# A Portfolio Approach to Venture Capital Financing*


| Yan Alperovych | Pascal François | Georges Hübner |
|---|---|---|
| EM Lyon | HEC Montréal | HEC Liège |


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Alperovych: Emlyon Business School, 23 Avenue Guy de Collongue, Ecully 69130, France (alperovych@em-lyon.com). François: HEC Montréal, 3000 Chemin de la Côte-Ste-Catherine, Montréal (QC) H3T 2A7, Canada (pascal.francois@hec.ca). Hübner: HEC Liège - Liège University, 14 Rue Louvrex, Bldg N1, Office 111, 4000 Liège, Belgium (g.hubner@uliege.be).

# A Portfolio Approach to Venture Capital Financing

**Abstract:** This paper offers an analysis of the contracting agreement between entrepreneurs and venture capitalists from the perspective of portfolio allocation. We demonstrate that the opportunity to transfer risk provides a sufficient incentive for a wealth-constrained and risk-averse entrepreneur to engage in the transaction with a venture capital investor. The allocation of investment and cash flow rights is then contingent on the entrepreneur's risk aversion and bargaining power. The portfolio approach also yields a novel partition of venture capitalists, where the entrepreneur's risk aversion is instrumental in the choice of investor type. We validate these predictions in an empirical investigation of 1,315 European venture capital investment rounds that occurred between 2010 and 2019.

JEL Classification: L26, G32, G24.

## 1 Introduction

The allocation of control and economic rights between entrepreneurs and venture capitalists (VCs) is one of the most critical challenges in the context of new venture financing. The negotiations over these rights are complex and span the economic, legal, and even psycho-sociological dimensions. To date, two interrelated streams of literature inquire into the nature and implications of the resulting contractual relationship between entrepreneurs and venture capital (VC) investors.

The first stream leverages on the agency (Jensen and Meckling, 1976) and incomplete contract (Grossman and Hart, 1986) theories. It usually abstracts from the investors' and entrepreneurs' heterogeneity and focuses on the optimal design of contracts featuring state-contingent control rights and mechanisms that align incentives, facilitate the information sharing, and govern the distribution of value (Hellmann, 1998, 2006; Cornelli and Yosha, 2003; Repullo and Suarez, 2004; Cestone, 2014; Bengtsson, 2011).[1] The second stream, in contrast, sees the control and economic rights as a result

[1] This strand of literature typically posits (i) a wealth-constrained entrepreneur with monopoly access to a profitable but risky venture and inalienable human capital (Bolton, Wang and Yang, 2019) and (ii) homogenous, passive, and competitive investors who provide financing but face severe information asymmetries and agency problems (Ewens, Gorbenko and Korteweg, 2022).

of the negotiation process shaped by the VCs' and entrepreneurs' characteristics. It argues that high quality entrepreneurs are trading off the economic and control rights for the affiliation with VCs of comparatively superior quality (Hsu, 2004). Since such investors can significantly enhance the value of the venture (Nahata, 2008), they likely possess greater bargaining power in negotiations with entrepreneurs. Contracts emerging from such negotiations thus depend on the socioeconomic and human capital characteristics of the transacting parties.[2]

In this paper, we take an alternative perspective and investigate how differences in the optimal risk-return trade-off of VC investors and entrepreneurs influence their contracting preferences. Indeed, extensive evidence indicates that entrepreneurs tend to be under-diversified (Abudy, Benninga and Shust, 2016; Bhamra and Uppal, 2019; Lyandres, Marchica, Michaely and Mura, 2019; Bach, Calvet and Sodini, 2020). We argue that this under-diversification of entrepreneurs provides incentives to enter risk-sharing agreements with specialized VC investors.

To establish the link between under-diversification and incentives to seek outside VC financing, we adapt the mean-variance portfolio choice framework, featuring rational and risk-averse agents with homogenous information.[3] Agents are of two types: a non-diversified and financially constrained entrepreneur with proprietary access to a profitable yet risky venture; and a VC investor with a diversified portfolio. The entrepreneur faces the option to either try to finance the venture alone (provided that bank financing is available), assuming full risk, or to partner with the VC investor who can absorb a significant portion of the venture's idiosyncratic risk in exchange for a

[2] Under this view, VC investors possess technology to reduce information asymmetry through screening (Gompers, Gornall, Kaplan and Strebulaev, 2020), are actively involved in monitoring and coaching their portfolio companies (Bernstein, Giroux and Townsend, 2015), are not perfectly competitive (Opp, 2019), and are heterogeneous in terms of their skill (Korteweg and Sørensen, 2017), experience and reputation (Casamatta, 2003, Hochberg, Ljungqvist and Vissing-Jørgensen, 2014).

[3] Assuming the existence of asymmetric information between the entrepreneur and investors entails that both types of agents have diverging estimates about the project's risk and expected return. This unnecessarily complexifies the model without bringing additional insights regarding its main results.

share of its value through vanilla common stock. As a result, the entrepreneur benefits from relinquishing a fraction of the venture's excess return[4] in exchange for a reduction in her risk exposure through the venture capital contract. The key finding here is that the entrepreneur has a rational incentive to always seek an outside investor.

In the spirit of Inderst and Müller (2004) and Renucci (2014), we explicitly model the bargaining game that leads to the risk sharing between the entrepreneur and the investor. This allows us to endogenize the proportion of capital invested, and the resulting equity ownership held by the entrepreneur. We obtain the separation between the decision of how much of her wealth the entrepreneur allocates to the venture (the "investment") and the arrangement of the equity share (the "stake") that she holds after dilution. Both dimensions (the investment and the stake) are relevant in the contract design, and we show that the entrepreneur's investment is negatively related to her risk aversion level, while the entrepreneur's stake decreases with the entrepreneur's risk aversion and increases with her bargaining power. This holds firmly in our theoretical framework and is solely related to transparent risk sharing mechanisms with symmetric information. Most notably, we derive these results without resorting to signaling (Leland and Pyle, 1977) or agency theories (Bitler, Moskowitz and Vissing-Jørgensen, 2005).

Our model also relates to the entrepreneur's decision regarding the choice of investor. The determinants of this decision have been explored from various perspectives, including the level of involvement in the venture, private information held by investors, availability of internal resources, experience, complementarities, perceived experience by entrepreneurs, and venture innovativeness (Ueda, 2004; Chemmanur and Chen, 2014; Katila, Rosenberger, and Eisenhardt, 2008; Subramanian, 2009; Sørensen, 2007; Hellmann, Lindsey, and Puri, 2008; Bengtsson and Wang, 2010;

[4] Here, the excess return is defined as the difference between the return generated by the venture and what the entrepreneur could obtain from investing in the financial market.

Hirsch and Walz, 2013). However, these categorizations do not explicitly consider the risk-adjusted cost of capital, which is a central concept in our approach. Therefore, we propose a taxonomy of investors based on variations in the cost of their own funding sources, or on their impact on the venture's expected return.

First, there are investors who have comparatively higher funding costs irrespective of their ability to increase the venture's value. This, for instance, is the case of pure private equity funds that are required to deliver an add-on to the market-implied cost of equity to their own limited partners. Second, there are investors who can benefit (either directly or through related entities) from their status as financial transformation institutions, thereby enjoying favorable funding and reinvestment rate conditions. This is typically the case of investors affiliated with banks and insurance companies. Third, there are investors that can leverage synergistic effects and enhance the venture's expected returns without being constrained by their own shareholders. This is the case of corporate VC programs of listed corporations. Whilst not mutually exclusive, these dimensions collectively encompass all relevant situations, and our approach relates investor types to the entrepreneur's risk aversion and the project's characteristics. Specifically, based on the following partition of VC: (i) those with a competitive edge on equity financing ("alpha-type" investors), (ii) those with a competitive edge on debt financing ("lambda-type" investors), and (iii) those with a competitive edge on project value enhancement ("rho-type" investors), we determine the investor type that offers superior contracting conditions depending on the entrepreneur's risk aversion and the project's size and risk.

The second part of the paper is devoted to the empirical testing of the predictions concerning the impact of an entrepreneur's risk aversion and bargaining power on her investment and resulting stake in the venture. There are, however, three caveats. First, to perform these tests, it is necessary to observe variations in entrepreneur risk aversion at the individual level, which unfortunately is impossible. To address this challenge, we adopt a multi-country setting, which has both positive and negative implications. On the positive side, we approximate the entrepreneur's risk aversion using the national "Fear to fail" indices compiled annually by the Global Entrepreneurship Monitor (GEM). On the negative side, we cannot utilize contractual data, as in Ewens, Gorbenko and Korteweg (2022).[5] Second, in the absence of contractual data, we rely on information on VC transactions, amounts raised, and post-money valuations (in U.S. dollars), obtained from Crunchbase (www.crunchbase.com, hereafter referred to as CB). Last, the analysis of entrepreneurial investments also requires access to financial data for companies receiving VC funding. Therefore, it is crucial to have a homogeneous setting where financial data on small firms is available.

The European setting satisfies all three abovementioned criteria.[6] Firstly, CB provides comprehensive coverage of VC investments in the EU. Secondly, the financial data of all EU-based companies, regardless of their status, is available through Orbis, a database commercialized by Bureau van Dijk. Thirdly, given the cross-country nature of our study, we anticipate some variation in risk aversion across nations. Our sample hence consists of 2,808 investment-investor-specific observations essentially covering the period 2010-2019.[7] These observations include data on 1,315 investment rounds over 993 target companies and by 1,501 investment firms.

The reduced-form regression analyses provide support for our three predictions related to the terms of the contract (investment and stake). The most complete specification indicates that a one standard deviation increase in the proxy for entrepreneur's risk aversion is associated with a 0.13 standard deviation reduction in entrepreneurial investment and a 0.12 standard deviation

[5] Their data is U.S.-specific, while we need the cross-country variation in the index.

[6] We limit our analyses to the investments in the EU member states and in non-EU but EEE member countries.

[7] In total, only 60 observations pre-date 2010.

reduction in entrepreneurial stake. Furthermore, a one standard deviation increase in the proxy for entrepreneur's bargaining power corresponds to a 0.20 standard deviation increase in entrepreneurial stake. To address potential concerns about the endogenous observability of round amounts and valuations (Cochrane, 2005), we employ 2-step Heckman models. The results from these checks consistently align with our main findings, reinforcing the robustness of our results.

Furthermore, we present a test of the pairings between investors and entrepreneurs in accordance with our suggested taxonomy.[8] Consistent with the model predictions and based on the difference between low- and high-risk aversion environments, our findings reveal that alpha-type investors primarily finance smaller-sized and riskier projects. While the evidence on lambda- and rho-type investors is not as strong, it aligns with our predictions. Lambda-type investors tend to finance larger projects, with no clear evidence regarding risk preferences. Rho-type investors also favor larger projects and show a shift towards riskier projects when average risk aversion increases, as anticipated by our theoretical model.

In the dynamic analysis, where we examine the evolution of the proportion of projects funded by each investor type in isolation, the model predicts that the average level of risk aversion influences the comparative advantage of each investor type and, consequently, the proportion of ventures they fund. As risk aversion increases, the proportion of alpha-type intervening in ventures decreases, while the opposite holds for rho-type investors. These findings align fully with our model and, to the best of our knowledge, are not predicted by any other framework that explores the relationships between entrepreneurs and investor categories.

In addition to its theoretical insights, our paper contributes to the empirical literature on VC

[8] The test is robust to a stricter version of classification, according to which only the major Crunchbase category of investors is retained for each investor type (specifically, "angels" for alpha-type, "investment banks" for lambda-type, and "venture capital" for rho-type).

contracting. We believe that the closest existing empirical study to ours is the one conducted by Ewens et al. (2022). These authors also recognize the significance of investors' bargaining power in determining contracting outcomes. However, they acknowledge their inability to identify the underlying economic mechanisms that drive these endogenous contracting terms. In contrast, our paper builds upon an original framework that provides theoretical justifications for specific aspects of contracting preferences, including the choice of investor type, the optimal allocation of investment amounts, and the distribution of control rights.

There is also a separate body of literature that examines the nature and evolution of different contractual terms in relation to the abilities of investors and entrepreneurs, as well as the potential for conflicts of interest (Bengtsson, 2011; Bengtsson and Sensoy, 2011). While this research acknowledges significant variation in contractual designs, an interesting finding is that VCs tend to employ a set of predetermined and relatively consistent contractual designs that are tailored to specific types of entrepreneurs in equilibrium (Bengtsson and Bernhardt, 2014). Our paper contributes to this literature by highlighting the role of entrepreneurs' risk aversion in shaping financing terms.

The rest of the paper is structured as follows. Section 2 presents our framework and assumptions. In Section 3, we characterize the contracts between the entrepreneur and the investors. The fourth section derives testable implications regarding the entrepreneur's investment, stake, and preferred type of investor. Data and variable construction are presented in Section 5. The results from the empirical analysis are reported in Section 6, and Section 7 concludes.

## 2 Framework and assumptions

**The financial market** Consider a financial market where a set of risky securities and a risk-free asset are traded in the absence of arbitrage. The return on the riskless asset is denoted by

$r_f$. All portfolio rates of return $\tilde{r}_j$ are fully characterized by their expectation $r_j \equiv \mathbb{E}(\tilde{r}_j)$, their standard deviation $\sigma_j \equiv \sqrt{\mathbb{V}ar(\tilde{r}_j)}$ and their beta with respect to the market portfolio.[9] The CAPM with two-fund separation is assumed to hold on the financial market. At equilibrium with financial assets, each investor holds her utility-maximizing portfolio $\phi$ by combining the risk-free asset with the market portfolio with expected return $r_m$.

**Agents and their preferences** An entrepreneur ($e$) has the possibility to transact with a continuum of investors ($i$). All agents have full access to the financial market but may differ in their risk aversion. The entrepreneur's endowment is normalized to 1. For any portfolio $j$, each agent $a$ assigns a utility score $E(\widetilde{U}_j^a) \equiv U_j^a = r_j - \frac{1}{2}\gamma^a \sigma_j^2$, where $U_j^a$ is a shortcut for the expected utility operator and $\gamma^a$ represents the agent's constant absolute risk aversion coefficient.

**The venture** The entrepreneur has proprietary access to a nonmarketed venture investment $\pi$ yielding an expected rate of return $r_\pi$ with volatility $\sigma_\pi$. Its beta with respect to the market portfolio is simply denoted $\beta$. This venture is not accessible to investors. We assume that the venture's initial outlay is $K > 1$ so that the entrepreneur needs additional financing to undertake it.[10] When scaled by its relative size, the project's risk-return trade-off $(K\sigma_\pi, r_f + K(r_\pi - r_f))$ locates it above the market Capital Market Line (CML) for the entrepreneur.[11] In the absence of any financial investor, she has to choose between her initial financial portfolio and the investment in the venture financed through a loan.[12] The venture is worth considering when the following two

[9] Throughout, subscripts and superscripts refer to portfolios and agents, respectively.

[10] The initial outlay $K$ should be viewed as the amount in the project that cannot be diversified away by combining it with risky assets or by resorting to alternative funding sources such as angels, crowds, or family and friends, that are not considered as pure financial investors.

[11] Because the project risk is not wholly diversifiable for the entrepreneur, the Security Market Line is not adequate for the analysis of the project's risk and return. See Garvey (2001) for a discussion.

[12] Renucci (2014) examines the entrepreneur's choice between VC and bank financing. In our framework, banks are also considered as one specific type of financiers, specifically one that uses their intermediation

conditions are met: (C1) the investment opportunity induces a higher risk for the entrepreneur than her financial portfolio $\phi$, i.e., $K\sigma_\pi > \sigma_\phi$; (C2) the venture investment lies above the CML, i.e., $\frac{r_\pi - r_f}{\sigma_\pi} > \frac{r_m - r_f}{\sigma_m}$.

**The investors** Investors contract with the entrepreneur, bring financing and use their expertise to provide asset value enhancement, resulting in improved project's characteristics. The investors' value enhancement is reflected through $r_\pi^i$ as the expected project return when the venture is financed by investor $i$. In addition, let $\mu^i$ and $\kappa^i$ denote the investor $i$'s cost of equity and cost of debt, respectively.

The standard set of assumptions underlying the mean-variance framework must be somehow adapted in the context of the entrepreneur's portfolio choice. When confronted with the decision to finance her own business project, the entrepreneur's situation diverges from that of a rational risk-averse investor willing to allocate her wealth to a portfolio of securities traded on the financial market. This divergence arises from three main (and not mutually exclusive) differences, all well-grounded in the entrepreneurship and economic literature, that we justify in detail hereafter. Those differences create specific investment and financing constraints for the entrepreneur and preclude the mere application of the Modern Portfolio Theory (MPT):

- First and most importantly, the entrepreneur holds a unique position enabling her to invest in a business project that in her absence is not accessible to other investors because the project is proprietary and/or can otherwise be protected. To be a relevant substitute for a financial portfolio, the project's expected rate of return is substantially higher than that of financial assets with similar risk.

margin to reduce the entrepreneur's cost of debt (see section 3.3). In contrast, we posit that the correct alternative to the project for the entrepreneur is to allocate her wealth on the financial market.

- Second, the project requires a large, unbreakable amount of investment outlay by the entrepreneur (investment constraint). The proportion of equity that she has to hold in the project cannot be split into a large number of smaller securities held by many different investors. From the entrepreneur's point of view, the hypothesis of liquid markets with perfectly divisible investments does not hold for this particular project. Because of the high amount of idiosyncratic risk borne by the entrepreneur, this also explains why the venture will only be worth being undertaken if it offers a sufficiently large risk premium to the entrepreneur. This is in line with the theoretical argument of Ewens, Jones and Rhodes-Kropf (2013) and the empirical confirmation by Mueller (2011).

- Third, the project's volatility of cash flow-based returns is considerably larger than that of the market portfolio. The venture naturally displays substantial total risk as a translation of its sources of uncertainties (mainly illiquidity and failure risks). For instance, Ang et al. (2018) find that the volatility of cash-flow based private equity returns amounts to 35% for venture capital funds and 25% for buyout funds. These figures are larger than stock market indices but also standard private equity industry indices. Moreover, in addition to its intrinsic characteristics, compared to the initial entrepreneurial endowment, the project size creates a potentially large leverage risk. This imposes a severe financing constraint on the entrepreneur, who can either face an untenable cost of financing if the market clears or cannot borrow at all if it does not (Stiglitz and Weiss, 1981).

We take that set of specificities of the entrepreneur's problem without any stance regarding the causal relationship between the project's high total or idiosyncratic risk and the expected return for the entrepreneur. We simply acknowledge that both characteristics apply in a portfolio choice context.

Combining the second and third characteristics (large initial outlay and high risk), the entrepreneur is subjected to a constrained concentration of wealth. This makes her unable to reach any desired level of global portfolio risk, thereby hindering the application of Tobin's separation theorem which underpins the development of the Capital Asset Pricing Model in the MPT framework.

**Contracting** The entrepreneur and the investor can enter a financing contract with at least two characteristics: (i) the initial equity participation of each party and (ii) the sharing rule of profits, which may differ from the initial participation due to dilution.[13]

- First, the contract specifies $I^i$ $\left(0 \leq I^i \leq K\right)$ as the amount invested by the entrepreneur.[14] Since the entrepreneur's wealth is 1, the investor will lend the amount of $I^i - 1$ when it is positive. In addition, the investor provides the amount $K - I^i$, which corresponds to her participation in the venture. The case $I^i = 1$ is a specific situation where there is no transfer payment between the two parties. Another particular case is $I^i = K$, where the entrepreneur takes over the whole venture with a loan from the investor.

- Second, the contract determines how the returns generated by the venture are split between the entrepreneur and investor. Interestingly, the profit sharing rules can differ from the initial participation, and dilution in the financing contract reflects this difference. We characterize

[13] Consistent with our contract characterization, in their empirical studies of 1,800 venture capital contracts, Bengtsson and Ravid (2010) report six types of contract terms that fundamentally serve two goals: (i) to define the contingent cash flows to be received by the investor (e.g., cumulative dividends or participation clauses) and (ii) to define the contingent cash flows that the investor commits to put on the table (e.g, a pay-to-play clause). In our model, we consider the plain vanilla case of a single all-equity investment performed by the VC investor, leaving aside contingent contracts that would complexify the application of the mean-variance analysis without altering the key insights.

