Entrepreneurs and the Process of Obtaining Resources

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This paper examines the process of how entrepreneurs assemble resources. In the model, the entrepreneur's challenge is to convince two complementary resource providers to commit their resources to a new venture. Before committing their resources, one of them needs to perform a costly evaluation. The entrepreneur has a problem with getting sufficient attention, because each provider has an incentive to wait and free-ride on the other's evaluation. For some parameters the entrepreneur solicits both partners with equal intensity ("knocking on every door"); for others, the entrepreneur always solicits the same partner ("pestering"). For many but not all parameter ranges, the process of assembling resources takes too much time relative to what is socially efficient. The model thus explores what factors facilitate or hinder the creation of new firms.

1. Introduction

Much of modern economic theory does not have a role for the entrepreneur.[1] For Schumpeter (1934, 1939) an innovative venture is a reallocation of existing resources to a new application. The entrepreneur is central, because she is the one who convinces existing controllers of resources to apply them to the newly proposed use. Yet, the process

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1. Schultz [1980], for example, notes that:

> "In a large measure economic theory either omits the entrepreneur or it burdens him with esoteric niceties the implications of which are rarely observable."

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of convincing potential contracting partners can be daunting. For example, while drafting venture capital contracts is highly standardized and takes relatively little time, the process of soliciting interest from venture capitalists, and passing their due diligence, is difficult and time-consuming. Understanding the process by which entrepreneurs obtain commitments from resource providers is therefore central to an economic theory of entrepreneurship.

This paper provides a theory of how an entrepreneur gathers resources for a new venture. It focuses on the decision process of the existing resources providers to join a new venture. It recognizes that information about the viability of the new venture creates interdependence among the various decision makers. The paper focuses on a so-called "chicken and egg" problem, where the venture needs to have credibility to get a partner's commitment, but also needs to have commitments from partners to have credibility. Birley and Norburn (1985) call this the "credibility merry-go-round." Bhide and Stevenson (1999) note

> [. . .] the desire of each participant to hold off a commitment until others have signed on. Customers are reluctant to spend time to evaluate, much less place an order [. . .] until the entrepreneur can actually deliver a product; employees are hesitant to commit to a job until the financing is in place; and investors are unwilling to step forward unless customers have shown a willingness to buy.

In the model an entrepreneur wants to create a new venture that requires the cooperation of two partners. The entrepreneur cannot prove viability by herself, and requires a positive evaluation from one of the partners. We use a stationary infinite horizon model, where in any period the entrepreneur can solicit one partner to evaluate the venture. We derive a partner's equilibrium willingness to perform an evaluation. We call this his "attention level," and show that it depends on three factors. First, there are private (and stochastic) costs of doing an evaluation. Second, using a simple bargaining game based on the Shapley value, we show that doing the evaluation conveys a first-mover bargaining advantage. These first two factors can be combined into a contemporaneous net value of evaluating. A partner is trading this off against a third factor, which is the value of waiting: instead of doing the evaluation and saying "yes" or "no" to the entrepreneur, a solicited partner may always give the famous "maybe later" response. Grousbeck and Keare (1998), for example, describe the experiences of an entrepreneur, who was trying to gather resources for starting a regional airline, as follows:

> "[Potential investors] typically said, 'I would rather not be the first investor you have, but give me a call when you get ready to close the deal and I'll be willing to put up [some money].' These names were placed [. . .] in the rapidly expanding 'Interested but Not Now' file."

The entrepreneur's problem is to convince one partner to be the first do the evaluation and commit. This involves what we call the "paradox of attention:" If a partner likes to be solicited to go first, the more the entrepreneur solicits that partner, the lower his attention level. The intuition is that a higher solicitation rate does not affect the contemporaneous value of doing the evaluation, but increases the value of waiting. By contrast, if a partner prefers not be solicited, then a higher solicitation rate decreases the value of waiting and increases his attention level.

The model generates two optimal solicitation strategies for the entrepreneur. If partners like to be solicited, then the optimal strategy is to "knock on every door," which means to randomize across partners. This keeps the value of waiting low, because no partner can take solicitation for granted. However, if partners dislike solicitation, then it is optimal for the entrepreneur to "pester" one partner. The problem is that each partner is waiting for the other to do the evaluation, so that it is best for the entrepreneur to always solicit the same partner.

The model generates some interesting predictions about the equilibrium attention level, and therefore the speed of closing a deal. We show that the higher the value that the entrepreneur can create with just one of the two partners, the greater the joint bargaining power of the entrepreneur and the first evaluating partner, and the greater the willingness of partners to be the first to evaluate the project. Comparing the equilibrium attention level with the attention level that would be socially efficient (i.e., that maximizes the sum of utilities), we find that for a large range of parameters there is too little attention relative to the efficient level. This means that evaluation takes too much time in equilibrium, and too many ventures falter even before partners agree to commit their resources. We call this a "social attention deficit." For a limited range of parameters where partners strongly care to preempt each other's evaluations, however, it is possible that the equilibrium attention level is socially excessive.

This paper is related to the work of Anton and Yao (1994, 1995, 2002, 2004), Baccara and Razin (2006ab), Biais and Perotti (2004), Hellmann and Perotti (2006) and Rajan and Zingales (2001). These papers examine how an entrepreneur can contract with one or multiple parties when there is leakage of intellectual property. In these models the entrepreneur is concerned that the other parties pay too much attention to her ideas, whereas here the entrepreneur faces a lack of attention. The analysis is related to the work on leadership (Hermalin, 1998) and also the question of access (Rajan and Zingales, 1998). The process of assembling resources bears some resemblance to the literature on search (Diamond, 1978), where an entrepreneur has to find suitable partners. In this paper, however, partners are readily identifiable, and the main problem is that they have an incentive to wait. The problem of waiting is related to wars of attrition (Bulow and Klemperer, 1999). Our analysis is also related to the literature on delay in bargaining (Admati and Perry, 1987), although the delay in our model is not due to asymmetric information itself. Noe and Wang (2004) show how mixed strategies can be beneficial in a sequential bargaining model with confidential negotiations. Marx and Shaffer (2004) examine related issues of bargaining in sequential contracting. Finally, the evaluation process builds on the large literature on screening and information gathering (Stiglitz, 1985).

The remainder of the paper is structured as follows. Section 2 sets out the base model. Section 3 presents and solves the bargaining game. Section 4 derives the equilibrium properties of the solicitation and evaluation game. Section 5 examines social efficiency. Section 6 discusses alternative model specifications. It is followed by a brief conclusion. All proofs are in the appendix.

2. The Base Model

There are three risk-neutral players. The entrepreneur, denoted by E, has an idea for a new venture. To implement it, she requires resource commitments from two partners, that we denote by A and B.[2] Each partner can contribute a unique resource to the venture, and having both resources creates more value than having only one. In the terminology of Anton and Yao (1994), this means that a duopoly (i.e., two resource providers) creates more value than a monopoly (i.e., a single provider). For tractability reasons, we focus on the case where A and B always have symmetric parameter values, that is, they will have the same preferences, costs, and so on . . . Obviously, this does not imply that they behave in exactly the same way, as we will see below.

The net investment costs are given by $I_k > 0$ ($k = E, A, B$), where symmetry implies $I_A = I_B$. In addition, we assume that the entrepreneur

2. Our definition of resources, commitments and partners are very general. Resources may be physical assets, human capital, financial capital, intellectual property or others. A commitment may be an acquisition, a supply contract, an employment contract, a financing commitment, a cooperative agreement, or other types of contracts. Finally, partners may be employees, financiers, suppliers, customers, alliance partners or others.

obtains a private benefit from undertaking the venture, denoted by η. In the base model we assume that $\eta > I_E$, so that the entrepreneur always wants to undertake the venture, even in the absence of any monetary returns. We relax this assumption in Section 6.1.

There is uncertainty about the gross returns of the new venture. With probability σ the venture is good and yields returns, and with probability $1 - \sigma$ it is bad and yields no returns. If the venture is good, the returns depend on exactly what partners participate. If both A and B participate, the gross returns are given by R.[3] The net returns (including private benefits) are given by $r = R + \eta - I_E - I_A - I_B > 0$. If only A participates, the gross returns are given by R_A, and the net returns are given by $r_A = Max(0, R_A + \eta - I_E - I_A)$. We assume that having both partners is better than only having one, that is, $r > r_A$. Using symmetry, we simplify our notation by writing $r_A = r_B = \gamma r$, so that γ (with $\gamma \in [0, 1)$) measures the fraction of net returns that can be obtained if only one partner signs on. Without an evaluation, the venture is assumed to be too risky.[4] We also assume that A and B cannot generate any value on their own, because the entrepreneur has some indispensable skills, and/or because she owns intellectual property rights to the idea. In Section 6.1 we relax this assumption.

We model the evaluation in the following simple way. The entrepreneur cannot perform the evaluation by herself, but needs to solicit it from a partner. In any one period, she can only solicit one partner. The solicited partner can perform an evaluation, that reveals whether the venture is good (which happens with probability σ) or bad. There is a private cost of performing the evaluation. Each period, a partner draws his evaluation cost c_t from a uniform distribution over the interval $[0, 1]$.[5] A and B's draws are independent of each other. We can think of this cost not only in terms of direct evaluation costs, but also in terms of the opportunity cost of a partner's time. This specification allows us to capture the notion that partners are "busy" people (or organizations), that are not entirely predictable in terms of whether or when they will perform an evaluation. If a partner is willing to do the evaluation for some cost level c_t, then he is also willing to do it for any cost lower than c_t. This implies that there exists a critical level λ_t, such that a partner is willing to do the evaluation if and only if $c_t \leq \lambda_t$. With a uniform distribution, the probability that a partner does the evaluation is simply given by λ_t. Thus, λ_t is our measure of a partner's attention level. The expected costs of evaluation are given by $\int_{c_t=0}^{c_t=\lambda_t} c_t \, dc_t = \frac{\lambda_t^2}{2}$.

