( \theta \) is large), both \( R_{1,b}^{*} (\theta) \) and \( R_{1,vc}^{*} (\theta) \) are large, so the only possible equilibrium is one where both entrepreneurs choose bank financing; if competition is moderate, either both these equilibria co-exist, or the only possible equilibrium is one where one entrepreneur chooses bank financing and the other entrepreneur chooses VC financing. Overall, competition leads to more bank financing and less VC financing.

2 Appendix

2.1 Other Ways to Measure Competition

2.1.1 Number of Competitors

In this section, we use the number of competitors as a measure of competition. The market is a Cournot oligopoly with \( n \) firms (\( n \geq 1 \)). The market inverse demand is \( p = a - Q \), with \( Q = \sum_{i=1}^{n} q_{i} \).

All \( n - 1 \) entrants have a cost \( \bar{c} \) while the venture’s cost is \( c \) if it successfully innovates.

If the venture innovates, its profit is \( \Pi^{b}(n) = \frac{(a-nc+\bar{c}(n-1))^{2}}{(n+1)^{2}} \), while it is \( \Pi^{s}(n) = \frac{(a-\bar{c})^{2}}{(n+1)^{2}} \) if it does not innovate. Therefore, the value of cost advantage is \( \Pi^{b}(n) - \Pi^{s}(n) = \frac{n(\bar{c} - \bar{c})}{(n+1)^{2}} [2(a - \bar{c}) + n(\bar{c} - \bar{c})] \).

It can be checked that \( \frac{d\Pi^{b}(n)}{dn} = -\frac{2(a-\bar{c})^{2}}{(n+1)^{3}} < 0 \). However \( \frac{d(\Pi^{b}(n) - \Pi^{s}(n))}{dn} = \frac{2(\bar{c} - \bar{c})}{(n+1)^{2}} (-a(n-1) + \bar{c}(2n-1) - \bar{c} n), \) which is positive iff \( n < \frac{a-\bar{c}}{a-2\bar{c}+2} \). Therefore, Lemma 1 in the main text does not always hold. Nevertheless, Proposition 5 still holds: as the industry becomes less concentrated, the relative attractiveness of bank financing increases (\( dR_{1}^{*}(n)/dn > 0 \)). To show this result, we show that the negative effect of competition on the downside of bank financing strictly dominates its effect on the upside of bank financing, despite the latter being potentially negative. More specifically, we show that the difference between the two effects, measured as \( \frac{dV_{b}(n) - V_{vc}(n)}{dn} - \frac{d\bar{V}_{b} R_{1}^{*} (n) = A [2(\Pi^{s} - L) \Delta t - \Delta \Pi^{s}]} \) (as shown in section A.3 in the main text) is positive, by showing that \( [2(\Pi^{s} - L) \Delta t - \Delta \Pi^{s}] > 0 \). Since \( \Pi^{s} < 0, \Delta t \geq 0 \) this inequality is automatically satisfied. However we must prove that the
inequality is also satisfied if $\Delta \theta < 0$. In that case, the left hand side of the inequality is an increasing function of $L$. Therefore, a sufficient condition for the inequality to be satisfied is if it satisfied for $L = 0$, i.e. if $2\Pi^a \Delta \theta - \Delta \Pi^s \theta \geq 0 \Rightarrow 2(a - \bar{c}) + n(n + 2)(\bar{c} - \bar{q}) \geq 0$, which is satisfied $\forall n \geq 1$. Therefore, $dR^*_1(n)/dn > 0$. □

2.1.2 Cournot duopoly with differentiated products

In this section we analyze the effect of competition on the financing trade-off in a differentiated Cournot duopoly. Assume that firm $i$ faces a demand curve of the form $p(q_i, q_j) = a - q_i - \theta q_j$, where $\theta$ measures how close substitutes the goods are. If $\theta = 1$ then goods are perfect substitutes, while for $\theta < 1$ firms have some monopoly power due to product differentiation. Thus, a rise in $\theta$ is interpreted as a rise in competition. The equilibrium profit of firm $i$ is $\Pi_i(\theta, c_i, c_j) = (\frac{a(2-\theta) - 2c_i + \theta c_j}{4-\theta^2})^2$. If the venture innovates, its profit is $\Pi^h(\theta) = (\frac{a(2-\theta) - 2c + \theta c}{4-\theta^2})^2$, while it is $\Pi^s(\theta) = (\frac{a-\bar{c}}{2-\theta})^2$ if it does not. We assume $a \geq \bar{c}$ so that demand is positive even with no innovation. The marginal benefit from successfully innovating is $\Pi^h(\theta) - \Pi^s(\theta) = \frac{4(\bar{c} - \bar{q})}{(4-\theta^2)^2}((a - \bar{c})(2 - \theta) + (\bar{c} - \bar{q})).$

It can be checked that $\frac{d\Pi^s(\theta)}{d\theta} = -\frac{2(a-c)^2}{(2+\theta)^3} < 0$. However $\frac{d[\Pi^h(\theta) - \Pi^s(\theta)]}{d\theta} = \frac{4(\bar{c} - \bar{q})((a-\bar{c})(-3\theta^2 + 8\theta - 4) + 4\theta(\bar{c} - \bar{q}))}{(4-\theta^2)^2}$ is not always positive. Therefore, Lemma ?? holds only under some conditions. Nevertheless, Proposition ?? still holds: Substitutability between products increases the appeal bank financing $(dR^*_1(\theta)/d\theta > 0)$.

Similar to Section 2.1.1, we derive this result by showing that $[2(\Pi^a - L)\Delta \theta - \Delta \Pi^s \theta] > 0$. Since $\Pi^s \theta < 0$, if $\Delta \theta \geq 0$ this inequality is automatically satisfied. However we must prove that it is also satisfied if $\Delta \theta < 0$. In that case, the left hand side of the inequality is an increasing function of $L$. Therefore, a sufficient condition for the inequality to hold is for it to hold for $L = 0$, i.e. if $2\Pi^a \Delta \theta - \Delta \Pi^s \theta \geq 0 \Rightarrow 2\theta(2 - \theta)(a - \bar{c}) + (3\theta + 2)(\bar{c} - \bar{q}) \geq 0$, which holds $\forall \theta \leq 1$. Therefore, $dR^*_1(\theta)/d\theta > 0$. □

2.2 First-Period Competition and Predatory Behavior Under Bank Financing

In this section we depart from the main model by examining the case where rival $m$ enters in the first period rather than in the second period. Rival $m$ is “deep-pocketed” - i.e. does not need outside capital to enter the market - and has marginal cost of production $\bar{c}$.

We assume that products are differentiated in the first period, and measure the degree of competition $\theta$ as the degree of homogeneity across products. We further assume that a unique consumer or group of consumers purchases one unit of the product from either $e$ or $m$ at the end of the first
period. This coincides with some of the demand specifications we considered in the main model - e.g. Hotelling line, Salop circle, logit - where expected demand can be interpreted as the probability of selling the product and of making a positive profit. Thus in this section we effectively endogenize $R_1(p_{1i}, p_{1im}, \theta)$, $i = vc, b$, as the probability that $m$ - rather than $e$ - will sell in the first period given venture price $p_{1i}$ and rival price $p_{1im}$. Conversely, $1 - R_1(p_{1i}, p_{1im}, \theta)$ captures $e$’s probability of selling - and her expected demand - in the first period.

In the second period, again a unique consumer or group of consumers purchases one unit of the product from either $e$ or $m$. However, for simplicity and to keep our focus on first-period competition, we assume that in that period products are perfectly homogeneous and rival ventures compete à la Bertrand. Without loss of generality, we also assume that the venture can be operated in the second period without the entrepreneur, but at a higher marginal cost $c_L > \bar{c}$, for example if another manager, less efficient than the entrepreneur or the rival, is hired. (We also normalize the venture liquidation value $L$ to zero.)

One can easily verify that the optimal contracts in this extension remain the same as in the main model: a simple debt contract under bank financing and an equity-type contract under VC financing. We examine each type of financing in turn, proceeding by backward induction.

**VC Financing.** As in the main model, the venture’s second period continuation surplus under VC financing is $V_{vc} = \Pi^s_{vc} + \gamma_{vc} \left[ \Pi^h_{2} - \Pi^s_{2} \right] - k\gamma_{vc}^2/2$ with $\gamma_{vc} = (1 - \lambda) \left[ \Pi^h_{2} - \Pi^s_{2} \right] / k$. The only difference with the main model in second period is that due to Bertrand price competition, the expressions for profits immediately simplify to: $\Pi^s_{2} = \Pi (\bar{c}, \bar{c}) = 0$ and $\Pi^h_{2} = \Pi (\bar{c}, \bar{c}) = \bar{c} - \bar{c}$. The second period continuation surplus for $m$, regardless of who successfully sold in the first period, is simply $V_{vcm} = (1 - \gamma_{vc}) \Pi^s_{2} = 0$.

In the first period, $e$ chooses $p_{1vc}$ to maximize her payoff $\Pi_{1vc} = [1 - R_{1vc}(p_{1vc}, p_{1vcm}, \theta)] [p_{1vc} - \bar{c}]$, while $m$ chooses $p_{1vcm}$ to maximize her payoff $\Pi_{1vcm} = R_{1vc}(p_{1vc}, p_{1vcm}, \theta) [p_{1vcm} - \bar{c}]$. This yields symmetric first-period equilibrium prices $p_{1vc}(\theta) = p_{1vcm}(\theta)$ which, when substituted into first-period profit, yield $\Pi_{1vc} (\bar{c}, \bar{c}, \theta) = [1 - R_{1vc}(\theta)] [p_{1vc}(\theta) - \bar{c}]$.