[14] Superscript $i$ on $I^i$ indicates that the entrepreneur's investment depends on the type of investor she is dealing with.

dilution by means of a transfer payment. The investor offers the entrepreneur the amount $\left(1 - I^i\right)\tau^i$ on top of her reward on the venture $\left(I^i \widetilde{r}^i_\pi\right)$, where $\tau^i$ denotes a riskless contractual transfer rate.[15] For ease of exposition, we will now characterize the contract with the pair $(I^i, \tau^i)$.

The entrepreneur's expected utility can be rewritten as

$$U^e(I^i, \tau^i) = \tau^i + I^i\left(r^i_\pi - \tau^i\right) - \frac{1}{2}\gamma^e\left(I^i\right)^2\sigma^2_\pi. \tag{1}$$

The investor considers the project as a building block in her financial portfolio. For any profit-maximizing investor, the purpose of the investment is to reach the highest possible surplus over invested capital. Indeed, from Tobin's separation theorem, well-diversified investors dissociate their risky investment decision from their financial leverage; only the latter decision depends on their level of risk tolerance. Consequently, the profit-making investor's utility function collapses to the expected cash flow less the dollar-cost of capital of the venture, i.e.,:

$$U^i(I^i, \tau^i) \equiv CF^i = \left(K - I^i\right)\left(r^i_\pi - \mu^i\right) - \left(1 - I^i\right)\left(\tau^i - \kappa^i\right), \tag{2}$$

The first term is the investor's net expected profit from the venture, while the second term accounts for the transfer to the entrepreneur. As this utility function is expressed in terms of the net cash flow, the corresponding reservation utility $U^i_\phi$ is set to zero.

# 3 Characterization of financing contracts

In this section, we first determine the set of feasible contracts between the entrepreneur and the investor. Then, the optimal contract is found as the Nash solution to a bargaining game between

[15] There is a one-to-one relation between the transfer rate and the (more intuitive) stake of the project captured by the entrepreneur and denoted by $S$. For technical reasons, the exposition of the model refers to $\tau^i$, but the interpretation of testable implications will rely on $S$ (see Section 4).

the two contracting parties. Finally, we establish a typology of investors based on their cost of capital and their ability to enhance project value. Relying on that typology, we associate the type of investor which, given the characteristics of the entrepreneur and that of the venture, maximizes the added value in contracting.

### 3.1 Feasible contracts

A contract between the entrepreneur and the investor is feasible if both parties have an incentive to participate. Denote $U^a(I^i, \tau^i)$ as the expected utility extracted by agent $a$ from the contract. It is feasible if and only if

$$\begin{cases} U^e(I^i, \tau^i) \geq \max\left(U^e_\phi, U^e_\pi\right) & \text{Entrepreneur's participation constraint,} \\ U^i(I^i, \tau^i) \geq U^i_\phi & \text{Investor's participation constraint.} \end{cases} \tag{3}$$

where $U^e_\phi = r_f + \frac{1}{2\gamma^e}\left(\frac{r_m - r_f}{\sigma_m}\right)^2$ denotes the entrepreneur's utility score if she invests all her wealth in the financial market.

A participation constraint becomes binding when the other agent has all the bargaining power in the contract negotiation. If the entrepreneur's (investor's) participation constraint is binding, the contract is investor- (entrepreneur-) dominant.

Between the entrepreneur and the investor, there exists a continuum of possible contracts $(I^i, \tau^i)$, depending on their relative bargaining powers. To assess the scope of feasible contracts, we examine extreme cases where either the investor or the entrepreneur can impose the terms of the contract. The entrepreneur-dominant contract with investor $i$ is denoted by $(I^{[e,i]}, \tau^{[e,i]})$. It corresponds to the pair $(I^i, \tau^i)$ that maximizes the entrepreneur's utility while satisfying the investor's participation constraint. In contrast, the corresponding investor-dominant contract $(I^{[i,e]}, \tau^{[i,e]})$ maximizes the investor's utility while binding the entrepreneur's participation constraint.

The following proposition summarizes the characteristics of the nondegenerate contracts ($I^i \neq 1$) (all proofs are gathered in the appendix):

**Proposition 1** *If $\mu^i - \kappa^i \neq \gamma^e \sigma_\pi^2$, a nondegenerate contract $(I^{*i}, \tau^{*i})$ between the entrepreneur and investor i is feasible when the following condition is respected:*

$$\begin{cases} \tau^{[e,i]} > \tau^{*i} > \tau^{[i,e]} & \text{if } I^{*i} < 1 \\ \tau^{[e,i]} < \tau^{*i} < \tau^{[i,e]} & \text{if } I^{*i} > 1, \end{cases}$$

*where*

$$\begin{aligned} \tau^{[e,i]} &\equiv \kappa^i + \frac{K - I^{*i}}{1 - I^{*i}}(r_\pi^i - \mu^i), \\ \tau^{[i,e]} &\equiv \frac{\max\left(U_\phi^e, U_\pi^e\right) - I^{*i} r_\pi^i + \frac{1}{2}\gamma^e \left(I^{*i}\right)^2 \sigma_\pi^2}{1 - I^{*i}}, \end{aligned}$$

*and where the entrepreneur's optimal investment level $I^{*i}$ is the same for any contract and given by*

$$I^{*i} = I^{[e,i]} = I^{[i,e]} = \min\left(\frac{\mu^i - \kappa^i}{\gamma^e \sigma_\pi^2}, K\right). \tag{4}$$

Proposition 1 entails that the optimal investment of the entrepreneur is constant regardless of the contract. It differs, however, with the identity of the investor. Two extreme cases deserve some discussion: the corner solution $I^i = K$ and the no-transfer solution $I^i = 1$. In the first situation, the entrepreneur takes over the whole project and borrows money from the investor. Note that $U^e(K, r_f) = U_\phi^e$. There is no investor who offers a lending rate lower than $r_f$, so there simply is no contract. Indeed, if the investor's risk premium $\mu^i - \kappa^i$ is too high relative to the preference-adjusted risk of the project $\gamma^e \sigma_\pi^2$, then no contract is feasible. In this case, the venture yields an attractive risk profile for the entrepreneur (low denominator of $I^{*i}$), while it is costly to finance for the investor (high numerator), who then steps away. The second situation is more insightful. The special case $\mu^i - \kappa^i = \gamma^e \sigma_\pi^2$ is the one where the marginal cost of the project is equal to its marginal benefit for the entrepreneur, so she merely gives up the share of the project that she cannot finance herself. There is no transfer and thus no dilution in that particular case.

**Corollary 1** *If the entrepreneur were able to circumvent her capital constraint using debt financing to finance a project above the CML, then the following hold:*

*(i) She would rather invest in the venture than in the financial market if and only if*

$$\gamma^e \leq \frac{(r_\pi - r_f) + \sqrt{(r_\pi - r_f)^2 - \sigma_\pi^2 \left(\frac{r_m - r_f}{\sigma_m}\right)^2}}{K\sigma_\pi^2}. \tag{5}$$

*(ii) She would be better off contracting with the investor than using debt financing.*

The first part of the corollary conveys the intuitive notion that entrepreneurs are less risk averse than other agents investing in financial markets (see, e.g., Kan and Tsai, 2006, or de Blasio et al., 2021, for empirical evidence). The second part of the corollary has an important implication: If the entrepreneur has the possibility to undertake a venture, then any VC contract is feasible in that it leaves both the entrepreneur and the venture capitalist better off. The rationale underlying this result is straightforward. The linear shape of the utility function of the investor enables the entrepreneur to eliminate a share of the project's risk in exchange for a proportional premium. On the other hand, the concavity of the entrepreneur's utility function provides a gain in expected utility from risk sharing that is more than proportional to the loss in returns. This implies that the presence of an investor always induces the entrepreneur to seek a risk sharing contract to obtain financing. As any feasible contract satisfies the investor's participation constraint, both the entrepreneur and the investor are better off with the contract than with their initial investment choice.

Figures 1a and 1b provide graphical representations of the feasible contracts between the entrepreneur and the investor. In Figure 1a, the utility score of the project is not sufficient to induce the entrepreneur to withdraw her money from her initial financial portfolio. The availability of a financing contract is powerful enough to shift up the expected utility, leading to a portfolio whose risk is $I^{*i}\sigma_\pi$ and that intersects the straight line relating $\left(0, \tau^{[i,e]}\right)$ to $\left(K\sigma_\pi, r_f + K(r^i_\pi - r_f)\right)$. In the investor-dominant case, the entrepreneur has access to a lending rate that is just high enough to make her indifferent between the venture and her initial financial portfolio. If the bargaining power of the entrepreneur increases, she can manage to raise her utility further, increasing it up to the point where the investor's participation constraint becomes binding. This situation corresponds to the upper segment originating from point $\left(K\sigma_\pi, r_f + K(r^i_\pi - r_f)\right)$ in the figure.

Insert Figure 1 here

The idea that the entrepreneur would prefer to contract rather than to undertake the project on her own is best illustrated in Figure 1b. The project is attractive, as it clearly stands above the CML. If the entrepreneur could undertake the project, she would increase her utility level, but in the absence of any investor, she is financially constrained and can only obtain the utility score $U^e_\phi$ derived from investing in the financial market. Nevertheless, the presence of an investor enhances the level of expected utility up to the maximum achievable indifference curve $U^e_{\max}$ corresponding to the entrepreneur-dominant contract, as shown by the arrow represented in the figure.

### 3.2 Optimal contract

The project is specific to the entrepreneur, but there are several kinds of investors with whom she can contract. Thus, two facets characterize the optimal contract design: the choice of the contractor and the terms of the contract.

If all the bargaining power lies within the hands of the entrepreneur, she will choose to contract with the investor that enables her to maximize her expected utility while binding the investor's participation constraint. Therefore, the program to maximize is

$$U^{[e,\bar{i}]} = \max_{i} \left[ U^e(I^{*i}, \tau^{[e,i]}) - U^e_{\phi,\pi} \right] \text{ s.t. } U^i(I^{*i}, \tau^{[e,i]}) = 0. \tag{6}$$

In the mirror case, the investor maximizes net cash flows while imposing a level of utility on the entrepreneur. If each investor competing for the same project is able to dictate the contract to the entrepreneur, the winner will be the one for whom the surplus extracted from the contract is highest. The resulting level of utility for the investor achieving the largest net return is given by:

$$U^{[\bar{i},e]} = \max_{i} U^i(I^{*i}, \tau^{[i,e]}) \text{ s.t. } U^e(I^{*i}, \tau^{[i,e]}) = U^e_{\phi,\pi}. \tag{7}$$

Between these two extreme cases, the entrepreneur and each type of investor enter a bargaining game.[16] Denoting $\eta$ the entrepreneur's bargaining power and $1-\eta$ the investor's bargaining power, we follow Inderst and Müller (2004) and solve for the Nash bargaining game between the entrepreneur and investor $i$. This yields the sharing rule that maximizes the following surplus:

$$G(I^{*i}, \tau^{*i}; \eta) = \left[ U^e(I^{*i}, \tau^{*i}) - U^e_{\phi,\pi} \right]^{\eta} \left[ U^i(I^{*i}, \tau^{*i}) \right]^{1-\eta}. \tag{8}$$

Note that the optimal contract design involves two objectives: (i) for a given investor, finding the optimal contract terms $\left(I^{*i}(\eta), \tau^{*i}(\eta)\right)$ as a function of the bargaining power $\eta$; (ii) determining the kind of investor for whom the game output is maximized. Thus, the objective function is

$$\max_{i} \max_{I^{*i}, \tau^{*i}} G(I^{*i}, \tau^{*i}; \eta). \tag{9}$$

Given the optimal share of the venture determined in Proposition 1 and the range of transfer rates that corresponds to each type of investor, provided that there exists an interior solution for $I^*$, we can characterize altogether the optimal contract terms and the optimal investor choice through the following Proposition.

[16] To simplify the optimal contract derivation, we abstract from competition effects that would result from interactions between multiple investors dealing with multiple entrepreneurs.

**Proposition 2** *If the entrepreneur can enter a nondegenerate venture capital contract with any type of investor, the solution to the bargaining game in equation (8) with* $0 \leq \eta \leq 1$ *is given by*

$$
\begin{aligned}
I^{*\bar{\imath}}(\eta) &= I^{*\bar{\imath}} = \frac{\mu^{\bar{\imath}} - \kappa^{\bar{\imath}}}{\gamma^e \sigma_\pi^2}, \\
\tau^{*\bar{\imath}}(\eta) &= \eta \tau^{[e,\bar{\imath}]} + (1-\eta)\tau^{[\bar{\imath},e]}, \\
\bar{\imath} &= \arg\max_i \left( \kappa^i + K\left(r_\pi^i - \mu^i\right) + \frac{\left(\mu^i - \kappa^i\right)^2}{2\gamma^e \sigma_\pi^2} \right) \text{ with } \frac{\mu^i - \kappa^i}{\gamma^e \sigma_\pi^2} < K.
\end{aligned}
$$

*In particular,* $G(I^{*\bar{\imath}}, \tau^{*\bar{\imath}}; 1) = U^{[e,\bar{\imath}]}$ *and* $G(I^{*\bar{\imath}}, \tau^{*\bar{\imath}}; 0) = U^{[\bar{\imath},e]}$.

The determinants of the optimal investor choice involve a mix of investor-, project- and entrepreneur-related elements. The function to maximize provides the impact of the characteristics that differentiate investors, namely $\mu^i$ and $\kappa^i$, in the case of an interior solution. It is straightforward to see that, *ceteris paribus,* their impact is indeterminate on the entrepreneur's preferences, depending on the values taken by the triplet $(K, \gamma^e, \sigma_\pi^2)$. This result calls for a closer look at the possible contracts, as discussed hereafter. The situation where $\frac{\mu^i - \kappa^i}{\gamma^e \sigma_\pi^2} \geq K$ corresponds to the corner solution in which $I^{*i} = K$, where we have seen that the entrepreneur would indeed be at least as well off as with her financial portfolio $\phi$.

Proposition 2 introduces a separation theorem regarding the optimal contract. It shows that the proportion of wealth invested in the project, $I^{*\bar{\imath}}$, is only a function of the investor's risk premium $\mu^{\bar{\imath}} - \kappa^{\bar{\imath}}$, the entrepreneur's risk tolerance, and project risk. This proportion is independent of the balance of the bargaining powers. The subsequent dilution in the entrepreneur's equity stake is reflected only in the transfer rate $\tau^{*\bar{\imath}}$, which depends on $\eta$.

An important implication is that, regardless of her bargaining power, the entrepreneur will invest a larger proportion in the project if its volatility is lower or if her outside wealth is larger (through a concurrent reduction in the risk aversion parameter $\gamma^e$). Bitler et al. (2005) derive similar predictions in the context of an agency theory framework. These results are also consistent with the signaling approach of Leland and Pyle (1977). But it should be stressed that in our case these predictions result from well-informed, risk averse entrepreneurs and therefore hold regardless of agency conflicts or information asymmetry.

Finally, note that the expected rate of return of the venture, $r_\pi$, has absolutely no impact on the contracting preferences. This rate is relevant because it drives the feasible character of each contract but it does not influence the contract design; this feature has important empirical implications. First, the project's expected return is difficult to assess empirically, but this is not a concern when the goal is to analyze the design of existing venture capital contracts. Second, one should expect the sample of observed financed ventures to be biased toward higher expected returns (projects exhibiting lower expected returns do not attract the attention of investors). Again, this selection bias should have no impact on the design of financing contracts.

### 3.3 Optimal investor type

An investor is characterized by three dimensions related to the rates of return that influence the contract defined in Proposition 2. These dimensions, which are not mutually exclusive, are the investor's cost of equity $\mu^i$, her cost of debt $\kappa^i$, and her impact on the project's expected return $r^i_\pi$. Each dimension corresponds to a potential improvement that the investor can bring to the contractual arrangement with the entrepreneur.

- The investor may require an additional return of $\alpha^i > 0$ from the project as compensation for the underdiversification of her private equity portfolio, which entails some economically significant idiosyncratic risk. This extra return tops up her cost of equity obtained from the CAPM based on the project beta. From equation (2), the necessity to achieve an extra return to satisfy her shareholders reduces the investor's expected utility, defined as the expected net cash flow from the venture. As a consequence, this induces her to lower the share of the venture that she wishes to acquire. Equation (4) shows that the increase in $\mu^i$ positively impacts the entrepreneur's optimal investment level, i.e., the amount that she will commit to the project. Thus, the investor's requirement to post an extra return indirectly leads to an increase in the entrepreneur's potential surplus compared to the market-based cost of equity.

- Either directly or through association with a related institution, the investor may benefit from a funding advantage related to its status as a financial transformation professional. This status provides her with the ability to borrow and lend at more favorable rates than those on the financial market. Let $r_f \pm \lambda^i$ be the effective lending (borrowing) rate, with $\lambda^i > 0$ being defined as the financial transformation margin.[17] The investor can split this funding and lending advantage by simultaneously capturing part of it and providing a premium to the entrepreneur when contracting the transfer rate in Proposition 2.

- Thanks to her active involvement, the investor may provide a positive enhancement to the project's expected return (see Alperovych and Hübner, 2013, Bernstein et al., 2015, or Quas et al., 2021, for a review of the potential sources of such extra value), which becomes equal to $r_\pi + \rho^i$ with $\rho^i > 0$. Because she offers more shareable surplus than her non-value-enhancing peer, the investor who is able to deliver such a $\rho^i$ will provide the entrepreneur with more favorable contract terms, all else being equal.

[17] One may naturally think of the investor as a bank, with $\lambda^i$ defined then as the intermediation margin. In reality, the investor is less likely to be a bank (because of the equity investment constraints introduced in the Basel II and III Accords) than to be an insurer or a pension fund. These institutions also benefit from a financial transformation margin through their premium reinvestment policies while simultaneously being subject to less stringent funding constraints for their private equity investments.

Note that rho and alpha represent two facets of a potentially identical reality: the investor selects projects and monitors her commitments to create positive value that will eventually be returned to her shareholders. Thus, one can naturally anticipate that the level of $\rho^i$ will match that of $\alpha^i$. Nevertheless, these two premiums might differ from each other. If $\rho^i > \alpha^i$, the investor manages to generate a return that exceeds her shareholders' requirements, thereby creating a truly abnormal return that enhances the economic value of the portfolio. Conversely, if $\rho^i < \alpha^i$, the investor is unable to meet her cost of equity. This does not necessarily mean that she does not create value for the project ($\rho^i > 0$ after all) but simply that the return enhancement is not sufficient to compensate for the idiosyncratic risk that is borne by the shareholder of her fund.

From Proposition 2, the optimal investor maximizes

$$\kappa^i + K\left(r_\pi^i - \mu^i\right) + \frac{\left(\mu^i - \kappa^i\right)^2}{2\gamma^e \sigma_\pi^2} = r_f \pm \lambda^i + K\left(r_\pi + \rho^i - \mu - \alpha^i\right) + \frac{\left(\mu + \alpha^i - r_f \mp \lambda^i\right)^2}{2\gamma^e \sigma_\pi^2},$$

where the $\pm$ sign stands for "plus" ("minus") and the $\mp$ sign stands for "minus" ("plus") if the entrepreneur is in a borrowing (lending) position.

