UNSW Business School Research Paper No. 2015 ECON 18

Movers and Shakers

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August 20, 2015

Abstract

Most projects, in most walks of life, require the participation of multiple parties. While it is difficult to unite individuals in a common endeavor, some people, whom we call "movers and shakers," seem able to do it. The paper specifically examines moving and shaking of an investment project. We analyze a model with two types of agents: managers and investors. Managers and investors initially form social connections. Managers then bid to buy control of the project, and the winning bidder puts effort into raising awareness of the project among investors. Investors who become aware receive private signals of the project's quality. Finally, they decide whether to invest in the project, whose return is a function both of its quality and aggregate investment. We first show that connections are valuable since they make it easier for a manager to "move and shake" the project (i.e., obtain capital from investors). When we endogenize the network, we find that, while managers are identical *ex ante*, a single manager emerges as most connected; he consequently earns a rent. In extensions, we move away from the assumption of *ex ante* identical managers to highlight forces that lead one manager or another to become a mover and shaker. Finally, we explore various applications, including: entrepreneurship, funds management, and seed capital.

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1 Introduction

Most projects – in business, politics, sports, and academia – require the participation of *multiple parties*. In business, they usually involve, among other things, raising capital from disparate sources. Many projects fail – or do not even get off the ground – because of the difficulty of bringing together the relevant parties. While it is not easy to unite individuals in a common endeavor, some people – often called "movers and shakers" – seem able to do it. This paper develops an equilibrium theory regarding who these movers and shakers will be and why they receive outsize compensation for their endeavors.

Skill, of course, helps in obtaining participation since people are more inclined to participate in skillfully run projects. But another attribute – social connectedness – can also make someone a mover and shaker. Someone who is well-connected can increase participation not only by making prospects aware of a project but, even more importantly, by making prospects aware that *others are aware* and are considering participating. Expressed differently, connections help both in raising awareness and in making that awareness *common knowledge*.

In our baseline model, there are a number of potential managers of a project – all equally skilled – and a number of potential investors. We first take the social network between managers and investors as exogenous; we show that the most connected manager becomes the project's mover and shaker – and also earns a rent from his network position. We subsequently endogenize the network. Even though managers are identical *ex ante*, one emerges in equilibrium as most connected and as a mover and shaker.

The model has three stages. In stage 1, investors form connections with managers. For simplicity, we assume each investor can link to one manager. In stage 2, managers bid to buy an asset. The asset is necessary for undertaking the project and entitles the owner to the project's return. For instance, if the project were the construction of a shopping mall, the asset might be the plot of land on which the mall is to be built. In stage 3, the winning bidder puts effort into raising awareness of the project among investors; investors who become aware of the project then receive private signals of the project's quality and decide whether to invest.

We first analyze the model taking the social network as exogenous. Connections increase a manager's valuation of the asset: since they make it easier to raise capital for the project (i.e., move and shake it). Consequently, in equilibrium, the manager – or one of the managers – who is most connected wins the auction and puts effort into moving and shaking the project. Furthermore, provided the auction winner is strictly more connected than other managers, he receives a higher expected payoff.

When we endogenize the social network, we find that all investors link to one particular manager, whom we may refer to as M. M wins the auction, moves and shakes the project, and earns a higher payoff than other managers. Investors link to the same manager in equilibrium because they have a preference to link to whichever manager is most connected. The most connected manager ends up controlling the project; unless an investor connects to the manager who controls the project, he will not have an opportunity to invest.

We consider several extensions to the basic model, from which we obtain additional predictions. While any manager can emerge as most connected and as mover and shaker in our baseline model, our extensions identify several attributes that make it more likely someone will become a mover and shaker: (1) skill at running the project; (2) ability to form social connections; and (3) talent as a communicator. We also consider the possibility that managers might have capital of their own. Having capital, it turns out, also makes it more likely a manager will emerge as a mover and shaker. The reason is that a manager can use his capital as seed money for the project; seeding the project helps attract investors.

