Internet Appendix for "Venture Capital Contracts"

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Internet Appendix

IA1. Contraction mapping details

The discrete-time representation derived in Proposition 1 allows us to numerically solve the contraction mapping (8) and (9) as a system of interdependent Bellman equations. Specifically,

1. We assume that $F_i(i)$ and $F_e(e)$ are flexible Beta distributions on [0,10]. We discretize qualities $i \sim F_i(i)$ and $e \sim F_e(e)$ by using a quadrature with 50 points for each distribution, resulting in 2,500 possible combinations of partner qualities. This fine grid proves more than sufficient to adequately approximate continuous distributions. The technical role of the support normalization is to allow for a sufficiently wide support of qualities so that the tails of the Beta distributions disappear at the boundaries. If the support is too narrow so that the density of qualities is positive at its boundaries, this would indicate that some qualities are not captured by the distribution. Our results are robust in the presence of wider and slightly narrower supports.
2. For any i and e, we set the initial guess of continuation values equal to $V^0 = (V_i^0(i), V_e^0(e)) = (0, \bar{V})$, where $\bar{V}$ is sufficiently large. For example, if the only contract term is the fraction of equity that the investor retains, then $\bar{V} = v_e(\bar{i}, \bar{e}, 0)$: the entrepreneur is guessed to retain the entire firm.[1] For any i and e, we set the initial guess of qualities of those agents from the opposite population, who are willing to match, equal to $(\mu_i^0, \mu_e^0) = (\mu_i^0(i), \mu_e^0(e)) = (\mathbf{1}_{i=\bar{i}}[\underline{e}, \bar{e}], [\underline{i}, \bar{i}])$. This choice implies that few agents are initially guessed to match, so the initial update to V^0, explained below, is smooth.
3. For every $n \geq 1$, we obtain $V^n = (V_i^n(i), V_e^n(e))$ and $(\mu_i^n, \mu_e^n) = (\mu_i^n(i), \mu_e^n(e))$ by inputting V^{n-1} and $(\mu_i^{n-1}, \mu_e^{n-1})$ into the right-hand side of the system of equations (8)–(9) and solving for the left-hand side. Because the system is a contraction mapping, $V = \lim_{n\to\infty} V^n$ is the equilibrium. We stop the process when $\|V^n - V^{n-1}\| < \varepsilon$, where $\varepsilon > 0$ is sufficiently small.

While theoretically there can be multiple equilibria in the search and matching game, we were unable to find parameters for which the equilibrium is not unique, despite examining a very broad parameter set.

IA2. Derivation of theoretical moments

Let w_e be the discretized probability that an investor meets an entrepreneur of quality e; w_i be the discretized probability that an entrepreneur meets an investor of quality i; and the match indicator $m(i, e) = 1$ if i and e form a startup, and zero otherwise.

IA2.1. Contract-related moments

The expected value of contract term $c_k^*(i, e)$, $k \in \{1..D\}$ across all deals is

$$E(c_k^*) = \frac{\sum_i \sum_e w_i w_e m(i,e) c_k^*(i,e)}{\sum_i \sum_e w_i w_e m(i,e)}. \tag{1}$$

[1] The static matching literature shows that this initial guess is consistent with an entrepreneur making an offer to match with a sufficiently good investor, and leads to computation of the so-called "entrepreneur-friendly" equilibrium. This terminology is somewhat confusing in the dynamic setting with contracts, as, once encountered and offered to match, it is an investor who offers the contract to an entrepreneur. The situation where the entrepreneur approaches the investor but is offered a take-it-or-leave-it contract in return is consistent with practice in the venture capital market. Our robustness checks explore the situation when the entrepreneur has extra bargaining power in addition to its threat to walk away from the deal and match with a different investor in the future.

The variance of $c_k^*(i,e)$ across all deals is

$$V(c_k^*) = \frac{\sum_i \sum_e w_i w_e m(i,e)(c_k^*(i,e) - E(c_k^*))^2}{\sum_i \sum_e w_i w_e m(i,e)}. \tag{2}$$

For terms that only take values of zero or one, the variance does not contain additional, compared to the expected value, information, so we do not use it in the estimation. Finally, the covariance between any two contract terms $c_k^*(i,e)$ and $c_l^*(i,e)$, $k,l \in \{1..D\}$ across all deals is

$$Cov(c_k^*, c_l^*) = \frac{\sum_i \sum_e w_i w_e m(i,e)(c_k^*(i,e) - E(c_k^*)) \cdot (c_l^*(i,e) - E(c_l^*))}{\sum_i \sum_e w_i w_e m(i,e)}. \tag{3}$$

IA2.2. Moments related to expected time between deals

Recall that after a successful deal, the distribution of the number of new encounters for investor i is a Poisson random variable with intensity λ_i. Each encounter, in equilibrium, results in a deal with probability $p_i = \sum_e w_e m(i,e)$. The distribution of the number of deals, conditional on k meetings, is therefore an independent Binomial distribution with number of trials k and success probability p_i. This implies that the distribution of the number of deals is a Poisson distribution with intensity $\lambda_i p_i$. Therefore, the time between deals, τ, for investor i has mean and variance equal to

$$E(\tau|i) = \frac{1}{\lambda_i p_i}; \quad V(\tau|i) = \frac{1}{(\lambda_i p_i)^2}. \tag{4}$$

Across all deals done by investors with different qualities, the expected time between deals is, from the law of iterated expectations,

$$E(\tau) = E[E(\tau|i)] = \sum_i w_i^* E(\tau|i),$$

where $w_i^* = w_i \frac{\sum_e w_e m(i,e)}{\sum_i \sum_e w_i w_e m(i,e)}$ is the equilibrium share of deals done by investor i among all deals. This is different from w_i, the probability distribution of investors, because some investors match more frequently than others. Inserting w_i^* into the above equation and using (4),

$$E(\tau) = \frac{\sum_i \sum_e w_i w_e m(i,e) \frac{1}{\lambda_i p_i}}{\sum_i \sum_e w_i w_e m(i,e)}. \tag{5}$$

Because τ is random for any given deal, its variance is, from the law of total variance,

$$V(\tau) = E[V(\tau|i)] + V[E(\tau|i)]. \tag{6}$$

Using (4), the first term of (6) is

$$E[V(\tau|i)] = \frac{\sum_i \sum_e w_i w_e m(i,e) \frac{1}{(\lambda_i p_i)^2}}{\sum_i \sum_e w_i w_e m(i,e)};$$

additionally using (5), the second term is

$$V[E(\tau|i)] = \sum_i w_i^* (E(\tau|i) - E(\tau))^2 = \frac{\sum_i \sum_e w_i w_e m(i,e) \left(\frac{1}{\lambda_i p_i} - E(\tau) \right)^2}{\sum_i \sum_e w_i w_e m(i,e)},$$