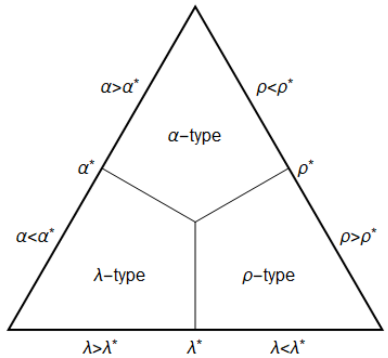
We take the right-hand side of that equation to define the following generic, three-parameter function:

$$F\left(\alpha, \lambda, \rho\right) = r_f \pm \lambda + K\left(r_\pi + \rho - \mu - \alpha\right) + \frac{\left(\mu + \alpha - r_f \mp \lambda\right)^2}{2\gamma^e \sigma_\pi^2}.$$

The investor that has a competitive edge on the equity financing side (the '$\alpha$-type' investor), generates a surplus $F\left(\alpha, 0, 0\right)$ with the entrepreneur.[18] Similarly, the investor that has a competitive edge on the debt financing side (the '$\lambda$-type' investor) generates a surplus $F\left(0, \lambda, 0\right)$ with the entrepreneur. Finally, the investor that has a competitive edge on the asset side (the '$\rho$-type' investor) generates a surplus $F\left(0, 0, \rho\right)$ with the entrepreneur.

[18] Note that the second and third arguments of the $F\left(.,.,.\right)$ function need not be equal to zero but are simply normalized to zero for clarity of exposition.

**Proposition 3** *The optimal investor type, defined as the one that maximizes the surplus from the contracting relation with the entrepreneur, is identified according to the following triangular representation:*




*with*

$$\alpha^* = -u + \sqrt{u^2 + \lambda^2 + 2\lambda\,|v|},$$

$$\lambda^* = -|v| + \sqrt{v^2 + 2\rho w},$$

$$\rho^* = \frac{1}{w}\left(\frac{\alpha^2}{2} + \alpha u\right),$$

*and* $u = \mu - r_f - K\gamma^e\sigma_\pi^2$, $v = \mu - r_f - \gamma^e\sigma_\pi^2$, *and* $w = K\gamma^e\sigma_\pi^2$.

**Corollary 2** *In the absence of a* $\lambda$*-type investor, the* $\alpha$*-type investor offers better contracting conditions than the financial market iff* $F(\alpha, 0, 0) > F(0, 0, 0)$, *that is, iff*

$$\alpha > -2u.$$

As our empirical study will show, there are few lambda-type investors in the European venture capital financing market. The corollary thus provides an approximate condition under which the underdiversified VC investor (alpha-type) brings enough added value to win the contract.

# 4 Entrepreneur's characteristics and VC financing contracts

Our theoretical analysis emphasizes the importance of the entrepreneur's risk aversion and bargaining power as key drivers of VC financing contracts. In this section we derive three sets of testable implications relating:

- the entrepreneur's risk aversion to the VC contract terms (entrepreneur's investment and the stake she obtains in return),
- the entrepreneur's bargaining power to the VC contract terms,
- the entrepreneur's risk aversion to the type of VC investor.

The following numerical analysis is carried out under a realistic base case scenario. Details of the model calibration are reported in Appendix A.

## 4.1 Risk aversion and contract terms

Figure 2 shows how the terms of the VC contract are related to the entrepreneur's risk aversion when the type of investor is endogenously determined. The VC contract terms are characterized by the entrepreneur's investment $I^*$ and stake $S^*$, the latter being defined as the fraction of expected project value accruing to the entrepreneur; that is,

$$S^* = \frac{\tau^* (1 - I^*) + I^* r_\pi}{K r_\pi}. \tag{10}$$

For an exogenous investor type (i.e., $\mu^i$ and $\kappa^i$ are given), we see from equation (4) that the entrepreneur's investment $I^*$ is a convex, decreasing function of the entrepreneur's risk aversion. The first order differentiation of equation (10) shows that given an exogenous investor type, the entrepreneur's stake $S^*$ also decreases with the entrepreneur's risk aversion. As shown in Figure

2, these relations still hold when the investor type is endogenous but they are punctuated by discontinuities due to switches in optimal investor type.

Insert Figure 2 here

We therefore formulate the following hypotheses related to the entrepreneur's risk aversion:

- **H1.** *The entrepreneur's investment decreases with her level of risk aversion.*

- **H2.** *The entrepreneur's stake decreases with her level of risk aversion.*

## 4.2 Bargaining power and contract terms

Proposition 2 establishes that the entrepreneur's investment does not depend on her bargaining power. However, the expression of equation (10) shows that the entrepreneur's stake is related to $\eta$ through the endogenous transfer rate $\tau^*$. Since $\tau^*$ is the linear combination of $\tau^{[e,\bar{\imath}]}$ and $\tau^{[\bar{\imath},e]}$ weighted by the respective bargaining powers, the relation between the entrepreneur's stake and her bargaining power depends on the ranking between these two transfer rates. As shown in Proposition 1, $\tau^{[e,\bar{\imath}]}$ is smaller than $\tau^{[\bar{\imath},e]}$ when the entrepreneur's investment exceeds her initial wealth ($I^* > 1$). In that case indeed, the entrepreneur must resort to the investor's financing and her goal is then to limit the scope of dilution by minimizing the transfer rate. We therefore conjecture the following hypothesis:

- **H3.** *When the entrepreneur's investment exceeds her initial wealth, her stake increases with her bargaining power.*

### 4.3 Investor type

As shown in Proposition 2 and the expression for $\bar{\imath}$, the choice of the investor type is not affected by the entrepreneur's bargaining power but it depends on her level of risk aversion. Figure 3 shows the optimal investor type as a function of venture size $K$ and risk $\beta$, for various degrees of entrepreneur risk aversion.

Insert Figure 3 here

There are two distinct splitting mechanisms between the three investor types depending on whether the entrepreneur's risk aversion coefficient is low or high (the cutoff level for risk aversion is $\gamma = 0.75$ with our calibration). Thus, from a static perspective of a fixed risk aversion level for the average entrepreneur in a given economy, we can draw the following two hypotheses:

- **H4A.** *When the average level of the entrepreneurs' risk aversion is low, investors with a competitive edge on equity financing ($\alpha$-type investors) mostly finance small projects, regardless of their risk; investors with a competitive edge on debt financing ($\lambda$-type investors) mostly finance large and high-risk projects; and investors with a competitive edge on asset value enhancement ($\rho$-type investors) mostly finance large and low-risk projects.*

- **H4B.** *When the average level of the entrepreneurs' risk aversion is high, investors with a competitive edge on equity financing ($\alpha$-type investors) mostly finance small and high-risk projects; investors with a competitive edge on debt financing ($\lambda$-type investors) mostly finance small and low-risk projects; and investors with a competitive edge on asset value enhancement ($\rho$-type investors) mostly finance large and projects regardless of their risk.*

The transition from each part of the figure indicates that the proportion of investors who participate in investment rounds depends on the prevailing risk aversion level of the entrepreneur. If one considers a market-wide level of risk aversion that changes from one region or period to another, the model entails the following:

- **H5A.** *The proportion of investors with a competitive edge on equity financing ($\alpha$-type investors) in a deal decreases with the level of risk aversion, with an increasing focus on smaller projects.*

- **H5B.** *The proportion of investors with a competitive edge on debt financing ($\lambda$-type investors) in a deal first decreases and then increases with the level of risk aversion.*

- **H5C.** *The proportion of investors with a competitive edge on asset value enhancement ($\rho$-type investors) in a deal first increases (with an increasing focus on smaller projects) and then decreases (with a decreasing focus on smaller projects) with the level of risk aversion.*

# 5 Empirical tests

This section presents a stylized empirical test of the predictions regarding investors and entrepreneurs outlined in the previous section (hypotheses **H1** to **H5C**). After describing the sources and characteristics of the data at the deal, investor, and entrepreneur levels, we explain the construction of variables. We then present the regression-based tests of hypotheses **H1** to **H3**. Finally, we show tests of our tentative partitioning of investor types.

## 5.1 Data sources

Venture capital transactions are extracted from the Crunchbase dataset (www.crunchbase.com, henceforth denoted as CB). Although CB is a relatively new player among VC data providers,[19]

[19] Other popular databases are Refinitiv (formerly known as Thomson One, Venture Economics, or VentureXpert), Venture Source, Capital IQ, etc. According to Investeurope, a European equivalent of NVCA,

scholars have already used it to study angel investments (Hellmann and Thiele, 2015) and crowdfunding (Signori and Vismara, 2018). In their analysis of eight major VC databases, Retterath and Bauer (2020) find that CB is in the top three in terms of deal coverage and information accuracy. One advantage of CB is that it provides reliable information on amounts raised by ventures as well as their postmoney valuations (both in U.S. dollars).[20] This is essential as we need to characterize the stakes taken by entrepreneurs and investors. We recover the whole history of CB investments up until December 31, 2019. As in all other VC transaction databases, the meaningful coverage of investments starts from approximately 1995, if not later (see Figure 5).[21]

Since we need cross-sectional variation in risk aversion (discussed below), we further limit our analyses to investments in EU member states and non-EU but EEE member countries.[22] We refer to these countries as "European countries".[23] For our analyses we also require financial data, unavailable in CB, but accessible through Orbis, a database commercialized by Bureau van Dijk (Moody's Analytics). The final sample consists of 2,808 investment-investor-specific observations that correspond to 1,315 investment rounds over 993 target companies and 1,501 investment firms.

Figure 4 highlights the time series of European investments recorded in CB. The European mar-

venture capital investments in 2019 amounted to EUR10.6bn (Investeurope, last accessed on Dec. 24th, 2020), which is roughly equivalent to the Crunchbase data in the same year. It should however be noted that Crunchbase and Investeurope do not necessarily classify investments in a consistent way; e.g., what Crunchbase may consider "venture capital", Investeurope puts into the "growth capital" category, and vice versa.

[20] Retterath and Bauer (2020) document that CB provides excellent coverage with regards to the investment amounts but claim that it does not provide postmoney values. This is indeed the case for the online version of CB in which only the investment amounts are reported. We recover our data using the API provided by CB. In contrast to the online front-end, the bulk download provides the postmoney valuations for a subset of venture rounds.

[21] This is not problematic for our analyses since we also require additional data, which are available from approximately 2010 onward. CB's coverage was already sufficient at that time.

[22] This limitation applies to entrepreneurial ventures (target companies) only.

[23] We are using the time-varying membership restriction for the EU members and non-EU but EEE members. Thus, we only retain investments made in targets located in EU or EEE member countries at the investment date.

kets show a sharp uptake starting immediately after the financial crisis of 2008. Orbis incidentally provides financials for the last 10 years as of the access date. We recovered information from Orbis in 2020; hence, the absence of deal activity in CB before 2008 is not problematic for us.

Insert Figure 4 here

The distributions of CB investments across industries and across countries are reported in Table 1. Although CB deals are associated with all sectors of the economy, there is a concentration of transactions in the information technology industry in a broad sense ("Software", "Internet services", "Data and analytics", etc.), which is typical to venture capital. Commerce, media and financial services are also well represented. Geographically speaking, more than half of the deals are located in the United Kingdom.

Insert Table 1 here

## 5.2 Variables

**Dependent variables** We start by constructing our variables of interest, namely the entrepreneur's investment ($I^*$) (hypothesis **H1**), the entrepreneur's stake ($S^*$) (hypotheses **H2** and **H3**), and the investor type (hypotheses **H4** and **H5**). The entrepreneur's investment ($I^*$) is the size of the project scaled by the target pretransaction total assets. The size of the project is estimated from the pre-money valuation of the target, as reported by CB.[24] The total assets are recovered

[24] The CB-reported pre-money valuation represents the venture capitalist's assessment of the inputs brought by the entrepreneur and possibly other investors prior to the focal financing round.

from Orbis.[25] We construct a proxy for the entrepreneur's stake ($S^*$) as

$$1 - \frac{\text{Amount raised}}{\text{Post-money valuation}}.$$

As far as the investor types are concerned, we rely on the mapping in Table 2 to relate a Crunchbase investor type with our theoretical typology introduced in Section 3.3.

Insert Table 2 here

Investors who display a competitive edge on the equity financing side ($\alpha$-type investors) primarily seek return enhancements in their global portfolio through their VC activity to maximize their information ratio, as shown by Black and Treynor (1973). They aim to reach this goal through active selection and management of their asset allocation in a limited number of venture projects. We expect smaller investors with a concentrated portfolio, such as micro VC funds and business angels, to belong to this group. These investors constitute the bulk of $\alpha$-type investors, which also comprise some specialized (government or family) offices that often have very targeted investment portfolios.

$\lambda$-type investors draw their comparative advantage through their active risk and maturity transformation role. In their quality of financial intermediaries at large, they enjoy better funding and lending conditions than the rest of the market. They view venture capital as a way to complete their mix of investment opportunities and to capture the intermediation margin in an alternative way.[26] Hence, we associate this investor type with financial institutions that play an intermediation role, such as funds and investment banks.

[25] While matching the CB data to Orbis, we implicitly impose the condition of the availability of the match between the two. This, however, is not strictly required for some of our analyses. To verify that our results are unaffected by this restriction, we run our econometric analyses on the unrestricted data as well. The results are materially similar.

[26] Such a view is consistent with empirical evidence shown by Hellmann et al. (2008) that a strategic motive for banks to invest in venture capital is to create opportunities for enhanced lending possibilities.

The set of $\rho$-type investors features large professional investment vehicles whose involvement, infrastructure and network can all potentially create positive externalities beyond the intrinsic value of the project. We include venture capital and private equity funds and their variations in this group.

Our categorization leads us to assign the majority of observations (50.42%) to the $\rho$-type group of investors. A little less than one-third (29.45%) of the sample belongs to the $\alpha$-type. The $\lambda$-type investor group includes only 3.01% of our observations. Nevertheless, with 90 observations, we can still consider this group as sufficiently large to enable us to test our hypotheses regarding the choice of investor type. Finally, we cannot associate 511 observations to any particular investor type and choose to leave them unclassified. Overall, the distribution of our classified investor types is fairly representative of the Crunchbase population.

Admittedly, the classification of some investor categories may be subject to debate. To alleviate this concern, we also tested our predictions regarding investor types with an alternative sample that only contains the major category in each type (i.e., the 560 "angels" for the $\alpha$-type, the 62 "investment banks" for the $\lambda$-type, and the 864 "venture capital" for the $\rho$-type).[27] Results (available upon request) are very similar to those obtained for the whole sample classified according to Table 2, which are reported in Tables 10 and 11 in section 6.3.

**Independent variables** The entrepreneur's risk aversion is proxied by the 'Fear to fail' index from the Global Entrepreneurship Monitor (GEM, https://www.gemconsortium.org) database. GEM tracks entrepreneurial behaviors and attitudes worldwide and over time since 1999. Formally, GEM defines the "Fear to fail" as the "Percentage of 18-64 population (individuals involved in any stage of entrepreneurial activity excluded) who indicate that fear of failure would prevent them

[27] Interestingly, this sample concentrated around the leading (and less disputable) categories preserves its representativeness of the Crunchbase population: $\alpha$-type investors account for 37.69% of the sample, $\lambda$-type investors are 4.17%, and $\rho$-type investors are 58.14%.

from setting up a business". A score (Fear to fail) is thus assigned to each entrepreneur per country per year, and varies both across and within countries.[28]

We follow Wang and Wang (2012) and proxy the VC investor's bargaining power (which is $1-\eta$) with the number of investors involved in the transaction (# investors). The rationale is that all investors involved benefit of a higher bargaining power when they form a larger syndicate.[29]

**Control variables** We add the following controls to our analyses. First, we use country and city information to recover the latitudes and longitudes (with Google's Geocoding API) and to compute the geodesic distances (in kilometers) between the investors and ventures. This variable (Distance) is calculated to control for the extent of local bias, the expected monitoring costs and the value-adding potential.[30] Second, we control for the age of the investor (Investor age) and the age of the target firm (Target age) at the transaction date. Next, we control for the fundraising activity (Fundraising) by collecting the overall VC fundraising, measured in terms of the number of funds, in European countries (Refinitiv). We also control for the experience of investors by building a measure (Investor experience) which is the number of transactions made by an investor in the last 60 months before the month of the focal transaction. Finally, since CB provides no information

[28] This definition may imply that an investor willing to contract with more / less risk-averse entrepreneur must target a foreign country (with a different level of Fear to fail). This interpretation, however, is not entirely consistent with our data. More than 60% of our sample consists of investments with local investors, and 40% of the sample involve local investors only. At the deal level, 70% of investors on average are local.

[29] To challenge the robustness of that assumption, we further conduct our empirical analysis at the aggregate deal level using average investor characteristics (see Appendix D).

[30] Bernstein et al. (2016), among others, demonstrate that the geographical distance between ventures and investors is one of the key elements that affect the decision to invest, the extent of on-site monitoring and the involvement of VCs into value-adding activities (see also Gompers et al. 2020; Sorenson 2018; Samila and Sorenson, 2011; Sorenson and Stuart, 2001). Cumming and Dai (2010) further investigate the variation in the local bias of VC investments as a function of investors' characteristics. The general conclusion of this stream of research indicates that local VC investors are better able to cope with information asymmetries, anticipate potential moral hazard, and add more value to their target companies. All of these factors form an ex ante basis for the valuation of the focal venture used by VC investors (Gompers et al., 2020). This, in turn, has a direct effect on our variables of interest.

on the risk of entrepreneurial projects, we control for industry risk, which can be approximated using stock market data. The industry beta (Beta) is thus calculated as the covariance between the industry and market returns scaled by the variance of market monthly returns over the last 60 months that precede the month of the focal investment. This requires establishing a specific mapping from CB industry categories into standard industry classification (SIC codes). The details of this mapping and the corresponding beta calculation are presented in Appendix B. Finally, given the weight of British deals in our sample (Table 1, panel B), the variable Dummy UK is included. Note that this variable also controls for the legal environment (Schmidt and Wahrenburg, 2003, La Porta et al., 1997) as Great Britain's common law jurisdiction contrasts with the rest of our sample mainly comprised of civil law countries.

The complete list of variables as well as their definitions is reported in Table 3. All monetary data is expressed in December 2019 U.S. dollars (using the monthly inflation rates from the U.S. Bureau of Labor Statistics).

Insert Table 3 here

The descriptive statistics of the variables for the whole sample are reported in Table 4. In Table 5, these statistics are split between seed and non-seed investments. Similar tables for the raw sample ('unrestricted sample') before matching with the Orbis financial data are reported in Appendix C. Crossing the observations with the available Orbis data cuts the sample size by a factor of approximately 1.6. However, such a restriction does not produce any significant bias in the final, 'restricted' sample (see Appendix C).

Insert Table 4 here

The entrepreneurial investment scaled by the total assets has an average of 3 log-points, and a large standard deviation of approximately 2 log-points. Both reflect the presence of large extreme values. However, the median of this variable in log-points is 2.67, which is equivalent to a premoney value to assets multiple of approximately 13.4x. Looking at the difference between the seed and non-seed rounds, we observe that most of the extreme observations are driven by the seed rounds (see Table 5) with an average $\log I^*$ for seed (non-seed) rounds of 3.69 (2.81). The difference is statistically significant at the 1% level in both parametric and nonparametric tests. We note, however, that we only observe the total assets for approximately half of the sample.

Insert Table 5 here

The average entrepreneurial stake is 0.83 (standard deviation is 0.11), which is higher than the stake of 0.6 reported by Ewens et al. (2022), but is consistent with the recent survey of European VC investors suggesting that the majority (63%) of VC investors in the EU demand stakes between 10% and 20% (Söderblom et al., 2023).[31] When we break the sample into seed and non-seed investments, we observe slightly larger (lower) entrepreneurial stakes of approximately 85% (81%) in the seed (non-seed) rounds. This difference is also statistically significant at the 1% level in both parametric and nonparametric Mann-Whitney tests.

Fear to fail has an average value of 37.31 and a fairly close median of 36.40, indicating that roughly one-third of the European population is reluctant to engage in any form of entrepreneurship. An average investor in our data has completed 56 investments prior to the focal one. The large standard deviation (122.03) and the low median (10.00) of this variable once again reflect a great heterogeneity of investors present in our data. On average, the experience of investors engaging in

[31] We also note that the sample of Ewens et al. (2022) is based on the U.S. data, which reflects a much more mature VC industry. Our data encompass VC investments in a less developed European market. Moreover, Ewens et al. (2022) include only first-round deals in their analyses, while we do not impose such restrictions. Finally, they operate with figures coming from another data source and spanning different sample years. Altogether, this may explain the difference observed in terms of the retained entrepreneurial stake.

seed rounds is higher (67.88 versus 46.74), but this difference is significant at the 1% level in the parametric test and in levels only. Once we take the log of this variable (as we do in our regressions), this difference disappears completely.