3. Note that R can also be thought of as the expected value of a stochastic return.
4. Formally, this amounts to saying that $\sigma R + \eta - I_E - I_A - I_B < 0$ and $\sigma R_A + \eta - I_E - I_A < 0$.
5. Using the unit interval is a convenient normalization.

The information structure of the game is as follows. All parties observe the entrepreneur's solicitation choice, and whether or not the solicited partner performs an evaluation or not.[6] However, the outcome of the evaluation is only observed by the entrepreneur and the evaluating partner. Although the nonevaluating partner does not observe the outcome of the evaluation, we will see that in equilibrium he is always able to infer it. Specifically, if the evaluating partner makes (does not make) a commitment, it must be that the evaluation was good (bad). Because of this, our game structure behaves like a full information game. The only instance where private information matters, is in the bargaining game, as discussed in Section 3.

The timing of the stage is as follows. In any given period t, the entrepreneur first has to decide which partner to solicit. We denote the probability of soliciting A, in period t, by α_t, and soliciting B by β_t. Because it is never optimal to solicit neither partner, we have $\beta_t = 1 - \alpha_t$. After the entrepreneur has solicited a partner, this partner performs an evaluation with probability λ_t. If he doesn't perform the evaluation, the game simply moves to the next period $t + 1$. If he finds a negative signal, this means that the venture is unprofitable, and he refuses to deal with the entrepreneur. If it is good, then a contracting game ensues. We describe the assumptions of the contracting game in section 3. All investment costs I_k are incurred after the conclusion of the bargaining game, and all returns are obtained thereafter. Prior to any evaluation there is no contracting. We further discuss this assumption in Section 6.2.

Between periods we apply a discount factor δ, which accounts for the value of time and/or the possibility that the opportunity vanishes as a result of the delay. The extensive form game is a full information Markov game. In every period there are two terminal states (a good or a bad signal) and one transitory state (no evaluation). This structure intuitively reflects the three answers that entrepreneurs can expect from resource providers: "yes," "no," and the famous "maybe later." The Markov process is stationary, and for tractability we limit the analysis to stationary strategies. Our equilibrium concept is a standard sequential equilibrium.

3. Bargaining

We begin by examining the bargaining game that ensues after a first partner has positively evaluated the venture. We use a simple bargaining model that is based on the Shapley value. The Shapley value provides

6. This assumption is necessary for stationarity. Relaxing it would generate a nonstationary inference model that is no longer tractable.

an intuitive division of surplus, that depends on the outside options that each player can have, both alone, and in coalition with others. The Shapley value was originally developed as a cooperative bargaining solution. Hart and Mas-Colell (1986) show how the Shapley value can be obtained as the outcome of a noncooperative game, using a multiparty (random-order) extension of the well-known two-person alternating offer game (Rubinstein and Wolinksy, 1985). We augment their game-specification along the lines of Segal (2003), who allows for the possibility of what he calls "collusion," prior to the onset of the random-order offer game. This simply means that prior to entering a three-person bargaining game, two parties can choose to make a side-agreement. This is optimal whenever such a side-agreement improves their joint bargaining position. Note that in our model, there is a natural possibility for side-agreements prior to the three-person bargaining game, namely between the entrepreneur and the first partner that performs the evaluation.

Formally, we use the standard assumption that there is an infinite number of possible bargaining stages, and that the discount factor for bargaining d approaches 1.[7] At any stage, bargaining follows the protocol defined by Hart and Mas-Colell (1986, p. 360). This protocol essentially specifies that (i) to reach an agreement, all concerned players must be present, (ii) that among all present players, one is chosen at random to make a proposal, and (iii) that in case that the proposal is rejected by at least one player, there is an ε probability (with $\varepsilon \to 0$) that the proposer "breaks down" (i.e., is eliminated forever from the bargaining game). To allow for side-agreements (Segal, 2003), we augment this game as follows. At every stage game, the entrepreneur designates with whom she wants to bargain.[8] If designated, a partner can agree or refuse to participate in the bargaining.

In the appendix we show that this bargaining game naturally breaks out into two distinct stages. In equilibrium, the first stage is resolved at the first date, and the second stage is resolved at the second date. The second stage consists of the trilateral bargaining game, between the entrepreneur and both partners. At the first stage, the entrepreneur and the first partner make a side-agreement. This side-agreement has the purpose of creating a unified front vis-à-vis the second partner, thus improving their joint bargaining position.

7. Note that $d \neq \delta$, since bargaining can happen at a different (faster) rate than evaluation.

8. The assumption that the entrepreneur designates whom to bargain with is natural—remember that the entrepreneur is indispensable—but not essential. In the appendix we show that the bargaining outcome would be the same if the first evaluating partner were to make that choice.

Lemma 1: *After a positive evaluation, the entrepreneur and the first partner always forge a collusive side-agreement before approaching the second partner.*

All formal proofs are in the appendix. The main idea is that the two incumbent partners (the entrepreneur and the first partner) always want to maintain the value of any coalition that they both belong to, but destroy the value of any coalition that separates them. The two incumbents maximize their bargaining strength by providing a united front against the outside player (i.e., the second partner). Put differently, the incumbents always want to eliminate the possibility that one of the players forms a coalition with the outside player. This implies that the two incumbent players find it optimal to have a collusive side-agreement. In our context, we can naturally think of this in terms of creating a firm.

Let ρ_j denote the value generated by the coalition $j = EAB, EA, EB, AB, E, A, B$, and let V_k, $k = E, A, B$ be the utility of party k from the bargaining game. In general, the Shapley values are given by

$$\begin{aligned} V_E &= \frac{1}{3}(\rho_{EAB} - \rho_{AB}) + \frac{1}{6}(\rho_{EA} - \rho_A) + \frac{1}{6}(\rho_{EB} - \rho_B) + \frac{1}{3}\rho_E \\ V_A &= \frac{1}{3}(\rho_{EAB} - \rho_{EB}) + \frac{1}{6}(\rho_{EA} - \rho_E) + \frac{1}{6}(\rho_{AB} - \rho_B) + \frac{1}{3}\rho_A \\ V_B &= \frac{1}{3}(\rho_{EAB} - \rho_{EA}) + \frac{1}{6}(\rho_{EB} - \rho_E) + \frac{1}{6}(\rho_{AB} - \rho_A) + \frac{1}{3}\rho_B. \end{aligned}$$

Suppose w.l.o.g. that A is the first evaluating partner. Lemma 1 implies $\rho_{EB} = 0$. Moreover, we have $\rho_{EAB} = r$, $\rho_{EA} = \gamma r$ and $\rho_{AB} = \rho_A = \rho_B = \rho_E = 0$. The second stage Shapley values are then given by $\frac{2+\gamma}{6}r$ for both E and A (the first evaluating partner) together, and by $\frac{1-\gamma}{3}r$ for B (the nonevaluating partner).

We now turn to the first stage bargaining game. When negotiating their side-agreement, the entrepreneur and the first partner need to agree on a division of their joint surplus $\frac{2+\gamma}{6}r$. In this two-player random-order offer game, the Shapley value reduces to the Nash bargaining solution. To solve the first stage of the bargaining game, we need to consider each player's outside options. Because the entrepreneur is indispensable, the first partner's outside option is zero. We now show that, under the informational assumptions of the base model, the entrepreneur's outside option is also zero.

The entrepreneur's outside option is the utility she would obtain if she were to approach the second partner, without having an agreement in hand from the first partner. The second partner, however, does not know whether the evaluation of the first partner was good or bad.

He faces the following inference problem. Under the assumption that $\eta > I_E$, the entrepreneur is willing to undertake the venture even if it is bad. One possibility is therefore that the first partner had a bad evaluation, and that the entrepreneur is still trying to get the venture started. The other possibility is, of course, that the first partner had a good evaluation, but that there was a bargaining breakdown. The first scenario (bad evaluation) occurs 'on the equilibrium path', with probability $1 - \sigma$, whereas the second scenario (good evaluation) only occurs 'off the equilibrium path', that is, with the probability of a bargaining breakdown ($\varepsilon \to 0$). The rational inference of the second partner is therefore to assume that the entrepreneur had a negative evaluation. He will therefore refuse to deal with her. It follows that the entrepreneur's outside option is zero at the first stage. Intuitively, the zero outside option of the entrepreneur reflects a lack of credibility, where, off the equilibrium path, the second partner does not trust the entrepreneur, because of her motivation to pursue the venture for private benefits, irrespective of financial returns. We discuss this further in section 6.1.

We are thus in a position to state the outcome of the bargaining game. It is useful to express the bargaining values in terms of their expected values prior to the evaluation. Let $v = \sigma r$ be the total expected returns from an evaluation. v_E measures the entrepreneur's expected returns, $v_1 (= \sigma V_1)$ measures a partner's expected benefit of moving first in the bargaining game, and $v_2 (= \sigma V_2)$ measures the expected benefit of moving second.

Proposition 1 (The bargaining outcome): *The equilibrium values of the bargaining game are given by*

$$v_E = \frac{2+\gamma}{6}v, \quad v_1 = \frac{2+\gamma}{6}v, \quad v_2 = \frac{1-\gamma}{3}v. \tag{1}$$

In Proposition 1 the entrepreneur and the first partner benefit from higher values of γ. This means that if the value of the coalition that excludes the second partner generates more value on its own, then both the entrepreneur and the first evaluating partner enjoy a stronger bargaining position. In addition, we note that $v_1 - v_2 = \frac{\gamma}{2}v$. This says that the bargaining first-mover advantage is also an increasing function of γ, a result that we will use repeatedly in Section 4.