The covariances between τ and contract term $c_k^*(i,e)$, $k \in \{1..D\}$ across all deals can similarly be derived from the law of total covariance,

$$Cov(\tau, c_k^*) = E[Cov(\tau, c_k^*|i)] + Cov[E(\tau|i), E(c_k^*|i)] \tag{7}$$

The first term of (7) is zero, because the time between deals does not vary with contract terms for a given investor. Using (1), (4), (5), and $E(c_k^*|i) = \frac{\sum_e w_e m(i,e) c_k^*(i,e)}{\sum_i \sum_e w_i w_e m(i,e)}$, the second term is

$$\begin{aligned}
Cov[E(\tau|i), E(c_k^*|i)] &= \sum_i w_i^*(E(\tau|i) - E(\tau)) \cdot (E(c_k^*|i) - E(c_k^*)) \\
&= \frac{\sum_i \sum_e w_i w_e m(i,e) \left(\frac{1}{\lambda_i p_i} - E(\tau)\right) \cdot (c_k^*(i,e) - E(c_k^*))}{\sum_i \sum_e w_i w_e m(i,e)}.
\end{aligned}$$

IA2.3. Success outcome-related moments

Recall that the probability of success for a given deal is

$$Pr(Success = 1|i,e) = \Phi(\kappa_0 + \kappa_1 \cdot \pi(i,e,c^*(i,e))), \tag{8}$$

with Φ the standard normal c.d.f. The expected success rate across all deals is then

$$\begin{aligned}
E(Success) &= E\left[E(Success = 1|i,e)\right] \\
&= E\left[Pr(Success = 1|i,e)\right] \\
&= \frac{\sum_i \sum_e w_i w_e m(i,e) \Phi(\theta_0 + \theta_1 \cdot \pi(i,e,c^*(i,e)))}{\sum_i \sum_e w_i w_e m(i,e)}.
\end{aligned} \tag{9}$$

Similarly to (6), because *Success* is random for any given deal, its variance is, from the law of total variance,

$$\begin{aligned}
V(Success) &= E(V(Success|i,e)) + V(E(Success|i,e)) \\
&= E(Pr(Success = 1|i,e) \cdot (1 - Pr(Success = 1|i,e))) + V(Pr(Success = 1|i,e)) \\
&= \frac{\sum_i \sum_e w_i w_e m(i,e) \Phi(\theta_0 + \theta_1 \cdot \pi(i,e,c^*(i,e))) \cdot (1 - \Phi(\theta_0 + \theta_1 \cdot \pi(i,e,c^*(i,e))))}{\sum_i \sum_e w_i w_e m(i,e)} \\
&\quad + \frac{\sum_i \sum_e w_i w_e m(i,e) (\Phi(\theta_0 + \theta_1 \cdot \pi(i,e,c^*(i,e))) - E(Success))^2}{\sum_i \sum_e w_i w_e m(i,e)},
\end{aligned} \tag{10}$$

where we use (8) and (9) to arrive at the final expression.

The covariances between *Success* and contract term $c_k^*(i,e)$, $k \in \{1..D\}$ across all deals are

$$\begin{aligned}
Cov(Success, c_k^*) &= E(Cov(Success, c_k^*|i,e)) + Cov(E(Success|i,e), E(c_k^*|i,e)) \\
&= Cov(Pr(Success|i,e), c_k^*(i,e)) \\
&= \frac{\sum_i \sum_e w_i w_e m(i,e) (\Phi(\theta_0 + \theta_1 \cdot \pi(i,e,c^*(i,e))) - E(Success)) \cdot (c_k^*(i,e) - E(c_k^*))}{\sum_i \sum_e w_i w_e m(i,e)},
\end{aligned} \tag{11}$$

where $E(Cov(Success, c_k^*|i,e))$ is zero because the contract is deterministic for a given pair of investor and entrepreneur, and therefore does not vary with the startup's success outcome. To arrive at the final expression, we use (1), (8), and (9).

Finally, the covariance between $Success$ and τ across all deals is

$$\begin{aligned}
Cov(\tau, Success) &= E[Cov(\tau, Success|i)] + Cov[E(\tau|i), E(Success|i)] \qquad (12)\\
&= Cov[E(\tau|i), E(Success|i)]\\
&= \sum_i w_i[E(\tau|i) - E(\tau)] \cdot [E(Success|i) - E(Success)]\\
&= \frac{\sum_i \sum_e w_i w_e m(i,e)\left(\frac{1}{\lambda_i p_i} - E(\tau)\right) \cdot (\Phi(\theta_0 + \theta_1 \cdot \pi(i,e,c^*(i,e))) - E(Success))}{\sum_i \sum_e w_i w_e m(i,e)},
\end{aligned}$$

where $E[Cov(\tau, Success|i)]$ is zero because the time between deals does not vary with the startup's success outcome for a given investor. To arrive at the final expression, we use (4), (5), (8), (9), and $E(IPO|i) = \frac{\sum_e w_e m(i,e) Pr(IPO|i,e)}{\sum_i \sum_e w_i w_e m(i,e)} = \frac{\sum_e w_e m(i,e)\Phi(\theta_0+\theta_1 \cdot \pi(i,e,c^*(i,e)))}{\sum_i \sum_e w_i w_e m(i,e)}$.

IA3. Positively assortative matching in matching models with contracts

Figure 2 shows that better VCs tend to match with better entrepreneurs, but this pattern is imperfect. The following proposition shows that if the contracts were, instead, exogenous, and the matching function $g(i,e)$ exhibited a sufficient degree of complementarity, we would obtain positively assortative matching (e.g., good VCs would always match with good entrepreneurs):

Proposition 2. *Suppose that $\rho \leq 0$ in specification (10) for $g(i,e)$, and that $c^*(i,e) \equiv const$ is exogenous. Then, the model solution admits positively assortative matching.*

Proof: The result follows from Shimer and Smith (2000) and Smith (2011). Specifically, when $\rho = 0$ and $c^*(i,e) \equiv const$, $\pi(i,e,c^*)$ depends on types i and e multiplicatively and is therefore log-modular. As a result, the model solution admits block segregation, in which VCs within a certain band of qualities only match with entrepreneurs within a certain band of qualities and never with anyone else, and vice versa. Formally, for $k \geq 1$, any VC quality $[\hat{i}_k, \hat{i}_{k-1}]$ matches with any entrepreneur quality $[\hat{e}_k, \hat{e}_{k-1}]$, where $(\hat{i}_0, \hat{e}_0) = (\bar{i}, \bar{e})$ and $(\hat{i}_k, \hat{e}_k)$, $k \geq 1$ are endogenous functions of model parameters. Block segregation immediately implies positively assortative matching. Further, when $\rho < 0$ and $c^*(i,e) \equiv const$, $\pi(i,e,c^*)$ is log-supermodular, which implies strict positively assortative matching.