As expected, the average risk of the sampled ventures (as proxied by the beta of their corresponding industries) is relatively high (approximately 2) with a similar median (2.03). The average target is 4 years old (1.85 in seed rounds). Contrary to the popular notion that investors invest under the "20-minute" rule (Cumming and Dai, 2010), the median distance between ventures and investors is 243km and is mostly driven by later stage investments. Consistent with the notion that most of the venture capital transactions are syndicated, we observe an average of 3.58 investors involved in each transaction in our sample. This number changes only marginally when we look at the seed and non-seed investments. Specifically, 3 VC firms back the seed deals on average vs. 4 in non-seed ones, with the difference being statistically significant at the 1% level in the t-test and the Mann-Whitney test.

### 5.3 Regression analysis

In this section, we conduct several multivariate regression analyses to test the hypotheses about entrepreneurial investment and stake (hypotheses **H1** to **H3**). Our unit of observation has the investment-investor form. This implies the duplication of the investment-invariant characteristics at the round level, which, in turn, induces a clustering of the standard errors. Accordingly, in investment-investor regressions, we always cluster standard errors at the deal level. Considering the different characteristics exhibited by seed and non-seed investments (see Table 5), we opt to run regressions on the whole sample as well as on these two distinct subsamples.[32] The multicollinearity

[32] As a robustness check, we collapse the sample at the deal level by averaging the investor-related characteristics, and re-estimate the models. The results are unaffected (see Appendix D).

diagnosis shows little correlation among dependent variables with one exception: The correlation coefficient between Fundraising and Dummy UK is around 85%. We choose to exclude the latter variable from the following regressions.[33]

We first present the regression results for the entrepreneur's investment in Table 6.[34] The results indicate a negative relation between the the entrepreneur's investment and her aversion to risk, thereby supporting **H1**. The corresponding coefficient is statistically significant at the 1% level in specifications involving all rounds. Its economic significance is also notable: a one standard deviation increase in entrepreneur's risk aversion results in a -0.262 point reduction in $I^*$(a 0.13 standard deviation reduction), which corresponds to a 8.42% decrease in her investment relative to the sample average. Interestingly, the effect of the entrepreneur's risk aversion is concentrated in non-seed deals.

Insert Table 6 here

We further notice that the variable proxying for the entrepreneur's bargaining power (i.e., the number of investors) is not statistically significant except in one specification. Even if the absence of statistical significance cannot be interpreted as a result, this is nonetheless consistent with our theoretical framework in which the entrepreneur's optimal investment and her bargaining power are not related.

Next, in Table 7, we turn our attention to the regression results for the entrepreneur's stake. As in the previous set of results on the entrepreneur's investment, Table 7 shows a very significantly negative association between the entrepreneur's stake in the project and her level of risk aversion. The strength of the relationship, with $p$-values lower than 1%, stands in all specifications except for

[33] The Dummy UK variable is reintroduced in the selection equation of models with endogenous self-reporting (next subsection). The very large number of observations for these equations makes multicollinearity much less of an issue.

[34] The size of the sample is reduced because we need to match the observations with information from Orbis.

the seed financing stage, and it is particularly pronounced in the other (non-seed) financing stages (Model (7)). In terms of economic magnitude, the most complete specification (Model (5)) suggests that a one standard deviation in entrepreneur's risk aversion results in an average 1.61% reduction of the entrepreneurial stake (a 0.12 standard deviation reduction). Thus, **H2** is fully supported in our sample.

Insert Table 7 here

We also obtain evidence of a significant influence of the bargaining power between the entrepreneur and the investor. The coefficients for the variable # investors are all significant and have the expected negative sign. Moreover, the economic magnitude of the estimates in Model (5) suggests that a one standard deviation increase in the investors' bargaining power implies an average 2.68% reduction of the entrepreneurial stake (a 0.20 standard deviation reduction). This is consistent with **H3**, which predicts that, irrespective of the choice of investor type, the entrepreneur's (investor's) bargaining power positively (negatively) affects the entrepreneur's stake in the project. Contrary to the effect of Fear to fail, the influence of bargaining power is particularly pronounced in the seed financing stage (see Model (6)).

Finally, examining specifications (1) to (4), we observe that each characteristic of the entrepreneur (risk aversion and bargaining power) brings its own contribution to the explanatory power of the model.

One potential concern regarding the regression analyses is related to the observability of the transaction values. In this context, Cochrane (2005) notes that round amounts are typically reported conditional on the success of a given venture and we note that both entrepreneurs' stakes and investments require relying on the pre- and postmoney values observed in Crunchbase. We cannot rule out the possibility of nonrandomness in the observability of deal values. However, we note that this case is essentially a sample (self-) selection problem that can be alleviated using the Heckman (1976; 1979) models. In Appendix E we report the regression outcomes controlling for endogenous round amounts. We find that self-selection concerns do not affect our results.

## 5.4 Tests for investor type proportions

We conduct two types of tests. The first tests compare the proportions of funded projects per investor type. The second tests examine the changes in funding proportions according to risk aversion.

### 5.4.1 Venture financing per investor type – static analysis

We focus on the three groups of interest for the analysis of the most likely entrepreneur-investor pairings. Our model predicts that depending on the project risk (proxied by the industry beta) and size (measured as a fraction of the entrepreneur's wealth), the entrepreneur's level of risk aversion has an impact on the investor's choice. To verify the associated hypotheses, we split the sample into two parts according to the median level of risk aversion. Next, for each investor type, we further split the observations according to the median beta and size of the associated ventures. Under the null hypothesis of the absence of any contracting preference related to project characteristics, each investor type should fund an equal proportion of ventures per quadrant, namely 25%. We apply a simple Pearson's chi square test on the actual observed proportions in each case. The results are displayed in Table 8 (the cells of interest are in boxed text).

Insert Table 8 here

Panel A, which displays the categorization of projects among investors when the average risk aversion level is low, provides relevant information regarding **H4A**. The evidence supports the model's conjecture concerning $\alpha$-type investors, who predominantly finance projects of smaller size. Nevertheless, this result could have been foreseen given the identities of this group's members. Regarding the preferences of $\lambda$-type and $\rho$-type investors, the evidence is mixed.[35] There is a clear shift toward larger projects for both categories, but they also tend to fund riskier projects. This is consistent with our model for $\lambda$-type investors only.

The results of Panel B (high level of risk aversion) show an increase in the proportion of small, high-risk projects financed by $\alpha$-type investors (31.83%, +6.02%), even though it does not exceed the proportion of low-size low-risk projects (41.38%, +3.45%). Regarding $\lambda$-type investors, there is indeed a clear shift from high-risk to lower-risk projects, but they mostly remain large in size. Finally, the focus of $\rho$-type investors remains on large projects, with a shift toward riskier ones, which is fully consistent with **H4B**.

Even though the evidence reported in Table 8 is only preliminary (based on static proportions) and largely confirms conventional wisdom regarding the natural distribution of project financing ($\alpha$-type investors finance smaller projects than $\lambda$-type and $\rho$-type investors), our model provides a theoretical explanation for the major differences between Panels A and B, especially for the larger investor categories. When Fear to fail increases, $\alpha$-type investors focus on smaller and riskier projects, while $\rho$-type investors shift their focus toward riskier ventures.

#### 5.4.2 Venture financing per investor type – dynamic analysis

Instead of considering each investor type in isolation, we now examine the share of projects that are funded in different circumstances. Our model predicts that the average level of risk aversion influences the competitive advantage of each investor type and, as a consequence, its share of the

[35] Given the small number of observations, we remain cautious regarding statistical inference on $\lambda$-type investors.

wallet. To test the associated hypotheses, denoted **H5A** to **H5C** in Section 4.2, we partition the sample of projects into four subsamples according to their sizes (represented by $K$) and risks (represented by their $\beta$). Each subsample is, in turn, cut into two halves according to the prevailing risk aversion level on the market at the moment of the deal. We perform a $Z$-test on the difference in the proportions of each investor type between the low-gamma and high-gamma environments. The results are displayed in Table 9.

Insert Table 9 here

The results of Panel A provide clear support for **H5A**, which posits a decreasing relationship between the proportion of $\alpha$-type investors in financing rounds and the average level of entrepreneurs' risk aversion. This decrease is more pronounced for large projects (both with high and low risk, with respective drops of 13.63% and 7.80%), as expected from the model. Regarding $\lambda$-type investors (Panel B), whose share in the wallet is much lower than those of the other investors, only the "low risk/large size" case posts significant results. The increase in the proportion of projects funded by this kind of investors, from 3.40% to 10.74%, is in line with the predictions of the model (hypothesis **H5B**) if the difference in risk aversion is sufficiently pronounced. Finally, Panel C, which reports the results for $\rho$-type investors, mostly corresponds to the model predictions in the zone of relatively low levels of risk aversion (hypothesis **H5C**). For low values of gamma, the proportion of projects funded by those kinds of investors materially increases with the level of risk aversion, as shown in the upper part of Figure 4. This is clearly the case in our sample, as indicated in the "low risk/small size" (from 45.67% to 53.22%) and "high risk/large size" (from 64.78% to 77.88%) cases, which are both significant.

Overall, the evidence provided in Table 9 confirms the influence of the prevailing risk aversion in the entrepreneurial landscape on the choice of the preferred investor type. The consistency of our results, mostly found for the largest categories of investors ($\alpha$-type and $\rho$-type), seems to best correspond to an overall low level of risk aversion. When gamma is close to zero, our model points to a gradual substitution of $\alpha$-type investors with $\rho$-type investors as risk aversion increases, with the former increasingly concentrating on smaller and riskier projects. This is precisely what we observe in our sample, and the significance of the changes in proportions assures us in our theoretical hypothesis that risk aversion plays a sensible role in venture contracting choices.

As mentioned previously, all these findings hold when the funding proportions are calculated over an alternative sample built from a stricter classification of investors (namely, only "angels", "investment banks" and "venture capital" representing the $\alpha$-, $\lambda$- and $\rho$-type investors, respectively).

## 6 Conclusion

Addressing the contracting preferences of an entrepreneur and her investor through the lens of a portfolio choice problem provides new insights into venture capital financing. A first key result is that merely the risk transfer opportunity given to the entrepreneur by the venture capital relationship provides sufficient incentive to transact with a professional investor. The fact that VC investors can absorb some of the idiosyncratic risk inherent to every entrepreneurial project thus appears as the foundation of a thriving VC industry. Regarding the venture financing contract, we further establish a separation theorem whereby the financial implication of the entrepreneur (her investment) solely depends on project characteristics and the investor's cost of capital, whereas the allocation of cash flow rights (her stake) results from a bargaining game between the contracting parties. Finally, we emphasize the impact that investor heterogeneity, namely, different costs of capital or value-enhancing capabilities, can have on contract choices and design. Our analysis sheds new light on the market shares of the VC industry by reclassifying investors based upon their impact on the project's rate of return.

The role of the entrepreneur's risk aversion level is particularly important to our analysis. To our knowledge, this is the first study that explicitly relates the entrepreneur's risk tolerance to her contracting choice. It contributes to solving a puzzle regarding the geographical variations in venture capital activity. Our empirical analysis on European data highlights the entrepreneur's risk aversion as an important determinant of the VC industry structure. The entrepreneur's risk aversion is also shown to influence the way different types of investors intervene across the stage financing process.

The portfolio approach of VC financing can be extended in several directions. Investor heterogeneity is an exogenous assumption in our framework. Identifying the determinants of our categorization of investors could enrich our understanding of contracting preferences. Another interesting extension is to allow for a certain degree of competition among financiers as well as among entrepreneurs. Most interestingly, adverse selection and agency cost considerations affect the venture capital relationship, as shown by previous literature. The next modeling milestone is to combine the portfolio approach with informational frictions. A controlled empirical investigation capable of disentangling their respective impacts on VC contracts would be of particular relevance.

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## Tables

**Table 1:** Sample distribution by industry and country.

Panel A reports the sample distribution across the Crunchbase industry categories. Crunchbase often assigns a venture to several industry categories. As a consequence, many ventures are counted multiple times. Panel B reports the sample distribution across the country of the target company.

| PANEL A: Industry distribution | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Industry | N | % | Industry | N | % | Industry | N | % |
| Software | 432 | 12.17 | Travel and Tourism | 66 | 1.86 | Clothing and Apparel | 33 | 0.93 |
| Internet Services | 249 | 7.01 | Design | 60 | 1.69 | Sustainability | 33 | 0.93 |
| Commerce and Shopping | 189 | 5.32 | Advertising | 59 | 1.66 | Biotechnology | 32 | 0.90 |
| Media and Entertainment | 178 | 5.01 | Community and Lifestyle | 57 | 1.61 | Music and Audio | 31 | 0.87 |
| Financial Services | 177 | 4.99 | Consumer Electronics | 50 | 1.41 | Privacy and Security | 31 | 0.87 |
| Data and Analytics | 171 | 4.82 | Content and Publishing | 48 | 1.35 | Events | 29 | 0.82 |
| Information Technology | 162 | 4.56 | Food and Beverage | 48 | 1.35 | Administrative Services | 20 | 0.56 |
| Mobile | 146 | 4.11 | Payments | 44 | 1.24 | Consumer Goods | 18 | 0.51 |
| Hardware | 128 | 3.61 | Lending and Investments | 42 | 1.18 | Navigation and Mapping | 18 | 0.51 |
| Science and Engineering | 126 | 3.55 | Sports | 40 | 1.13 | Platforms | 16 | 0.45 |
| Health Care | 113 | 3.18 | Video | 40 | 1.13 | Messaging and Telecom. | 15 | 0.42 |
| Sales and Marketing | 106 | 2.99 | Education | 37 | 1.04 | Natural Resources | 11 | 0.31 |
| Apps | 98 | 2.76 | Gaming | 37 | 1.04 | Unknown | 9 | 0.25 |
| Artificial Intelligence | 86 | 2.42 | Professional Services | 37 | 1.04 | Agriculture and Farming | 6 | 0.17 |
| Transportation | 83 | 2.34 | Manufacturing | 36 | 1.01 | Government and Military | 3 | 0.08 |
| Real Estate | 66 | 1.86 | Energy | 34 | 0.96 | | | |
| | | | | | | Total | 3,550 | 100.00 |

| PANEL B: Country distribution | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Country | N | % | Country | N | % | Country | N | % |
| Great Britain | 524 | 52.77 | Netherlands | 18 | 1.81 | Austria | 5 | 0.50 |
| Spain | 81 | 8.16 | Poland | 15 | 1.51 | Czech Republic | 5 | 0.50 |
| Germany | 77 | 7.75 | Estonia | 13 | 1.31 | Hungary | 5 | 0.50 |
| Italy | 52 | 5.24 | Latvia | 12 | 1.21 | Lithuania | 4 | 0.40 |
| Sweden | 35 | 3.52 | Denmark | 9 | 0.91 | Slovenia | 4 | 0.40 |
| Bulgaria | 29 | 2.92 | Portugal | 8 | 0.81 | Cyprus | 2 | 0.20 |
| Ireland | 29 | 2.92 | Belgium | 6 | 0.60 | Malta | 2 | 0.20 |
| France | 26 | 2.62 | Luxemburg | 6 | 0.60 | | | |
| Finland | 20 | 2.01 | Slovakia | 6 | 0.60 | Total | 993 | 100.00 |

**Table 2:** Correspondence between Crunchbase and theoretical investor types.

The table establishes how Crunchbase investor classes are assigned to a type ($\alpha$, $\lambda$ or $\rho$) according to their cost of capital and their ability to enhance project value.

| Crunchbase investor class | Number | Investor type | Fraction of classified investor types Sample / Crunchbase population |
|---|---|---|---|
| Angel | 560 | | |
| Angel group | 78 | | |
| Co-working space | 4 | | |
| Entrepreneurship program | 4 | $\alpha$-type | 35.53% / 39.58% |
| Family investment office | 30 | (29.45%) | |
| Government office | 44 | | |
| Micro venture capital | 152 | | |
| Secondary purchaser | 3 | | |
| University program | 4 | | |
| Fund of funds | 11 | | |
| Hedge fund | 13 | $\lambda$-type | 3.63% / 2.38% |
| Investment bank | 62 | (3.01%) | |
| Pension fund | 4 | | |
| Accelerator | 224 | | |
| Corporate venture capital | 101 | | |
| Incubator | 47 | $\rho$-type | 60.84% / 58.04% |
| Investment partner | 49 | (50.42%) | |
| Private equity firm | 220 | | |
| Venture capital | 864 | | |
| Syndicate | 13 | | |
| Unknown | 489 | unclassified | |
| Venture debt | 9 | (17.12%) | |

**Table 3:** List of variables.

All variables used in the empirical study are listed with their source and a short definition.

| Name | Source | Definition |
|---|---|---|
| Distance | Crunchbase / Google API / own calculations | The shortest distance between the target and investors cities ('as the crow flies') defined by their respective latitudes and longitudes. The distance is computed according to the 'haversine method'. The latitudes and longitudes were obtained by geocoding the cities of targets and investors using Google's Geocoding API. |
| Investor age | Crunchbase / own calculations | The age of investor at the transaction date. |
| Target age | Crunchbase / own calculations | The age of the target firm at the transaction date. |
| Fundraising | Refinitiv | Number of all funds raised in the target country in a year before the focal transaction. |
| Investor experience | Crunchbase / own calculations | Number of transactions made by an investor in the last 60 months before the month of the focal transaction. |
| Industry beta | Datastream / own calculations | Covariance between the industry and market returns scaled by the variance of market returns. This measure is computed over the last 60 months that precede the month of the focal investment. |
| Dummy UK | Crunchbase | Dummy variable (=1) if the target is registered in the U.K. |
| Fear to fail ($\gamma^e$) | GEM | Percentage of 18-64 population (individuals involved in any stage of entrepreneurial activity excluded) who indicate that fear of failure would prevent them from setting up a business (see www.gemconsortium.org). |
| # investors ($1-\eta$) | Crunchbase / own calculations | Number of investors involved in the transaction. |
| Entrepreneur's investment ($I^*$) | Crunchbase / Orbis | The size of the entrepreneurial project scaled by the target pre-transaction total assets. |
| Entrepreneur's stake ($S^*$) | Crunchbase | Entrepreneur's stake post-transaction defined as 1 – (Amount raised) / (Post-money valuation). |

**Table 4:** Sample descriptive statistics.

The table collects descriptive statistics for the variables used in the econometric analyses. We also present statistics in levels for the variables that are log-transformed in regression analyses. The definitions of each variable are provided in Table 3. All monetary figures are expressed in 2019 U.S. dollars. The sample is CONSTRAINED by the availability of ORBIS company financial data, and is composed of 1,315 investment rounds involving 993 target companies and 1,501 investors, observed during the period 2010-2019, and distributed across 2,808 investment-investor-level observations. Column N reports the number of nonmissing data points.