As with any bargaining game, the solution of the game depends on the assumptions about the bargaining and information structure. In Section 6.1, we explain how our results are affected by alternative assumptions.

4. Equilibrium

We now derive the steady-state equilibria of the model. For notational simplicity we omit all time subscripts t. We denote the expected payoffs by π_A, π_B, and π_E. In any one period, A is solicited with probability α. If solicited, he performs an evaluation with probability λ_A, receiving a payoff v_1; from Section 2, the expected evaluation costs are $\frac{\lambda_A^2}{2}$. With probability $1 - \lambda_A$, A does not perform an evaluation, in which case the game moves into the next period, where A receives again π_A, though discounted by δ. With probability β (=$1 - \alpha$), B is solicited. In this case B performs an evaluation with probability λ_B, so that A receives v_2; with probability $1 - \lambda_B$, B does not evaluate, and the game moves again into the next period. These observations imply that A's expected payoff is given by

$$\pi_A = \alpha\left(\lambda_A v_1 - \frac{\lambda_A^2}{2} + (1 - \lambda_A)\delta\pi_A\right) + \beta(\lambda_B v_2 + (1 - \lambda_B)\delta\pi_A).$$

Similar considerations show that B's expected payoff is given by

$$\pi_B = \alpha(\lambda_A v_2 + (1 - \lambda_A)\delta\pi_B) + \beta\left(\lambda_B v_1 - \frac{\lambda_B^2}{2} + (1 - \lambda_B)\delta\pi_B\right).$$

and E's expected payoff is given by

$$\pi_E = \alpha(\lambda_A v_E + (1 - \lambda_A)\delta\pi_E) + \beta(\lambda_B v_E + (1 - \lambda_B)\delta\pi_E).$$

We can solve these expressions and obtain

$$\pi_A = \frac{\alpha\lambda_A\left(v_1 - \frac{\lambda_A}{2}\right) + \beta\lambda_B v_2}{1 - \delta + \delta\alpha\lambda_A + \delta\beta\lambda_B}, \quad \pi_B = \frac{\alpha\lambda_A v_2 + \beta\lambda_B\left(v_1 - \frac{\lambda_B}{2}\right)}{1 - \delta + \delta\alpha\lambda_A + \delta\beta\lambda_B} \tag{2}$$

$$\pi_E = \frac{\alpha\lambda_A v_E + \beta\lambda_B v_E}{1 - \delta + \delta\alpha\lambda_A + \delta\beta\lambda_B}.$$

We now want to derive the optimal choices of λ_A (for A), λ_B (for B) and α (for E). For this we note that the one-shot deviation principle applies in our model (see Fudenberg and Tirole, 1991, 108–110). This means that we only need to verify that in any equilibrium no individual can do better by changing a single decision in a single period. Consider A's choice of attention level λ_A. The benefit of doing the evaluation is v_1, the cost is c, and the utility of not doing the evaluation is $\delta\pi_A$. Doing an evaluation is worthwhile whenever $v_1 - c \geq \delta\pi_A$. A's optimal attention level in any one period therefore satisfies

$$v_1 - \lambda_A - \delta\pi_A = 0. \tag{3}$$

This equation contains an important intuition. A's attention level depends on three main factors: the expected returns that A gets from discovering the viability of the venture (measured by v_1), the marginal cost of evaluation (measured by λ_A), and the value of waiting another period (measured by $\delta\pi_A$). The subtlety is that A considers not only the attractiveness of the venture itself, but also its urgency.

Analogously, B's optimal attention level is given by

$$v_1 - \lambda_B - \delta\pi_B = 0. \tag{4}$$

Turning to E's optimal choice of α, we note that the utility of soliciting A is $\lambda_A v_E + (1 - \lambda_A)\delta\pi_E$, whereas the utility of soliciting B is given by $\lambda_B v_E + (1 - \lambda_A)\delta\pi_E$. From (2) we have $v_E > \delta\pi_E$, so that soliciting A is more attractive whenever $\lambda_A \geq \lambda_B$. Therefore, the optimal choice of α is determined as follows:

$$\alpha = 0 \quad \text{if } \lambda_A < \lambda_B, \quad \alpha \in [0, 1) \quad \text{if } \lambda_A = \lambda_B \quad \text{and} \quad \alpha = 1 \quad \text{if } \lambda_A > \lambda_B \tag{5}$$

Conditions (3), (4), and (5) allow us to determine all equilibria. Consider first the possibility that E plays a pure strategy equilibrium. Let us focus on the case of $\alpha = 1$ (the case of $\beta = 1$ is analogous). If E always solicits A, it must be from (5) that $\lambda_A \geq \lambda_B$. Equations (3) and (4) then imply $\pi_A \leq \pi_B$. Using $\alpha = 1$ we note from (2) that

$$\pi_A = \frac{\lambda_A \left(v_1 - \dfrac{\lambda_A}{2} \right)}{1 - \delta + \delta\lambda_A} \quad \text{and} \quad \pi_B = \frac{\lambda_A v_2}{1 - \delta + \delta\lambda_A} \tag{6}$$

so that $\pi_A \leq \pi_B$ is equivalent to

$$v_1 - v_2 - \frac{\lambda_A}{2} \leq 0. \tag{7}$$

We define

$$\Phi_A \equiv v_1 - v_2 - \frac{\lambda_A^*}{2}, .$$

where Φ_A is a measure of the net first-mover advantage, that is, a partner's net advantage of evaluating first. It consists of the bargaining advantage of moving first ($v_1 - v_2$), minus the expected evaluation costs ($\frac{\lambda_A^*}{2}$, see equation (8) below). In essence, Φ_A measures how much a partner likes it if he, rather than the other partner, is being solicited.

We note that (7) is equivalent to $\Phi_A \leq 0$. This says that E's pure strategy of soliciting always the same partner is an equilibrium as long as there is a net first-mover disadvantage.

To derive the equilibrium attention level, we use (6) in (3) and obtain after transformations:

$$\frac{1-\delta}{\delta}v_1 - \frac{1-\delta}{\delta}\lambda_A - \frac{\lambda_A^2}{2} = 0.$$

It is easy to verify that this quadratic equation has a single positive root. Using (1) we obtain

$$\lambda_A^* = -\frac{1-\delta}{\delta} + \sqrt{\left(\frac{1-\delta}{\delta}\right)^2 + \frac{1-\delta}{\delta}\frac{2+\gamma}{3}v}. \tag{8}$$

Consider now the possibility that E plays a mixed strategy equilibrium, that is, $0 < \alpha < 1$. For this to be optimal it must be from (5) that $\lambda_A = \lambda_B \equiv \lambda$. From (2) we have

$$\pi_A = \frac{\alpha\lambda\left(v_1 - \frac{\lambda}{2}\right) + \beta\lambda v_2}{1-\delta+\delta\lambda} \quad \text{and} \quad \pi_B = \frac{\alpha\lambda v_2 + \beta\lambda\left(v_1 - \frac{\lambda}{2}\right)}{1-\delta+\delta\lambda}. \tag{9}$$

Moreover, from (3) and (4) we have $\lambda = v_1 - \delta\pi_A = v_1 - \delta\pi_B$, implying $\pi_A = \pi_B$. We use this in (9) to obtain

$$\alpha\lambda\left(v_1 - v_2 - \frac{\lambda}{2}\right) = \beta\lambda\left(v_1 - v_2 - \frac{\lambda}{2}\right).$$

We note that —except for the special case of $\lambda = 2(v_1 - v_2)$, discussed under part (iii) of Proposition 2—the only mixed strategy equilibrium is the symmetric mixed strategy equilibrium where $\alpha = \beta = \frac{1}{2}$.

To derive the equilibrium attention level for the mixed strategy equilibrium, we use $\alpha = \beta = \frac{1}{2}$ in $\lambda = v_1 - \delta\pi_A = v_1 - \delta\pi_B$, and obtain after simple transformations

$$2\frac{1-\delta}{\delta}v_1 + \lambda v_1 - \lambda v_2 - 2\frac{1-\delta}{\delta}\lambda - \frac{3}{4}\lambda^2 = 0.$$

It is easy to verify that this quadratic equation has a single positive root. Using (1), we obtain

$$\lambda^* = \frac{1}{6}\left(\gamma v - 4\frac{1-\delta}{\delta}\right) + \frac{1}{6}\sqrt{(\gamma v)^2 + 16\left(\frac{1-\delta}{\delta}\right)^2 + 16v\frac{1-\delta}{\delta}}. \tag{10}$$

Before stating our main proposition it is useful to introduce one more definition and lemma. Similar to Φ_A for the pure strategy equilibrium, we define for the mixed strategy equilibrium

$$\Phi \equiv v_1 - v_2 - \frac{\lambda^*}{2},$$

where Φ again measures the net first mover advantage, the only difference being that the evaluation costs now pertain to (10) rather than (8). The following lemma establishes the relationship between Φ_A and Φ, as well as their respective properties.

LEMMA 2: *Φ and Φ_A are both strictly increasing functions of γ. There exists $\hat{\gamma} \in (0, 1)$, so that $\gamma \gtreqless \hat{\gamma} \Leftrightarrow \Phi_A \gtreqless 0 \Leftrightarrow \Phi \gtreqless 0$.*

Lemma 2 shows that Φ_A and Φ share the same properties. That is, the net first-mover advantages behave similarly, irrespective of whether they are evaluated at (8) or (10). Henceforth we simplify the exposition by focusing only on Φ. Everything that is true for Φ will also be true for Φ_A.