It is useful, in thinking about movers and shakers, to have a concrete example in mind. To that end, consider William Zeckendorf, who was, in the 1950s and 60s, the United States' preeminent real estate developer. He undertook a variety of ambitious projects including Mile High Center in downtown Denver, Place Ville-Marie in Montreal, and L'Enfant Plaza in Washington, D.C. He was also famous for his role in bringing the United Nations to New York.[1] Key to Zeckendorf's success (and his ability to move and shake) were his social connections, as he recognized himself: "the greater the

[1]Upon learning of the United Nations' difficulty finding a suitable New York site – and their intention, in consequence, to locate in Philadelphia – he realized he could help. He offered them a site he had assembled on the East River for a large development.

number of...groups...one could interconnect...the greater the profit."[2] He knew all the important real estate brokers, bankers, and insurance agents; he served on numerous corporate boards; and he was a fixture of New York society. Zeckendorf also owned a nightclub, the Monte Carlo, where he would hold court several nights a week, entertaining friends and business acquaintances.

His Montreal project, Place Ville-Marie, provides an excellent example of his talents as a mover and shaker. Since the 1920s, the Canadian National Railway (CNR) had been attempting, without success, to develop a 22-acre site in downtown Montreal, adjacent to the main train station: "a great, soot-stained, angry-looking, open cut where railway tracks ran out of a three-mile tunnel."[3] While the site had enormous potential, Canadian developers shied away, considering the challenges too daunting. Desperate, CNR approached Zeckendorf in 1955. He was immediately enthusiastic, appreciating that: "a sort of Rockefeller Center-cum-Grand Central Station could create a new center of gravity and focal point for the city."[4] But, making this vision a reality would require the participation of two constituencies. First, he would need to raise large sums from investors: one hundred million dollars for the tower he proposed to build as the site's centerpiece. Second, and even more vexing, was the challenge of leasing office space. Every major company had its offices on St. James Street. "The very idea of a shift to center-town offices struck many as dangerously radical."[5] Zeckendorf initially faced a freeze, unable to get anyone to lease space. As he put it, "nobody...believed we would ever put up a project as big as we said we would."[6] But, through his tireless efforts, the freeze began to thaw. The first crack came when he convinced the Royal Bank of Canada to move into the new building and become its prime tenant. He had been introduced to the CEO, James Muir, by his friend John McCloy, chairman of Chase; Zeckendorf set out to woo Muir, making him his Canadian banker. With RBC lined up, he managed, with considerable pressing, to obtain a fifty million dollar loan from Met Life – half of what was needed. Also with considerable pressing, he lined up a second big tenant: Aluminium Limited. At that point, it became clear to all that the project would indeed

[2] Zeckendorf and McCreary (1970), p. 42.
[3] Ibid., p. 167.
[4] Ibid., p. 170.
[5] Ibid., p. 174.
[6] Ibid., p. 174.

become a reality. Other companies – which had previously turned him down – agreed to take space, and he was able to obtain the additional capital he needed.

Our theory sheds light on a range of observed patterns. For instance, certain fund managers consistently outperform the market, achieving higher risk-adjusted returns (see Kaplan and Schoar (2005)). Our model provides a novel explanation for this phenomenon. Our theory also speaks to the topic of entrepreneurship since starting a business usually requires moving and shaking. Additionally, seeding of projects – or, "anchor investments" – seems to be empirically important. Movers and shakers are often independently wealthy and use their own funds to seed projects. In other instances, a mover and shaker might obtain help in seeding a project from a large investor. Our model speaks to this topic as well.

Our paper relates to a number of different literatures. At a formal level, the problem we analyze is a global game and thus relates to the now large literature pioneered by Carlsson and van Damme (1993) and Morris and Shin (1998).

The model we analyze also relates to large theoretical and empirical literatures in finance. A natural benchmark for thinking about investments and returns is, of course, Q-theory.[7] Investors, in Q-theory, earn the same rate of return whether they invest one dollar or one million. By contrast, investment is lumpy in our model. Agents invest in projects; projects yield a poor rate of return unless they are well capitalized. An important consequence is that the rate of return to a project/asset depends upon the social network that exists among agents. We predict, moreover, that agents with a privileged position in the network will earn outsize returns, because they can move and shake contributions from others.[8] Our model is, to the best of our knowledge, the first to emphasize the importance of network structure for investment.