| Variable | N | Mean | SD | Min | $Q_{0.25}$ | Median | $Q_{0.75}$ | Max |
|---|---|---|---|---|---|---|---|---|
| Distance | 2,075 | 2,050.17 | 3,366.30 | 0.00 | 0.00 | 237.26 | 1,748.30 | 18,325.44 |
| log(1+Distance) | 2,075 | 4.45 | 3.62 | 0.00 | 0.00 | 5.47 | 7.47 | 9.82 |
| Investor age | 1,979 | 16.48 | 30.82 | 0.00 | 3.45 | 6.58 | 15.41 | 350.41 |
| log(1+Investor age) | 1,979 | 2.18 | 1.06 | 0.00 | 1.49 | 2.03 | 2.80 | 5.86 |
| Target age | 2,766 | 4.18 | 7.60 | 0.00 | 0.94 | 2.67 | 5.34 | 171.66 |
| log(1+Target age) | 2,766 | 1.29 | 0.78 | 0.00 | 0.66 | 1.30 | 1.85 | 5.15 |
| Fundraising | 2,755 | 36.04 | 24.05 | 1.00 | 12.00 | 41.00 | 54.00 | 184.00 |
| log(1+Fundraising) | 2,755 | 3.24 | 1.03 | 0.69 | 2.56 | 3.74 | 4.01 | 5.22 |
| Investor experience | 2,808 | 55.97 | 122.05 | 0.00 | 1.00 | 10.00 | 48.00 | 1,254.00 |
| log(1+Investor experience) | 2,808 | 2.38 | 1.94 | 0.00 | 0.69 | 2.40 | 3.89 | 7.13 |
| Industry beta | 2,793 | 2.00 | 0.29 | 0.54 | 1.87 | 2.03 | 2.14 | 3.62 |
| Fear to fail | 2,642 | 37.41 | 4.09 | 20.89 | 35.23 | 36.40 | 37.66 | 57.68 |
| # investors | 2,808 | 3.57 | 3.40 | 1.00 | 1.00 | 2.00 | 5.00 | 24.00 |
| Entrepreneur's investment | 1,395 | 3.11 | 2.08 | 0.01 | 1.97 | 2.67 | 3.67 | 20.08 |
| Entrepreneur's stake | 2,808 | 0.83 | 0.13 | 0.01 | 0.78 | 0.86 | 0.92 | 1.00 |

**Table 5:** Difference tests between seed and non-seed investments.

The table collects descriptive statistics for the variables used in the econometric analyses further broken down by seed and non-seed investment types. We also present statistics in levels for the variables that are log-transformed in regression analyses. The definitions of each variable are provided in Table 3. All monetary figures are expressed in 2019 U.S. dollars. The sample is CONSTRAINED by the availability of ORBIS company financial data, and is composed of 1,315 investment rounds involving 993 target companies and 1,501 investors, observed during the period 2010-2019, and distributed across 2,808 investment-investor-level observations. Columns N report the number of nonmissing data points. The $t$-test and MW columns display the $p$-values of the univariate $t$- and Mann-Whitney tests of differences.

| | Seed investments | | | Non-seed investments | | | | |
|---|---|---|---|---|---|---|---|---|
| Variable | N | Mean | SD | N | Mean | SD | t-test | MW |
| Distance | 843 | 807.13 | 2,236.49 | 1,232 | 2,900.73 | 3,726.77 | 0.00 | 0.00 |
| log(1+Distance) | 843 | 2.99 | 3.27 | 1,232 | 5.46 | 3.50 | 0.00 | 0.00 |
| Investor age | 822 | 7.66 | 20.97 | 1,157 | 22.75 | 34.91 | 0.00 | 0.00 |
| log(1+Investor age) | 822 | 1.71 | 0.77 | 1,157 | 2.51 | 1.11 | 0.00 | 0.00 |
| Target age | 1,208 | 1.85 | 2.09 | 1,558 | 5.99 | 9.58 | 0.00 | 0.00 |
| log(1+Target age) | 1,208 | 0.86 | 0.59 | 1,558 | 1.63 | 0.75 | 0.00 | 0.00 |
| Fundraising | 1,199 | 36.05 | 22.86 | 1,556 | 36.03 | 24.95 | 0.98 | 0.60 |
| log(1+Fundraising) | 1,199 | 3.23 | 1.07 | 1,556 | 3.24 | 1.00 | 0.63 | 0.60 |
| Investor experience | 1,224 | 67.88 | 143.95 | 1,584 | 46.76 | 101.04 | 0.00 | 0.20 |
| log(1+Investor experience) | 1,224 | 2.36 | 2.09 | 1,584 | 2.40 | 1.81 | 0.61 | 0.20 |
| Industry beta | 1,216 | 1.98 | 0.28 | 1,577 | 2.01 | 0.30 | 0.00 | 0.00 |
| Fear to fail | 1,146 | 37.51 | 4.43 | 1,496 | 37.33 | 3.82 | 0.26 | 0.31 |
| # investors | 1,224 | 3.00 | 3.66 | 1,584 | 4.02 | 3.11 | 0.00 | 0.00 |
| Entrepreneur's investment | 487 | 3.69 | 2.23 | 908 | 2.81 | 1.93 | 0.00 | 0.00 |
| Entrepreneur's stake | 1,224 | 0.85 | 0.11 | 1,584 | 0.81 | 0.15 | 0.00 | 0.00 |

**Table 6:** Regression models of entrepreneur's investment.

The table collects the results of the OLS models with entrepreneur's investment ($I^*$) standardized by target company's pre-transaction total assets as the dependent variable. The definitions of each variable are provided in Table 3. All monetary figures are expressed in 2019 U.S. dollars. The sample is CONSTRAINED by the availability of ORBIS company financial data, and is composed of 1,315 investment rounds involving 993 target companies and 1,501 investors, observed during the period 2010-2019, and distributed across 2,808 investment-investor-level observations. The reduction in the number of observations in each model depends on the missing data in the regressors. Investment stage dummies are "Growth", "Late" and "Unidentified" (the reference category is "Early" stage). Standard errors clustered at the deal level are reported in parentheses.

| | All rounds | | | | | Seed | Non-seed |
|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| Intercept | 2.469** | 4.546*** | 2.518** | 4.884*** | 5.438*** | −0.273 | 4.791*** |
| | (0.971) | (1.306) | (0.994) | (1.364) | (1.308) | (1.987) | (1.490) |
| log(1+Distance) | 0.004 | 0.003 | 0.009 | 0.006 | −0.009 | 0.012 | 0.019 |
| | (0.032) | (0.032) | (0.031) | (0.032) | (0.034) | (0.048) | (0.037) |
| log(1+Investor age) | −0.043 | −0.016 | −0.025 | −0.004 | 0.001 | 0.156 | −0.029 |
| | (0.078) | (0.083) | (0.082) | (0.086) | (0.091) | (0.317) | (0.096) |
| log(1+Target age) | −0.828*** | −0.865*** | −0.803*** | −0.848*** | −0.837*** | −1.447*** | −0.598*** |
| | (0.184) | (0.191) | (0.185) | (0.192) | (0.199) | (0.546) | (0.216) |
| log(1+Fundraising) | 0.248** | 0.330*** | 0.230** | 0.298** | 0.277** | 0.616*** | 0.195 |
| | (0.098) | (0.109) | (0.101) | (0.119) | (0.113) | (0.188) | (0.163) |
| log(1+Investor experience) | 0.094** | 0.050 | 0.090** | 0.048 | 0.025 | −0.021 | 0.072 |
| | (0.044) | (0.045) | (0.045) | (0.046) | (0.046) | (0.092) | (0.055) |
| Industry beta | 0.362 | 0.286 | 0.427 | 0.347 | 0.119 | 0.934 | 0.197 |
| | (0.448) | (0.447) | (0.437) | (0.433) | (0.428) | (0.658) | (0.523) |
| Fear to fail | | −0.056*** | | −0.063*** | −0.064*** | −0.038 | −0.055** |
| | | (0.022) | | (0.022) | (0.021) | (0.042) | (0.028) |
| # investors | | | −0.060 | −0.051 | −0.088* | 0.135 | −0.074 |
| | | | (0.039) | (0.045) | (0.046) | (0.152) | (0.048) |
| Investment stage: Growth | | | | | 0.538 | | |
| | | | | | (0.365) | | |
| Investment stage: Late | | | | | −0.583 | | |
| | | | | | (0.534) | | |
| Investment stage: Unidentified | | | | | −0.541** | | |
| | | | | | (0.257) | | |
| Adj. $R^2$ | 0.105 | 0.121 | 0.110 | 0.124 | 0.145 | 0.160 | 0.074 |
| Period dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Num. obs. | 991 | 929 | 991 | 929 | 929 | 305 | 624 |

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$.

**Table 7:** Regression models of entrepreneur's stake.

The table collects the results of the fractional regression models (Papke and Wooldridge, 1996) with entrepreneur's stake ($S^*$) as the dependent variable. The definitions of each variable are provided in Table 3. All monetary figures are expressed in 2019 U.S. dollars. The sample is UNCONSTRAINED by the availability of ORBIS company financial data, and is composed of 2,219 investment rounds involving 1,722 target companies and 2,387 investors, observed during the period 2010-2019, and distributed across 4,652 investment-investor-level observations. The reduction in the number of observations in each model depends on the missing data in the regressors. Investment stage dummies are "Growth", "Late" and "Unidentified" (the reference category is "Early" stage). Standard errors clustered at the deal level are reported in parentheses.

| | All rounds | | | | | Seed | Non-seed |
|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| Intercept | 1.535*** | 2.369*** | 1.462*** | 2.509*** | 2.463*** | 2.374*** | 2.491*** |
| | (0.268) | (0.388) | (0.280) | (0.412) | (0.430) | (0.529) | (0.593) |
| log(1+Distance) | −0.008 | −0.006 | −0.002 | −0.001 | 0.000 | −0.015* | 0.011 |
| | (0.008) | (0.008) | (0.009) | (0.009) | (0.008) | (0.009) | (0.012) |
| log(1+Investor age) | −0.041* | −0.030 | −0.029 | −0.019 | −0.008 | −0.088** | 0.005 |
| | (0.024) | (0.024) | (0.025) | (0.026) | (0.028) | (0.042) | (0.030) |
| log(1+Target age) | −0.038 | −0.047 | −0.006 | −0.020 | 0.005 | 0.000 | 0.022 |
| | (0.037) | (0.039) | (0.041) | (0.042) | (0.053) | (0.063) | (0.056) |
| log(1+Fundraising) | −0.061* | −0.051 | −0.062* | −0.065 | −0.062 | 0.089** | −0.157** |
| | (0.037) | (0.043) | (0.037) | (0.046) | (0.046) | (0.041) | (0.068) |
| log(1+Investor experience) | 0.062*** | 0.057*** | 0.061*** | 0.056*** | 0.052*** | 0.052*** | 0.050*** |
| | (0.012) | (0.012) | (0.012) | (0.012) | (0.011) | (0.014) | (0.018) |
| Industry beta | 0.084 | 0.101 | 0.142 | 0.160 | 0.162 | −0.157 | 0.235 |
| | (0.116) | (0.118) | (0.124) | (0.126) | (0.119) | (0.131) | (0.168) |
| Fear to fail | | −0.024*** | | −0.029*** | −0.028*** | −0.008 | −0.036*** |
| | | (0.007) | | (0.008) | (0.008) | (0.008) | (0.013) |
| # investors | | | −0.055*** | −0.057** | −0.054** | −0.102*** | −0.046* |
| | | | (0.021) | (0.023) | (0.026) | (0.015) | (0.027) |
| Investment stage: Growth | | | | | −0.063 | | |
| | | | | | (0.127) | | |
| Investment stage: Late | | | | | 0.052 | | |
| | | | | | (0.292) | | |
| Investment stage: Unidentified | | | | | −0.210 | | |
| | | | | | (0.160) | | |
| McFadden adj. pseudo $R^2$ | 0.125 | 0.128 | 0.157 | 0.161 | 0.178 | 0.354 | 0.197 |
| Period dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Deviance | 256.651 | 242.265 | 248.749 | 234.543 | 233.097 | 66.706 | 156.188 |
| Num. obs. | 2,603 | 2,418 | 2,603 | 2,418 | 2,418 | 1,063 | 1,355 |

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$.

**Table 8:** Proportions of funded projects per investor type.

The table reports the percentages of projects funded by each investor type ($\alpha$-type, $\lambda$-type and $\rho$-type) in the situations when the prevailing average risk aversion is below (Panel A) or above (Panel B) the median level across all observations during the period 2010-2019. For each investor type, the sample is partitioned according to the median beta and size of the associated ventures. The cells of interest for the tested hypotheses are in boxed text. For each tested 2x2 matrix, we report value of the chi-square test of equality of proportions and its associated $p$-value.

Panel A: Low $\gamma$ observations

| | $\alpha$-type | | $\lambda$-type | | $\rho$-type | |
|---|---|---|---|---|---|---|
| | Low $K$ | High $K$ | Low $K$ | High $K$ | Low $K$ | High $K$ |
| High $\beta$ | [25.81%] | 21.69% | 6.45% | [58.06%] | 17.59% | 33.49% |
| Low $\beta$ | [38.83%] | 13.67% | 9.68% | 25.81% | 23.61% | [25.31%] |
| N | 461 | | 31 | | 648 | |
| $\chi^2$ | 61.09 | | 20.74 | | 33.42 | |
| $p$-value | 0.00 | | 0.00 | | 0.00 | |

Panel B: High $\gamma$ observations

| | $\alpha$-type | | $\lambda$-type | | $\rho$-type | |
|---|---|---|---|---|---|---|
| | Low $K$ | High $K$ | Low $K$ | High $K$ | Low $K$ | High $K$ |
| High $\beta$ | [31.83%] | 14.59% | 5.66% | 37.74% | 15.96% | [36.02%] |
| Low $\beta$ | 41.28% | 12.20% | [7.55%] | 49.06% | 24.83% | 23.19% |
| N | 377 | | 53 | | 733 | |
| $\chi^2$ | 88.54 | | 30.09 | | 60.50 | |
| $p$-value | 0.00 | | 0.00 | | 0.00 | |

**Table 9:** Changes in funding proportions according to risk aversion.

The table reports the changes in percentages of projects funded by $\alpha$-type (Panel A), $\lambda$-type (Panel B) and $\rho$-type (Panel C) investors according to whether the prevailing average risk aversion is below or above the median level across each category of ventures (beta and size) during the period 2010-2019. For each investor type, the sample is partitioned according to the median beta and size of the associated ventures. For each tested pair, we report value of the standard normal $Z$-test of equality of proportions and its associated $p$-value.

| Panel A: $\alpha$-type investors | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Low $K$ | | | | High $K$ | | | |
| | Low $\gamma$ | High $\gamma$ | $Z$-test | $p$-value | Low $\gamma$ | High $\gamma$ | $Z$-test | $p$-value |
| High $\beta$ | 50.64% | 50.00% | 0.139 | 0.889 | 29.85% | 16.22% | 4.203 | 0.000 |
| N | 235 | 240 | | | 335 | 339 | | |
| Low $\beta$ | 53.43% | 45.61% | 2.304 | 0.042 | 26.81% | 19.01% | 2.028 | 0.043 |
| N | 335 | 342 | | | 235 | 242 | | |

| Panel B: $\lambda$-type investors | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Low $K$ | | | | High $K$ | | | |
| | Low $\gamma$ | High $\gamma$ | $Z$-test | $p$-value | Low $\gamma$ | High $\gamma$ | $Z$-test | $p$-value |
| High $\beta$ | 0.85% | 1.25% | -0.426 | 0.670 | 5.37% | 5.90% | -0.296 | 0.767 |
| N | 235 | 240 | | | 335 | 339 | | |
| Low $\beta$ | 0.90% | 1.17% | -0.352 | 0.724 | 3.40% | 10.74% | -3.115 | 0.002 |
| N | 335 | 342 | | | 235 | 242 | | |

| Panel C: $\rho$-type investors | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Low $K$ | | | | High $K$ | | | |
| | Low $\gamma$ | High $\gamma$ | $Z$-test | $p$-value | Low $\gamma$ | High $\gamma$ | $Z$-test | $p$-value |
| High $\beta$ | 48.51% | 48.75% | -0.522 | 0.958 | 64.78% | 77.88% | -0.958 | 0.000 |
| N | 235 | 240 | | | 335 | 339 | | |
| Low $\beta$ | 45.67% | 53.22% | -1.963 | 0.050 | 69.79% | 70.25% | -0.110 | 0.913 |
| N | 335 | 342 | | | 235 | 242 | | |

# Figures

**Figure 1: Feasible contracts.**

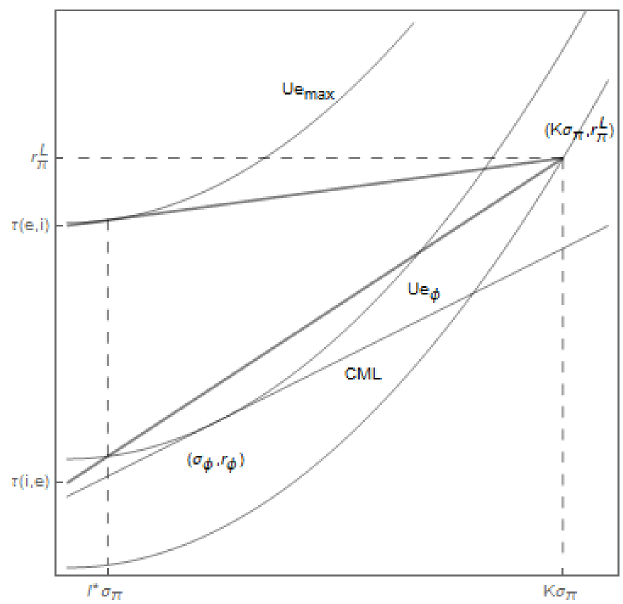



Figure 1a

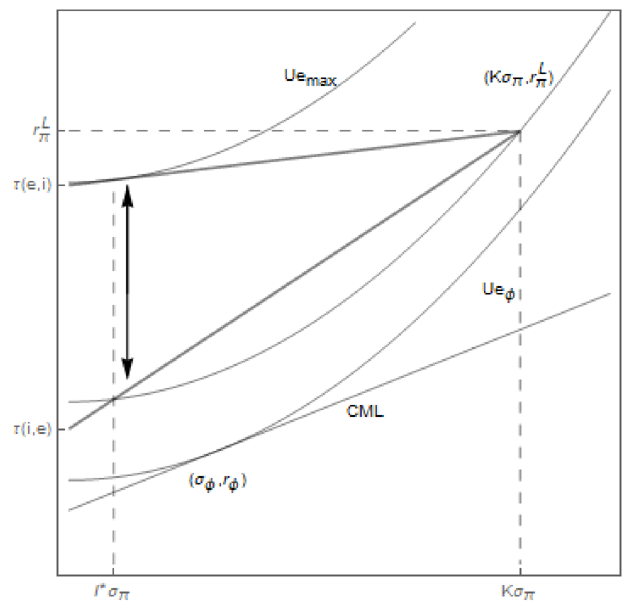



Figure 1b

Figures 1a and 1b illustrate the feasible contracts between the entrepreneur and the venture capitalist in the standard deviation - mean space when the entrepreneur does not (figure 1a) or does (figure 1b) finance the venture. The curve labeled $U^e_\phi$ is the entrepreneur's initial utility function. The straight line labeled CML is the Capital Market Line. Their tangency point is at coordinates $\left(\sigma_\phi, \mu_\phi\right)$. The bold straight lines connect the project characteristics $\left(K\sigma_\pi, r^L_\pi\right)$, where $r^L_\pi \equiv r_f + K\left(r_\pi - r_f\right)$ denotes the project's levered return, with the lower and upper bounds for the admissible rate of transfer between the entrepreneur and the venture capitalist ($\tau^{[e.i]}$ and $\tau^{[i,e]}$). The arrow in figure 1b spans the possible utility gains for the entrepreneur resulting from all feasible contracts.