The most important insight from Lemma 2 is that Φ is increasing in γ, with Φ negative (positive) for low (high) values of γ. The intuition is that the larger the value that the entrepreneur and the first evaluating partner can create by themselves (larger γ), the larger the bargaining first mover advantage $(v_1 - v_2)$.[9]

We are now in a position to state the equilibrium properties of the model.

PROPOSITION 2, PARTS (I) TO (III) (OPTIMAL SOLICITATION STRATEGIES):

(i) **Knocking on every door**:*There always exists a mixed strategy equilibrium where E solicits A and B with equal probabilities $\alpha = \frac{1}{2}$. The equilibrium level of attention is given by* (10). *λ^* is increasing in γ* and *v, and decreasing in δ.*

(ii) **Pestering**: *If $\Phi < 0$ then there also exist two pure strategy equilibria where E only solicits one partner, either only A (i.e., $\alpha = 1$), or only B (i.e., $\beta = 1$). If targeted, A's level of attention is determined by* (8). *λ_A^* is increasing in γ* and *v, and decreasing in δ.*

(iii) *If $\Phi = 0$, then any $\alpha \in [0, 1]$ is an equilibrium, and the level of attention is given by $\lambda_A^* = \lambda^* = 2(v_1 - v_2) = \hat{\gamma} v$.*

Proposition 2 characterizes all possible equilibria. The mixed equilibrium is intuitive, in the sense that the two symmetric partners are treated in a symmetric manner. Every period E symmetrically randomizes between soliciting A or B, i.e., $\alpha = \frac{1}{2}$. We call this the door-knocking equilibrium because E leaves no partner unattended and tries her luck with all partners. The pestering equilibria is slightly more surprising,

9. In the proof of Lemma 2, we also show that Φ is increasing in δ. The main intuition is that the smaller the discount rate (higher δ), the less urgency, the smaller the optimal level of λ in equation (10), and thus the smaller the expected evaluation costs ($\frac{\lambda}{2}$). In the appendix we also show that the derivative of Φ w.r.t. v is ambiguous.

because it treats symmetric partners in an asymmetric manner. We call it the pestering equilibrium, because E always solicits the same partner, even though that partner does not want to be solicited. Proposition 2 also characterizes the knife-edge case of $\Phi = 0$, where partners are indifferent between being solicited or not, and where any randomization α is an equilibrium. Because this case occurs only for a unique value $\hat{\gamma}$, we ignore it for the remainder of the analysis.

The equilibria of Proposition 2 have intuitive comparative statics. The higher is γ, the higher the equilibrium attention level. The intuition is again that if the value that the entrepreneur and the first evaluating partner can create on their own is higher, then the bargaining first mover bargaining advantage $(v_1 - v_2)$ is larger. This increases the incentive for each partner to preempt the other by doing the evaluation first, and thus results in a higher attention level. The intuition for why lower discount rates (i.e., higher values of δ) decrease the equilibrium attention level goes directly back to equation (3), which shows that a lower discount rate increases the value of waiting, and thus discourages doing an evaluation.

For $\Phi > 0$ the equilibrium is unique, but for $\Phi < 0$ there are two pure strategy and one mixed-strategy equilibrium. A natural question to ask is whether the equilibria are stable, in the sense that a small deviation from the optimal strategy would correct itself. The pestering equilibrium is naturally stable. To see this, suppose E always solicits one partner, say A. The condition $\Phi < 0$ implies that A has a lower value of waiting than B, that is, $\delta\pi_A < \delta\pi_B$. From (3) this means that A has a higher attention level than B, i.e., $\lambda_A > \lambda_B$, which in turn justifies E always soliciting A. If E were to marginally increase her solicitation of B, then $\lambda_A > \lambda_B$ implies that she would want to correct this deviation and reduce her solicitation of B back to $\beta = 0$.

Consider now the mixed strategy equilibrium, and suppose that E were to marginally increase her solicitation rate for A (the argument is analogous for B). The effect of this turns out to be of broader interest.

Proposition 2, Part (iv) (the Paradox of Attention):

(iv) *Starting from the mixed strategy equilibrium of Proposition 2(i), consider an increase in the solicitation rate of A.*
- *Suppose partners like to be solicited* ($\Phi > 0$), *then they provide less attention when solicited more. Formally, we have* $\frac{d\lambda_A}{d\alpha} < 0$ *and* $\frac{d\lambda_B}{d\alpha} > 0$.
- *Suppose partners do not like to be solicited* ($\Phi < 0$), *they provide more attention when solicited more. Formally, we have* $\frac{d\lambda_A}{d\alpha} > 0$ *and* $\frac{d\lambda_B}{d\alpha} < 0$.

To get an intuition for this paradox, note from equation (3) that a partner's attention level depends on two competing forces. The first two terms represent the contemporaneous net benefit of evaluating.

These terms are not affected by the solicitation rate (α), because by the time a partner makes an evaluation decision, he has already been solicited. However, the third term, the value of waiting, depends on the solicitation rate, as can be seen from (2). If a partner likes to be solicited, a higher solicitation rate increases his value of waiting, which lowers the attention level. Similarly, if he dislikes it, a higher solicitation rate decreases his value of waiting, and thereby raises his attention level.

The paradox of attention is of interest by itself. It also helps us to examine the stability of the mixed strategy equilibrium. Consider what happens if E were to marginally increase her solicitation rate for A? For $\Phi > 0$, the paradox of attention tells us that an increase in E's solicitation rate will decrease A's attention level and increase B's attention level. This would make B the more attractive partner. Hence E would want to marginally decrease her solicitation rate of A again. This shows that the mixed strategy equilibrium is stable. For $\Phi < 0$, however, the paradox of attention tells us that A pays more attention and B pays less attention, making A more attractive for E. Thus E would want to further increase her solicitation rate for A. This shows that the mixed strategy equilibrium is not stable.

Proposition 2, Part (v) (Stability of Door-Knocking Equilibrium):

(v) *The mixed strategy equilibrium of Proposition 2(i) is stable for* $\Phi > 0$*, but unstable for* $\Phi < 0$.

This last result implies that once we limit our attention to stable equilibria, the model identifies two distinct equilibrium outcomes. If there is a net first-mover advantage ($\Phi > 0$), then the only stable steady state equilibrium is the mixed strategy (door-knocking) equilibrium; and if there is a net first-mover disadvantage ($\Phi < 0$), then the only stable steady state equilibria are the two pure strategy (pestering) equilibria.

5. Efficiency

How efficient is the entrepreneurial process? Does the entrepreneur get enough attention? Or does she have to spend too much time waiting for a partner to perform an evaluation?

We define a socially efficient outcome as an outcome that maximizes the sum of utilities of E, A, and B. We continue to assume that evaluation costs are privately known and that the entrepreneur makes her solicitation decision without knowing these cost realizations.[10]

10. If E had access to the cost realizations of each partner, then the efficient outcome would also condition on these realization. In particular, E would always choose to solicit the partner with the lower cost. Because we assume that E cannot observe these cost

Because partners are symmetric, from an efficiency perspective it doesn't matter which partner does the evaluation. This implies that any $\alpha \in [0, 1]$ is optimal. Moreover, it is easy to see that any efficient outcome has both partners paying the same level of attention, that is, $\lambda_A^s = \lambda_B^s = \lambda^s$, where the superscript s denotes the socially efficient outcome.

To determine the socially efficient payoff π^s, we note that each period E solicits one partner. That partner performs an evaluation with the socially efficient probability λ^s, generating a social value v; with probability $(1 - \lambda^s)$ no evaluation takes place, and the game moves into the next period. This implies that the socially efficient payoff π is given as follows

$$\pi^s = \alpha\big(\lambda_A^s v + \big(1 - \lambda_A^s\big)\delta\pi\big) + \beta\big(\lambda_B^s v + \big(1 - \lambda_B^s\big)\delta\pi\big).$$

Using $\lambda_A^s = \lambda_B^s = \lambda^s$ we solve this for π and obtain

$$\pi^s = \frac{\lambda^s\left(v - \dfrac{\lambda^s}{2}\right)}{1 - \delta + \delta\lambda^s}.$$

Using similar reasoning than for (3), the optimal attention level is given by

$$v - \lambda^s - \delta\pi^s = 0.$$

Straightforward calculations then show that the socially efficient attention level satisfies

$$\lambda^s = -\frac{1}{2}\frac{1-\delta}{\delta} + \sqrt{\frac{1}{4}\left(\frac{1-\delta}{\delta}\right)^2 + \frac{1-\delta}{\delta}v}.$$

We want to compare the socially efficient λ^s to the equilibrium outcome, denoted by λ^e. Focusing on the stable equilibria (see Proposition 2(v)), λ^e is given by (10) for $\Phi > 0$, and by (8) for $\Phi < 0$. To measure the inefficiencies of the equilibrium outcome, we define

$$\Lambda = \lambda^e - \lambda^s$$

Λ measures the "social attention surplus/deficit." If $\Lambda < 0$, then E receives too little attention relative to the social optimum. In this case the expected time to close a deal is too high, and too many opportunities vanish before partners evaluate them. For $\Lambda > 0$ the opposite is true. We are now in a position to state the main result about social efficiency.

realizations, we condition the efficient outcome on this informational constraint. This ensures that the efficient outcome is a meaningful benchmark for assessing equilibrium outcomes.

PROPOSITION 3 (EFFICIENCY):

(i) (*Pestering*, $\Phi < 0$) *In a pure strategy equilibrium* Λ *is always negative, that is, there is a social attention deficit.*
(ii) *(Door-knocking,* $\Phi > 0$) *In a mixed strategy equilibrium* Λ *may be positive or negative.* Λ *is an increasing function of* γ. *Near* $\gamma = 0$, *we always have* $\Lambda < 0$ (*social attention deficit) but near* $\gamma = 1$, *there exists* $\hat{\delta} \in (0, 1)$, *so that* $\Lambda \gtreqless 0 \Leftrightarrow \delta \gtreqless \hat{\delta}$.