Moving back to date 0, $e$’s expected payoff from VC financing can be expressed as: $U^{pred}_{vc}(\theta) = \Pi_{1vc} (\bar{c}, \bar{c}, \theta) + V_{vc} - I$. We interpret $V_{vc}$ as the minimum payoff from VC financing, which $e$ receives no matter what happens in the first period. In contrast, $\Pi_{1vc}$ captures the expected bonus from short-term success: if the venture is successful in the first period, which occurs with probability $[1 - R_{1vc}(\theta)]$, $e$ receives bonus $[p_{1vc}(\theta) - \bar{c}]$ over and above minimum payoff $\Pi_{1vc}$.

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Bank Financing. Again as in the main model, the venture’s second period continuation surplus under bank financing is \( V_b = \Pi_2^e + \gamma_b \left( \Pi_2^b - \Pi_2^c \right) - k \gamma_b^2 / 2 \) with \( \gamma_{vc} = \left( \Pi_2^b - \Pi_2^c \right) / k \). Bertrand competition yields second-period profits \( \Pi_2^e = \Pi (\bar{c}, \bar{c}) = 0 \) and \( \Pi_2^m = \Pi (\bar{c}, \bar{c}) = \bar{c} - \bar{c} \). This surplus \( V_b \) is generated only if the venture successfully sells in the first period, in which case the entrepreneur can repay the bank loan and retains full control over the venture in the second period. In that case rival \( m \) receives expected payoff \( (1 - \gamma_b) \Pi_2^m = 0 \) in the second period.

If the venture fails to sell in the first period, \( e \) defaults on the debt repayment date 1 and the bank takes control of the venture, which operates at cost \( c_L > \bar{c} \) in the second period. It then follows directly from Bertrand competition that the venture makes zero profit, while \( m \)’s second period continuation surplus in that case is \( V_{bm} = \Pi_2^m = c_L - \bar{c} \).

In the first period, \( e \) chooses \( p_{1b} \) to maximize her expected payoff \( \Pi_{1b} = \left[ 1 - R_{1b} \left( p_{1b}, p_{1bm}, \theta \right) \right][p_{1b} - \bar{c} + V_b] \); while \( m \) chooses \( p_{1bm} \) to maximize her expected payoff \( \Pi_{1bm} = R_{1b} \left( p_{1b}, p_{1bm}, \theta \right)[p_{1bm} - \bar{c} + V_{bm}] \). We underline two point here. First, continuation surpluses \( V_b \) and \( V_{bm} \) can effectively be interpreted as negative marginal costs in \( e \)’s and \( m \)’s first-period maximization programs, which are themselves isomorphic to, and can be interpreted as, expected profit. Substituting equilibrium prices \( p_{1b} (V_b, V_{bm}, \theta) \) and \( p_{1bm} (V_{bm}, V_b, \theta) \),

\[ p_{1b} (V_b, V_{bm}, \theta) = \left[ 1 - R_{1b} \left( V_b, V_{bm}, \theta \right) \right][p_{1b} (V_b, V_{bm}, \theta) - \bar{c} + V_b] \quad \text{and} \quad p_{1bm} (V_{bm}, V_b, \theta) = R_{1b} \left( V_b, V_{bm}, \theta \right)[p_{1bm} (V_{bm}, V_b, \theta) - \bar{c} + V_{bm}] , \]

Second, using any of the demand specifications mentioned above, one can readily show that in equilibrium, both prices are lower than the equilibrium price under VC financing: \( p_{1b} (V_b, V_{bm}, \theta) < p_{1vc} (\theta) \) and \( p_{1bm} (V_{bm}, V_b, \theta) < p_{1vcm} (\theta) \). This is because both \( e \) and \( m \) have a greater marginal benefit from decreasing price than under VC financing. Rival \( m \) has an extra incentive to lower the price to reduce \( e \)’s probability of selling in the first period, because failure to sell would lead \( e \) to default and would generate a continuation surplus \( V_{bm} \) for \( m \). At the same time, \( e \) has an extra incentive to lower the price to sell in the first period, in order to avoid the very default that \( m \) is trying to instigate, and to obtain additional payoff \( V_b \) in the second period.

From a date 0 point of view, \( e \)’s expected payoff from bank financing can be expressed as:

\[ \Pi_{1b}^{pred} (\theta) = \Pi_{1b} (\bar{c} - V_b, \bar{c} - V_{bm}, \theta) - I. \]

Using the same terminology as under VC financing, we interpret \( \Pi_{1b} \) as the expected bonus from short-term success: if the venture is successful in the first period, \( e \) will receive an expected bonus \( \Pi_{1b} (\bar{c} - V_b, \bar{c} - V_{bm}, \theta) \); if the venture is not successful in the first period, \( e \) will receive an expected bonus \( \Pi_{1b} (\bar{c} - V_{bm}, \bar{c} - V_b, \theta) \). In the demand specifications mentioned above, equilibrium prices do not depend on \( \bar{c} \).

\[ \text{In the demand specifications mentioned above, equilibrium prices do not depend on } \bar{c}. \]
period, which occurs with probability \(1 - R_{1b}\), \(e\) receives bonus \([p_{1b} - \bar{c} + V_b]\). Note that unlike VC financing, here there is no minimum payoff if the venture is unsuccessful in the first period.

**Financing Tradeoff and Effects of Competition.** The entrepreneur chooses bank financing over VC financing iff:

\[
U_{b}^{pred}(\theta) - U_{vc}^{pred}(\theta) \geq 0, \quad \text{iff}
\]

\[
[V_b - V_{vc}] - R_{1b} V_b - \left[ (1 - R_{1vc}) (p_{1vc} - \bar{c}) - (1 - R_{1b}) (p_{1b} - \bar{c}) \right] \geq 0 \quad \text{or}
\]

\[
[\Pi_{1b}(\bar{c} - V_b, \bar{c} - V_{bm}, \theta) - \Pi_{1vc}(\bar{c}, \bar{c}, \theta)] - V_{vc} \geq 0.
\] (1)

There are two interpretations of the financing tradeoff. The first one is depicted in the middle rows of expression (1). As in the main model, the upside of bank financing is that it leads to a greater second-period continuation surplus than VC financing \((V_b > V_{vc})\), and a downside of bank financing is that with probability \(R_{1b}\) inefficient liquidation occurs - an expected cost of \(R_{1b} V_b\). In this extension, however, bank financing has the additional downside associated with \(m\)’s predatory pricing and \(e\)’s “default-avoidance” pricing in the first period, which leads to a lower expected profit under bank financing in that period: \([(1 - R_{1vc}) (p_{1vc} - \bar{c}) - (1 - R_{1b}) (p_{1b} - \bar{c})] > 0\). Thus, \(e\) chooses bank financing over VC financing iff the upside more than offsets the two downsides.

The second interpretation is depicted in the last row of expression (1): On the one hand, VC financing yields a minimum payoff \(V_{vc}\) no matter what happens in the first period, while bank financing does not. On the other hand, bank financing *may* yield a greater expected bonus from short-term success \(\Pi_{1b}(\bar{c} - V_b, \bar{c} - V_{bm}, \theta) > \Pi_{1vc}(\bar{c}, \bar{c}, \theta)\).

Recall from the above discussion that these expected bonuses are effectively expected profits where continuation surpluses \(V_b\) and \(V_{bm}\) are interpreted as negative marginal costs. Importantly, the relative size of these expected bonuses/profits depends on the relative “cost” advantage that \(e\) may have relative to \(m\) under the two types of financing. Note that under VC financing \(e\) and \(m\) have identical marginal costs \(\bar{c}\) and hence \(e\) has neither cost advantage or disadvantage over \(m\). Now consider bank financing. If \(V_b \leq V_{bm}\), then \(e\) effectively has a cost disadvantage over \(m\) under bank financing, and as a result the expected bonus/profit from short-run success will be lower than under VC financing where \(e\) and \(m\) are on equal footing cost-wise: \(\Pi_{1b}(\bar{c} - V_b, \bar{c} - V_{bm}, \theta) \leq \Pi_{1vc}(\bar{c}, \bar{c}, \theta)\). In this case, bank financing has only downsides - no minimum payoff and a lower bonus from short-run success - relative to VC financing; and VC financing is always optimal regardless of the degree of competition.

Conversely, if \(V_b > V_{bm}\), then \(e\) has a cost advantage over \(m\) under bank financing, and as result
the expected bonus/profit from short-run success will be greater than under VC financing where $e$ and $m$ have equal costs: $\Pi_{1b} (\bar{c} - V_b, \bar{c} - V_{bm}, \theta) > \Pi_{1vc} (\bar{c}, \bar{c}, \theta)$.\footnote{The proof that $\Pi_{1b} (\bar{c} - V_b, \bar{c} - V_{bm}, \theta) > \Pi_{1vc} (\bar{c}, \bar{c}, \theta)$ follows directly from substituting the different marginal costs of production into the equilibrium expected profit functions for the demand specifications to which this extension pertains. These equilibrium expected profit functions are derived in the proof of Lemma 1 in the appendix of the main text.} In that case a real financing tradeoff exists: $e$ will choose bank financing over VC financing iff the advantage in terms of expected bonus from short-term success more that offsets the absence of minimum payoff.