[7] A host of papers have documented departures from Q-theory and highlighted the implications of such departures. Liquidity constraints are important (see, among others, Fazzari et al. (1988), Hoshi et al. (1991), Blanchard et al. (1994), Kashyap et al. (1994), Sharpe (1994), Chevalier (1995), Kaplan and Zingales (1997), Lamont (1997), Peek and Rosengren (1997), Almeida et al. (2004), and Bertrand and Schoar (2006)) as are short-term biases (Stein (1988, 1989)). Moreover, there is compelling evidence that there are real consequences of such inefficiencies (see, for instance, Morck et al. (1988) and the large ensuing literature on the equity channel of investment).

[8] Another, quite distinct, form of "lumpiness" has been well studied: adjustment costs (see Uzawa (1969), Lucas and Prescott (1971), Hayashi (1982), and for a recent dynamic analysis, Miao and Wang (2014)). It is well known that such lumpiness can have significant macroeconomic implications (see, for instance, Lucas (1967), Prescott (1986), and Caballero et al. (1995)).

Our model relates to the economic literature on leadership since a mover and shaker is arguably a type of leader. It particularly relates to work examining how leaders persuade followers. Several papers consider signaling by leaders as a means of persuasion (see, for instance, Prendergast and Stole (1996), Hermalin (1998), and Majumdar and Mukand (2004)). There is also work on leaders creating cascades to influence followers (see Caillaud and Tirole (2007)). In our paper, the mover and shaker persuades investors by publicizing the project. This feature of our model bears some relation to Dewan and Myatt (2007, 2008), who have explored how public speeches by politicians can influence followers. Chwe (2001) also emphasizes the role of public announcements in acting as coordination devices in a variety of settings such as advertising. In addition, there is work on the use of authority by leaders in settings where agents, as in our model, have a desire to coordinate. For instance, Bolton et al. (2013) argue that resoluteness is an important quality in a leader because a leader who is overly responsive to new information can undermine coordination.

While our focus is an investment setting, our model also relates to a literature on attention within organizations (see especially Dessein (2002), Dessein and Santos (2006), Alonso et al. (2008), Rantakari (2008), and Calvo-Armengol et al. (2014), Dessein and Santos (2014), and Dessein et al. (2014)). Agents in these models, as in our own, wish to coordinate their actions. In Calvo-Armengol et al. (2014), agents decide how much to listen to – and communicate with – other agents. Since there are neither increasing costs nor decreasing benefits of listening to multiple agents, agents' attention is dispersed.[9] This contrasts with our own model, in which investors' attention is concentrated on a mover and shaker. While agents/investors decide whom to pay attention to in Calvo-Armengol et al. (2014) and in our own model, two recent papers (Dessein and Santos (2014) and Dessein et al. (2014)) consider a setting in which a principal decides the allocation of attention. They find that it is optimal for there to be some concentration of attention, since it aids coordination. Although attention is also concentrated in our model, it is not necessarily optimally placed. In particular, we obtain equilibria in which the mover and shaker is more or less skilled, resulting respectively in a more or less efficient outcome. [10] Another related paper, Hellwig and Veldkamp (2009), examines

[9]Formally, these features arise in Calvo-Armengol et al. (2014) because they assume additive separability (and a strict form of continuity) of the listening cost function.

[10]Intuitively, investors coordinate on linking to a particular manager, whose skill may be higher or

attention in a trading rather than an organizational setting. Somewhat analogous to the coordination of attention in our setting, they find traders may coordinate attention on one piece of information or another.