When contracts are endogenous, there is no guarantee that the model solution admits positively assortative matching. In particular, Figure 2 shows that this matching pattern does not occur under our parameter estimates. This pattern is even more distorted in settings, in which qualities are weaker complements (e.g., in the IT market, as shown in Table IA4). Intuitively, because contracts are chosen endogenously, it can pay, for a lower-quality VC who otherwise would have been excluded by the best entrepreneurs, to offer a larger fraction of the startup to these entrepreneurs to make a deal. The lower the VC quality, the higher is the fraction it has to offer to a given entrepreneur, and the higher is the cut-off on the entrepreneur quality, at which this VC can benefit.[2] This result suggests that it may be risky to simply assume positively assortative matching in settings that are affected by contracts (e.g., Cong and Xiao, 2018; Sannino, 2019).

[2]Formally, the VC's payoff may not be log-supermodular in the deal, in which an entrepreneur of the highest quality matches with a VC of the lowest quality allowed for such an entrepreneur in equilibrium: $\frac{\partial \pi_i(i,e,c^*(i,e))}{\partial i \partial e} < 0$ (see Theorem 1 in Smith (2011)).

IA4. Calibration of the value of convertible preferred equity

To rationalize the 13.5% estimated valuation gap between common equity and (nonparticipating) convertible preferred in the value-maximizing contract of the search model, consider the following example in the spirit of Metrick and Yasuda (2010). We assume the startup's value starts at $\pi(0) = 1$ at time 0 and follows a geometric Brownian motion with an annual volatility of 90% (as in Metrick and Yasuda (2010) and Gornall and Strebulaev (2020)). The risk-free rate (which is the drift of π under the risk-neutral measure) is 2%, equal to the average Treasury rate over our sample period.

If the firm's value drops below 0.15, the company files for bankruptcy. Following Cochrane (2005), the probability of exit at time t through an IPO or acquisition is a logistic function of firm value: $Pr(Success) = 1/[1 + \exp(-a(\ln \pi(t) - b))]$. We set $a = 1.5$ and $b = 5.5$. This gives an approximate 5 year expected time to exit (this is the same expected exit time as in Metrick and Yasuda and also equals our sample period average). Convertible stock is convertible to 14.7% of the common equity (the equity stake associated with the value-maximizing contract), and the investor makes a time-zero investment of 0.25. For simplicity, we assume no future financing rounds are expected to be necessary.

We simulate 1 million paths to compute the value of various types of securities at time 0. Table IA1 summarizes the results. The value of convertible preferred with a 1X liquidation preference and no cumulative dividend is 0.243 (or 24.3% of firm value), an increase of almost 10 percent of firm value compared to pure common equity, and quite close to the estimated 28.2% of firm value that the VC receives in our model. Adding participation raises the value of the security by one percent of firm value, to 0.253. This example ignores other contractual features of the convertible preferred equity security, such as voting rights and protective provisions, which are nearly always present. These features increase the security's value and widen the valuation gap with common equity even further. Also note that the estimated valuation gap between convertible preferred and common equity in our model results is substantially smaller for the average observed contract $c^{*,Avg}$ and the unconstrained VC contract $c^{*,Unc}$. In contrast, an 8% cumulative dividend only raises the security's value by 0.1% of firm value (0.5% in the case of participation). This happens because the chance of ending up in the range of exit values where cumulative dividends make a material difference to the investor is relatively small.

Table IA1
Value of securities simulation

	No cum. div.	8% cum. div.
Common stock	0.147	N/A
Convertible Preferred w/ 1X liquidation preference	0.243	0.244
Participating Convertible Preferred w/ 1X liquidation preference	0.253	0.258

The endogenous exit probability above is different from the exponential distribution of Metrick and Yasuda (2010) and Gornall and Strebulaev (2020), in which exit times are independent of firm value. Under exponentially distributed exit times (with a mean of 5 years), the value of convertible preferred with no dividends is slightly lower, at 0.23. Participation is more valuable (0.282). While dividends are also more valuable (0.248 without participation and 0.303 with participation), their impact it still considerably lower than participation.

It may be true that dividends matter more in later rounds when VCs invest larger amounts, but they do not appear to make a large difference in the early stage rounds we consider. Finally, note that the true $1 million valuation is different from the post-money valuation computed as $0.25 million / 0.147 = $1.7 million. The post-money valuation overstates the true value because its calculation assumes common equity (Metrick and Yasuda, 2010; Gornall and Strebulaev, 2020).

IA5. Counterfactual analysis: Removing contractual features

Because some contractual features appear to benefit VCs at the expense of the startup, we consider the effect of removing certain contract terms that implement these features on deal values, the frequency of deals, and the present value of all deals in the market. A naive approach would be to simply remove a term that implements a particular feature and recalculate the startup value and its split for all deals, but this approach ignores the fact that, in the new equilibrium, agents rebalance the remaining terms that implement the remaining features and they may match differently. Instead, we consider the aggregate equilibrium effect and decompose it into two partial effects. The first effect captures the rebalancing of contract terms, while constraining VCs to compensate entrepreneurs enough to retain the match. This effect is still off-equilibrium, as some VCs who suffer a decrease in their expected value have incentives to rematch. Still, this exercise helps to understand the impact of contracts on the firm in the absence of market effects. The first three columns of Table IA2 show that the average effect of re-balancing terms on the startup's value and its split is uniformly negative and very small. For example, if contractual features implemented by participation (VC board seats) are removed, rebalancing results in a 0.01% (0.14%) decrease in the startup's value. The VC's value decreases by the same amount (all effects in the first three columns are expressed as percentages of the average startup value from our main model).