Proposition 3 shows that the equilibrium will in general not be socially efficient. In determining his attention level, a partner only considers his private benefits, but does not consider the social returns. Thus, the likelihood that a new venture will get started does not depend on its total value, but rather on the value that the first contracting partner can extract. In a pestering equilibrium the first partner only considers the private value of evaluation, given by $v_1 = \frac{2+\gamma}{6}v$, which is always less than the social value v. As a consequence the equilibrium always entails an attention deficit. In a door-knocking equilibrium, there is an additional countervailing effect that arises from the competition of evaluating first. If there is a net first mover advantage, then each partner wants to preempt the other. If both γ and δ are sufficiently large, this competitive effect can outweigh the private value effect, and lead to an equilibrium where partners are paying too much attention, relative to the first best. The main intuition is that for large γ, partners are quite willing to incur evaluation costs to be the first, even though incurring these costs can be socially inefficient. This is easiest to see for $\delta \to 1$, where we have $\lambda^s \to 0$ but $\lambda^e \to \lambda^e_{\delta=1} > 0$. Overall, we note that the case of a social attention surplus applies to a relatively limited set of parameters, whereas the case of a social attention deficit applies to a relatively broad set of parameters.

6. EXTENSIONS

6.1 ALTERNATIVE BARGAINING GAMES

As with any bargaining game, the result depends on the assumptions that are made. In this section, we briefly review how the equilibrium of the bargaining game is affected if we change some of the underlying assumptions.

We investigate the importance of private information. The base model assumes that doing an evaluation creates a private signal. Consider now the case where the first partner cannot hide the information. This might be because the information itself is publicly observable, or because it is impossible to hide his willingness to make a deal with the entrepreneur. With public information, the second partner no longer has an inference problem when the entrepreneur approaches him without an agreement from the first partner. At the first stage, this increases the entrepreneur's outside option from zero to $\frac{\gamma}{2}r$, which is the Nash bargaining value from the random-order offer game between the entrepreneur and that second partner. This affects the values for the first stage bargaining game as follows. The entrepreneur and the first partner have a joint value of $\frac{2+\gamma}{3}v$. Using again the Nash bargaining value, we obtain

$$v_E = \frac{4+5\gamma}{12}v, \quad v_1 = \frac{4-\gamma}{12}v \quad \text{and} \quad v_2 = \frac{1-\gamma}{3}v.$$

Relative to the private information case, we see that the first partner obtains a lower bargaining value. Moreover, v_1 is now a decreasing function of γ. In the model with private information, the first evaluating partner benefited from a higher γ, because the threat of doing the venture with only one partner was valuable at the second bargaining stage. In the model with public information, there is an additional effect that dominates: the option of doing the venture with only one partner now hurts the first evaluating partner, since the entrepreneur can use it as a threat in the first stage.

The overall structure of the solicitation equilibrium remains the same for the public information model. The only notable difference concerns the comparative statics of γ in Proposition 2. In the Appendix, we show that in a pestering equilibrium, λ_A^* is always decreasing in γ. In a door-knocking equilibrium, the sign of $\frac{d\lambda^*}{d\gamma}$ is ambiguous, and depends on δ.

Consider next relaxing the assumption that the entrepreneur receives a large private benefit. Suppose now that $\eta < I_E$, so that the entrepreneur would not want to continue after a bad signal. In this case, the second partner would make a different inference about an entrepreneur approaching him without an agreement from the first partner. In particular, the probability that the signal was bad is zero, whereas the probability that the signal was good, but there was a bargaining breakdown (ε) is positive, even if infinitely small. The rational inference is thus that the signal was good, so that the second partner is willing to make a deal with the entrepreneur. This means that the model is identical to the model with public information.

The distinction between $\eta < I_E$ and $\eta > I_E$ has an interesting economic interpretation. The case of $\eta < I_E$ concerns an entrepreneur who has a high opportunity cost of undertaking the venture. Such an entrepreneur enjoys high credibility, because she can be relied upon not to pursue money-loosing ventures. By contrast, the case of $\eta > I_E$

concerns an entrepreneur who has a high private benefit of doing ventures. Such an entrepreneur enjoys less credibility, and thus weaker bargaining power, because of her willingness to pursue money-loosing ventures.

Finally, consider relaxing the assumption that the entrepreneur is indispensable, or that her intellectual property rights are perfectly safe. It might be possible for the two partners to form a coalition that excludes the entrepreneur. We denote the value of that coalition by $\gamma_{AB}r$. In the proof of Lemma 1 we show that the optimal side-agreement prevents such a coalition at the second stage. At the first stage, however, the availability of this coalition improves the bargaining position of the first partner, who now enjoys an outside option of $\frac{\gamma_{AB}}{2}r$. For the private information bargaining model we obtain

$$v_E = \frac{4 + 2\gamma - 3\gamma_{AB}}{12}v, \quad v_1 = \frac{4 + 2\gamma + 3\gamma_{AB}}{12}v \quad \text{and} \quad v_2 = \frac{1 - \gamma}{3}v.$$

It is easy to verify that this model is very similar to the base model.

Overall, we notice that while the information structure clearly affects the equilibrium bargaining values, the general structure of the model remains fairly similarly across all these permutations.

6.2 Paying for Attention

One possible way of generating attention is to pay for it. The working paper version (Hellmann, 2005) contains a model extension, where it is possible to write contracts about the process of contracting itself. We use a mechanism design approach to examine the set of all possible contracts that could be written *ex ante*, before any evaluation takes place. In such an environment it is always possible to achieve a first-best outcome. The optimal mechanism specifies an early signing bonus that provides sufficient incentives for a partner to efficiently evaluate the venture. However, because offering partners the optimal early signing bonus is expensive for the entrepreneur, the optimal mechanism requires that the entrepreneur charges partners an up-front fee for the right to evaluate the venture.

The optimal mechanism design contract relies on a number of strong assumptions. It assumes that there are no wealth constraints. Especially in the context of starting a new firm, the various parties may not have the wealth to pay the various transfers. Even if a partner has the wealth, he may be reluctant to pay these transfers, because there is an obvious adverse selection problem with paying for the right to evaluate an unknown venture proposal. The mechanism design solution also requires a high level of contractual precision, at a time when the partners have only a rudimentary understanding of the venture. If there are contracting costs, it is unlikely that the parties would want to occur these costs at such an early stage, when they haven't had time to find out whether they are even interested in a deal. This discussion suggests that while it may be possible in some circumstances to write optimal contracts about the process of contracting itself, in many circumstances we would expect that the problems mentioned above limit the ability of the parties to write such contracts.[11]

7. Conclusion

There are countless stories about the trials and tribulations of entrepreneurs who persevere against all odds to build great companies, going through a long process of begging for resources. This paper attempts to capture one important aspect of the entrepreneurial process, specifically looking at the entrepreneur's challenge to find someone who is willing to evaluate the venture and make the first commitment. Partners may have an incentive to wait, and the entrepreneur has to devise an optimal solicitation strategy. Knocking on every door is optimal if partners like to be solicited, and pestering is optimal if partners prefer that others are solicited. The current model focuses on one important issue, namely the difficulty of generating interest among potential resource providers. Naturally, there are many more facets to the entrepreneurial process. Examining the economic forces that underlie the process of entrepreneurship remains a fruitful area for future research.

Appendix

A.1 Proofs Related to Section 3

We first explain why the bargaining game naturally divides into two steps. Because an agreement requires all three parties to be present, the game must always end with a final stage where all three parties are present. From Hart and Mas-Colell, we know that in equilibrium, this game is always resolved within a single stage. The only question is thus whether the entrepreneur wants to immediately get all three parties together, or whether she prefers to approach one partner first.

11. Note also that there is a methodological issue here. In this paper we ask the question of how parties get to contract with each other. The mechanism design approach *assumes* that the parties can optimally contract with each other. Relying on optimal contracts about the contracting process itself thus comes close to answering the research question by assuming its answer.

In particular, we ask whether the entrepreneur and the first evaluating partner would benefit from making a collusive side-agreement. In principle, instead of approaching the first evaluating partner, the entrepreneur could approach the other partner. However, the analysis in the main text already derives that the other partner would always refuse to make a deal with the entrepreneur. We can therefore focus on the merits of colluding with the first evaluating partner.