Our paper also connects to the literature in economics on networks – especially work on coordination and communication in endogenous networks. Several papers (Calvo-Armengol et al. (2014), Dessein et al. (2014), and Dessein and Santos (2014)) have already been mentioned. Hagenbach and Koessler (2010) examines network formation with cheap talk communication. Galeotti and Goyal (2010) predicts the emergence of star networks, as we do. Furthermore, a small number of agents are influential in equilibrium even though they are ex ante similar to others. But the logic underpinning their result is quite different from ours. In their paper, there are increasing (and concave) benefits from information, but linear costs of information acquisition, in addition to substitutability of information acquired by different individuals. It follows that any (strict) equilibrium must involve a concentrated number of information acquirers. [11]

Our paper also relates to models of coordination and communication in exogenously given networks, such as Galeotti et al. (2013) and Calvo-Armengol and de Marti (2009). Calvo-Armengol and de Marti (2009), for instance, find that adding links to a network can reduce welfare because it reduces coordination.

Additionally, our paper relates to a central notion in the sociological literature on networks, developed by Burt (1992, 2001, 2004). According to Burt, individuals who bridge "structural holes" in a network (i.e., who link disparate parties) have the "opportunity to...control the projects that bring together people from opposite sides of the hole."[12]

The paper proceeds as follows. Section 2 contains the setup of our model and the analysis of equilibrium. We first take the network structure as exogenous; subsequently, we endogenize it. In Section 3 we consider a number of extensions of the basic model an-

lower. This finding suggests the possibility of constructing a mover-and-shaker model, similar to our own, in which there are persistent performance differences across firms. Some firms get stuck paying attention to the wrong people. Persistent performance differences have been shown to be ubiquitous (see Gibbons and Henderson (2012)). There is considerable interest in understanding what drives these productivity differences (see Gibbons (2006), Chassang (2010), and Ellison and Holden (2014)).

[11]Several papers, studying contexts quite different from our own, have also predicted the emergence of star networks (see Jackson and Wolinksy (1996), Bala and Goyal (2000), Galeotti et al. (2006), Goyal and Vega-Redondo (2007), Feri (2007), Hojman and Szeidl (2007) and Bloch and Dutta (2009)).

[12]Burt (2001), p. 208.

alyzed in Section 2. Section 4 highlights a number of concrete settings that illustrate the properties of our model. Section 5 concludes. Proofs of all formal results are contained in the Appendix.

2 The model

2.1 Statement of the problem

Consider a setting with an investment project and two types of agents: managers and investors. Managers have skills needed to run the project; investors each have one unit of capital they can contribute to the project. We assume there are at least two managers; the total number of managers and investors is finite. Let N_M denote the set of managers and N_I denote the set of investors.

A network g exists between managers and investors. $g_{ij} = 1$ if manager i and investor j are connected; $g_{ij} = 0$ otherwise. For now, we take the network as exogenous; we will endogenize it in Section 2.4.

The model has four periods. All choices made by agents are observable. In the first period, managers bid in a second-price auction for an asset A. The asset is needed to undertake the project and entitles the owner to the project's return. The asset might, for instance, be a parcel of land; the project might be the construction of a building on that parcel. The project yields a return R at the end of the game that depends both upon the project's underlying quality (θ) and the amount of capital raised for the project (K). More specifically, $R = \theta + v \cdot K$, where $v > 1$ parameterizes the return to raising capital (i.e., the return to "moving and shaking"). The agents have a common prior that θ is distributed $N(\mu, \tau^2)$, with $\mu, \tau > 0$. Let b_i denote manager i's bid in the auction, let $b_{(2)}$ denote the second highest bid, and let M denote the winning bidder. In the event multiple managers place the highest bid, we assume, for simplicity, the one with the lowest index wins the auction.

In the second period, the auction winner, M, decides how much effort $e_M \in [0, 1]$ to exert to make investors aware of the project. Investor j becomes aware of the project with probability e_M if he is connected to M ($g_{Mj} = 1$) and with probability 0 otherwise.

The probability of two investors becoming aware of the project is independent. The cost to M of exerting effort is $c(e_M)$, where $c'(0) = 0$ and $c'(e) > 0$ for $e > 0$. Let S denote the set of investors who are aware of the project and let n denote the cardinality of S. M knows S; S is also commonly known to investors in set S.