**Effects of Competition on Financing Tradeoff.** To understand the effects of competition, let us consider the second interpretation of the financing tradeoff. The disadvantage of bank financing in terms of minimum payoff, $V_{vc}$, is unaffected by $\theta$ in this extension. The advantage of bank financing in terms of expected bonus from short-term success, $\Pi_{1b} (\bar{c} - V_b, \bar{c} - V_{bm}, \theta) - \Pi_{1vc} (\bar{c}, \bar{c}, \theta)$, is simply the value of gaining a cost advantage $V_b - V_{bm}$ over rival $m$, and we have already examined the impact of competition the value of a cost advantage in the main model. Indeed, for the same reasons, and using the same proof of Lemma 1 in the main model, one can show that competition, by raising the value of gaining a cost advantage, increases the advantage of bank financing in this extension, and in turn increases its appeal relative to VC financing. Thus, a threshold degree of competition $\theta^{pred} \in [\theta_{min}, \theta_{max}]$ exists such that bank financing is optimal if $\theta > \theta^{pred}$, and VC financing is optimal for other values of $\theta$.

### 2.3 Effort by the Venture Capitalist

To capture value-creating services provided by the venture capitalist, here we assume that the venture capitalist can - much like the entrepreneur - make an effort at the beginning of the second period. The venture capitalist’s effort $\gamma^f$ increases the probability of successful innovation in the second period, and that probability is assumed to be the sum of the entrepreneur’s effort and the venture capitalist’s effort: $\Pr (c = c) = \gamma + \gamma^f$. His cost of effort is $Kf (\gamma^f) = \frac{\gamma^f}{2} \gamma^2$. Moreover, we also assume that the venture capitalist can still manage the venture even in the absence of the entrepreneur, generating second period surplus $Vr (\theta)$.

Consider the second period. Under financier control, the entrepreneur anticipates getting nothing in end-of-period renegotiation, and does not remain involved in the venture during the second period, as in the main model. The venture capitalist, on the other hand, expects to extract 100% of the rents at the end of the second period, and chooses effort $\gamma^f = \arg \max \Pi^s (\theta) + \gamma^f [\Pi^h (\theta) - \Pi^s (\theta)] - kr \gamma^2 / 2$, or $\gamma^f (\theta) = [\Pi^h (\theta) - \Pi^s (\theta)] / kr$. The surplus generated in the second period under financier control
is $\nabla t(\theta) = \Pi_2 (\gamma t(\theta), \theta) - k t [\gamma t(\theta)]^2 / 2$, where the probability of innovation is Pr$(c = e) = \gamma t(\theta)$.

Under entrepreneur control, the entrepreneur anticipates extracting $(1 - \lambda)\%$ of the rents at the end of the second period, and exerts effort $\gamma_{vc}(\theta) = (1 - \lambda) [\Pi^b(\theta) - \Pi^e(\theta)] / k$, again as in the main model. The venture capitalist expects to extract $\lambda\%$ of the rents, and he chooses effort $\gamma^f(\theta) = \arg \max \lambda [\Pi^b(\theta) + \gamma^f [\Pi^b(\theta) - \Pi^e(\theta)]] - k t \gamma^f / 2$, or $\gamma^f = \lambda [\Pi^b(\theta) - \Pi^e(\theta)] / k t$. The total surplus generated in the second period under entrepreneur control is $V^e(\theta) = \Pi_2 (\gamma^f(\theta), \gamma_{vc}(\theta), \theta) - k t [\gamma^f(\theta)]^2 / 2 - k [\gamma_{vc}(\theta)]^2 / 2$, where that probability of innovation is Pr$(c = e) = \gamma^f(\theta) + \gamma_{vc}(\theta)$.

Now consider the first period. The only difference between financier control and entrepreneur control is that in the former case the entrepreneur, anticipating no end-of-period reward, prefers not to be involved in the venture; while in the latter case she does remain involved. However, since there are no first period efforts, and since - as assumed here - the venture capitalist can manage the venture even in the absence of the entrepreneur, the total expected surplus $\Pi_1$ generated in the first period is the same under both financier control and entrepreneur control.

This suggests that under VC financing, the entrepreneur’s contract space reduces to two possible contracting alternatives. One type of contract specifies entrepreneur control in both periods and regardless of the state of the world, and a payment $I + T$ from the venture capitalist to the entrepreneur at date 0, with $T \geq 0$ chosen so as to leave no ex ante rents to the financier. This contract yields ex ante payoff $U^t(\theta) = \Pi_1 + V^t(\theta) - I$ to the entrepreneur.

The other type of contract specifies financier control in both periods and regardless of the state of the world, and a payment $I + T$ from the venture capitalist to the entrepreneur at date 0, with $T \geq 0$ chosen so as to leave no ex ante rents to the financier. In that case the ex ante payoff to the entrepreneur is $\Pi^f(\theta) = \Pi_1 + V^f(\theta) - I$. The entrepreneur chooses entrepreneur control over financier control iff $U^t(\theta) > U^f(\theta)$, which simplifies to:

$$\nabla t(\theta) > \nabla f(\theta), \quad \text{iff} \quad \frac{[\Pi^b(\theta) - \Pi^e(\theta)]^2}{2 k t} (\lambda k (2 - \lambda) + kt (1 - \lambda) (1 + \lambda)) > \frac{[\Pi^b(\theta) - \Pi^e(\theta)]^2}{2 k t}, \quad \text{iff} \quad \frac{k}{k t} < \frac{(1 + \lambda)}{(1 - \lambda)}. \quad (2)$$

**Case 1.** Suppose first that $k / k t \geq (1 + \lambda) / (1 - \lambda)$. Then the optimal contract under VC financing is to specify financier control in both periods and regardless of the state of the world. In this case there is no VC financing as we understand it in the main model, i.e. where the venture capitalist
provides financing and the entrepreneur manages the venture. Instead, this case corresponds to selling the venture to the venture capitalist (or to anyone else who can purchase the venture and exert effort $\gamma t$ at cost $Kt(\gamma t) = \frac{\lambda k}{2} \gamma^2$), who manages the venture throughout the game and exerts effort $\gamma t(\theta)$.

What is the optimal choice between selling the venture to the venture capitalist, and bank financing in that case? It is easy to see that, since $(1 + \lambda)/(1 - \lambda) > 1$ and $k/kt \geq (1 + \lambda)/(1 - \lambda)$, this situation may only arise when $kt < k$. In that case, from the entrepreneur’s date 0 point of view selling the venture strictly dominates bank financing, for two reasons. First, selling the venture avoids the potential inefficient default; Second, it leads to more effort and to a higher innovation probability: $kt < k$ implies $\gamma t(\theta) > \gamma_b(\theta)$. This in turn leads to a higher probability of innovation success, and to a higher continuation surplus $V_t(\theta) > V_b(\theta)$. Comparing date 0 expected payoffs for the entrepreneur, we can capture these two factors more formally: $U_b(\theta) - U_t(\theta) = [V_b(\theta) - V_t(\theta)] - R_1 [V_b(\theta) - L] < 0$, where the first and second factors represent the innovation disadvantage and the default disadvantage of bank financing, respectively.

**Case 2.** Now suppose that $k/kt < (1 + \lambda)/(1 - \lambda)$. Then the optimal contract specifies entrepreneur control in both periods and regardless of the state of the world. This is the same contract as in the main model. The only difference is that the probability of a successful innovation under VC financing is $\gamma t(\theta) + \gamma_{vc}(\theta)$, while it is $\gamma_{vc}(\theta)$ in the main model. Thus, overall effort (including the entrepreneur’s and venture capitalist’s) and innovation probability under VC financing goes up in this version of the model relative to the main model.

One possible consequence of this is that - for certain parameter values - the continuation surplus may be greater under VC financing than under bank financing. Indeed, we show below that we have $V_t(\theta) \geq V_b(\theta)$ iff $k/kt \geq \lambda/(2 - \lambda)$.

**Proof that $V_t(\theta) \geq V_b(\theta)$ iff $k/kt \geq \lambda/(2 - \lambda)$:**

\[
\frac{[\Pi_b(\theta) - \Pi^*(\theta)]^2}{2kkr} \geq \frac{[\lambda k (2 - \lambda) + k t (1 - \lambda) (1 + \lambda)]}{2k} \geq 0, \quad \text{iff} \quad \frac{k}{kt} \geq \frac{\lambda}{(2 - \lambda)}. \quad (3)
\]

Note that since $\lambda/(2 - \lambda) < (1 + \lambda)/(1 - \lambda)$ for all $\lambda \in [0, 1]$ and a fortiori for all $\lambda \in [\lambda_{\min}, 1]$, there are two sub-cases to examine here:
Clearly, if \( \lambda/(2 - \lambda) \leq k/k_r < (1 + \lambda)/(1 - \lambda) \), bank financing is strictly dominated by VC financing, which leads to greater continuation surplus than bank financing \((V_t(\theta) > V_b(\theta))\) and avoids inefficient defaults: \(U_b(\theta) - U_t(\theta) = [V_b(\theta) - V_t(\theta)] - R_1 [V_b(\theta) - L] < 0\).

In contrast, if \( k/k_r < \lambda/(2 - \lambda) \), the continuation surplus is lower under VC financing than under bank financing, and the tradeoff between the two types of financing is again the same as in the main model: bank financing leads to a greater continuation surplus than VC financing \((V_b(\theta) > V_t(\theta))\) but may lead to inefficient liquidation. Thus, there exists a threshold level of venture risk below which bank financing is optimal: \(R^*_b(\theta) = 1 - (V_t(\theta) - L)/(V_b(\theta) - L)\) such that bank financing is optimal if \(R_1 \leq R^*_b(\theta)\), and VC financing is optimal otherwise. Moreover, we show below that - as in the main model - competition increases the value of a cost reduction, which has a disproportionately positive effect on bank financing - and increases its appeal - relative to VC financing. More formally, competition raises the venture risk threshold \(R^*_b(\theta)\) below which bank financing is optimal.