Consider the types of agreements that the entrepreneur could make with the first evaluating partner. For notational simplicity, we assume that the first partner is A—the argument is symmetrical if B were the first partner. At the first stage, E and A can make an agreement that affects the value of several subcoalitions. They can write a contract that forbids E to form a coalition with B, thus reducing ρ_{EB} to zero. Let x_{EB} be the probability of allowing a coalition of E and B (or alternatively, the fraction by which value is reduced). Even though we assume in the base model that the value of the coalition of A and B has zero value, we increase the generality of this proof by allowing it to take a nonnegative value $\gamma_{AB} r$ (see also Section 6.1). Let x_{AB} be the probability of allowing this coalition. E and A can also commit to reduce the value of their own coalition. Let x_{EA} be the probability of reducing the value to zero. Similarly for the grand coalition, let x_{EAB} be the probability of reducing its value to zero. Finally, E and A can specify a transfer x_E, in case that their own coalition were to break up. We therefore have $\rho_{EAB} = x_{EAB} r$, $\rho_{EA} = x_{EA}\gamma r$, $\rho_{EB} = x_{EB}\gamma r$, $\rho_{AB} = x_{AB}\gamma_{AB} r$, $\rho_E = x_E$, $\rho_A = -x_E$, $\rho_B = 0$. The Shapley values for the second stage bargaining game are thus given by (the superscript (2) denotes the fact that these are second stage bargaining values):

$$V_E^{(2)} = \frac{1}{3}x_{EAB}r + \frac{1}{6}x_{EA}\gamma r + \frac{1}{6}x_{EB}\gamma r - \frac{1}{3}x_{AB}\gamma_{AB}r - \frac{1}{6}x_E$$

$$V_A^{(2)} = \frac{1}{3}x_{EAB}r - \frac{1}{3}x_{EB}\gamma r + \frac{1}{6}x_{EA}\gamma r + \frac{1}{6}x_{AB}\gamma_{AB}r + \frac{1}{6}x_E$$

$$V_B^{(2)} = \frac{1}{3}x_{EAB}r - \frac{1}{3}x_{EA}\gamma r + \frac{1}{6}x_{EB}\gamma r + \frac{1}{6}x_{AB}\gamma_{AB}r$$

E and A choose $\{x_{EAB}, x_{EA}, x_{EB}, x_{AB}, x_E\}$ to maximize their joint surplus, given by

$$V_E^{(2)} + V_A^{(2)} = \frac{2}{3}x_{EAB}r + \frac{1}{3}x_{EA}\gamma r - \frac{1}{6}x_{EB}\gamma r - \frac{1}{6}x_{AB}\gamma_{AB}r$$

We immediately obtain the optimal values as

$$x_{EAB} = 1, \quad x_{EA} = 1, \quad x_{EB} = 0, \quad x_{AB} = 0.$$

E and A never reduce the value of those collations that they are both part of. However, they forbid any coalition that only one of them is part of. Note also that the value of x_E is irrelevant, so that w.l.o.g. we can set it to zero.

We call this optimal contract a collusive contract because E and A form a united bargaining front against B. They agree to maintain the full value of all the coalitions that they jointly belong to ($x_{EAB} = 1$, $x_{EA} = 1$), and destroy the value of any coalition that separates them ($x_{EB} = 0$, $x_{AB} = 0$).

So far we assumed that the entrepreneur designates the first evaluating partner is his bargaining partner at the first stage. If the first evaluating partner were to determine who he wants to bargain with, he would also choose the entrepreneur. To see this, note that A and B create no value on their own. It is immediate that if the first evaluating partner were to choose the other partner, to form a coalition with, then the Shapley bargaining values are simply $\frac{1}{3}r$ for all parties. The first evaluating partner therefore always prefers to form a coalition with the entrepreneur, rather than the nonevaluating partner. This completes the proof if Lemma 1.

For Proposition 1 we simply note that in the second stage bargaining, E and A have symmetrical values $V_E^{(2)} = V_A^{(2)} = \frac{2+\gamma}{6}r$. Using the logic developed in the main text, they also have symmetric outside options of zero, at the first bargaining stage. Hence the Nash bargaining solution implies that $V_E = V_A = \frac{2+\gamma}{6}r$. This is increasing in γ.

A.2 Proofs Related to Section 4

For the remainder of the appendix, we define

$$D \equiv \frac{1-\delta}{\delta}.$$

For Lemma 2, we use (10) in $\Phi = v_1 - v_2 - \frac{\lambda^*}{2} = \frac{\gamma v}{2} - \frac{\lambda^*}{2}$ to obtain

$$\Phi = \frac{5}{12}\gamma v + \frac{1}{3}D - \frac{1}{12}\sqrt{(\gamma v)^2 + 16D^2 + 16vD}.$$

We evaluate Φ at $\gamma = 0$ to obtain $\Phi(\gamma = 0) = \frac{1}{3}D - \frac{1}{3}\sqrt{D^2 + vD} < 0$. Evaluating Φ at $\gamma = 1$, we obtain $\Phi(\gamma = 1) = \frac{5}{12}v + \frac{1}{3}D - \frac{1}{12}\sqrt{v^2 + 16D^2 + 16vD} > 0$.[12] Moreover, we have $\frac{d\Phi}{d\gamma} = \frac{5}{12}v - \frac{1}{24} \times \frac{2\gamma v^2}{\sqrt{(\gamma v)^2+16D^2+16vD}} > 0$.[13]

12. This follows from $5v + 4D > \sqrt{v^2 + 16D^2 + 16vD} \Leftrightarrow 25v^2 + 16D^2 + 40vD > v^2 + 16D^2 + 16vD \Leftrightarrow 24v^2 + 24vD > 0$.

13. This follows from $\frac{5}{12}v > \frac{1}{24}\frac{2\gamma v^2}{\sqrt{(\gamma v)^2+16D^2+16vD}} \Leftrightarrow \sqrt{(\gamma v)^2 + 16D^2 + 16vD} > \frac{\gamma v}{5} \Leftrightarrow (\gamma v)^2 + 16D^2 + 16vD > \frac{(\gamma v)^2}{25} \Leftrightarrow \frac{24}{25}(\gamma v)^2 + 16D^2 + 16vD > 0$.

To see that Φ is increasing in δ, we note that $\frac{d\delta}{dD} = -\frac{1}{\delta^2} < 0$ and $\frac{d\Phi}{dD} = \frac{1}{3} - \frac{1}{24}\frac{32D+16v}{\sqrt{(\gamma v)^2+16D^2+16vD}} < 0.$[14] We also note that

$$\frac{d\Phi}{dv} = \frac{5}{12}\gamma - \frac{1}{24}\frac{2v\gamma^2+16D}{\sqrt{(\gamma v)^2+16D^2+16vD}}.$$

This can be positive or negative, depending on γ.[15]

To see that $\lambda^* = \lambda_A^*$ at $\Phi = 0$, we note that from (3) and the definition of the pure strategy equilibrium we know that

$$v_1 - \lambda_A^* - \delta\frac{\lambda_A^*\left(v_1 - \frac{\lambda_A^*}{2}\right)}{1-\delta+\delta\lambda_A^*} = 0,$$

whereas from (3) and the definition of the mixed strategy equilibrium we know that

$$v_1 - \lambda^* - \delta\frac{1}{2}\frac{\lambda^*\left(v_1 - \frac{\lambda^*}{2}\right) + \lambda^* v_2}{1-\delta+\delta\lambda^*} = 0.$$

Now note that $\Phi = 0 \Leftrightarrow v_2 = v_1 - \frac{\lambda^*}{2}$. We use this in the previous equation to obtain after simple transformations

$$v_1 - \lambda^* - \delta\frac{\lambda^*\left(v_1 - \frac{\lambda^*}{2}\right)}{1-\delta+\delta\lambda^*} = 0.$$

This is exactly the same as the above condition for λ_A^*. Thus $\lambda^* = \lambda_A^*$.

So far we have focused on Φ. Consider now Φ_A. We can use (10) in $\Phi_A = v_1 - v_2 - \frac{\lambda_A^*}{2} = \frac{\gamma v}{2} - \frac{\lambda_A^*}{2}$ to obtain

$$\Phi_A = \frac{1}{2}\gamma v + \frac{1}{2}D - \frac{1}{2}\sqrt{D^2 + D\frac{2+\gamma}{3}v}$$

14. This follows from $\frac{1}{3} < \frac{1}{24}\frac{32D+16v}{\sqrt{(\gamma v)^2+16D^2+16vD}} \Leftrightarrow \sqrt{(\gamma v)^2+16D^2+16vD} < 4D + 2v \Leftrightarrow (\gamma v)^2 + 16D^2 + 16vD < 16D^2 + 4v^2 + 16vD \Leftrightarrow \gamma^2 < 4$.

15. Formally, we have $\frac{d\Phi}{dv} > 0 \Leftrightarrow 5\gamma\sqrt{(\gamma v)^2+16D^2+16vD} > v\gamma^2 + 8D \Leftrightarrow 25\gamma^4 v^2 + 400\gamma^2 D^2 + 400\gamma^2 vD > \gamma^4 v^2 + 64D^2 + 16v\gamma^2 D \Leftrightarrow \gamma^4 v^2 + \frac{50}{3}\gamma^2 D^2 + 16\gamma^2 vD > 3D^2$. At $\gamma = 1$ this condition is always satisfied, but at $\gamma = 0$, the condition is not satisfied.