**Figure 2: Optimal entrepreneur's investment, stake and risk aversion.**

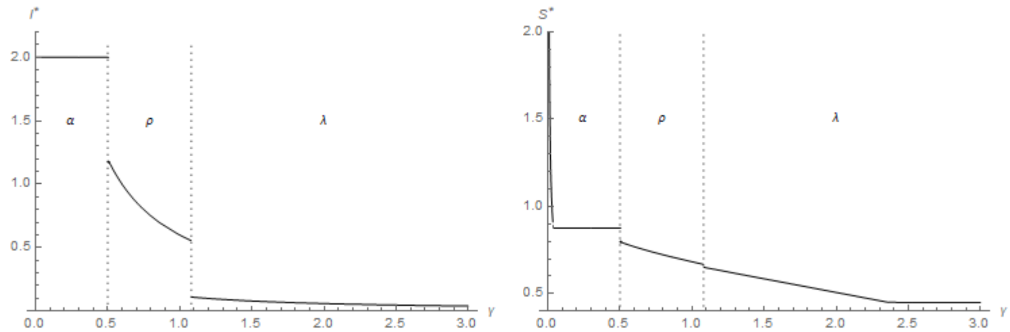
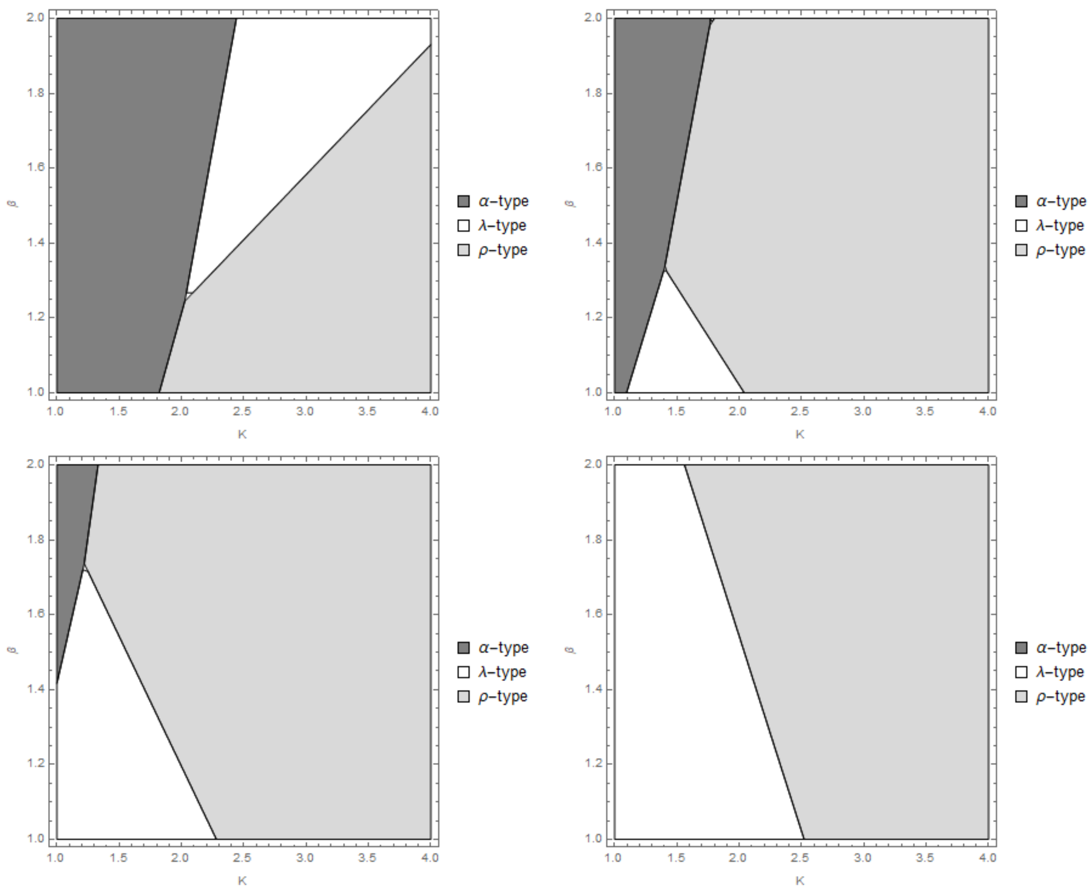


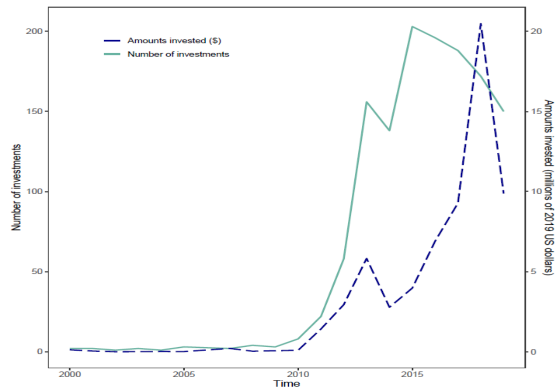

Figure 2 shows the amount $I^*$ invested by the entrepreneur (left-hand side graph) and stake $S^*$(right-hand side graph) as a function of entrepreneur's risk aversion. The investor type is endogenous and is indicated by $\alpha$, $\lambda$, or $\rho$ on the corresponding contracting regions. Parameter values are reported in Appendix A.

**Figure 3: Optimal investor type.**




In the $(K, \beta)$ space, the figure shows the domains for the type of venture capitalist that maximizes contract surplus with the entrepreneur. Parameter values are reported in Appendix A. In the top left, top right, bottom left and bottom right graphs, the entrepreneur's risk aversion coefficient is 0.5, 0.75, 1, and 1.5, respectively.

**Figure 4: Deals reported in the Crunchbase dataset.**




The figure shows the evolution, between 2000 and 2019, of the number of investments (straight line, left scale) and the total amounts invested (dashed line, right scale) reported in the Crunchbase dataset.

## Proofs

### Proposition 1

First, we characterize the entrepreneur's share of investment for a contract between the entrepreneur and a given investor $i$. Consider the two contracts in which one of the agents captures all the surplus (i.e., maximizes her expected utility while binding the other agent's participation constraint). These two contracts lead to the following optimization programs:

$$\begin{aligned} I^{*i,x_e} &= \arg\max_{I^i} U^i(I^i,\tau^i) \text{ s.t. } U^e(I^i,\tau^i) = \max\left(U^e_\phi, U^e_\pi\right), \\ \text{or } I^{*e,x_i} &= \arg\max_{I^i} U^e(I^i,\tau^i) \text{ s.t. } U^i(I^i,\tau^i) = 0. \end{aligned}$$

In the first program, the entrepreneur's utility constraint is bound at transfer rate $\tau^{*i,x_e}$. Similarly, in the second program, the investor's utility constraint is bound at transfer rate $\tau^{*e,x_i}$. Inserting the binding constraint, the optimal investor's share of the project is solution to

$$\begin{aligned} I^{*i,x_e} &= \arg\max_{I^i} \left(-\max\left(U^e_\phi, U^e_\pi\right) + K\left(r^i_\pi - \mu^i\right) + (1-I^i)\kappa^i + I^i\mu^i - \frac{1}{2}\gamma^e\left(I^i\right)^2\sigma^2_\pi\right), \\ I^{*e,x_i} &= \arg\max_{I^i} \left(K\left(r^i_\pi - \mu^i\right) + (1-I^i)\kappa^i + I^i\mu^i - \frac{1}{2}\gamma^e\left(I^i\right)^2\sigma^2_\pi\right). \end{aligned}$$

Note that the investor's cost of equity $\mu^i$ is the same in both programs. The cost of debt $\kappa^i$ switches from $r_f + \lambda^i$ to $r_f - \lambda^i$ at $I^i = 1$. Excluding that degenerate case, both programs are piecewise quadratic functions of $I^i$. Since they only differ by a constant, applying the FOC yields the same optimum for $I^i$:

$$\arg_{I^i}\left(\frac{\partial U^i(I^i,\tau^{*i,x_e})}{\partial I^i} = 0\right) = \arg_{I^i}\left(\frac{\partial U^e(I^i,\tau^{*e,x_i})}{\partial I^i} = 0\right) = \frac{\mu^i - \kappa^i}{\gamma^e\sigma^2_\pi}.$$

Because $U^i(I^i)$ is increasing and then decreasing, and since the value of $I^i$ is bounded above by

$K$, we obtain the optimal level of entrepreneur's investment as

$$I^{*i} = I^{*i,x_e} = I^{*e,x_i} = \min\left(\frac{\mu^i - \kappa^i}{\gamma^e \sigma_\pi^2}, K\right).$$

The condition for the existence of an optimal contract simply follows from binding the participation constraint for the extreme cases. For the entrepreneur-dominant case, we set $x_i = 0$ and retrieve the transfer rate from equation (2):

$$\tau^{[e,i]} = \kappa^i + \frac{K - I^{*i}}{1 - I^{*i}}\left(r_\pi^i - \mu^i\right).$$

For the investor-dominant case, we get the entrepreneur's participation constraint $x_e = \max\left(U_\phi^e, U_\pi^e\right)$, and retrieve the transfer rate from equation (1):

$$\tau^{[i,e]} = \frac{\max\left(U_\phi^e, U_\pi^e\right) - I^{*i} r_\pi^i + \frac{1}{2}\gamma^e \left(I^{*i}\right)^2 \sigma_\pi^2}{(1 - I^{*i})}.$$

In the case where $\lambda^i = 0$, the determination of $\mu^i$ and $\kappa^i$ is straightforward as they can only take one value.

For $\lambda^i > 0$, the function $U^e(I^i, \tau^i)$ is piecewise linear. So, function $U^e(I^i, \tau^{*i})$, that writes

$$U^e(I^i, \tau^{*i}) = \begin{cases} K\left(r_\pi^i - \mu^i\right) + (1 - I^i)\left(r_f + \lambda^i\right) + I^i\left(r_f + \beta(r_m - r_f)\right) - \frac{1}{2}\gamma^e \left(I^i\right)^2 \sigma_\pi^2 & \text{if } I^i > 1 \\ K\left(r_\pi^i - \mu^i\right) + (1 - I^i)\left(r_f - \lambda^i\right) + I^i\left(r_f + \beta(r_m - r_f)\right) - \frac{1}{2}\gamma^e \left(I^i\right)^2 \sigma_\pi^2 & \text{otherwise} \end{cases},$$

with $\mu^i > r_f + \lambda^i > r_f - \lambda^i$, is piecewise quadratic in $I^i$, with the same FOC as before. Three cases are to be distinguished:

1. if $r_f + \beta(r_m - r_f) - \left(r_f - \lambda^i\right) > r_f + \beta(r_m - r_f) - \left(r_f + \lambda^i\right) \geq \gamma^e \sigma_\pi^2$, then $I^{[e,i]} \geq 1$ (lending situation) and the prevailing rate is $r_f + \lambda^i$;

2. if $\gamma^e \sigma_\pi^2 \geq r_f + \beta(r_m - r_f) - \left(r_f - \lambda^i\right) > r_f + \beta(r_m - r_f) - \left(r_f + \lambda^i\right)$, then $I^{[e,i]} \leq 1$ (borrowing situation) and the prevailing rate is $r_f - \lambda^i$;

3. if $r_f + \beta(r_m - r_f) - \left(r_f - \lambda^i\right) > \gamma^e \sigma_\pi^2 > r_f + \beta(r_m - r_f) - \left(r_f + \lambda^i\right)$, then the local optima $I_l^{[e,i]} = \frac{r_f + \beta(r_m - r_f) - \left(r_f + \lambda^i\right)}{\gamma^e \sigma_\pi^2} < 1$ and $I_d^{[e,i]} = \frac{r_f + \beta(r_m - r_f) - \left(r_f - \lambda^i\right)}{\gamma^e \sigma_\pi^2} > 1$, corresponding to the two quadratic segments of the utility function, are not compatible with the domain of $\left(r_f + \lambda^i\right)$ and $\left(r_f - \lambda^i\right)$, respectively. In this case, as $U^e(I^i, \tau^{*i})$ is piecewise quadratic and has a negative coefficient in $\left(I^i\right)^2$, the global maximum of this function is $I^{[e,i]} = 1$ which is a degenerate case where there is no transfer between the entrepreneur and the investor.

## Corollary 1

Since the venture and financial markets are mutually exclusive investment opportunities, the entrepreneur must compare the utility levels $U_\pi^e$ versus $U_\phi^e$. If the entrepreneur does not undertake the venture, she holds a portfolio of financial assets whose expected rate of return is:

$$r_\phi^e = \frac{\sigma_\phi^e}{\sigma_m} r_m + \left(1 - \frac{\sigma_\phi^e}{\sigma_m}\right) r_f,$$

where

$$\sigma_\phi^e = \arg\max_\sigma \left(\frac{\sigma}{\sigma_m} r_m + \left(1 - \frac{\sigma}{\sigma_m}\right) r_f - \frac{1}{2}\gamma^e \sigma^2\right) = \frac{r_m - r_f}{\gamma^e \sigma_m}.$$

The entrepreneur's initial utility score is

$$U_\phi^e = r_f + \frac{1}{2\gamma^e}\left(\frac{r_m - r_f}{\sigma_m}\right)^2 = r_f + \frac{1}{2\gamma^e}\left(\frac{r_\phi^e - r_f}{\sigma_\phi^e}\right)^2. \tag{11}$$

To undertake the project with debt financing, the entrepreneur must borrow $K - 1$. Assuming the entrepreneur can borrow this amount at $r_f$,[36] the expected return from her investment in the venture has expectation $r_f + K\left(r_\pi - r_f\right)$ and standard deviation $K\sigma_\pi$. The expected utility extracted from the venture project is

$$U_\pi^e = r_f + K\left(r_\pi - r_f\right) - \frac{1}{2}\gamma^e K^2 \sigma_\pi^2. \tag{12}$$

[36] This is a conservative assumption. If the entrepreneur is charged a premium on her borrowing, debt financing will become even less appealing.

The indifference point for adopting the venture is $U^e_\pi = U^e_\phi$, which yields given equations (11) and (12)

$$2\gamma^e K\left(r_\pi - r_f\right) - \left(\gamma^e\right)^2 K^2\sigma_\pi^2 = \left(\frac{\mu_\phi - r_f}{\sigma_\phi}\right)^2.$$

The solutions to that quadratic equation in $\gamma^e$ are:

$$\gamma_1^e = \frac{\left(r_\pi - r_f\right) - \sqrt{\left(r_\pi - r_f\right)^2 - \sigma_\pi^2\left(\frac{\mu_\phi - r_f}{\sigma_\phi}\right)^2}}{K\sigma_\pi^2} \quad \text{and} \quad \gamma_2^e = \frac{\left(r_\pi - r_f\right) + \sqrt{\left(r_\pi - r_f\right)^2 - \sigma_\pi^2\left(\frac{\mu_\phi - r_f}{\sigma_\phi}\right)^2}}{K\sigma_\pi^2},$$

and the project is undertaken with debt financing for $\gamma^e \in [\gamma_1^e, \gamma_2^e]$. For any real positive numbers $a$ and $b$ such that $a > b$, we have $\sqrt{a^2 - b^2} > a - b$. Hence,

$$\gamma_1^e < \frac{\mu_\phi - r_f}{K\sigma_\pi\sigma_\phi},$$

and, since $K\sigma_\pi > \sigma_\phi$ by assumption,

$$\gamma_1^e < \frac{\mu_\phi - r_f}{\sigma_\phi^2} = \gamma^e.$$

Because condition $\gamma^e > \gamma_1^e$ is always satisfied, the debt financing condition reduces to

$$\gamma^e \leq \frac{\left(r_\pi - r_f\right) + \sqrt{\left(r_\pi - r_f\right)^2 - \sigma_\pi^2\left(\frac{\mu_\phi - r_f}{\sigma_\phi}\right)^2}}{K\sigma_\pi^2}.$$

## Proposition 2

We first solve the nested objective function $\max_{I^{*i}(\eta),\tau^{*i}(\eta)} G(I^{*i}(\eta), \tau^{*i}(\eta); \eta)$ for a particular investor $i$. First note that, from Proposition 1, the optimal entrepreneur's share in the venture is the same for any contract with a given investor, therefore $I^{*i}(\eta) = I^{*i}$. Since we assume the contract to be nondegenerate, $I^{*i} < K$. The only variable that drives the optimal contract as a function of the bargaining power is the transfer rate $\tau^{*i}$.

Taking the log of the nested objective function, applying the FOC and rearranging yields

$$\tau^{*i}(\eta) = \arg\left\{\eta\left[U^i(I^{*i}, \tau^{*i})\right] - (1-\eta)\left[U^e(I^{*i}, \tau^{*i}) - U^e_{\phi,\pi}\right] = 0\right\}$$

Equations (2) and (1) provide the values of $U^i$ and $U^e$, respectively. This gives a linear equation in $\tau^{*i}$ whose solution is given by

$$\tau^{*i}(\eta) = \eta \left[ \kappa^i + \frac{K - I^{*i}}{1 - I^{*i}} (r^i_\pi - \mu^i) \right] + (1 - \eta) \left[ \frac{U^e_{\phi,\pi} - I^{*i} r^i_\pi + \frac{1}{2}\gamma^e \left(I^{*i}\right)^2 \sigma^2_\pi}{1 - I^{*i}} \right],$$

where the first expression between brackets equals $\tau^{[e,i]}$ and the second one equals $\tau^{[i,e]}$ from Proposition 1. We easily check that the second order condition is satisfied.

To solve the global problem at the equilibrium transfer rate $\tau^{*i}(\eta)$: $\max_i G(I^{*i}, \tau^{*i}(\eta))$, we note that, from equation (2), and noting that $U^i(I^{*i}, \tau^{[e,i]}) = 0$ by definition, we get:

$$U^i(I^{*i}, \tau^{*i}(\eta)) = U^i(I^{*i}, \tau^{*i}(\eta)) - U^i(I^{*i}, \tau^{[e,i]}) = \left(1 - I^{*i}\right)(1 - \eta) \left(\tau^{[e,i]} - \tau^{[i,e]}\right).$$

Similarly, applying equation (1) and using the fact that $U^e_\phi = U^e(I^{*i}, \tau^{[i,e]})$, we get

$$U^e(I^{*i}, \tau^{*i}(\eta)) - U^e_\phi = U^e(I^{*i}, \tau^{*i}(\eta)) - U^e(I^{*i}, \tau^{[i,e]}) = \left(1 - I^{*i}\right)\eta \left(\tau^{[e,i]} - \tau^{[i,e]}\right).$$

Hence, the global maximization problem simplifies to

$$\max_i G(I^{*i}, \tau^{*i}(\eta)) = \max_i \left(1 - I^{*i}\right) \left(\tau^{[e,i]} - \tau^{[i,e]}\right).$$

From the definitions of $\tau^{[e,i]}$ and $\tau^{[i,e]}$ provided in Proposition 1, the preferred investor type verifies

$$\bar{\imath} = \arg\max_i \left[ \kappa^i \left(1 - I^{*i}\right) + \left(K - I^{*i}\right)(r^i_\pi - \mu^i) - \left( U^e_{\phi,\pi} - I^{*i} r^i_\pi + \frac{1}{2}\gamma^e \left(I^{*i}\right)^2 \sigma^2_\pi \right) \right].$$

Using the fact that $I^{*i} = \frac{\mu^i - \kappa^i}{\gamma^e \sigma^2_\pi}$ if the contract is not degenerate, removing all terms that are independent of $i$ and rearranging yields

$$\bar{\imath} = \arg\max_i \left( \kappa^i + K\left(r^i_\pi - \mu^i\right) + \frac{\left(\mu^i - \kappa^i\right)^2}{2\gamma^e \sigma^2_\pi} \right),$$

which completes the proof.

## Proposition 3

The $\alpha$-type investor maximizes

$$F(\alpha,0,0)=\frac{\alpha^2}{2\gamma^e\sigma_\pi^2}+\alpha\left(\frac{\mu-r_f}{\gamma^e\sigma_\pi^2}-K\right)+r_f-K(\mu-r_\pi)+\frac{(\mu-r_f)^2}{2\gamma^e\sigma_\pi^2}.$$

When it comes to the $\lambda$-type investor,[37] if $\mu-r_f>\gamma^e\sigma_\pi^2$, which implies $I^*>1$ (the entrepreneur is borrowing),

$$F(0,\lambda,0)=r_f-\lambda+K(r_\pi-\mu)+\frac{(\mu-r_f+\lambda)^2}{2\gamma^e\sigma_\pi^2}.$$

If $\mu-r_f<\gamma^e\sigma_\pi^2$, which implies $I^*<1$ (the entrepreneur is lending),

$$F(0,\lambda,0)=r_f+\lambda+K(r_\pi-\mu)+\frac{(\mu-r_f-\lambda)^2}{2\gamma^e\sigma_\pi^2}.$$

And the $\rho$-type investor maximizes

$$F(0,0,\rho)=r_f+K(r_\pi+\rho-\mu)+\frac{(\mu-r_f)^2}{2\gamma^e\sigma_\pi^2}.$$

The indifference regions between the three types of investors are characterized by the equations $F(\alpha,0,0)=F(0,\lambda,0)$, $F(0,0,\rho)=F(\alpha,0,0)$ and $F(0,\lambda,0)=F(0,0,\rho)$ that can be respectively rewritten as

$$\frac{\alpha^2}{2}+\alpha u = \frac{\lambda^2}{2}+\lambda|v|, \quad (13)$$

$$\rho w = \frac{\alpha^2}{2}+\alpha u, \quad (14)$$

$$\frac{\lambda^2}{2}+\lambda|v| = \rho w, \quad (15)$$

[37] Note that we excluded $\lambda$ from the lending / borrowing condition. If $\lambda$ is included, there is an indeterminate region where we can have both conditions satisfied

$$\mu-r-\lambda<\gamma\sigma^2<\mu-r+\lambda,$$

i.e., the entrepreneur could be lending or borrowing.

with $u = \mu - r_f - K\gamma^e\sigma_\pi^2$, $v = \mu - r_f - \gamma^e\sigma_\pi^2$, and $w = K\gamma^e\sigma_\pi^2$.