Proof that \(d [V_b(\theta) - V_t(\theta)]/d\theta > 0\) and that \(dR^*_b(\theta)/d\theta > 0\) when \(k/k_r < \lambda/(2 - \lambda)\):

Let \(k/k_r < \lambda/(2 - \lambda)\). First, note that continuation surpluses are \(V_b(\theta) = \Pi^s(\theta) + (\Pi^b(\theta) - \Pi^s(\theta))^2/(2kR)\) and \(V_t(\theta) = \Pi^s(\theta) + (\Pi^b(\theta) - \Pi^s(\theta))^2/[k(2 - \lambda) + kR(1 - \lambda^2)]\).

It then follows directly that:

\[
\frac{d [V_b(\theta) - V_t(\theta)]}{d\theta} = \frac{d(\Pi^b(\theta) - \Pi^s(\theta))}{d\theta} \frac{\lambda(\Pi^b(\theta) - \Pi^s(\theta))}{k} [\lambda - \frac{k}{k_r} (2 - \lambda)] > 0,
\]

since from Lemma ?? we have \(d[\Pi^b(\theta) - \Pi^s(\theta)]/d\theta > 0\).

Second, note that since \(R^*_b(\theta) = 1 - (V_t(\theta) - L)/(V_b(\theta) - L)\), \(dR^*_b(\theta)/d\theta = -d(V_t(\theta) - L)/(V_b(\theta) - L)/d\theta\).

One can easily verify that:

\[
\frac{V_t(\theta) - L}{V_b(\theta) - L} = 1 - \frac{\lambda [\lambda - \frac{k(2 - \lambda)}{k_r}]}{1 + 2k [\Pi^b(\theta) - \Pi^s(\theta)]^2}.
\]

We know from Lemma ?? that \(d(\Pi^b(\theta) - \Pi^s(\theta))/d\theta > 0\) and \(d\Pi^s(\theta)/d\theta < 0\), which implies \(d[\Pi^s(\theta) - L]/(\Pi^b(\theta) - \Pi^s(\theta))^2] < 0\), \(d(V_t(\theta) - L)/(V_b(\theta) - L)/d\theta < 0\), and in turn \(dR^*_b(\theta)/d\theta > 0\). \(\square\)

Summary. Allowing for effort by the venture capitalist, two parametric regions emerge.

If the venture capitalist is very efficient relative to the entrepreneur - if \(\lambda/(2 - \lambda) \leq k/k_r\) - then VC financing (or selling the venture to the venture capitalist in the extreme case where \(k/k_r \geq (1 + \lambda)/(1 - \lambda)\)) strictly dominates bank financing regardless of the degree of competition.

If the entrepreneur is sufficiently efficient relative to the venture capitalist - if \(k/k_r < \lambda/(2 - \lambda)\) - then as in the main model, there exists a threshold level of venture risk below which bank financing is
preferred, with VC financing being chosen otherwise. Moreover, as in our main model this threshold level of venture risk is increasing with competition; in other words, competition makes bank financing relatively more attractive.

**Complementary efforts.** One could also argue that the venture capitalist, in addition to playing a role in increasing the probability of innovation, as we have assumed immediately above, also helps by explicitly lowering the entrepreneur’s marginal cost of effort through effective advising and mentoring. One way to capture this more formally is to assume that the entrepreneur’s and venture capitalist’s efforts are complementary: an increase in one agent’s effort raises the net marginal benefit of the other agent’s effort. The easiest way - analytically - to reflect this complementarity is to posit the following costs of effort for e and f, respectively: \( K(\gamma, \gamma_t) = \frac{k}{2}(\gamma - a\gamma_t)^2 \) and \( K_t(\gamma, \gamma) = \frac{k_t}{2}(\gamma - a\gamma)^2 \), where \( a \in (0, 1) \). Note that the marginal costs of effort for \( e \) and \( f \) can be expressed as \( \partial K(\gamma, \gamma_t) / \partial \gamma = k(\gamma - a\gamma_t) \) and \( \partial K_t(\gamma, \gamma) / \partial \gamma_t = k_t(\gamma_t - a\gamma) \), respectively: an increase in an agent’s effort reduces the other agent’s marginal cost of effort. The probability of successful innovation in the second period remains \( \Pr(c = 0) = \gamma + \gamma_t \).

It is easy to show that the results here are qualitatively the same as in the “independent efforts” case discussed above. In the second period under financier control, the venture capitalist chooses the same effort as previously: \( \gamma_t(\theta) = \left[ \Pi^h(\theta) - \Pi^s(\theta) \right] / k_t \). Thus, the total surplus generated in the second period under financier control is \( \bar{V}_t(\theta) = \Pi_2 \left( \gamma_t(\theta) , \theta \right) - k_t [\gamma_t(\theta)]^2 / 2 \), where the probability of a successful innovation is \( \Pr(c = 0) = \gamma_t(\theta) \).

Under entrepreneur control, efforts are now \( \gamma = \left[ \Pi^h(\theta) - \Pi^s (\theta) \right] [k_t(1 - \lambda) + a\lambda k] / [kk_t(1 - a^2)] \) for the entrepreneur and \( \gamma_t = \left[ \Pi^h(\theta) - \Pi^s (\theta) \right] [\lambda k + a(1 - \lambda) k_t] / [kk_t(1 - a^2)] \) for the venture capitalist. The resulting surplus generated in the second period under entrepreneur control is \( \bar{V}_t(\theta) = \Pi_2 \left( \gamma_t(\theta) , \gamma(\theta) , \theta \right) - k_t [\gamma(\theta) - a\gamma_t(\theta)]^2 / 2 - k [\gamma_t(\theta) - a\gamma(\theta)]^2 / 2 \), where that probability of a successful innovation is \( \Pr(c = 0) = \gamma(\theta) + \gamma_t(\theta) \).

Using the same logic as in the case of independent efforts discussed above, one can readily show that very similar results emerge in the case of complementary efforts (the details of the proof are omitted for conciseness). Indeed, there exists a threshold \( \hat{k}(\lambda, a) = \frac{1-a-(1-\lambda)(1+a+\lambda(1-a))}{\lambda(2-\lambda(1-a))} \) such that: 1) If the venture capitalist is very efficient relative to the entrepreneur - if \( k/k_t > \hat{k}(\lambda, a) \) - VC financing strictly dominates bank financing regardless of the degree of competition. 2) If the entrepreneur is sufficiently efficient relative to the venture capitalist - if \( k/k_t \leq \hat{k}(\lambda, a) \) - then as in the main model, there exists a threshold level of venture risk below which bank financing is preferred, with VC financing being
chosen otherwise. Moreover, as in our main model this threshold level of venture risk is increasing with competition; in other words, competition makes bank financing relatively more attractive.

2.4 Verifiable Profits under VC Financing

Suppose that thanks to the venture capitalist’s expertise, second period cash flows under VC financing are verifiable with probability \( \delta \in [0, 1] \), while with probability \( (1 - \delta) \) cash flows remain unverifiable as in the main model. Moreover, for simplicity let us assume that \( e \) learns about the verifiability of cash flows at the beginning of the second period, before choosing her effort level. Finally, let us assume that bank financing remains as in the main model.

**VC financing.** The optimal contract in that case is simple and includes two key elements: a) \( e \) retains control of the ventures throughout the game, as in the main model; and b) \( e \) retains 100% of the cash flows rights, minus a constant payment \( z \) at the end of the second period when cash flows are positive. This is optimal because it maximizes \( e \)'s effort incentives, and allows \( e \) to extract all rents from \( f \) through a judicious choice of \( z \).

In this environment, if at the beginning of the second period \( e \) learns profits are verifiable, she anticipates receiving all profits minus \( z \) at the end of the period, and exerts first-best effort \( \gamma_{FB} = \gamma_b \), leading to continuation surplus \( V_{FB}(\theta) = V_b(\theta) \) in the second period. If \( e \) learns that profits are not verifiable, her anticipated bargaining outcome is the same as in the main model, and hence she exerts effort \( \gamma_{vc} \), leading to continuation surplus \( V_{vc}(\theta) \) in the second period.

Moving back to the beginning of the game, \( f \)'s participation constraint can be expressed as \( \delta z + (1 - \delta) \lambda \Pi_2 (\gamma_{vc}(\theta), \theta) - I \geq 0 \). Note that \( f \)'s payoff now includes both debt-type (a fixed payment \( z \), with probability \( \delta \)) and equity-type (a fraction \( \lambda \) of profit, with probability \( 1 - \delta \)) elements, much like the preferred securities observed in VC contracts in practice.

The entrepreneur chooses \( z \) to make \( f \)'s participation constraint binding and extracts the entire surplus from the venture to herself, generating the following payoff:

\[
U_{ver}^{vc}(\theta, \delta) = \Pi_1 + \delta V_b(\theta) + (1 - \delta) V_{vc}(\theta) - I.
\]

Clearly, the greater the degree of verifiability \( \delta \), the greater \( e \)'s expected effort and surplus generated. If \( \delta = 1 \) and cash flows are perfectly verifiable, the first-best can be reached.