The second effect captures the rematching that occurs when VCs rebalance the remaining contract terms without constraining them to keep the same matches. If contractual features implemented by participation are removed, the aggregate equilibrium effect is a 2.45% decrease in average startup value, implying that rematching alone is responsible for a 2.44% decrease. The aggregate equilibrium distribution of value to the VC (entrepreneur) decreases by 1.51% (0.94%), so that rematching alone is responsible for a 1.50% (0.94%) decrease. Removing contractual features implemented by VC board seats has comparable effects, decreasing the aggregate equilibrium distribution of value to the VC (entrepreneur) by 1.62% (0.81%). The effects from removing pay-to-play features are much smaller.

One explanation for the modest value effects is that the market for venture capital exhibits a high degree of contractual completeness, so that removed features are easily replicated by the remaining contract terms. Alternatively, it may be that deal-specific effects are large, but they cancel out in the aggregate. We find only limited evidence for this alternative explanation. In unreported analysis, the largest effect from removing participation is for entrepreneurs with qualities in the lowest decile, whose startups increase in value by 41.57%, with VCs (entrepreneurs) gaining 20.40% (21.17%). However, these deals' values are too small to strongly impact the average startup value across all deals. At the same time, the effect is small for startups formed by entrepreneurs with qualities above the median and for startups financed by investors of any quality. The effect from removing VC board seats is similar, while that of removing pay-to-play is small across all qualities.

The fourth column of Table IA2 shows the effects on deal frequencies. If features implemented by participation are removed, deal frequency increases by 5.30% on average. Similarly to deal values, this is mainly driven by entrepreneurs of low qualities: for example, entrepreneurs with qualities in the lowest decile match 27.42% more frequently, while entrepreneurs with qualities in the top decile, in fact, match 3.69% less frequently. Additional deals with low-quality entrepreneurs are conducted by low-quality investors: investors with qualities in the 10th to 50th percentiles match 13.85% more frequently, while investors with qualities in the 50th to 90th percentiles lose entrepreneurs and match 2.46% less frequently. Removing VC board seats has a similar effect, while removing pay-to-play does not materially affect deal frequencies.

The combined intuition behind the value and frequency results is as follows. Elimination of VC-friendly terms reduces, in any given deal, value for the VC and improves value for the entrepreneur and startup as a whole. The agents' values of waiting are similarly impacted. As a result, entrepreneurs become more selective and are prepared to wait for investors of higher quality and drop investors of lower quality. The opposite is true for investors. Whether the average startup value across all deals increases or not depends on the eagerness with which investors of high versus low quality are prepared to accept deals with entrepreneurs of lower quality than before. For our estimated parameters, the density of investors of low quality (and hence their competitiveness) is high, so elimination of VC-friendly terms strongly decreases their bargaining power, which leads to an influx of low-value deals signed with entrepreneurs of low quality who were hitherto virtually ignored. This influx positively affects the average deal frequency (despite the counterbalancing impact of entrepreneurs of high quality dropping their worst matches) and negatively affects the average startup value (despite the counterbalancing impact of higher-value deals signed by entrepreneurs of high quality).[3]

The above intuition suggests that even though the average deal value decreases in the absence of VC-friendly terms, there are more deals in the market, which can lead to a larger overall market size. The last three columns of Table IA2 show how the changes in deal values and frequencies combine to affect the expected present value of all deals in the market (the market size). For example, when participation is removed, the expected present value of all deals increases by 1.70%. VCs (entrepreneurs) on average lose 0.20% (gain 1.90%) (all effects are expressed as a percentage of the expected present value of all deals under estimated parameters). More detailed analysis reveals that entrepreneurs of high quality benefit disproportionately: top decile entrepreneurs capture 15.8% of the total entrepreneurial gain in present value, or 17.7% of the total change in the present value of all deals. When VC board seats are removed, the present value of all deals increases by 1.66%, while VCs (entrepreneurs) on average lose 0.35% (gain 2.00%). Pay-to-play has little impact, since its impact on both values and frequencies is negligible. To summarize, a removal of VC-friendly features could lead to modest firm value creation, suggesting that the market could benefit from (self-)regulation by restricting some VC-friendly features, such as the "double-dip" of participation. However, attempts to regulate contracts will likely encounter resistance from certain VCs and entrepreneurs (including high quality VCs), because they lose out following the removal of such terms. A few other caveats apply. First, because we do not explicitly model mechanisms through which contractual terms affect values, we cannot examine the effect of including a new feature, or removing a feature that is always present. Second, we cannot control for VCs devising new contract terms that implement the same features as the terms that are taken away, and it is complicated to write legal rules that prevent such contractual engineering. Finally, we do not consider entry and exit into the VC market. Because VC values are less affected than entrepreneurs, removing VC-friendly contract features would likely add more value from newly entering entrepreneurs than what is lost from departing VCs.

[3] For other parameters (i.e., if investors' qualities are more evenly distributed, decreasing competitiveness among investors of low quality), we find that the influx of low-value deals can be dominated, in terms of its impact on the average value of deals and their frequency, by the impact of less frequent high-value deals signed by entrepreneurs of high quality.

Fig. IA1. Sensitivity of selected moments to model parameters

The top row shows sensitivity of moments of the time between investors' deals to the change in frequency of encounters parameters, λ_i and λ_e. The middle row shows sensitivity of covariances between time between deals and contract terms to the change in quality distribution parameters, a_i, b_i, a_e, and b_e. The bottom row shows sensitivity of higher moments of time between deals and the VC equity share to the change in the complementarity parameter, ρ. The change in parameters on the horizontal axes is relative to their estimated values presented in Table 5. The estimated ρ is negative, such that a higher parameter value relative to the estimate means a more negative ρ. All other parameters estimates are positive.