In the third period, M chooses how much equity, β_M, to offer investors in set S in exchange for contributing their capital to the project. Investors in S then receive private signals of the project's quality: $x_j = \theta + \varepsilon_j$, where the ε_j's are distributed iid $N(0, \sigma^2)$. We will focus on the case where $\sigma \to 0$ as this results in closed-form solutions.

In the final period, investors in set S decide whether to invest in exchange for an equity share of the project. Let $a_j \in \{0, 1\}$ denote investor j's decision. Observe that the total capital raised for the project is $K = \sum_{j \in S} a_j$.

The project is then undertaken, yields return $R = \theta + v \cdot K$, and players receive the shares of the return due to them. We can write players' payoffs at the end of the game as follows. Investors receive a payoff of $\beta_M R$ if they invest in the project and 1 otherwise. The auction winner receives a payoff of $(1 - \beta_M K)R - c(e_M) - b_{(2)}$ while other managers receive 0.

It is useful to summarize the timing: (1) managers simultaneously place bids (b_i) for asset A and the winning bidder (M) acquires the asset; (2) the auction winner (M) decides how much effort to exert (e_M) to make investors aware of the project; (3) M offers equity shares (β_M) to potential investors; (4) potential investors then acquire private signals of the project's quality and simultaneously decide whether to invest (a_i), after which the project is undertaken, its return R is realized, and players receive the share of the return due to them.

2.2 Discussion of the model

We now pause briefly to discuss a number of the modeling choices we have made.

First, our game has four periods and, at first inspection, might seem complicated in this respect. In fact, this is the simplest formulation that captures all the economics we wish to convey. It is important to us to highlight that, in equilibrium, more connected players value asset A more than less connected players. The simplest way to demonstrate this is through the auction we consider at time 1. Similarly, the effort choice is indispensable to our story since this is what moving and shaking *is* – hence time 2. Finally, we need two periods to address investment since it necessarily involves the equity offer and the choice of whether to invest.

Second, we model the project's return as increasing in the amount of capital invested. This results in strategic complementarities and captures our basic story about the importance of participation. Note that it is important that R is increasing in K over some range; it is not important that R is increasing in K indefinitely (we have only made this assumption for simplicity).

Third, the set S is commonly known to investors in set S. This assumption reflects the idea that the mover and shaker not only raises awareness of the project but also makes that awareness common knowledge.

Fourth, we assume the marginal cost of effort is equal to zero at $e_M = 0$ ($c'(0) = 0$). This ensures that it is optimal for M to exert positive effort whenever he has social connections. More importantly, it means that more connected managers value asset A strictly – rather than weakly – more than less connected managers.

Fifth, we consider a particular form of financial contracting: equity. The benefit of focusing on equity contracting is that it results in closed-form solutions; but this is not the most general contracting space one could consider, to be sure. However, we conjecture that our main results hold in a more general contracting space. [13]

Finally, one could imagine modeling movers and shakers in a different way. Imagine an investment game with a good equilibrium (with a high level of investment) and a bad equilibrium (with a low level of investment). The mover and shaker might serve as a coordination device that makes the good equilibrium focal. While it is certainly plausible that movers and shakers play such a role, there are three reasons it is not so appealing to model them in this way. First, Schelling-type focal points are interesting but not micro-founded and raise more questions than they answer. Second, the global games approach was developed precisely to provide more rigorous answers to the multiple equilibrium problem. Perhaps most importantly, the global games approach is more fruitful in generating predictions. It yields the prediction that social connections

[13] For instance, we believe our results hold when the project is debt financed rather than equity financed.

matter for moving and shaking. It also allows us, in extensions to the baseline model, to describe characteristics associated with movers and shakers.

2.3 Equilibrium

Our focus will be on Perfect Bayesian Equilibria, which henceforth, we will refer to simply as the equilibria of the game. Proposition 1 characterizes the equilibria. The proof is discussed in detail below.

Proposition 1. *There exists a $\hat{v}$ such that, whenever $v > \hat{v}$, all equilibria have the following properties, and moreover, such equilibria exist:*

(1) The auction winner, M, will be the manager with the most social connections (or one of the managers with the most connections if multiple managers have the maximal number).