These equations are quadratic in $\alpha$ and $\lambda$, and linear in $\rho$. Since $\alpha > 0$, $\lambda > 0$ and $\rho > 0$, the quadratic equations have one positive root and one negative root. Furthermore, since the gain functions are only considered over $\mathbb{R}^+$, only the positive roots must be considered. Hence, let us define the following triangular relations

$$\begin{aligned} \alpha^*(\lambda) &= -u + \sqrt{u^2 + \lambda^2 + 2\lambda|v|}, \\ \rho^*(\alpha) &= \frac{1}{w}\left(\frac{\alpha^2}{2} + \alpha u\right), \\ \lambda^*(\rho) &= -|v| + \sqrt{v^2 + 2\rho w}. \end{aligned}$$

We obtain the following rule:

| | $\lambda < \lambda^*(\rho)$ | $\rho < \rho^*(\alpha)$ | $\alpha < \alpha^*(\lambda)$ |
|---|---|---|---|
| $\alpha < \alpha^*(\lambda)$ | $\rho$-type | | |
| $\lambda < \lambda^*(\rho)$ | | $\alpha$-type | |
| $\rho < \rho^*(\alpha)$ | | | $\lambda$-type |

# Appendix A: Calibration

**Venture characteristics** One way to proxy for $K$ is to divide the value of the venture's assets by the book value of the entrepreneurs' equity (interpreted as their historical cost of acquisition of the project). From Table II (which uses National Survey of Small Businesses data) of Bitler et al. (2005), this ratio is worth 2.36 if we take mean values. We thus set $K = 2$.

We rely on the average mean return (19%) and volatility (28%) levels of the Cambridge Associates venture index as reported by Ang et al. (2018), and we set the representative project expected return and standard deviation to $r_\pi = 20\%$ and $\sigma_\pi = 25\%$, respectively. When rescaled by the relative size of the venture for the entrepreneur, this translates into twice these values. This is also broadly consistent with evidence shown by Manigart et al. (2002) on venture capital investments across five European countries, for which the authors obtained estimates of required returns from early-stage VC investments ranging between 36% to 45%.

To obtain the project beta, we rely on Kerins, Kiholm Smith and Smith (2004) who use the CAPM to estimate the cost of capital for an entrepreneur. They find that the average correlation between a sample of 2,623 early-stage firms' equity returns and S&P 500 returns is 0.195. The standard deviation of their sample firms' equity returns is 102.4% (see their Table 4). Consistent with these figures, the value of $\beta$ is set equal to $0.2 \times 100/16 = 1.25$.

**Financial market characteristics** These characteristics are estimated from U.S. market data over the 1988-2018 period. The average U.S. 10-year daily zero-coupon yield is 5.02%. The S&P 500 index daily log-returns display an average of 7.36% and a standard deviation of 17.43%. Accordingly, we set $r_f = 5\%$, $r_m = 8\%$ and $\sigma_m = 20\%$.

**Entrepreneur characteristics** Several contributions propose a methodology for estimating the investors' attitude toward risk. However, we should keep in mind that entrepreneurs are supposedly less risk averse than average individuals. Tarashev *et al.* (2003) show that the risk aversion coefficient implicit from S&P options varies from 0 to 2. Bliss and Panigirtzoglou (2004) obtain a range from 0 to 4.4, but the upper bound decreases to less than 1.3 after removing the five largest stock return volatility changes. Based on the empirical distribution of terminal payoffs from venture capital-backed projects, Hall and Woodward (2010) induce that a risk aversion coefficient of 2 makes the entrepreneur indifferent between launching the venture or not. Given that we are only interested in those projects that are being undertaken, entrepreneurs should be less risk averse than marginally indifferent entrepreneurs. We therefore set $\gamma^e = 1$ for the base case.

**Investor characteristics** Ang et al. (2018) report an average alpha of 5% for private equity funds listed in the Cambridge Association Venture Capital Index over the 1992-2008 period. Ewens et al. (2013) find that the quartile of the least diversified venture capital funds in their sample generates an alpha of 2.6% per quarter. We therefore set $\alpha = 7\%$.

Demirgüç-Kunt et al. (2004) report a net interest margin of 4.34% for the U.S. We use that number as a proxy for the cost of financial intermediation, which in our model is $2\lambda$. We therefore set $\lambda = 2\%$.

The investor's potential enhancement brought to the expected return of the venture is split into two parts: the one that is included in her required rate of return $\left(\alpha^i\right)$, and the one that can be viewed on top of the abnormal return to generate abnormal returns $\left(\rho^i - \alpha^i\right)$. In our calibration, we focus on the distinctive features of each investor type and therefore characterize the return enhancement as the investor's generation of abnormal returns for her shareholders. The notion that is closest to ours is the abnormal returns posted by Corporate Venture Capital (CVC) programs, whose cost of capital is unlikely to be adversely affected by idiosyncratic risk effects. On a sample of 1,000 CVC investments done by U.S. public corporations between 2002 and 2012, Mohamed and Schwienbacher (2016) document an abnormal return of announced CVC program deals of 2.1%. Given that these are multiyear investment programs, the yearly expected rate of return is likely to be lower than that figure. Consequently, we conservatively set $\rho^i$ to 1%. The following table summarizes the model calibration.

**Table A1:** Summary of calibrated parameters

| Characteristics | Parameter | Notation | Value |
|---|---|---|---|
| Venture | Size | $K$ | 2 |
| | Expected return | $r_\pi$ | 0.2 |
| | Standard deviation | $\sigma_\pi$ | 0.25 |
| | Beta | $\beta$ | 1.25 |
| Financial market | Risk-free rate | $r_f$ | 0.05 |
| | Market return | $r_m$ | 0.08 |
| | Market volatility | $\sigma_m$ | 0.2 |
| Entrepreneur | Risk aversion coefficient | $\gamma^e$ | 1 |
| | Bargaining power | $\eta$ | 0.5 |
| Investor | Specific risk premium | $\alpha$ | 0.07 |
| | Intermediation margin | $2\lambda$ | 0.06 |
| | Return enhancement | $\rho$ | 0.01 |

## Appendix B: Industry mapping and beta calculation

CB's industry classification is platform specific and does not directly map to any known standard industry classification scheme of which we are aware. In particular, at the time we accessed CB, it operated 744 distinct industry categories grouped into 46 category groups. Our investigations of CB reveal that categories are not group specific; i.e., the same category can be found in many groups at a time (e.g., the "Bitcoin" category is present in "Financial Services", "Payments", and "Software" groups at the same time). In addition, each target company can simultaneously be associated with multiple categories. In fact, CB industry categories essentially function as tags to provide for efficient searches within the database. On the other end, the available sector indices (e.g., Eurostoxx or Morningstar) are typically defined on a very general industry classification. Because of this complexity, linking CB categories to the standard and available sector indices is inappropriate. Our approach is therefore to build portfolios of stocks from industries that closely correspond to the CB category groups and thus better reflect the risk of CB target companies. To achieve this, we begin by manually mapping the CB's industry groups to the SIC codes. In so doing, we rely on the category group names, but also on the category names.[38] We encounter 1-to-1, 1-to-many, many-to-1, and many-to-many mappings. In each of these cases, we keep all SIC codes that we are able to associate with the specific CB industry category group. In the end, we have a many-to-many mapping of the SIC codes to the category groups. Details of the mapping are reported in the table below.

The details for the calculation of the industry beta are as follows. To recover the historical

[38] For example, category group "Apps" include the following categories: "App Discovery", "Apps", "Consumer Applications", "Enterprise Applications", "Mobile Apps", "Reading Apps", "Web Apps". Category group "Software" includes 88 categories, some of which are much less intuitive for the mapping purposes, such as "Billing" and "Cryptocurrency".

stock pricing data in the European countries, we first construct the universe of all traded common stocks (both listed and delisted). There are two complementary approaches to achieve this. First, there are Worldscope country lists, publicly available equity research lists, and country-level dead stock lists. All of these are unfortunately not complete and are infrequently updated (if updated at all). Our second method is to run direct queries for entities currently and formerly traded on all European stock exchanges. From both approaches we obtain the list of unique Datastream-specific security identifiers (DS-codes) with which we collect static and dynamic data on every entity.

Static information includes the security type, the country of origin of the underlying company, the 4-digit SIC code of the underlying company, the name and the country of a stock exchange on which the security is/was traded, the listing/delisting dates, and the current (as of the date of access) trading status. Some European firms are traded on foreign exchanges; we exclude these securities from our records. However, we retain the stocks of foreign firms, which are traded on the European exchanges. We also normalize the security types across all entities[39] by using the security description data items (SHARETYPE, TRAC, and TRAD). Finally, we filter the list of equities for common stocks, traded on all European exchanges, and with available SIC codes. Overall, these filters yield 17,444 DS codes of traded entities over the period of December 31, 1989 to December 31, 2019. Using the DS-codes we download the time series of stock pricing data, namely the monthly adjusted prices, the trading volumes, the market capitalizations of the listed firms (in millions of USD), and the number of outstanding shares. We then construct two types of portfolios. The first is the market portfolio of all traded stocks, while the second type is a set of all industry-specific portfolios. The following procedure describes the construction of both.

Denote $I$ the set of CB industry category groups, and let $i$ be a category group from $I$ for which

[39] Security types are often ill recorded; e.g., "Ordinary shares" and "Common shares" both refer to the same security type, but are stored as such in the records.

we have performed the SIC code mapping as defined above. Each $i \in I$ therefore is a collection of SIC codes; the latter can overlap in $i_j$ and $i_k$ $(j, k \in \{1, ..., 46\}, j \neq k)$. Let $E_t$ be the set of all traded common equities at date $t$. Subset $e_{i,t} \subset E_t$ contains traded stocks from industry category $i$ on the same date $t$. Note that the tracking of stocks on a monthly basis automatically adjusts for new listings and delistings. At each date, we filter $E_t$ using the following conditions (all must be met): (i) the unadjusted stock prices exceed \$5, (ii) each stock's market capitalization is observed, (iii) each stock's market trading volume is observed, and (iv) the monthly liquidity (defined as the trading volume over the number of shares outstanding) of each stock exceeds the first decile (10%) of the empirical distribution of liquidity at date $t$. These filters eliminate illiquid stocks, penny stocks, and securities for which some data are missing from $E_t$ and $e_{i,t}$. Essentially, this creates reduced pools of stocks $E^*$ and $e^*_{i,t}$ which are sufficiently liquid and have all the data we need to construct our market and industry portfolios. For every stock from $E^*$ and $e^*_{i,t}$ we compute the series of monthly returns, and at each $t$, we combine them into the market value-weighted market or industry category portfolios.[40] The weighting (rebalancing) is performed at each date $t$.[41] Having obtained the series of monthly returns of the stock market portfolio and of the portfolios representing each industry category from CB, we proceed by calculating the required measure of industry risk as the covariance between the industry and market returns, scaled by the variance of market returns over the last 60 months (lagged one month) with respect to the focal date. This time-varying measure of industry risk is then linked to the investment data via the investment year-month and the target industry

[40] If a security is excluded from $E_t$, its market capitalization does not enter the computation of total market value.

[41] As a sanity check, we verified our computations by calculating the annualized market and industry returns. The annualized average of the market monthly returns is 7.63%; the average of the annualized market monthly returns is 7.55%. Our monthly return series correlate with the STOXX600 index at the level of 72.33%.

category group.[42]

| Crunchbase category | SIC category | SIC code |
|---|---|---|
| Administrative Services | Personnel supply services | 736, 874 |
| Advertising<br>Sales and Marketing | Advertising | 731, 733 |
| Agriculture and Farming | Agricultural Production-Crops | 01, 02, 07 |
| Apps<br>Artificial Intelligence<br>Gaming<br>Information Technology<br>Internet Services<br>Payments<br>Platforms<br>Software | Computer Programming,<br>Data Processing<br>and Other Computer<br>Related Services | 737 |
| Biotechnology | Research, Development, and Testing Services | 873 |
| Clothing and Apparel | Apparel & Other Finished Products | 23,56, 721 |
| Commerce and Shopping | General Merchandise Stores | 53 |
| Community and Lifestyle | Social Services | 83, 86 |
| Consumer Electronics<br>Hardware | Computer and office equipment | 36, 357<br>573, 737 |
| Consumer Goods | Tobacco Products | 21, 23, 25, 57<br>391, 723, 2844 |
| Content and Publishing<br>Media and Entertainment | Printing, Publishing & Allied Industries | 27, 78, 79<br>573, 722 |
| Data and Analytics<br>Design<br>Science and Engineering | Engineering & Architectural Services | 871, 873 |
| Education | Educational Services | 82 |
| Energy | Electric, Gas & Sanitary Services | 13, 49 |
| Events | Amusement & Recreation Services | 79 |
| Financial Services | Depository Institutions | 60, 63, 67 |
| Food and Beverage | Food & Kindred Products | 20,54, 58 |

[42] If the target is assigned to several industry categories, we take a simple average of the corresponding betas.

| Crunchbase category | SIC category | SIC code |
|---|---|---|
| Government and Military | Executive, Legislative and General Government | 91, 92 |
| Health Care | Health Services | 80, 83 |
| Manufacturing | Engineering, Accounting, Research, | 87, 871 |
| | Management & Related Services | 8711 |
| | Industrial & Commercial Machinery | 35 |
| | & Computer Equipment | |
| | Lumber & Wood Products exc. Furniture | 24 |
| | Manufacturing | 20/39, 27 |
| | Paper & Allied Products | 26 |
| | Primary Metal Industries | 33 |
| | Rubber & Miscellaneous | 30, 282 |
| | Plastics Products | 22 |
| Messaging and Telecommunications | Telephone communication | 481 |
| Music and Audio | Home Furniture, Furnishings | 57, 5735 |
| | & Equipment Stores | 5736 |
| Natural Resources | Coal Mining | 12, 14 |
| | Forestry | 08 |
| | Metal Mining | 10, 12, 13 |
| | Oil and Gas Extraction | 13 |
| | Water Well Drilling | 178 |
| Navigation and Mapping | Transportation Services | 47 |
| Privacy and Security | Business Services | 73, 7382 |
| Professional Services | Legal Services | 81, 872, 874 |
| Real Estate | Building Construction - General Contractors | 15, 52, 65 |
| | & Operative Builders | |
| Sports | Commercial Sports | 794 |
| Sustainability | Administration of Environmental Quality | 95 |
| | & Housing Programs | |
| Transportation | Railroad Transportation | 40 to 45 |
| Travel and Tourism | Hotels, Rooming Houses, Camp | 70, 84 |
| Video | Motion Pictures | 78 |

## Appendix C: Statistics for the unconstrained sample

The table below collects descriptive statistics for the variables. We also present statistics in levels for the variables that are log-transformed in regression analyses. The definitions of each variable are provided in Table 3. All monetary figures are expressed in 2019 U.S. dollars. The sample is UNCONSTRAINED by the availability of ORBIS company financial data, and is composed of 2,219 investment rounds involving 1,722 target companies and 2,387 investors, observed during the period 2010-2019, and distributed across 4,652 investment-investor-level observations. Column N reports the number of nonmissing data points.

**Table C1:** Descriptive statistics for the unconstrained sample

| Variable | N | Mean | SD | Min | $Q_{0.25}$ | Median | $Q_{0.75}$ | Max |
|---|---|---|---|---|---|---|---|---|
| Distance | 2,902 | 1,912.84 | 3,269.30 | 0.00 | 0.00 | 199.98 | 1,450.14 | 18,325.44 |
| log(1+Distance) | 2,902 | 4.29 | 3.63 | 0.00 | 0.00 | 5.30 | 7.28 | 9.82 |
| Investor age | 3,173 | 15.36 | 28.55 | 0.00 | 3.42 | 6.37 | 13.75 | 350.41 |
| log(1+Investor age) | 3,173 | 2.14 | 1.03 | 0.00 | 1.49 | 2.00 | 2.69 | 5.86 |
| Target age | 4,566 | 3.78 | 6.62 | 0.00 | 0.92 | 2.32 | 4.63 | 171.66 |
| log(1+Target age) | 4,566 | 1.23 | 0.76 | 0.00 | 0.65 | 1.20 | 1.73 | 5.15 |
| Fundraising | 4,529 | 32.96 | 23.89 | 1.00 | 8.00 | 39.00 | 51.00 | 184.00 |
| log(1+Fundraising) | 4,529 | 3.11 | 1.07 | 0.69 | 2.20 | 3.69 | 3.95 | 5.22 |
| Industry beta | 4,629 | 1.98 | 0.29 | 0.54 | 1.85 | 2.02 | 2.13 | 3.62 |
| # investors | 4,652 | 3.51 | 3.31 | 1.00 | 1.00 | 2.00 | 5.00 | 24.00 |
| Fear to fail | 4,151 | 37.72 | 4.30 | 20.89 | 35.23 | 36.70 | 38.91 | 61.58 |
| Investor experience | 4,652 | 57.89 | 128.11 | 0.00 | 0.00 | 9.00 | 47.00 | 1,602.00 |
| log(1+Investor experience) | 4,652 | 2.32 | 1.98 | 0.00 | 0.00 | 2.30 | 3.87 | 7.38 |
| Entrepreneur's investment | 1,395 | 3.11 | 2.08 | 0.01 | 1.97 | 2.67 | 3.67 | 20.08 |
| Entrepreneur's stake | 4,652 | 0.83 | 0.13 | 0.00 | 0.78 | 0.86 | 0.92 | 1.00 |

The next table below collects the variables' descriptive statistics further broken down by seed and non-seed investment types. The $t$-test and MW columns display the $p$-values of the univariate $t$- and Mann-Whitney tests of differences.