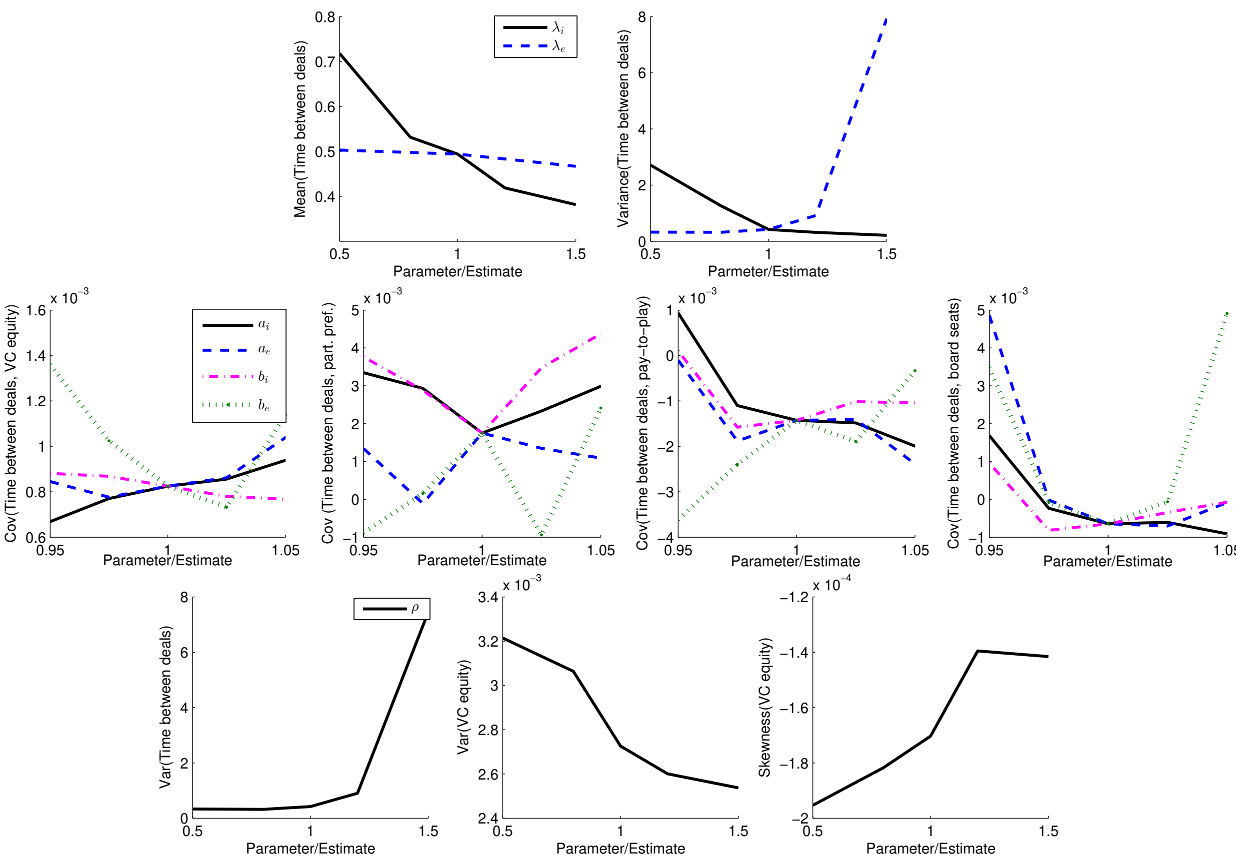

Table IA2
Counterfactuals: Elimination of contract features

This table reports the results of counterfactual exercises that disallow the use of one of three contract features: participation preference, pay-to-play, or VC board seats. The first column shows the change in the average expected startup value across all deals when moving from the unrestricted model equilibrium (at the parameters shown in Table 5) to the restricted contracts counterfactual, $\Delta\pi^{cf}(All) = \pi^{cf}(All) - \pi^{*}(All)$, as a percentage of the average expected startup value across all deals in the unrestricted model, $\pi^{*}(All)$. The "rebalanced terms only" rows report the partial effect of VCs rebalancing the remaining contract terms such that the set of matches does not change, while the "equilibrium" rows report the total effect of rebalancing and rematching in the new equilibrium. The second and third columns show the change in the average expected value for the VC and entrepreneur, respectively. Both are computed as a percentage of $\pi^{*}(All)$, such that columns 2 and 3 add up to the numbers in column 1. The fourth column reports the change in equilibrium expected deal frequencies (expected number of deals per year) in the market, $\Delta\Lambda^{cf}(All) = \Lambda^{cf}(All) - \Lambda^{*}(All)$, as a percentage of the expected deal frequency in the unrestricted equilibrium, $\Lambda^{*}(All)$. The final three columns report the change in the present value of all deals in the market, $\Delta PV^{cf}(All) = PV^{cf}(All) - PV^{*}(All)$, and the change in present values of all VCs and entrepreneurs. All present value changes are computed as percentages of the unrestricted equilibrium present value of deals in the market, $PV^{*}(All)$, so that columns 6 and 7 add up to the numbers in column 5.

	Change in percentage of startup value			Change in deal frequencies	Change in PV of deals		
	$\frac{\Delta\pi^{cf}(All)}{\pi^{*}(All)}$	$\frac{\Delta\pi_i^{cf}(All)}{\pi^{*}(All)}$	$\frac{\Delta\pi_e^{cf}(All)}{\pi^{*}(All)}$	$\frac{\Delta\Lambda^{cf}(All)}{\Lambda^{*}(All)}$	$\frac{\Delta PV^{cf}(All)}{PV^{*}(All)}$	$\frac{\Delta PV_i^{cf}(All)}{PV^{*}(All)}$	$\frac{\Delta PV_e^{cf}(All)}{PV^{*}(All)}$
No participation preference							
Rebalanced terms only	-0.01	-0.01	0	–	–	–	–
Equilibrium	-2.45	-1.51	-0.94	5.30	1.70	-0.20	1.90
No pay-to-play							
Rebalanced terms only	-0.01	-0.01	0	–	–	–	–
Equilibrium	-0.29	-0.05	-0.24	-0.31	-0.002	-0.002	-0.000
No VC board seats							
Rebalanced terms only	-0.14	-0.14	0	–	–	–	–
Equilibrium	-2.43	-1.62	-0.81	5.30	1.66	-0.35	2.00

Table IA3
Parameter estimates of model modifications: alternative success outcome and contract definitions.

The table reports parameter estimates of model modifications described in Section 7. Panel A reports the estimates of the model where success outcomes are captured by IPO. Panel B reports the estimates of the model where success outcomes are captured by follow-on financing. Panel C reports estimates of the main model (success outcomes are captured by IPO+Acq.$> 2X$ variable) where missing contract terms are imputed as zeros, provided the VC equity fraction and at least one additional term is non-missing in the data. Standard errors are clustered by lead VC firm. Significance: ***: $p < 0.01$, **: $p < 0.05$, *: $p < 0.10$.