**Bank financing.** This remains the same as in the main model, with \( e \) receiving an expected payoff \( U_b(\theta) = \Pi_1 + (1 - R_1) V_b(\theta) + R_1 L - I \).
Financing tradeoff. At date 0, ε prefers bank financing over VC financing iff $U_b(θ) ≥ U_{vc}^*(θ, δ)$, which simplifies to $R_1 ≤ R_{1}^{vgrs}(θ, δ)$ with $R_{1}^{vgrs}(θ, δ) = (1 - δ)\left(1 - \frac{V_{vc} - L}{V_b - L}\right)$. One can easily verify that $R_{1}^{vgrs}(θ, δ) ∈ [0, R_{max})$ for all $δ ∈ [0, 1]$ and $θ ∈ [θ_{min}, θ_{max}]$.

Clearly the results of the main model continue to hold here: First, there exists a threshold level of venture risk $R_{1}^{vgrs}(θ, δ)$ such that below that threshold bank financing is optimal, while above that threshold VC financing is optimal. Second, one can see immediately that the impact of competition on that threshold, $\partial R_{1}^{vgrs}(θ, δ) / \partial θ = (1 - δ)\partial R_{1}^{v}(θ) / \partial θ > 0$ is proportional to the impact of competition on the threshold derived in the main model, and thus has the same positive sign. In other words, competition continues to increase the threshold level of risk below which bank financing is optimal: competition increases the appeal of bank financing over VC financing. Finally, the degree of verifiability of cash flows δ has a negative effect on the relative appeal of bank financing: as mentioned above δ makes VC financing more efficient, while it has no impact on bank financing. □

2.5 Staged Financing

Suppose that, instead of a single investment $I$ being required at the beginning of period 1, two investments $I_1$ and $I_2$ are required at the beginning of periods 1 and 2, respectively. Moreover, suppose we replace regularity condition (??) by the following “adapted” regularity condition reflecting these changes in investment requirements:

$$I_1 + I_2 ≤ λ_{min} Π^s (θ_{max}) .$$

VC financing. As in the main model and for the same reasons, under this type of financing the optimal contract involves entrepreneur control in both periods regardless of the state of the world. The maximum gross payoff that f can expect to get is $λΠ_2 (γ_{vc} (θ), θ)$; and hence VC financing is feasible only if $I_1 + I_2 ≤ λΠ_2 (γ_{vc} (θ), θ)$. Regularity condition (??) ensures that VC financing is feasible for all $λ ∈ [λ_{min}, 1]$ and all $θ ∈ [θ_{min}, θ_{max}]$. Entrepreneur e’s expected payoff from VC financing can be expressed as: $U_{vc}^{st}(θ) = Π_1 + [V_{vc} (θ) - I_2] - I_1$.

Bank financing. Similar to the main model, the optimal (“pure strategy”) contract is a simple debt contract, which specifies at date 0 the debt repayment $D$ to be made at date 1. If e pays $D$ to f at date 1, f makes investment $I_2$ in the second period and e retains full control in period 2. On the other hand, if e does not repay $D$ at date 1, f obtains full control over the venture.

One can readily verify that bank financing will be feasible iff $I_1 ≤ (1 - R_1) [V_b (θ) - I_2] + R_1 L$, or $R_1 ≤ R_{max}^{st} (θ)$ with $R_{max}^{st} (θ) = 1 - \frac{L}{V_b (θ) - I_2 - L}$. Regularity condition (1) in the main text ensures that
$R_{\text{max}}^e(\theta) > 0$ for all $\theta \in [\theta_{\text{min}}, \theta_{\text{max}}]$. Entrepreneur $e$'s expected payoff from bank financing can be expressed as:

\[ U_b^e(\theta) = \Pi_1 + (1 - R_1) [V_b(\theta) - I_2] + R_1 L - I_1. \]

Financing tradeoff. Bank financing is to be preferred over VC financing iff:

\[ U_b^e(\theta) - U_{\text{VC}}^e(\theta) \geq 0, \quad \text{iff} \]

\[ [V_b(\theta) - V_{\text{VC}}(\theta)] - R_1 [V_b(\theta) - I_2 - L] \geq 0. \]

One can readily verify from (7) that the main results of the model continue to hold in this extension with staged financing. First, there exists a threshold level of venture risk $R_1^{\text{st}}(\theta) = 1 - \frac{V_{\text{VC}}(\theta) - I_2 - L}{V_b(\theta) - I_2 - L}$ such that bank financing is optimal if $R_1 \leq R_1^{\text{st}}(\theta)$ while VC financing is optimal otherwise. Regularity condition (6) is sufficient to ensure that bank financing is always feasible at the venture risk threshold $R_1^{\text{st}}(\theta)$. $R_1^{\text{st}}(\theta) < R_{\text{max}}^e(\theta)$ for all $\theta \in [\theta_{\text{min}}, \theta_{\text{max}}]$ threshold.

Second, the upside $[V_b(\theta) - V_{\text{VC}}(\theta)]$ and the downside $R_1 [V_b(\theta) - I_2 - L]$ of bank financing are affected by competition in exactly the same way as in the main model, and hence the impact of competition on the tradeoff between the two sources of financing remains the same: competition improves the appeal of bank financing relative to VC financing. □

### 2.6 “Mixed Strategies” in Control Allocations

First note that under VC financing, allowing for randomizations across control allocations has no effect on the model. Entrepreneur control allows $e$ to commit to return cash to $f$ through ex post bargaining over profit, and generates stronger entrepreneurial incentives and greater total surplus than investor control. It therefore strictly dominates investor control and is chosen with probability 1.

Under bank financing, the model is similar to Bolton and Scharfstein (1996). The optimal contract for $e$ to offer to $f$ is a simple debt contract, which specifies at date 0 the debt repayment $D$ to be made at date 1. If $e$ pays $D$ to $f$ at date 1, she retains full control in period 2 with probability $\beta_D$, while $f$ gains full control over the venture with probability $1 - \beta_D$. If $e$ does not repay $D$ at date 1, she retains full control with probability $\beta_0$ while $f$ gains full control probability $1 - \beta_0$.

Recall $V_b(\theta) = \Pi_2(\gamma_b(\theta), \theta) - k [\gamma_b(\theta)]^2 / 2$, which represents the venture’s continuation surplus in the second period, if $e$ remains involved. At date 0 $e$ chooses $\beta_D$, $\beta_0$, and $D$ to maximize her expected payoff $(1 - R_1) [\Pi_1 - D + \beta_D V_b] + R_1 \beta_0 V_b$, subject to her own incentive compatibility (IC) constraint $-D + \beta_D V_b \geq \beta_0 V_b$ which ensures she has an incentive to make debt repayment $D$ at date 1 in the good state; and to $f$’s individual rationality (IR) constraint $(1 - R_1) (D + (1 - \beta_D) L) + R_1 (1 - \beta_0) L - I \geq \ldots$

\[ \ldots \]

\[ \ldots \]

\[ \ldots \]
0. It is optimal to have \( \beta_D = 1 \) since \( \beta_D \) has positive impacts on \( e \)'s objective function and incentive compatibility; \( D = [I - L(R_1(1 - \beta_0) + (1 - R_1)(1 - \beta_D))] / (1 - R_1) \) since it allows \( e \) to extract all rents from \( f \); and \( \beta_0 = \beta_D - D/V_b = 1 - I/[(1 - R_1)V_b + R_1L] \) as the maximum value of \( \beta_0 \) consistent with the IC constraint.

Using the optimal values of \( \beta_D \) and \( D \), we can express \( e \)'s date 0 expected payoff - which is also the total surplus generated by the venture under bank financing, since as mentioned above \( e \) extracts all rents from \( f \) at date 0 - as follows:

\[
U_{br} (\theta) = (1 - R_1) [\Pi_1 + V_b (\theta)] + R_1 [\beta_0 V_b (\theta) + (1 - \beta_0) L] - I.
\]

As in the main model, as long as \( e \) retains full control over the venture, bank financing is efficient: it generates first-best entrepreneurial effort \( \gamma_b (\theta) = \gamma_{FB} (\theta) \) and in turn first-best continuation surplus \( V_b (\theta) = V_{FB} (\theta) \). On the other hand, if the negative shock occurs and \( e \) loses control of the venture, inefficient liquidation occurs, leading to the liquidation value \( L \).

In the main model, transfer of control and the ensuing inefficient liquidation occur systematically following default in the bad state of the world. This occurs with probability \( R_1 \), while \( e \) retains control with probability \( (1 - R_1) \). In contrast, in this randomization extension, \( e \) retains control not only in the good state of the world, but also with probability \( \beta_0 \) in the bad state of the world; thus with probability \( (1 - R_1) + R_1 \beta_0 \) overall. And inefficient liquidation occurs with lower probability \( R_1 (1 - \beta_0) \). This is the first difference between the main model and this extension.

The financing tradeoff is also similar to the main case:

\[
U_{br} (\theta) - U_{vc} (\theta) = [V_b (\theta) - V_{vc} (\theta)] - R_1 [1 - \beta_0] [V_b (\theta) - L]. \tag{8}
\]

The intuition behind this tradeoff is the same as in the main model: whenever bank financing enables \( e \) to retain full control and access to the venture’s rents, it gives her stronger (first-best) effort incentives and yields a surplus larger than what could be obtained under VC financing, where rent sharing mutes entrepreneurial incentives. On the other hand bank financing may lead to inefficient liquidation, while under VC financing inefficient liquidation does not arise.