**Table C2:** Descriptive statistics for the unconstrained sample: Seed vs. non-seed

| | Seed investments | | | non-seed investments | | | | |
|---|---|---|---|---|---|---|---|---|
| Variable | N | Mean | SD | N | Mean | SD | t-test | MW |
| Distance | 1,276 | 804.94 | 2,250.59 | 1,626 | 2,782.26 | 3,659.21 | 0.00 | 0.00 |
| log(1+Distance) | 1,276 | 2.90 | 3.29 | 1,626 | 5.37 | 3.51 | 0.00 | 0.00 |
| Investor age | 1,446 | 8.27 | 20.88 | 1,727 | 21.31 | 32.48 | 0.00 | 0.00 |
| log(1+Investor age) | 1,446 | 1.76 | 0.80 | 1,727 | 2.47 | 1.08 | 0.00 | 0.00 |
| Target age | 2,128 | 1.84 | 2.16 | 2,438 | 5.47 | 8.48 | 0.00 | 0.00 |
| log(1+Target age) | 2,128 | 0.86 | 0.58 | 2,438 | 1.55 | 0.75 | 0.00 | 0.00 |
| Fundraising | 2,116 | 33.38 | 22.45 | 2,413 | 32.58 | 25.08 | 0.25 | 0.74 |
| log(1+Fundraising) | 2,116 | 3.13 | 1.08 | 2,413 | 3.09 | 1.06 | 0.19 | 0.74 |
| Industry beta | 2,165 | 1.96 | 0.27 | 2,464 | 2.00 | 0.30 | 0.00 | 0.00 |
| # investors | 2,176 | 2.98 | 3.39 | 2,476 | 3.98 | 3.16 | 0.00 | 0.00 |
| Fear to fail | 1,962 | 37.92 | 4.52 | 2,189 | 37.54 | 4.08 | 0.01 | 0.07 |
| Investor experience | 2,176 | 65.08 | 139.60 | 2,476 | 51.57 | 116.75 | 0.00 | 0.09 |
| log(1+Investor experience) | 2,176 | 2.30 | 2.08 | 2,476 | 2.34 | 1.88 | 0.43 | 0.09 |
| Entrepreneur's investment | 487 | 3.69 | 2.23 | 908 | 2.81 | 1.93 | 0.00 | 0.00 |
| Entrepreneur's stake | 2,176 | 0.85 | 0.11 | 2,476 | 0.82 | 0.14 | 0.00 | 0.00 |

## Appendix D: Regressions with average investor characteristics

The table below collects the results of the OLS models with the entrepreneur's investment ($I^*$) standardized by target company's pretransaction total assets as the dependent variable. The definitions of each variable are provided in Table 3. All monetary figures are expressed in 2019 U.S. dollars. The sample is CONSTRAINED by the availability of ORBIS company financial data, and is composed of 1,315 investment rounds involving 993 target companies and 1,501 investors, observed during the period 2010-2019, and distributed across 2,808 investment-investor-level observations. The reduction in the number of observations in each model depends on the missing data in the regressors. Furthermore, in the models, we use the investment-level sample with investor characteristics averaged at the deal level. Investment stage dummies are "Growth", "Late" and "Unidentified" (the reference category is "Early" stage). Robust standard errors are reported in parentheses.

**Table D1:** Regression results for entrepreneur's investment with average investor characteristics

| | All rounds | | | | | Seed | non-seed |
|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| Intercept | 3.383*** | 5.522*** | 3.402*** | 5.562*** | 5.848*** | 0.333 | 6.358** |
| | (1.188) | (1.721) | (1.193) | (1.736) | (1.806) | (1.999) | (2.507) |
| log(1+Distance) | −0.015 | −0.013 | −0.011 | −0.009 | −0.011 | 0.021 | −0.010 |
| | (0.045) | (0.046) | (0.045) | (0.047) | (0.052) | (0.045) | (0.084) |
| log(1+Investor age) | −0.017 | −0.020 | −0.004 | −0.008 | 0.002 | 0.231 | −0.067 |
| | (0.127) | (0.136) | (0.128) | (0.137) | (0.146) | (0.330) | (0.199) |
| log(1+Target age) | −0.796*** | −0.815*** | −0.802*** | −0.822*** | −0.788*** | −1.118*** | −0.660** |
| | (0.196) | (0.201) | (0.197) | (0.202) | (0.195) | (0.363) | (0.279) |
| log(1+Fundraising) | 0.217* | 0.206 | 0.213* | 0.201 | 0.195 | 0.496*** | 0.064 |
| | (0.119) | (0.154) | (0.120) | (0.155) | (0.154) | (0.186) | (0.243) |
| log(1+Investor experience) | 0.109* | 0.072 | 0.111* | 0.073 | 0.057 | −0.006 | 0.105 |
| | (0.062) | (0.066) | (0.062) | (0.065) | (0.067) | (0.102) | (0.096) |
| Industry beta | −0.091 | −0.118 | −0.066 | −0.093 | −0.207 | 0.594 | −0.402 |
| | (0.521) | (0.531) | (0.517) | (0.528) | (0.560) | (0.534) | (0.679) |
| Fear to fail | | −0.052*** | | −0.053** | −0.054** | −0.031 | −0.045* |
| | | (0.021) | | (0.021) | (0.021) | (0.045) | (0.024) |
| # investors | | | −0.038 | 0.038 | −0.064 | 0.112 | −0.064 |
| | | | (0.041) | (0.044) | (0.046) | (0.105) | (0.052) |
| Investment stage: Growth | | | | | 0.314 | | |
| | | | | | (0.418) | | |
| Investment stage: Late | | | | | −0.935 | | |
| | | | | | (0.572) | | |
| Investment stage: Unidentified | | | | | −0.348 | | |
| | | | | | (0.288) | | |
| Adj. $R^2$ | 0.089 | 0.090 | 0.088 | 0.089 | 0.094 | 0.122 | 0.048 |
| Period dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Num. obs. | 506 | 481 | 506 | 481 | 481 | 204 | 277 |

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$.

The next table collects the results of the fractional regression models (Papke and Wooldridge, 1996) with Entrepreneur's stake ($S^*$) as the dependent variable. The definitions of each variable are provided in Table 3. All monetary figures are expressed in 2019 U.S. dollars. The sample is UNCONSTRAINED by the availability of ORBIS company financial data, and is composed of 2,219 investment rounds involving 1,722 target companies and 2,387 investors, observed during the period 2010-2019, and distributed across 4,652 investment-investor-level observations. The reduction in the number of observations in each model depends on the missing data in the regressors. Furthermore, in the models, we use the investment-level sample with investor characteristics averaged at the deal level. Investment stage dummies are "Growth", "Late" and "Unidentified" (the reference category is "Early" stage). Robust standard errors are reported in parentheses.

**Table D2:** Regression results for entrepreneur's stake with average investor characteristics

| | All rounds | | | | | Seed | non-seed |
|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| Intercept | 1.724*** | 2.402*** | 1.695*** | 2.400*** | 2.292*** | 2.177*** | 2.360*** |
| | (0.196) | (0.353) | (0.195) | (0.353) | (0.357) | (0.539) | (0.460) |
| log(1+Distance) | −0.023*** | −0.020*** | −0.017** | −0.013* | −0.008 | −0.013 | −0.004 |
| | (0.007) | (0.008) | (0.007) | (0.008) | (0.008) | (0.011) | (0.012) |
| log(1+Investor age) | −0.088*** | −0.081*** | −0.071** | −0.064** | −0.044 | −0.114** | −0.019 |
| | (0.029) | (0.031) | (0.029) | (0.031) | (0.034) | (0.047) | (0.045) |
| log(1+Target age) | −0.081** | −0.091** | −0.084** | −0.095*** | −0.056 | 0.008 | −0.105** |
| | (0.035) | (0.036) | (0.035) | (0.037) | (0.041) | (0.069) | (0.044) |
| log(1+Fundraising) | −0.031 | −0.029 | −0.033 | −0.033 | −0.030 | 0.068* | −0.118*** |
| | (0.024) | (0.030) | (0.024) | (0.030) | (0.030) | (0.040) | (0.042) |
| log(1+Investor experience) | 0.073*** | 0.069*** | 0.077*** | 0.071*** | 0.069*** | 0.066*** | 0.057** |
| | (0.014) | (0.014) | (0.014) | (0.014) | (0.014) | (0.017) | (0.024) |
| Industry beta | 0.025 | 0.046 | 0.056 | 0.078 | 0.089 | 0.007 | 0.055 |
| | (0.079) | (0.080) | (0.078) | (0.081) | (0.081) | (0.117) | (0.110) |
| Fear to fail | | −0.019*** | | −0.020*** | −0.019*** | −0.008 | −0.023*** |
| | | (0.007) | | (0.007) | (0.007) | (0.010) | (0.009) |
| # investors | | | −0.057*** | −0.059*** | −0.053*** | −0.090*** | −0.046** |
| | | | (0.015) | (0.015) | (0.016) | (0.017) | (0.020) |
| Investment stage: Growth | | | | | −0.182* | | |
| | | | | | (0.101) | | |
| Investment stage: Late | | | | | −0.156 | | |
| | | | | | (0.237) | | |
| Investment stage: Unidentified | | | | | −0.161* | | |
| | | | | | (0.091) | | |
| McFadden adj. pseudo $R^2$ | 0.209 | 0.209 | 0.231 | 0.233 | 0.262 | 0.442 | 0.331 |
| Period dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Deviance | 122.209 | 114.434 | 120.228 | 112.471 | 111.904 | 45.432 | 62.930 |
| Num. obs. | 1,438 | 1,318 | 1,438 | 1,318 | 1,318 | 708 | 610 |

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$.

## Appendix E: Endogeneity of round amounts

One potential concern regarding the regression analyses is related to the observability of the transaction values. In this context, Cochrane (2005) notes that round amounts are typically reported conditional on the success of a given venture and we note that both entrepreneurs' stakes and investments require relying on the pre- and postmoney values observed in Crunchbase. We cannot rule out the possibility of nonrandomness in the observability of deal values. However, we note that this case is essentially a sample (self-) selection problem that can be alleviated using the Heckman (1976; 1979) models.

These models consist of two parts: selection and outcome. In the selection part the dependent variable, Value Observability, is equal to one if we observe the pre- and postmoney values. Since this must be correlated with the successful development of the venture (Cochrane, 2005), we model the value observability as a function of covariates that also correlate with success. In particular, we include log(1+Investor experience), log(1+Investor age), log(1+Target age), and # investors as main predictors. We also include the region and the year dummies to control for the time and location of our investments. In the outcome part, as before, the dependent variable is the entrepreneur's investment or the entrepreneur's stake. To preserve consistency, we explicitly use the same explanatory covariates as those used in Tables 6 and 7 (see Models (5)-(6) in the two tables). The estimations are presented in Table E1 (entrepreneur's investment) and in Table E2 (entrepreneur's stake). The upper part of both tables shows the parameter estimates for the selection equations (coefficients prelabelled 'S') while the lower part depicts the outcome equations (coefficients prelabelled 'O'). We omit the year, and region dummy coefficients from the tables to save space. Finally, we use the more efficient (Greene, 2018, pp. 917-918) maximum likelihood approach to estimate the parameters (although the usual 2-step method yields similar results).

**Table E1:** Regression models of entrepreneur's investment controlling for deal self-reporting.

The table collects the results of the Heckman selection models with entrepreneur's investment ($I^*$) standardized by target company's pre-transaction total assets as the outcome variable. The upper part of the table shows the parameter estimates for the selection equations (coefficients prelabelled 'S') while the lower part depicts the outcome equations (coefficients prelabelled 'O'). The selection equation models the observability of the transaction values. Definitions of each variable are provided in Table 3. All monetary figures are expressed in 2019 U.S. dollars. Investment stage dummies are "Growth", "Late" and "Unidentified" (the reference category is "Early" stage). Standard errors are reported in parentheses while the type of clustering is reported in model diagnostics information. Models (1) and (2) use the investment-investor-level data; Models (3) and (4) use the investment-level data with investor characteristics averaged at the deal level.

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| S: Intercept | $-2.919^{***}$ | $-2.922^{***}$ | $-3.022^{***}$ | $-3.030^{***}$ |
| | (0.221) | (0.221) | (0.191) | (0.192) |
| S: log(1+Investor experience) | $-0.028^{***}$ | $-0.028^{***}$ | 0.000 | $-0.000$ |
| | (0.010) | (0.010) | (0.012) | (0.012) |
| S: log(1+Investor age) | $0.065^{***}$ | $0.065^{***}$ | $0.083^{***}$ | $0.083^{***}$ |
| | (0.019) | (0.019) | (0.021) | (0.021) |
| S: log(1+Target age) | $0.173^{***}$ | $0.174^{***}$ | $0.127^{***}$ | $0.127^{***}$ |
| | (0.026) | (0.026) | (0.022) | (0.022) |
| S: # investors | $0.029^{**}$ | $0.029^{**}$ | 0.014 | 0.014 |
| | (0.014) | (0.014) | (0.011) | (0.011) |
| S: Dummy UK | $0.607^{***}$ | $0.606^{***}$ | $0.601^{***}$ | $0.600^{***}$ |
| | (0.066) | (0.066) | (0.054) | (0.054) |
| O: Intercept | $5.763^{***}$ | $6.109^{***}$ | $6.803^{***}$ | $6.720^{***}$ |
| | (1.560) | (1.549) | (2.300) | (2.442) |
| O: log(1+Distance) | 0.006 | $-0.008$ | $-0.008$ | $-0.010$ |
| | (0.032) | (0.033) | (0.046) | (0.051) |
| O: log(1+Investor age) | $-0.019$ | $-0.011$ | $-0.027$ | $-0.013$ |
| | (0.086) | (0.092) | (0.134) | (0.144) |
| O: log(1+Target age) | $-0.889^{***}$ | $-0.869^{***}$ | $-0.856^{***}$ | $-0.815^{***}$ |
| | (0.192) | (0.199) | (0.198) | (0.192) |
| O: log(1+Fundraising) | $0.279^{**}$ | $0.262^{**}$ | 0.160 | 0.167 |
| | (0.118) | (0.111) | (0.161) | (0.161) |
| O: log(1+Investor experience) | 0.055 | 0.031 | 0.073 | 0.057 |
| | (0.045) | (0.046) | (0.064) | (0.065) |
| O: Industry beta | 0.351 | 0.123 | $-0.094$ | $-0.206$ |
| | (0.429) | (0.424) | (0.518) | (0.548) |
| O: Fear to fail | $-0.059^{***}$ | $-0.061^{***}$ | $-0.051^{**}$ | $-0.053^{***}$ |
| | (0.021) | (0.021) | (0.020) | (0.021) |
| O: # investors | $-0.061$ | $-0.096^{**}$ | $-0.044$ | $-0.068$ |
| | (0.045) | (0.046) | (0.045) | (0.046) |
| O: Investment stage: Growth | | 0.540 | | 0.318 |
| | | (0.360) | | (0.410) |
| O: Investment stage: Late | | $-0.566$ | | $-0.909^{*}$ |
| | | (0.528) | | (0.549) |
| O: Investment stage: Unidentified | | $-0.532^{**}$ | | $-0.332$ |
| | | (0.254) | | (0.282) |
| Sigma | $2.094^{***}$ | $2.057^{***}$ | $2.170^{***}$ | $2.142^{***}$ |
| | (0.206) | (0.197) | (0.225) | (0.210) |
| Rho | $-0.158$ | $-0.122$ | $-0.177$ | $-0.126$ |
| | (0.128) | (0.143) | (0.156) | (0.188) |
| Period dummies | Yes | Yes | Yes | Yes |
| Standard errors | Clustered | Clustered | Robust | Robust |
| Log likelihood | $-6,119.442$ | $-6,107.124$ | $-3,258.641$ | $-3,255.848$ |
| Num. obs. | 42,960 | 42,960 | 24,984 | 24,984 |
| Censored | 42,031 | 42,031 | 24,503 | 24,503 |
| Observed | 929 | 929 | 481 | 481 |

$^{***}p < 0.01; ^{**}p < 0.05; ^{*}p < 0.1.$

**Table E2:** Regression models of entrepreneur's stake controlling for deal self-reporting.

The table collects the results of the Heckman selection models with entrepreneur's stake ($S^*$) as the outcome variable. The upper part of the table shows the parameter estimates for the selection equations (coefficients prelabelled 'S') while the lower part depicts the outcome equations (coefficients prelabelled 'O'). The selection equation models the observability of the transaction values. The definitions of each variable are provided in Table 3. All monetary figures are expressed in 2019 U.S. dollars. Investment stage dummies are "Growth", "Late" and "Unidentified" (the reference category is "Early" stage). Standard errors are reported in parentheses while the type of clustering is reported in model diagnostics information. Models (1) and (2) use the investment-investor-level data; Models (3) and (4) use the investment-level data with investor characteristics averaged at the deal level.

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| S: Intercept | −1.856*** | −1.855*** | −1.753*** | −1.752*** |
| | (0.119) | (0.120) | (0.102) | (0.102) |
| S: log(1+Investor experience) | −0.019*** | −0.019*** | −0.001 | −0.001 |
| | (0.007) | (0.007) | (0.008) | (0.008) |
| S: log(1+Investor age) | 0.062*** | 0.062*** | 0.077*** | 0.077*** |
| | (0.014) | (0.014) | (0.015) | (0.015) |
| S: log(1+Target age) | −0.065*** | −0.065*** | −0.117*** | −0.117*** |
| | (0.023) | (0.023) | (0.020) | (0.020) |
| S: # investors | 0.031*** | 0.031*** | 0.014* | 0.014* |
| | (0.010) | (0.010) | (0.008) | (0.008) |
| S: Dummy UK | 0.468*** | 0.469*** | 0.493*** | 0.494*** |
| | (0.043) | (0.043) | (0.034) | (0.034) |
| O: Intercept | 0.901*** | 0.889*** | 0.886*** | 0.866*** |
| | (0.069) | (0.072) | (0.055) | (0.055) |
| O: log(1+Distance) | −0.000 | 0.000 | −0.002* | −0.001 |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| O: log(1+Investor age) | −0.002 | 0.000 | −0.008* | −0.005 |
| | (0.004) | (0.004) | (0.004) | (0.005) |
| O: log(1+Target age) | −0.004 | −0.001 | −0.015*** | −0.010* |
| | (0.006) | (0.007) | (0.005) | (0.005) |
| O: log(1+Fundraising) | −0.007 | −0.007 | 0.002 | −0.001 |
| | (0.006) | (0.006) | (0.004) | (0.004) |
| O: log(1+Investor experience) | 0.007*** | 0.006*** | 0.009*** | 0.009*** |
| | (0.002) | (0.002) | (0.002) | (0.002) |
| O: Industry beta | 0.022 | 0.022 | 0.010 | 0.011 |
| | (0.018) | (0.017) | (0.011) | (0.011) |
| O: Fear to fail | −0.004*** | −0.004*** | −0.003*** | −0.003*** |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| O: # investors | −0.008** | −0.007* | −0.008*** | −0.007*** |
| | (0.003) | (0.004) | (0.002) | (0.003) |
| O: Investment stage: Growth | | −0.009 | | −0.026* |
| | | (0.019) | | (0.014) |
| O: Investment stage: Late | | 0.005 | | −0.025 |
| | | (0.039) | | (0.036) |
| O: Investment stage: Unidentified | | −0.032 | | −0.022* |
| | | (0.025) | | (0.013) |
| Sigma | 0.125*** | 0.125*** | 0.113*** | 0.113*** |
| | (0.011) | (0.011) | (0.005) | (0.005) |
| Rho | 0.216** | 0.236** | 0.201** | 0.224*** |
| | (0.104) | (0.105) | (0.084) | (0.079) |
| Period dummies | Yes | Yes | Yes | Yes |
| Standard errors | Clustered | Clustered | Robust | Robust |
| Log likelihood | −7,222.389 | −7,214.767 | −3,884.040 | −3,880.654 |
| Num. obs. | 43,797 | 43,797 | 25,442 | 25,442 |
| Censored | 41,379 | 41,379 | 24,124 | 24,124 |
| Observed | 2,418 | 2,418 | 1,318 | 1,318 |

$^{***}p < 0.01; ^{**}p < 0.05; ^{*}p < 0.1$.

Comparing the parameter estimates of the outcome equation in Table E1 with those in Table 6 suggests that self-selection concerns do not affect our results. Indeed, not only are all of the coefficients of interest (Fear to fail and # investors)) of the same order of magnitude, but they also retain the equivalent statistical power; the situation is similar when we compare Table E2 with Table 7. Here, however, we observe some changes in magnitudes due to the differences in the estimation procedures used[43] but do not observe changes in directions or in the significance of our variables of interest. In particular, the parameter estimates of Fear to fail are both stronger (less negative) and significant at the 1% level. Furthermore, the coefficient of # investors remains negative and significant (though weakly so in specification (2)).

[43] The point estimates in Table E2 differ from those in Table 7 by a factor of 10. This comes entirely from the difference in the estimation procedures used. Specifically, in Table 7, we use the fractional regression models which are appropriate for modeling the entrepreneur's stake. Conversely, the outcome equations in Heckman-type models are casted like the OLS models. This is also clear from the alternative 2-step Heckman procedure wherein the second step is an OLS regression. Note that in the case of the entrepreneur's investment (with OLS models everywhere), the estimates remain similar in both the standard OLS and Heckman (1976; 1979) models.