	A. IPO		**B. Follow-on financing**		**C. Imputed terms**	
Parameter	Estimate	S.E.	Estimate	S.E.	Estimate	S.E.
Distribution of qualities, a_i	1.876***	0.579	2.191***	0.398	1.921***	0.251
Distribution of qualities, b_i	3.512***	1.166	2.369***	0.580	3.653***	1.400
Distribution of qualities, a_e	3.182**	1.571	4.612***	0.667	3.106***	0.710
Distribution of qualities, b_e	4.233***	0.924	3.711***	1.362	4.062***	0.789
Frequency of encounters, λ_i	13.417***	4.568	12.936**	5.444	13.475***	3.656
Frequency of encounters, λ_e	10.311	7.363	9.076**	4.099	10.954***	4.127
Substitutability of qualities, ρ	-1.334***	0.261	-1.307***	0.121	-1.343***	0.152
Probability of success, intercept, κ_0	-4.072***	1.157	-6.661	7.328	-4.091***	1.235
Probability of success, total value, κ_1	0.075***	0.029	0.458	0.488	0.113***	0.043
Total value, share of VC equity, β_1	0.682*	0.367	0.754***	0.108	0.650**	0.312
Total value, share of VC equity squared, β_2	-2.347***	0.639	-2.692***	0.326	-2.375***	0.322
Total value, participation, β_3	-0.163***	0.032	-0.168**	0.083	-0.163***	0.043
Total value, pay-to-play, β_4	0.024	0.066	0.031	0.047	0.023	0.027
Total value, VC board seat, β_5	-0.026***	0.010	-0.028*	0.016	-0.026***	0.007
Total value, participation × pay-to-play, β_6	0.016	0.091	0.013	0.035	0.017	0.026
Total value, participation × VC board seat, β_7	0.033	0.032	0.039	0.083	0.032	0.043
Total value, pay-to-play × VC board seat, β_8	0.019	0.020	0.013	0.038	0.019	0.058
Split of value, intercept, γ_1	-0.211*	0.116	-0.215***	0.058	-0.211***	0.032
Split of value, participation, γ_2	-0.175***	0.054	-0.157*	0.089	-0.171***	0.055
Split of value, pay-to-play, γ_3	0.056	0.057	0.053	0.051	0.057***	0.008
Split of value, VC board seat, γ_4	-0.040***	0.006	-0.041***	0.015	-0.040***	0.002
Split of value, participation × pay-to-play, γ_5	0.016	0.114	0.011	0.035	0.016	0.026
Split of value, participation × VC board seat, γ_6	0.029	0.054	0.028	0.089	0.029	0.055
Split of value, pay-to-play × VC board seat, γ_7	0.012	0.094	0.011	0.036	0.013	0.068
Number of observations	1,695		2,581		2,439	

Table IA4
Parameter estimates of model modifications: industry and geography subsamples.

The table reports parameter estimates of model modifications described in Section 7. Panel A reports the estimates of the model using a subsample of deals in the IT industry. Panel B reports the estimates of the model using a subsample of deals in the Healthcare industry. Panel C reports the estimates of the model using a subsample of deals with startups located in California. Standard errors are clustered by lead VC firm. Significance: ***: $p < 0.01$, **: $p < 0.05$, *: $p < 0.10$.

	A. IT		**B. Healthcare**		**C. California**	
Parameter	Estimate	S.E.	Estimate	S.E.	Estimate	S.E.
Distribution of qualities, a_i	1.681***	0.259	2.075***	0.408	1.920**	0.775
Distribution of qualities, b_i	3.407***	0.912	3.756**	1.653	3.559***	0.924
Distribution of qualities, a_e	3.131***	1.057	2.709*	1.516	3.132***	0.728
Distribution of qualities, b_e	4.272***	0.897	4.333**	2.066	4.161***	1.449
Frequency of encounters, λ_i	13.785***	4.077	10.901**	4.957	16.494***	5.241
Frequency of encounters, λ_e	11.736**	5.138	8.571*	4.488	12.952***	4.099
Substitutability of qualities, ρ	-1.155***	0.094	-1.597***	0.175	-1.367***	0.306
Probability of success, intercept, κ_0	-4.113*	2.296	-4.308*	2.476	-3.967**	2.000
Probability of success, total value, κ_1	0.112*	0.060	0.115*	0.059	0.108*	0.062
Total value, share of VC equity, β_1	0.701**	0.290	0.738***	0.233	0.680	0.569
Total value, share of VC equity squared, β_2	-2.452***	0.204	-2.113***	0.376	-2.373***	0.547
Total value, participation, β_3	-0.170*	0.099	-0.147***	0.022	-0.163***	0.059
Total value, pay-to-play, β_4	0.029	0.131	0.022	0.050	0.023	0.152
Total value, VC board seat, β_5	-0.026***	0.009	-0.025***	0.008	-0.026***	0.010
Total value, participation × pay-to-play, β_6	0.016	0.097	0.014	0.042	0.016	0.032
Total value, participation × VC board seat, β_7	0.033	0.099	0.034*	0.020	0.032	0.059
Total value, pay-to-play × VC board seat, β_8	0.016	0.035	0.018	0.089	0.019	0.024
Split of value, intercept, γ_1	-0.206***	0.070	-0.174***	0.054	-0.211***	0.076
Split of value, participation, γ_2	-0.177*	0.096	-0.179***	0.031	-0.174**	0.070
Split of value, pay-to-play, γ_3	0.058	0.172	0.058*	0.034	0.056	0.173
Split of value, VC board seat, γ_4	-0.041***	0.006	-0.043***	0.005	-0.041***	0.007
Split of value, participation × pay-to-play, γ_5	0.018	0.121	0.016	0.079	0.016	0.095
Split of value, participation × VC board seat, γ_6	0.028	0.096	0.030	0.031	0.029	0.070
Split of value, pay-to-play × VC board seat, γ_7	0.012	0.025	0.012	0.074	0.013	0.101
Number of observations	788		444		934	

Table IA5
Parameter estimates of model modifications: time subsamples.

The table describes parameter estimates of model modifications described in Section 7. Panel A reports the estimates of the model using a subsample of deals before the release of Amazon's AWS cloud in 2007. Panel B reports the estimates of the model using a subsample of deals after the release of Amazon's AWS cloud. Panel C reports the estimates of the model using a subsample of deals before the Lehman bankruptcy (09/15/2008). Panel D reports the estimates of the model using a subsample of deals after the Lehman bankruptcy. Standard errors are clustered by lead VC firm. Significance: ***: $p < 0.01$, **: $p < 0.05$, *: $p < 0.10$.