Substituting the optimal value of \( \beta_0 = \beta_D - D/V_b = 1 - I/[(1 - R_1)V_b + R_1L] \) in tradeoff (8), and expressing it in terms of venture risk, yields:

renegotiate since by assumption \( f \) has all bargaining power in renegotiation. Note also that there is no IC constraint in the bad state (if the negative shock does occur), because in that case \( e \) has no choice but to default on payment \( D \), and there is no scope for renegotiation since \( e \) has no cash with which to renegotiate.
\[ U_{br} (\theta) - U_{vc} (\theta) = [V_b (\theta) - V_{vc} (\theta)] - R_1 [V_b (\theta) - L] \left[ \frac{I}{(1 - R_1) V_b (\theta) + R_1 L} \right]. \]

We underline two points here. First, as in the main model, \( R_1 \) increases the disadvantage of bank financing relative to VC financing. One reason for this is that \( R_1 \) increases the probability of a date 1 default, which in turn may lead to a transfer of control and inefficient liquidation with probability \( (1 - \beta_0) \). But venture risk also has a more subtle effect that is specific to this extension: it reduces the probability \( (1 - R_1) \) that \( f \) will get payment \( D \) at date 1, and hence increases the value of \( D \) that he must receive in order to be willing to finance the venture in the first place. In turn, as \( D \) increases, \( e \)'s incentives to default at date 1 in the good state rise, and hence the probability \( (1 - \beta_0) \) of loss of control in case of default must increase for the contract to remain incentive compatible. While increasing \( (1 - \beta_0) \) ensures that \( e \) repays \( D \) in the good state, it also raises the probability of inefficient liquidation in the bad state, thus increasing the relative cost of bank financing.

All in all, a threshold level of risk \( R_{1mx} (\theta) = V_b (\theta) - V_{vc} (\theta) \left( V_b (\theta) - L \right) \left( I + V_b (\theta) - V_{vc} (\theta) \right) \) exists such that, as in the main model, bank financing is optimal if venture risk is below the threshold, and VC financing otherwise. One can easily check that \( R_{1mx} (\theta) \in (0, R_{max}) \) for all \( \theta \in [\theta_{min}, \theta_{max}] \).

The second point to be underlined is that the impact of competition on the upside of bank financing is the same as in the main model, which we have shown to be increasing in \( \theta \). Moreover, in this extension the impact of competition on the downside of bank financing, \( R_1 \left( V_b (\theta) - L \right) \left( \frac{I}{(1 - R_1) V_b (\theta) + R_1 L} \right) \) is equal to \( R_1 \frac{dV_b (\theta)}{d\theta} \left( \frac{I L}{(1 - R_1) V_b (\theta) + R_1 L} \right)^2 \). If competition reduces the downside of bank financing in our main model (i.e. if \( \frac{dV_b (\theta)}{d\theta} \leq 0 \)), then it does so here too. If on the contrary if increases it (i.e. if \( \frac{dV_b (\theta)}{d\theta} > 0 \)), then its positive impact is weaker in this extension than in our main model, since \( \frac{I L}{(1 - R_1) V_b (\theta) + R_1 L} \leq 1 \). In the main model the impact of competition on the downside of bank financing is always strictly dominated by its positive effect on the upside of bank financing, so it must be the case here too: competition increases the appeal of bank financing relative to VC financing.

\[ \square \]

### 2.7 Entrant with either Low or High Marginal Cost of Production

Here the entrant’s cost is \( \zeta \) with probability \( \alpha \), and \( \bar{\zeta} \) with probability \( 1 - \alpha \). Let \( \Pi^c (\theta) = \Pi (\zeta, \zeta, \theta) \) and \( \Pi^l (\theta) = \Pi (\bar{\zeta}, \zeta, \theta) \). The venture generates an expected profit \( \Pi^v (\theta, \alpha) = \alpha \Pi^c (\theta) + (1 - \alpha) \Pi^h (\theta) \) if the venture successfully innovates, and \( \tilde{\Pi} (\theta, \alpha) = \alpha \Pi^l (\theta) + (1 - \alpha) \Pi^v (\theta) \) otherwise.
We can express the continuation surplus under financing type $j = b, vc$ as

$$
\tilde{V}_b(\theta, \alpha) = \frac{(\tilde{\Pi}^b(\theta, \alpha) - \tilde{\Pi}^s(\theta, \alpha))^2}{2k} + \tilde{\Pi}^s(\theta, \alpha)
$$

(9)

$$
\tilde{V}_{vc}(\theta, \alpha) = \frac{(1 - \lambda^2)(\tilde{\Pi}^b(\theta, \alpha) - \tilde{\Pi}^s(\theta, \alpha))^2}{2k} + \tilde{\Pi}^s(\theta, \alpha).
$$

We show below that under the different demand specifications: $d\Pi^l(\theta)/d\theta \leq 0$, and $d(\Pi^c(\theta) - \Pi^l(\theta))/d\theta \leq 0$. Therefore, $\Pi^s = d\Pi^s(\theta, \alpha)/d\theta \leq 0$, but be can have $\Delta t = d(\tilde{\Pi}^b(\theta, \alpha) - \tilde{\Pi}^b(\theta, \alpha))/d\theta \geq 0$. Therefore, Lemma 1 in the main text does not always hold, and although competition has a negative effect on the downside of bank financing, it may have a negative on its upside as well. Nevertheless, Proposition 5 still holds: as the industry becomes less concentrated, the relative attractiveness of competition on the downside of bank financing offsets its effect on the upside. In other words, we show that the difference between these two effects, measured as $d[\tilde{V}_b(\theta) - \tilde{V}_{vc}(\theta)]/d\theta - d[\tilde{V}_b(\theta) - \tilde{V}_{vc}(\theta)]/d\theta$, is positive, by showing that $2(\tilde{\Pi}^s - L)\Delta t - \Delta \tilde{\Pi}^s > 0$. Since $\Delta t < 0$, if $\Delta t \geq 0$ this inequality is automatically satisfied. However, we must prove that it is also satisfied if $\Delta t < 0$. In that case, the left hand side of the inequality is an increasing function of $L$. Therefore, a sufficient condition for it to be satisfied is if it satisfied for $L = 0$, i.e. if $2\tilde{\Pi}^s\Delta t - \Delta \tilde{\Pi}^s > 0$. This can be rewritten as

$$
2 \left[ \alpha \Pi^l(\theta) + (1 - \alpha)\Pi^c(\theta) \right] \left[ \alpha \frac{d(\Pi^c(\theta) - \Pi^l(\theta))}{d\theta} + (1 - \alpha) \frac{d(\Pi^b(\theta) - \Pi^s(\theta))}{d\theta} \right] - \left[ \alpha(\Pi^c(\theta) - \Pi^l(\theta)) + (1 - \alpha)(\Pi^b(\theta) - \Pi^s(\theta)) \right] \left[ \alpha \frac{d\Pi^l(\theta)}{d\theta} + (1 - \alpha) \frac{d\Pi^c(\theta)}{d\theta} \right] \geq 0.
$$

(10)

The left hand side of (10) is as a quadratic function of $\alpha$, of the type $A \alpha^2 - B \alpha + C$, where $A = 2 \left[ \Pi^c(\theta) - \Pi^l(\theta) \right] \left[ \frac{d(\Pi^b(\theta) - \Pi^s(\theta))}{d\theta} - \frac{d(\Pi^b(\theta) - \Pi^s(\theta))}{d\theta} \right] - \left( \Pi^b(\theta) - \Pi^s(\theta) \right) \left[ \frac{d(\Pi^b(\theta) - \Pi^s(\theta))}{d\theta} - \frac{d(\Pi^b(\theta) - \Pi^s(\theta))}{d\theta} \right]$ and $C = 2\Pi^s(\theta) \left[ \frac{d(\Pi^b(\theta) - \Pi^s(\theta))}{d\theta} - \frac{d(\Pi^b(\theta) - \Pi^s(\theta))}{d\theta} \right] - \left( \Pi^b(\theta) - \Pi^s(\theta) \right) \left[ \frac{d(\Pi^b(\theta) - \Pi^s(\theta))}{d\theta} - \frac{d(\Pi^b(\theta) - \Pi^s(\theta))}{d\theta} \right]$ are both positive. Indeed, we show below that under the different demand specifications, $\Pi^b(\theta) - \Pi^s(\theta) \geq \Pi^c(\theta) - \Pi^l(\theta)$ and $d(\Pi^c(\theta) - \Pi^l(\theta)) \leq 0$. Therefore, if in addition $B$ is negative, then the left hand side of (10) is positive $\forall \alpha \in [0, 1]$. But if $B > 0$, then the left hand side of (10) has two roots and it is negative when $\alpha$ is between these two roots. However, the lower root (equal to $(B - \sqrt{B^2 - 4AC})/2A$) is higher than 1 if the left hand side of (10) is positive for $\alpha = 1$ (i.e. if $A - B + C \geq 0$). So a sufficient condition for (10) to be satisfied is if it is satisfied for $\alpha = 1$. When $\alpha = 1$, the left hand side of (10) is equal to $2\Pi^l(\theta) \frac{d(\Pi^c(\theta) - \Pi^l(\theta))}{d\theta} - (\Pi^c(\theta) - \Pi^l(\theta)) \frac{d\Pi^l(\theta)}{d\theta}$. We show below that this is positive under the different demand specifications. Therefore, (10) is satisfied, so $2\Pi^s\Delta t - \Delta \tilde{\Pi}^s \geq 0$ and as a result $d[\tilde{V}_b(\theta) - \tilde{V}_{vc}(\theta)]/d\theta - d[\tilde{V}_b(\theta) - \tilde{V}_{vc}(\theta)]/d\theta$ : and increase in competition increases the relative appeal of bank financing.
2.7.1 Example 1: Hotelling model