We thus have $\frac{d\Phi_A}{d\gamma} = \frac{1}{2}v - \frac{1}{12}\frac{Dv}{\sqrt{D^2+D\frac{2+\gamma}{3}v}} > 0$.[16] Moreover, $\frac{d\Phi_A}{dD} = \frac{1}{2} - \frac{1}{4}\frac{2D+\frac{2+\gamma}{3}v}{\sqrt{D^2+D\frac{2+\gamma}{3}v}} < 0$.[17] The condition $\gamma \gtreqless \hat{\gamma} \Leftrightarrow \Phi_A \gtreqless 0 \Leftrightarrow \Phi \gtreqless 0$ follows from the previous result that at $\gamma = \hat{\gamma}$ we have $\Phi(\hat{\gamma}) = 0$, and $\lambda^* = \lambda_A^*$, thus also implying $\Phi_A(\hat{\gamma}) = 0$.[18]

We also verify that Lemma 2 remains valid for the bargaining solution with public information. In this case we have $v_1 = \frac{4-\gamma}{12}v$, $v_2 = \frac{1-\gamma}{3}v$, and thus $v_1 - v_2 = \frac{\gamma}{4}v$. After standard transformations we note that (10) simplifies to

$$\lambda = \frac{1}{3}\left(\frac{\gamma}{4}v - 2D\right) + \frac{1}{3}\sqrt{\frac{1}{16}(\gamma v)^2 + 4D^2 + (4-2\gamma)vD}$$

so that

$$\Phi = \frac{5}{24}\gamma v + \frac{1}{3}D - \frac{1}{6}\sqrt{\frac{1}{16}(\gamma v)^2 + 4D^2 + (4-2\gamma)vD}$$

Evaluating Φ at $\gamma = 0$, we obtain $\Phi(\gamma = 0) = \frac{1}{3}D - \frac{1}{3}\sqrt{D^2 + vD} < 0$. Evaluating Φ at $\gamma = 1$, we obtain $\Phi(\gamma = 1) = \frac{5}{24}v + \frac{1}{3}D - \frac{1}{6}\sqrt{\frac{1}{16}v^2 + 4D^2 + 2vD} > 0$.[19] Moreover, we have $\frac{d\Phi}{d\gamma} = \frac{5}{24}v - \frac{1}{12} \times \frac{\frac{2}{16}\gamma v^2 - 2vD}{\sqrt{\frac{1}{16}v^2+4D^2+2vD}} > 0$.[20] Finally, we have $\frac{d\Phi}{dD} = \frac{1}{3} - \frac{1}{12} \times \frac{8(D)+(4-2\gamma)v}{\sqrt{\frac{1}{16}(\gamma v)^2+4D^2+(4-2\gamma)vD}} < 0$.[21]

Most of the proof of Proposition 2 is already contained in the main text. For the comparative statics of (10), we obtain

16. This follows from $6 > \frac{D}{\sqrt{D^2+D\frac{2+\gamma}{3}v}}$.

17. This follows from $\frac{1}{2} < \frac{1}{4}\frac{2D+\frac{2+\gamma}{3}v}{\sqrt{D^2+D\frac{2+\gamma}{3}v}} \Leftrightarrow \sqrt{D^2 + D\frac{2+\gamma}{3}v} < D + \frac{2+\gamma}{6}v \Leftrightarrow D^2 + D\frac{2+\gamma}{3}v < D^2 + (\frac{2+\gamma}{6}v)^2 + 2D\frac{2+\gamma}{6}v \Leftrightarrow 0 < (\frac{2+\gamma}{6}v)^2$.

18. In addition, it is easy to see that $\Phi_A > \Phi$ for $\Phi > 0$ and $\Phi_A < \Phi$ for $\Phi < 0$. This follows from the fact that for $\Phi > 0$ we have $\pi_A(\alpha = 1) > \pi_A(\alpha = \frac{1}{2}) \Leftrightarrow \lambda_A^* < \lambda^*$, and similarly for $\Phi < 0$ we have $\pi_A(\alpha = 1) < \pi_A(\alpha = \frac{1}{2}) \Leftrightarrow \lambda_A^* > \lambda^*$.

19. This follows from $\frac{5}{4}v + 2D > \sqrt{\frac{1}{16}v^2 + 4D^2 + 2vD} \Leftrightarrow \frac{25}{16}v^2 + 4D^2 + 5vD > \frac{1}{16}v^2 + 4D^2 + 2vD \Leftrightarrow \frac{24}{16}v^2 + 3vD > 0$.

20. This follows from $\sqrt{\frac{1}{16}v^2 + 4D^2 + 2vD} > \frac{1}{20}\gamma v - \frac{4}{5}D \Leftrightarrow \frac{1}{16}(\gamma v)^2 + 4D^2 + (4 - 2\gamma)vD > \frac{1}{400}(\gamma v)^2 + \frac{16}{25}D^2 - \frac{4}{50}\gamma vD \Leftrightarrow \frac{24}{400}(\gamma v)^2 + \frac{84}{25}D^2 + (4-2\gamma)vD + \frac{4}{50}\gamma vD > 0$.

21. This follows from $2\sqrt{\frac{1}{16}(\gamma v)^2 + 4D^2 + (4-2\gamma)vD} < 4(D) + (2-\gamma)v \Leftrightarrow \frac{1}{4}(\gamma v)^2 + 16D^2 + (16-8\gamma)vD < 16D^2 + (2-\gamma)^2v^2 + 8(2-\gamma)vD \Leftrightarrow \frac{1}{4}\gamma^2 < (2-\gamma)^2 \Leftrightarrow \frac{1}{2}\gamma < (2-\gamma) \Leftrightarrow 3\gamma < 4$.

$\frac{d\lambda^*}{d\gamma} = \frac{1}{6}v + \frac{1}{6}\frac{\gamma v^2}{\sqrt{(\gamma v)^2 + 16D^2 + 16vD}} > 0$ and $\frac{d\lambda^*}{dD} = -\frac{2}{3} + \frac{1}{12}\frac{32D + 16v}{\sqrt{(\gamma v)^2 + 16D^2 + 16vD}} > 0$.[22] For the comparative statics of (8), we obtain $\frac{d\lambda_A^*}{d\gamma} = \frac{1}{3}\frac{Dv}{\sqrt{D^2 + D\frac{2+\gamma}{3}v}} > 0$ and $\frac{d\lambda_A^*}{dD} = -1 + \frac{1}{2}\frac{2D + \frac{2+\gamma}{3}v}{\sqrt{D^2 + D\frac{2+\gamma}{3}v}} < 0$.[23]

We now turn to the proof of the paradox of attention. Using (2) in (3) and (4) we obtain the following two equations:

$$EQ_A \equiv D(v_1 - \lambda_A) + \beta\lambda_B(v_1 - v_2 - \lambda_A) - \alpha\frac{\lambda_A^2}{2} = 0$$

$$EQ_B \equiv D(v_1 - \lambda_B) + \alpha\lambda_A(v_1 - v_2 - \lambda_B) - \beta\frac{\lambda_B^2}{2} = 0.$$

We totally differentiate this to get

$$\xi \begin{pmatrix} \frac{d\lambda_A}{d\alpha} \\ \frac{d\lambda_B}{d\alpha} \end{pmatrix} + \begin{pmatrix} \frac{dEQ_A}{d\alpha} \\ \frac{dEQ_B}{d\alpha} \end{pmatrix} = 0$$

where ξ is the second derivative, that is,

$$\xi = \begin{pmatrix} -(D + \alpha\lambda_A + \beta\lambda_B) & \beta(v_1 - v_2 - \lambda_A) \\ \alpha(v_1 - v_2 - \lambda_B) & -(D + \alpha\lambda_A + \beta\lambda_B) \end{pmatrix}.$$

We have

$$\xi^{-1} = \frac{1}{|\xi|}\begin{pmatrix} -(D + \alpha\lambda_A + \beta\lambda_B) & -\beta(v_1 - v_2 - \lambda_A) \\ -\alpha(v_1 - v_2 - \lambda_B) & -(D + \alpha\lambda_A + \beta\lambda_B) \end{pmatrix}$$

and

$$\begin{pmatrix} x_{11} & x_{12} \\ x_{21} & x_{22} \end{pmatrix} = -|\xi| * \xi^{-1}$$

where

$$x_{11} = (D + \alpha\lambda_A + \beta\lambda_B)$$

$$x_{12} = \beta(v_1 - v_2 - \lambda_A) = \frac{1}{\lambda_B}\left(\frac{\alpha}{2}\lambda_A^2 + D\lambda_A - Dv_1\right) \text{ (using } EQ_A = 0)$$

$$x_{21} = \alpha(v_1 - v_2 - \lambda_B) = \frac{1}{\lambda_A}\left(\frac{\beta}{2}\lambda_B^2 + D\lambda_B - Dv_1\right) \text{ (using } EQ_A = 0)$$

$$x_{22} = (D + \alpha\lambda_A + \beta\lambda_B)$$

22. This follows from $\frac{1}{12}\frac{32D+16v}{\sqrt{(\gamma v)^2+16D^2+16vD}} > \frac{2}{3} \Leftrightarrow 4D + 2v > \sqrt{(\gamma v)^2 + 16D^2 + 16vD} \Leftrightarrow 16D^2 + 4v^2 + 16vD > (\gamma v)^2 + 16D^2 + 16vD \Leftrightarrow 3v^2 > 0$.

23. This follows from $\sqrt{D^2 + D\frac{2+\gamma}{3}v} < D + \frac{2+\gamma}{6}v \Leftrightarrow D^2 + D\frac{2+\gamma}{3}v < D^2 + (\frac{2+\gamma}{6}v)^2 + D\frac{2+\gamma}{3}v \Leftrightarrow 0 < D^2$.