	A. Before AWS		**B. After AWS**		**C. Before Lehman**		**D. After Lehman**	
Parameter	Estimate	S.E.	Estimate	S.E.	Estimate	S.E.	Estimate	S.E.
Distribution of qualities, a_i	1.972***	0.542	2.017***	0.669	1.924***	0.421	2.092***	0.735
Distribution of qualities, b_i	3.686***	0.952	3.415***	1.230	3.748***	1.015	3.485*	1.778
Distribution of qualities, a_e	3.014***	1.381	3.103***	1.078	3.154**	1.574	3.110**	1.272
Distribution of qualities, b_e	4.057***	1.353	3.743***	1.375	4.157***	1.347	3.599	2.412
Frequency of encounters, λ_i	12.117**	3.002	13.409***	5.048	13.434***	2.965	13.518**	5.304
Frequency of encounters, λ_e	8.301**	3.358	17.037***	5.342	10.431**	4.166	17.699***	6.316
Substitutability of qualities, ρ	-1.594***	0.218	-1.213***	0.521	-1.400***	0.162	-1.301***	0.375
Probability of success, intercept, κ_0	-4.058**	1.951	-4.236	3.287	-3.997*	2.252	-4.300	4.203
Probability of success, total value, κ_1	0.103**	0.058	0.108*	0.062	0.105*	0.059	0.102	0.808
Total value, share of VC equity, β_1	0.673*	0.395	0.656*	0.394	0.682***	0.209	0.556	0.667
Total value, share of VC equity squared, β_2	-2.176***	0.228	-2.550***	0.542	-2.333***	0.201	-2.497***	0.837
Total value, participation, β_3	-0.146***	0.015	-0.177***	0.045	-0.159***	0.022	-0.177**	0.077
Total value, pay-to-play, β_4	0.024*	0.014	0.026	0.055	0.027	0.018	0.027	0.073
Total value, VC board seat, β_5	-0.026***	0.004	-0.027***	0.011	-0.026***	0.004	-0.027*	0.015
Total value, participation × pay-to-play, β_6	0.014	0.043	0.017	0.303	0.016	0.063	0.016	0.257
Total value, participation × VC board seat, β_7	0.027***	0.002	0.033	0.045	0.032***	0.0082	0.033	0.077
Total value, pay-to-play × VC board seat, β_8	0.018	0.043	0.016	0.113	0.017	0.047	0.017	0.090
Split of value, intercept, γ_1	-0.216***	0.035	-0.232***	0.040	-0.196***	0.037	-0.230***	0.085
Split of value, participation, γ_2	-0.182***	0.018	-0.175***	0.034	-0.174***	0.0183	-0.172***	0.064
Split of value, pay-to-play, γ_3	0.056**	0.027	0.056	0.138	0.057	0.036	0.057	0.105
Split of value, VC board seat, γ_4	-0.045***	0.004	-0.043***	0.011	-0.041***	0.003	-0.040***	0.010
Split of value, participation × pay-to-play, γ_5	0.015	0.171	0.016	0.416	0.015	0.174	0.017	0.458
Split of value, participation × VC board seat, γ_6	0.033***	0.008	0.029	0.034	0.029***	0.008	0.029	0.064
Split of value, pay-to-play × VC board seat, γ_7	0.016	0.081	0.012	0.070	0.012	0.056	0.012	0.104
Number of observations	885		810		1,360		335	

Table IA6
Parameter estimates of model modifications: alternative theoretical assumptions I.

The table describes parameter estimates of model modifications described in Section 7. Panel A reports model estimates where different investor and entrepreneur qualities encounter counterparties with different frequencies ($\lambda_i + \Lambda_i i$ and $\lambda_i + \Lambda_e e$). Panel B reports estimates for a model where different investor and entrepreneur qualities encounter counterparties from different quality distributions (c.d.f. $F_e(e,i)$ of entrepreneur quality encountered by investor i is such that p.d.f. $f_e(e,i) = \frac{\xi(e,i) f_e(e)}{\int_{\tilde{e}} \xi(\tilde{e},i) f_e(\tilde{e})}$, where $f_e(e)$ is the p.d.f. of the Beta distribution with parameters a_e and b_e and $\xi(e,i) = \left(0.5\left(\frac{e}{\bar{e}}\right)^{\chi} + 0.5\left(\frac{i}{\bar{i}}\right)^{\chi}\right)^{\frac{2}{\chi}}$ is a flexible constant-elasticity-of-substitution (CES) function that captures deviations of $f_e(e,i)$ from the random search case ($\chi = 0$); c.d.f. $F_i(i,e)$ of investor quality encountered by entrepreneur e is defined symmetrically). Panel C reports estimates where entrepreneurs have additional bargaining power to shift the contract towards the entrepreneur-optimal outcome (with a constant bargaining power parameter of 20%). Panel D reports estimates where entrepreneurs have additional type-specific bargaining power (equal to 5% × entrepreneur quality). Standard errors are clustered by lead VC firm. Significance: ***: $p < 0.01$, **: $p < 0.05$, *: $p < 0.10$.