The equilibrium profit of firm $i$ is $\Pi_i(c_i, c_j, \theta) = \frac{1}{2g}(1 + \frac{\theta(c_j - c_i)}{3})^2$. The profits for the different outcomes are: $\Pi^c(\theta) = \frac{1}{2g}$ and $\Pi^l(\theta) = \frac{1}{2g}(1 - \frac{\theta(c_j - c_i)}{3})^2$. It can be checked that $\frac{d\Pi^l(\theta)}{d\theta} = \frac{-1}{2g^2}(1 - \frac{\theta(c_j - c_i)}{3})(1 + \frac{\theta(c_j - c_i)}{3}) < 0$, and $\frac{d\Pi^c(\theta) - \Pi^l(\theta)}{d\theta} = -\frac{(c_j - c_i)^2}{18} < 0$. After rearranging, $2\Pi^l(\theta)d\Pi^c(\theta) - \Pi^l(\theta) = \frac{(c_j - c_i)^2}{6\theta} - \frac{\theta(c_j - c_i)^2}{18} - \frac{1}{3}$. We have assumed that $\theta(c_j - c_i) < 3$, so $\frac{(c_j - c_i)^2}{6\theta} - \frac{\theta(c_j - c_i)^2}{18} - \frac{1}{3} < 0$, and $2\Pi^l(\theta)d\Pi^c(\theta) - \Pi^l(\theta) > 0$. □

2.7.2 Example 2: Salop Model

Each of the venture's competitors has a cost $c$ with probability $\alpha$ and $\bar{c}$ with probability $1 - \alpha$. Therefore, the average of all marginal costs is now $\bar{c}(\bar{c}, c; \alpha) = \sum_{k=0}^{n-1} \binom{n-1}{k} \alpha^k(1 - \alpha)^{n-1-k}(k\bar{c} + (n - 1 - k)c) + c_i/n$. Let $\bar{c}(\bar{c}, c; \alpha) = \sum_{k=0}^{n-1} \binom{n-1}{k} \alpha^k(1 - \alpha)^{n-1-k}(k\bar{c} + (n - 1 - k)c)$, which is a decreasing function of $\alpha$ with $\bar{c}(\bar{c}, c; 0) = (n - 1)c$ and $\bar{c}(\bar{c}, c; 1) = (n - 1)c$.

If the venture innovates, its profit is $\bar{\Pi}^h(\theta) = \frac{1}{\bar{g}c}(1 + \frac{2\theta(c - (n-1)c)}{3})^2$, while it is $\bar{\Pi}^s(\theta) = \frac{1}{\bar{g}c}(1 + \frac{2\theta(c - (n-1)c)}{3})^2$ if it does not. Here, $2(\bar{\Pi}^s - L)\Delta\theta - \Delta\bar{\Pi}^s \theta > 0$ if $4\theta\bar{c} - 3\theta(n-1)c - \theta(n-1)c + 3 > 0$. For the venture's demand to be positive when it does not innovate we must have $3 + 2\theta\bar{c} - 2\theta(n-1)c > 0$, which yields $4\theta\bar{c} - 3\theta(n-1)c - \theta(n-1)c + 3 > 2\theta\bar{c} + \theta(n-1)c - 3\theta(n-1)c$. We can rewrite the right hand side as $2\theta(c - (n-1)c) + \theta(n-1)(c - \bar{c}) > 0$. Therefore, $2(\bar{\Pi}^s - L)\Delta\theta - \Delta\bar{\Pi}^s \theta > 0$. □

2.7.3 Example 3: CES (Dixit-Stiglitz) Model

The profit of firm $i$ can be written as: $\Pi_i(c_i, c_j, \theta) = \frac{1+\theta(c_i/c_j)^{\rho}}{1+(c_i/c_j)^{\rho}}$. So the profits for the different outcomes are: $\Pi^c(\theta) = \frac{2\theta^4}{4}$ and $\Pi^l(\theta) = \frac{\theta^4(1-\theta+\theta\rho^4)}{(1+c^4)^2}$, where $c = \bar{c}/\bar{c} < 1$. It can be checked that $d\Pi^l(\theta) = \frac{-\theta^5(1-\theta+\theta\rho^4)}{(1+c^4)^3}$. We have assumed that $\theta(c_j - c_i) < 3$, so $\frac{-\theta^5(1-\theta+\theta\rho^4)}{(1+c^4)^3} < 0$, and $2\Pi^l(\theta)d\Pi^c(\theta) - \Pi^l(\theta) = \frac{\theta^5(1-\theta+\theta\rho^4)}{(1+c^4)^3} - \frac{\theta^5(1-\theta+\theta\rho^4)}{(1+c^4)^3} > 0$. □

2.7.4 Example 4: Logit Model

Equilibrium prices are such that $p_i = c_i + \frac{1}{d} + \frac{1}{\theta \exp(-\theta p_i)}$. Let $X = \exp(-\theta p^*_1)$ where $p^*_1 = \bar{c} + \frac{1}{\theta \exp(-\theta p^*_1)}$ and $p^*_2 = \bar{c} + \frac{1}{\theta \exp(-\theta p^*_2)}$. Since $\bar{c} > \bar{c}$, $p^*_1 < p^*_2$ so $X > 1$. Moreover, $\ln X = \theta(p^*_2 - p^*_1) = \theta(\bar{c} - \bar{c}) + \frac{1}{\theta} - X$. By differentiating both sides with respect to $\theta$ we obtain $\frac{d}{d\theta}(\frac{X^2 + X - 1}{X^2}) = \bar{c} - \bar{c}$.

Profits are the following: $\Pi^c(\theta) = \frac{N}{\theta}$ and $\Pi^l(\theta) = N \frac{1}{\theta X}$, where $N$ is the mass of consumers. It can be checked that $\frac{1}{N}\Pi^l(\theta) = -\frac{1}{\theta X} - \frac{1}{\theta X} \frac{dX}{d\theta} = -\frac{1}{\theta X} - \frac{\theta X - 1}{\theta(X^2 + X + 1)} < 0$. Moreover, $\frac{1}{N}\Pi^l(\theta) = \frac{1}{\theta X} \frac{dX}{d\theta} = \frac{2X}{X^2 + X + 1} < \frac{1}{\theta X}$. □
Each of the venture’s competitors has a cost effect on the downside dominates the negative effect on the upside, so that overall an increase in the venture risk level decreases both the upside and the downside of bank financing: 
\[ \frac{d(\tilde{\Pi}_b(n, \alpha) - \tilde{\Pi}_c(n, \alpha))}{dn} < 0 \text{ and } R_1^*(n, \alpha) \frac{d\tilde{V}_b(n, \alpha)}{dn} < 0. \]
However we show that the negative effect on the downside dominates the negative effect on the upside, so that overall an increase in the number of firms increases the appeal of bank financing.

Following equation (11) in the main text, for a given level of competition, the associated threshold venture risk level \( R_1^*(n, \alpha) \) can be expressed as 
\[ R_1^*(n, \alpha) = \frac{x_1}{\pi^2 \Delta^2}. \]
The impact of \( n \) on the threshold
$R_1(n, \alpha)$ is positive iff $\frac{dR_1(n, \alpha)}{dn} \geq 0 \iff -\frac{\lambda^2}{k} L \Delta \frac{d\Delta}{dn} \geq 0$. Since $\frac{d\Delta}{dn} < 0$, this inequality holds $\forall \alpha \in [0, 1]$. \qed

## 2.8 Two competing ventures

In this section we study a setting with two ventures, each composed of an entrepreneur $e_i$ and a financier $f_i$ ($i = 1, 2$), who is either a banker or venture capitalist. At date 1, with probability $1 - R_1$, venture 1 generates monopoly profit $\Pi_1$ while venture 2 makes zero profit. With probability $R_1$, venture 2 generates monopoly profit $\Pi_1$ while venture 1 makes zero profit. We focus a discrete choice of efforts in order to make the analysis more tractable. At the beginning of the second period, if $e_i$ is still involved in the venture at that point, she exerts an effort $\gamma_i = \{\overline{\gamma}, \underline{\gamma}\}$ at personal cost $K(\overline{\gamma}) = K$ and $K(\underline{\gamma}) = 0$, to potentially reduce her second period marginal cost: $c_i(\overline{\gamma}) = c$ and $c_i(\underline{\gamma}) = c$. At date 2, under $e_i$’s management, the venture generates expected duopoly profit $\Pi(c_i(\gamma_i), c_j(\gamma_j), \theta)$ if both entrepreneurs are still involved in the ventures, and monopoly profit $\Pi(c_i(\gamma_i))$ if $f_j$ took control of venture $j$ at date 1 (which happens if $f_j$ is a bank and $e_j$ defaulted at date 1).

### 2.8.1 Dominant strategies under bank and VC financing

To remain consistent with the results from the main model, we focus on parameter values such that $\overline{\gamma}$ is a dominant strategy under bank financing and $\underline{\gamma}$ is a dominant strategy under VC financing. Here we specify the range of parameters such that this result holds.

Let $\Pi(c, \overline{\gamma}, \theta) = \Pi^h(\theta)$, $\Pi(c, \underline{\gamma}, \theta) = \Pi^s(\theta)$, $\Pi(c, \overline{\gamma}, \theta) = \Pi^c(\theta)$, $\Pi(c, \underline{\gamma}, \theta) = \Pi^l(\theta)$.