Note that $|\xi| = x_{11}x_{22} - x_{12}x_{21} > 0$.[24]

We thus obtain the following expression from our total derivative.

$$\begin{pmatrix} \frac{d\lambda_A}{d\alpha} \\ \frac{d\lambda_B}{d\alpha} \end{pmatrix} = \frac{1}{|\xi|} \begin{pmatrix} x_{11} & x_{12} \\ x_{21} & x_{22} \end{pmatrix} \begin{pmatrix} \frac{dEQ_A}{d\alpha} \\ \frac{dEQ_B}{d\alpha} \end{pmatrix}.$$

This allows us to identify the following expressions for our comparative statics:

$$\frac{d\lambda_A}{d\alpha} = \frac{1}{|\xi|} x_{11} \frac{dEQ_A}{d\alpha} + \frac{1}{|\xi|} x_{12} \frac{dEQ_B}{d\alpha} \text{ and}$$
$$\frac{d\lambda_B}{d\alpha} = \frac{1}{|\xi|} x_{21} \frac{dEQ_A}{d\alpha} + \frac{1}{|\xi|} x_{22} \frac{dEQ_B}{d\alpha}$$

Evaluating $\frac{dEQ_A}{d\alpha}$ and $\frac{dEQ_B}{d\alpha}$ at the mixed strategy equilibrium $\lambda_A = \lambda_B = \lambda$ we get $\frac{dEQ_A}{d\alpha} = -\lambda(v_1 - v_2 - \lambda) - \frac{\lambda^2}{2}$ and $\frac{dEQ_B}{d\alpha} = \lambda(v_1 - v_2 - \lambda) + \frac{\lambda^2}{2}$ so that

$$\frac{d\lambda_A}{d\alpha} = \frac{x_{11}}{|\xi|} \frac{dEQ_A}{d\alpha} + \frac{x_{12}}{|\xi|} \frac{dEQ_B}{d\alpha} = -\frac{(x_{11} - x_{12})}{|\xi|} \lambda \left(v_1 - v_2 - \frac{\lambda}{2} \right)$$
$$\frac{d\lambda_B}{d\alpha} = \frac{x_{21}}{|\xi|} \frac{dEQ_A}{d\alpha} + \frac{x_{22}}{|\xi|} \frac{dEQ_B}{d\alpha} = -\frac{(x_{21} - x_{22})}{|\xi|} \lambda \left(v_1 - v_2 - \frac{\lambda}{2} \right)$$

Note that $x_{11} - x_{12} = (D + \lambda) - (\frac{1}{2}\frac{\lambda}{2} + D - D\frac{v_1}{\lambda}) = \frac{3}{4}\lambda + D\frac{v_1}{\lambda} > 0$. Similarly $x_{22} - x_{21} > 0$. We have thus shown that if $\Phi = v_1 - v_2 - \frac{\lambda}{2} < 0$ then $\frac{d\lambda_A}{d\alpha} > 0$ and $\frac{d\lambda_B}{d\alpha} < 0$, and if $\Phi = v_1 - v_2 - \frac{\lambda}{2} > 0$ then $\frac{d\lambda_A}{d\alpha} < 0$ and $\frac{d\lambda_B}{d\alpha} > 0$.

A.3 Proofs Related to Section 5

We use $\pi = \frac{\lambda^s(v - \frac{\lambda^s}{2})}{1 - \delta + \delta\lambda^s}$ in $v - \lambda^s - \delta\pi^s = 0$ to obtain after transformations

$$Dv - \lambda^s D - \frac{1}{2}(\lambda^s)^2 = 0.$$

Eliminating the negative root, we obtain

$$\lambda^s = -\frac{1}{2}D + \sqrt{\frac{1}{4}D^2 + Dv}.$$

24. This follows from $x_{11}x_{22} - x_{12}x_{21} = (D + \alpha\lambda_A + \beta\lambda_B)^2 - \beta(v_1 - v_2 - \lambda_A)\alpha(v_1 - v_2 - \lambda_B) = [(D + \alpha\lambda_A + \beta\lambda_B)^2 - (\alpha\frac{\lambda_A}{2} + D - D\frac{v_1}{\lambda_A})(\beta\frac{\lambda_B}{2} + D - D\frac{v_1}{\lambda_B})]$. From $D + \alpha\lambda_A + \beta\lambda_B > \alpha\frac{\lambda_A}{2} + D - D\frac{v_1}{\lambda_A}$ and $D + \alpha\lambda_A + \beta\lambda_B > \beta\frac{\lambda_B}{2} + D - D\frac{v_1}{\lambda_B}$, it follows that $|\xi| > 0$.

For the pure strategy equilibrium, we compare λ^s with $\lambda^e = \lambda^*_A$, given by (8). We immediately note that $\Lambda < 0$ since $v_1 < v$. Moreover, since $\frac{dv_1}{d\gamma} > 0$, we also have $\frac{d\Lambda}{d\gamma} > 0$, that is, higher values of γ reduce the social attention deficit.

For the mixed strategy equilibrium we compare λ^s with $\lambda^e = \lambda^*$, given by (10), and obtain after transformations

$$\Lambda = \frac{1}{6}\gamma v - \frac{1}{6}D + \frac{1}{3}\sqrt{\frac{\gamma^2}{4}v^2 + 4D^2 + 4vD} - \sqrt{\frac{1}{4}D^2 + Dv}.$$

We immediately note that Λ is increasing in γ. Next, we evaluate Λ at $\gamma = 0$, so that $\Lambda_{\gamma=0} = -\frac{1}{6}D + \frac{2}{3}\sqrt{D^2 + vD} - \sqrt{\frac{1}{4}D^2 + Dv}$. Evaluating $\Lambda_{\gamma=0}$ for $v \to 0$, we note that $\Lambda_{\gamma=0} \to -\frac{1}{6}D + \frac{2}{3}D - \frac{1}{2}D = 0$. Moreover, we have $\frac{d\Lambda_{\gamma=0}}{dv} = \frac{1}{3}\frac{D}{\sqrt{D^2+Dv}} - \frac{1}{2}\frac{D}{\sqrt{\frac{1}{4}D^2+Dv}} < 0$.[25] Thus, near $\gamma = 0$ we have $\Lambda_{\gamma=0} < 0$ for all $v > 0$.

Finally, we evaluate Λ at $\gamma = 1$, so that $\Lambda_{\gamma=1} = \frac{1}{6}v - \frac{1}{6}D + \frac{1}{3}\sqrt{(\frac{1}{2}v - 2D)^2 + 6vD} - \sqrt{\frac{1}{4}D^2 + Dv}$. Consider first $\delta \to 1 \Leftrightarrow D \to 0$, then $\lim_{\delta\to1}\Lambda_{\gamma=1} = \frac{2}{6}v > 0$. Moreover, for $\delta = 0$, it is easiest to go back to the first-order condition of λ, given by (3), so that $\lambda = v_1$. Similarly, we obtain $\lambda^s = v$, so that $\lim_{\delta\to0}\Lambda_{\gamma=1} = v_1 - v < 0$. Moreover, we note that $\frac{d\Lambda_{\gamma=1}}{dD} = -\frac{1}{6} + \frac{1}{6}\frac{8D+4v}{\sqrt{\frac{1}{4}v^2+4D^2+4vD}} - \frac{1}{2}\frac{\frac{1}{2}D+v}{\sqrt{\frac{1}{4}D^2+Dv}} < 0$.[26]

We have thus seen that, near $\gamma = 1$, Λ is strictly increasing in γ, with $\Lambda < 0$ for low δ and $\Lambda > 0$ for high δ. It follows that there exists a critical value $\hat{\delta}$, so that $\Lambda \gtreqless 0 \Leftrightarrow \delta \gtreqless \hat{\delta}$.

For the public information case, the analysis for the pestering equilibrium is analogous. For the door-knocking equilibrium, we obtain

$$\Lambda = \frac{\gamma}{12}v - \frac{1}{6}D + \frac{1}{3}\sqrt{\frac{1}{16}(\gamma v)^2 + 4D^2 + (4-2\gamma)vD} - \sqrt{\frac{1}{4}D^2 + Dv},$$

25. This follows from $2\sqrt{\frac{1}{4}D^2 + Dv} < 3\sqrt{D^2 + Dv} \Leftrightarrow D^2 + 4Dv < 9D^2 + 9Dv \Leftrightarrow 8D^2 + 5Dv > 0$.

26. This follows from $\frac{4D+2v}{\sqrt{\frac{v^2}{16}+4D^2+4vD}} < (\frac{3}{2}D + 3v + \sqrt{\frac{1}{4}D^2 + Dv})/\sqrt{\frac{1}{4}D^2 + Dv} \Leftrightarrow$ $(16D^2 + 4v^2 + 16Dv)(\frac{1}{4}D^2 + Dv) < (\frac{v^2}{16} + 4D^2 + 4vD)(\frac{9}{4}D^2 + 9v^2 + 9Dv + \frac{1}{4}D^2 + Dv + M_1)$ where $M_1 = 2(\frac{3}{2}D + 3v)\sqrt{\frac{1}{4}D^2 + Dv} \Leftrightarrow 4D^4 + D^2v^2 + 4D^3v + 16D^3v + 4Dv^3 + 16D^2v^2 < M_2 + \frac{5}{32}D^2v^2 + 10D^4 + 2D^3v + \frac{9}{16}v^4 + 36D^2v^2 + 36Dv^3 + \frac{5}{8}Dv^3 + 40D^3v + 40D^2v^2$ where $M_2 = (\frac{v^2}{16} + 4D^2 + 4vD)M_1 \Leftrightarrow M_2 + 6D^4 + \frac{9}{16}v^4 + (32 + \frac{5}{8})Dv^3 + 22D^3v + (59 + \frac{5}{32})D^2v^2 > 0$.

where Λ need not be an increasing function of γ (such as if D large). Evaluating Λ at $\gamma = 0$, we have $\Lambda_{\gamma=0} = -\frac{1}{6}D + \frac{2}{3}\sqrt{D^2 + vD} - \sqrt{\frac{1}{4}D^2 + Dv}$, which is the same as before, implying $\Lambda_{\gamma=0} < 0$ for all $v > 0$. Evaluating Λ at $\gamma = 1$, we have $\Lambda_{\gamma=1} = \frac{v}{12} - \frac{1}{6}D + \frac{1}{3}\sqrt{\frac{1}{16}v^2 + 4D^2 + 2vD} - \sqrt{\frac{1}{4}D^2 + Dv}$. Consider first $\delta \to 1 \Leftrightarrow D \to 0$, then $\lim_{\delta \to 1} \Lambda_{\gamma=1} = \frac{v}{12} + \frac{1}{3}\frac{v}{4} > 0$. For $\delta \to 0$, we go back to (3), noting that $\lambda = v_1 < v = \lambda^s$. Again we find that Λ is negative for low values of γ, but positive for sufficiently large values of γ and δ.

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