	A. Directed search I		**B. Directed search II**		**C. Ent. barg. power I**		**D. Ent. barg. power II**	
Parameter	Estimate	S.E.	Estimate	S.E.	Estimate	S.E.	Estimate	S.E.
Distribution of qualities, a_i	1.900***	0.674	2.008**	0.930	2.020***	0.610	2.025***	0.295
Distribution of qualities, b_i	3.516***	0.717	4.106*	2.172	3.576***	1.341	3.336**	1.484
Distribution of qualities, a_e	3.343***	0.250	3.070**	1.771	3.087**	1.483	3.086***	0.575
Distribution of qualities, b_e	5.253*	2.725	4.559**	1.977	4.070***	0.949	4.172*	2.223
Base frequency of encounters, λ_i	9.001***	2.280	13.330**	6.228	9.903**	4.383	11.578**	5.803
Base frequency of encounters, λ_e	7.091***	1.878	10.798***	3.551	12.241*	6.403	12.840*	6.804
Substitutability of qualities (value), ρ	-1.421***	0.288	-1.395***	0.422	-1.216***	0.201	-1.512***	0.242
Probability of success, intercept, κ_0	-3.979*	2.316	-4.487	2.746	-4.319	2.672	-4.088***	1.357
Probability of success, total value, κ_1	0.107*	0.064	0.108*	0.056	0.109	0.067	0.104**	0.043
Total value, share of VC equity, β_1	0.726*	0.373	0.716***	0.133	0.551***	0.118	0.508***	0.185
Total value, share of VC equity squared, β_2	-2.271***	0.552	-2.198***	0.138	-2.470***	0.287	-2.066***	0.111
Total value, participation, β_3	-0.158***	0.061	-0.160**	0.076	-0.169***	0.046	-0.152***	0.044
Total value, pay-to-play, β_4	0.024	0.156	0.023	0.079	0.023	0.076	0.023	0.069
Total value, VC board seat, β_5	-0.028	0.026	-0.029***	0.007	-0.026**	0.013	-0.024	0.023
Total value, participation × pay-to-play, β_6	0.016	0.138	0.026	0.154	0.016	0.547	0.018	0.039
Total value, participation × VC board seat, β_7	0.036	0.061	0.042	0.076	0.034	0.046	0.036	0.044
Total value, pay-to-play × VC board seat, β_8	0.016	0.212	0.018	0.290	0.019	0.038	0.018	0.053
Split of value, intercept, γ_1	-0.247***	0.087	-0.260***	0.056	-0.254***	0.073	-0.191*	0.114
Split of value, participation, γ_2	-0.173***	0.043	-0.175**	0.079	-0.171***	0.046	-0.180***	0.047
Split of value, pay-to-play, γ_3	0.058	0.149	0.059	0.372	0.060*	0.035	0.065	0.127
Split of value, VC board seat, γ_4	-0.049***	0.018	-0.050***	0.008	-0.042***	0.009	-0.044***	0.016
Split of value, participation × pay-to-play, γ_5	0.017	0.639	0.014	0.287	0.015	0.137	0.017	0.328
Split of value, participation × VC board seat, γ_6	0.028	0.043	0.028	0.079	0.035	0.046	0.035	0.047
Split of value, pay-to-play × VC board seat, γ_7	0.012	0.191	0.011	0.199	0.013	0.079	0.013	0.093
Change in freq. of encounters, Λ_i	1.508***	0.341	–	–	–	–	–	–
Change in freq. of encounters, Λ_e	1.484**	0.719	–	–	–	–	–	–
Substitutability of qualities (encounters), χ	–	–	-2.129***	0.346	–	–	–	–
Entrepreneur bargaining power (fixed)	–	–	–	–	20%	–	5% × e	–
Number of observations	1,695		1,695		1,695			

Table IA7
Parameter estimates of model modifications: alternative theoretical assumptions II.

The table describes parameter estimates of model modifications described in Section 7. Panel A reports model estimates where the annual discount rate for the agents is 20%. Panel B reports model estimates where the annual discount rate for VCs (entrepreneurs) is 10% (20%). Panel C reports estimates for a version of the model where entrepreneurs are overconfident (the overconfidence parameter is 25%). Panel D reports estimates of the model where firm values are affected by a match-specific shock. Standard errors are clustered by lead VC firm. Significance: ***: $p < 0.01$, **: $p < 0.05$, *: $p < 0.10$.

	A. High disc. rate		**B. Asym. disc. rates**		**C. Ent. overconfidence**		**D. Match-spec. shocks**	
Parameter	Estimate	S.E.	Estimate	S.E.	Estimate	S.E.	Estimate	S.E.
Distribution of qualities, a_i	2.030***	0.257	1.959***	0.745	2.537***	0.305	1.925***	0.470
Distribution of qualities, b_i	3.560***	0.847	3.597*	2.043	4.078**	1.693	3.495***	0.821
Distribution of qualities, a_e	3.423***	0.274	3.365***	0.265	2.976***	0.905	3.300***	0.749
Distribution of qualities, b_e	4.372***	0.951	4.204***	0.750	4.176**	1.745	3.930***	1.317
Frequency of encounters, λ_i	8.199***	0.815	11.055***	3.436	13.732***	2.666	12.525***	4.650
Frequency of encounters, λ_e	7.458**	3.002	16.215**	7.561	10.742***	3.055	11.940**	5.765
Substitutability of qualities, ρ	-1.391***	0.198	-1.403***	0.307	-1.343***	0.290	-1.506***	0.156
Probability of success, intercept, κ_0	-3.984***	0.752	-4.022**	1.925	-4.122*	2.188	-4.449**	2.098
Probability of success, total value, κ_1	0.105***	0.024	0.106*	0.059	0.107*	0.056	0.110*	0.058
Total value, share of VC equity, β_1	0.680***	0.198	0.680***	0.180	0.682	0.408	0.507	0.317
Total value, share of VC equity squared, β_2	-2.338***	0.750	-2.362***	0.411	-2.375***	0.273	-2.215***	0.297
Total value, participation, β_3	-0.161***	0.053	-0.163**	0.081	-0.165*	0.091	-0.143***	0.006
Total value, pay-to-play, β_4	0.022	0.015	0.025	0.090	0.023	0.032	0.019**	0.009
Total value, VC board seat, β_5	-0.026***	0.008	-0.026**	0.013	-0.026***	0.009	-0.021***	0.004
Total value, participation × pay-to-play, β_6	0.016	0.048	0.017	0.028	0.018	0.053	0.015	0.213
Total value, participation × VC board seat, β_7	0.033	0.053	0.033	0.081	0.032	0.091	0.032	0.042
Total value, pay-to-play × VC board seat, β_8	0.019	0.092	0.019	0.021	0.019	0.085	0.019	0.016
Split of value, intercept, γ_1	-0.205***	0.053	-0.209**	0.085	-0.204**	0.102	-0.271***	0.058
Split of value, participation, γ_2	-0.172***	0.015	-0.173**	0.081	-0.176*	0.093	-0.176***	0.024
Split of value, pay-to-play, γ_3	0.060***	0.017	0.058	0.061	0.056	0.040	0.062***	0.018
Split of value, VC board seat, γ_4	-0.041***	0.005	-0.041**	0.016	-0.041***	0.013	-0.044***	0.014
Split of value, participation × pay-to-play, γ_5	0.015	0.055	0.015	0.058	0.016	0.048	0.016	0.136
Split of value, participation × VC board seat, γ_6	0.029*	0.015	0.029	0.081	0.029	0.093	0.031	0.024
Split of value, pay-to-play × VC board seat, γ_7	0.012	0.152	0.012	0.046	0.011	0.269	0.013	0.071
Entrepreneur overconfidence (fixed)	–	–	–	–	25%	–	–	–
St.dev. of match-specific shock, σ	–	–	–	–	–	–	0.323*	0.171
Number of observations	1,695		1,695		1,695		1,695	

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