Under bank financing, $\overline{\gamma}$ is a dominant strategy iff 1) $\Pi^h(\theta) - K \geq \Pi^s(\theta)$; 2) $\Pi^c(\theta) - K \geq \Pi^l(\theta)$; 3) $\Pi(c) - K \geq \Pi(\overline{\gamma})$.

Under VC financing, $\underline{\gamma}$ is a dominant strategy iff 4) $(1 - \lambda)\Pi^s(\theta) \geq (1 - \lambda)\Pi^h(\theta) - K$; 5) $(1 - \lambda)\Pi^l(\theta) \geq (1 - \lambda)\Pi^c(\theta) - K$; 6) $(1 - \lambda)\Pi(\overline{\gamma}) \geq (1 - \lambda)\Pi(c) - K$.

As shown in the previous section, under the different demand specifications we have $\Pi^h(\theta) - \Pi^s(\theta) \geq \Pi^c(\theta) - \Pi^l(\theta)$. Therefore we restrict the analysis to parameter values such that $(1 - \lambda)(\Pi^h(\theta) - \Pi^s(\theta)) \leq K \leq \Pi^c(\theta) - \Pi^l(\theta)$, and $(1 - \lambda)(\Pi(c) - \Pi(\overline{\gamma})) \leq K \leq \Pi(c) - \Pi(\overline{\gamma})$, so that $\overline{\gamma}$ is a dominant strategy under bank financing and $\underline{\gamma}$ is a dominant strategy under VC financing.

### 2.8.2 Proof of the main results of the model

**Financing choice when rival chooses VC financing.** We start by considering the optimal financing choice for $e_1$ given that $e_2$ chooses VC financing. Hence $e_2$ will be involved in the second period,
and will exert effort $\gamma$, yielding cost $\overline{c}$.

If $e_1$ also chooses VC financing, then she also exerts effort $\gamma$ in the second period and both ventures face a cost $\overline{c}$. Therefore, $e_1$’s expected payoff (from a date 0 point of view) from VC financing is $U_{vc,vc}(\theta) = \Pi_1 + \Pi^*(\theta) - I$.

If $e_1$ chooses bank financing, then she defaults with probability $R_1$, while with probability $1 - R_1$ she is still involved in the second period and exerts effort $\overline{c}$, which yields cost $\overline{c}$. Therefore, $e_1$’s expected payoff (from a date 0 point of view) from bank financing is $U_{b,vc}(\theta) = \Pi_1 + (1 - R_1)(\Pi^b(\theta) - K) + R_1L - I$.

When $e_2$ chooses VC financing, $e_1$ prefers bank financing over VC financing iff $U_{b,vc}(\theta) - U_{vc,vc}(\theta) \geq 0$ iff $[\Pi^b(\theta) - \Pi^*(\theta) - K] - R_1[\Pi^b(\theta) - L - K] \geq 0$. This in turn can be expressed as $R_1 \leq R^*_{1,vc}(\theta) = 1 - (\Pi^*(\theta) - L) / (\Pi^b(\theta) - L - K)$. Therefore, there exists a threshold level of risk $R^*_{1,vc}(\theta)$ such that when $e_2$ chooses VC financing, bank financing is optimal for $e_1$ if venture risk is below that threshold, and VC financing is optimal otherwise.

Moreover, the impact of competition on the upside of bank financing (measured by $\frac{d(\Pi^b(\theta) - \Pi^*(\theta))}{d\theta}$) is positive, and its impact on the downside of bank financing (measured by $\frac{d\Pi^*(\theta)}{d\theta}$) is negative. More formally: $\frac{d(\Pi^b(\theta) - \Pi^*(\theta))}{d\theta} - \frac{d\Pi^*(\theta)}{d\theta}R^*_{1,vc}(\theta) \geq 0$. Therefore, $dR^*_{1,vc}(\theta)/d\theta \geq 0$ : when the rival chooses VC financing, competition increases the appeal of bank financing relative to VC financing.

**Financing choice when rival chooses bank financing.** We now turn to the optimal financing choice for $e_1$ given that $e_2$ chooses bank financing. Hence $e_2$ defaults with probability $1 - R_1$, while with probability $R_1$ she is still involved in the second period and exerts effort $\overline{c}$, yielding cost $\overline{c}$.

If $e_1$ chooses VC financing, then she is involved in the second period and exerts effort $\overline{c}$ which yields cost $\overline{c}$. Therefore, $e_1$’s expected payoff (from a date 0 point of view) from VC financing is $U_{vc,b}(\theta) = \Pi_1 + R_1\Pi^1(\theta) + (1 - R_1)\Pi(\overline{c}) - I$.

If $e_1$ chooses bank financing, then she defaults with probability $R_1$, while with probability $1 - R_1$ she is still involved in the second period (while $e_2$ defaulted) and exerts effort $\overline{c}$, yielding cost $\overline{c}$. Therefore, $e_1$’s expected payoff (from a date 0 point of view) from bank financing is $U_{b,b}(\theta) = \Pi_1 + (1 - R_1)(\Pi(\overline{c}) - K) + R_1L - I$.

Therefore, when $e_2$ chooses bank financing, $e_1$ chooses bank financing over VC financing iff $U_{b,b}(\theta) - U_{vc,b}(\theta) \geq 0 \iff [\Pi(\overline{c}) - \Pi(\overline{c}) - K] - R_1[\Pi(\overline{c}) - \Pi(\overline{c}) + \Pi^1(\theta) - K - L] \geq 0 \iff R_1 \leq R^*_{1,b}(\theta) = (\Pi(\overline{c}) - \Pi(\overline{c}) - K) / (\Pi(\overline{c}) - \Pi(\overline{c}) + \Pi^1(\theta) - K - L)$. Therefore, there exists a threshold level of risk $R^*_{1,b}(\theta)$ such that when $e_2$ chooses bank financing, bank financing is optimal for $e_1$ if venture risk is below that threshold, and VC financing is optimal otherwise.
Moreover, competition has no impact on the upside of bank financing \((\frac{d(\Pi(c) - \Pi(\tau))}{d \theta} = 0)\) is positive, and it has a negative impact on the downside of bank financing through \(\Pi'(\theta) \frac{d(\Pi(c) - \Pi(\tau) + \Pi'(\theta))}{d \theta} = \frac{d\Pi'(\theta)}{d \theta}\), and as shown in the previous section \(\frac{d\Pi'(\theta)}{d \theta} \leq 0\) under different demand specifications). Therefore, \(dR^*_{1,vc}(\theta)/d \theta \geq 0\): when the rival chooses VC financing, competition decreases the downside of bank financing without affecting its upside, so it increases the relative appeal of bank financing.

### 2.8.3 Nash equilibrium

Here we derive the industry equilibrium in financing choice and see how it is affected by competition. We have seen in the previous section that when \(e_2\) chooses financing type \(j = b, vc\) \(e_1\) prefers bank financing over VC financing iff \(R_1 \leq R^*_{1,j}(\theta)\). For \(e_2\), the "risk" of the venture is \(1 - R_1\), so when \(e_1\) chooses financing type \(j = b, vc\), \(e_2\) prefers bank financing over VC financing iff \(1 - R_1 \leq R^*_{1,j}(\theta)\).

Therefore, there exists an equilibrium where both entrepreneurs choose VC financing if \(R_1 \geq R^*_{1,vc}(\theta)\) and \(1 - R_1 \geq R^*_{1,vc}(\theta)\), i.e. if \(R_1 \in [R^*_{1,vc}(\theta), 1 - R^*_{1,vc}(\theta)]\); there exists an equilibrium where both entrepreneurs choose bank financing if \(R_1 \leq R^*_{1,b}(\theta)\) and \(1 - R_1 < R^*_{1,b}(\theta)\), i.e. if \(R_1 \in [1 - R^*_{1,b}(\theta), R^*_{1,b}(\theta)]\); there exists an equilibrium where one entrepreneur chooses VC financing and the other chooses bank financing if \(R_1 \leq \min\{R^*_{1,vc}(\theta), 1 - R^*_{1,b}(\theta)\}\) or \(R_1 \geq \max\{R^*_{1,b}(\theta), 1 - R^*_{1,vc}(\theta)\}\).

For a given \(R_1\), the Nash equilibrium depends on the degree of competition \(\theta\), through the values of \(R^*_{1,b}(\theta)\) and \(R^*_{1,vc}(\theta)\) compared to \(R_1\) and \(1 - R_1\). Recall that \(R^*_{1,b}(\theta)\) and \(R^*_{1,vc}(\theta)\) are increasing functions of \(\theta\). Therefore, when competition is weak (\(\theta\) is small), both \(R^*_{1,b}(\theta)\) and \(R^*_{1,vc}(\theta)\) are smaller than \(R_1\) and \(1 - R_1\), so the only possible equilibrium is one where both entrepreneurs choose VC financing; if competition is strong (\(\theta\) is large), both \(R^*_{1,b}(\theta)\) and \(R^*_{1,vc}(\theta)\) are larger than \(R_1\) and \(1 - R_1\), so the only possible equilibrium is one where both entrepreneurs choose bank financing; if competition is intermediate, there are two possibilities: (i) the only possible equilibrium is one where one entrepreneur chooses bank financing and the other entrepreneur chooses VC financing; (ii) two equilibria can arise: either both entrepreneurs choose VC financing, or both choose bank financing. □
References