(2) Provided M is connected to at least one investor, he exerts positive effort to make investors aware of the project ($e_M > 0$).

(3) M receives a higher expected payoff than other managers if he is strictly more connected; otherwise, he receives the same payoff.

According to the proposition, the most connected manager wins the auction; he puts positive effort into moving and shaking the project (i.e., raising capital); and he receives a higher payoff than his peers if he is strictly more connected.

The formal proof is given below, but it is useful to first consider the basic intuition. As we will see presently, the more connected a manager, the greater his ability to move and shake the project (i.e., raise capital). Consequently, more connected managers value the project more than less connected managers and outbid them in the auction. Moreover, if one manager is strictly more connected than other managers, he values the project strictly more and hence receives a positive rent.

Proof of Proposition 1.

We can use backwards induction to solve for the equilibria of the game. First, consider time 4. The time 4 game is a global game. As is standard in such games, investors follow cutoff strategies in equilibrium of the form: invest if and only if $x_i > \kappa$. Lemma 1, the proof of which is given in the Appendix, characterizes κ for the case where $\sigma \to 0$.

Lemma 1. *As $\sigma \to 0$, the cutoff $\kappa \to \frac{1}{\beta_M} - v(\frac{n+1}{2})$.*

According to Lemma 1, investors are more inclined to invest (κ is lower) when: (1) they are offered more equity (β_M is higher); and (2) more investors are aware of the project (n, the cardinality of set S, is higher). It is intuitive that investors are more inclined to invest when they are offered more equity. They are more inclined to invest when n is higher because they expect greater total investment in the project, leading to a higher overall return R.

Turning to time 3, we can write the auction winner's expected payoff as $\Pi_M(n, \beta_M) - c(e_M) - b_{(2)}$, where $\Pi_M(n, \beta_M)$ denotes M's expected share of the project's return when set S has cardinality n and M offers investors equity shares of size β_M. M will choose β_M to maximize Π_M: $\beta_M^*(n) = \arg\max_\beta \Pi_M(n, \beta)$.

Observe that, as $\sigma \to 0$, investors in set S invest with probability 1 when $\theta > \kappa$. Consequently, $K = n$ with probability 1 when $\theta > \kappa$. Similarly, $K = 0$ with probability 1 when $\theta < \kappa$. This allows us to write an explicit formula for $\Pi_M(n, \beta_M)$:

$$\begin{aligned}
\Pi_M(n, \beta_M) &= E[(1 - \beta_M K)R] \\
&= E[(1 - \beta_M K) \cdot (\theta + vK)] \\
&= E[\theta] + E[vK \cdot (1 - \beta_M K)] - E[\beta_M K \theta] \\
&= \mu + v \cdot n(1 - \beta_M n) \cdot \Pr(\theta > \kappa) - \beta_M n \cdot E(\theta|\theta > \kappa) \cdot \Pr(\theta > \kappa),
\end{aligned}$$

$$\text{where } \kappa = \frac{1}{\beta_M} - v\left(\frac{n+1}{2}\right).$$

From this formula for Π_M, we obtain the following lemma (the proof of which is given in the Appendix).

Lemma 2. *There exists a $\hat{v}$ such that, for all $v > \hat{v}$, $\Pi_M(n, \beta_M^*(n))$ is strictly increasing in n.*

The intuition behind Lemma 2 is straightforward. The larger is n, the easier it is for the auction winner to raise capital. It is easier because there are more potential investors;

it is also easier because any given investor's willingness to invest is increasing in n. It follows that, if v is large – so that it is particularly valuable to M to raise capital – an increase in n unambiguously raises M's payoff.

Now, consider time 2. Let $d_i = \sum_{j \in N_I} g_{ij}$ denote the number of connections of manager i. When M exerts effort e_M, n is drawn from a binomial distribution with parameters d_M and e_M: $B(d_M, e_M)$. M's expected payoff when he exerts effort e_M is: $E[\Pi_M(n, \beta_M^*(n)) | n \sim B(d_M, e_M)] - c(e_M) - b_{(2)}$. M will choose the level of effort, $e_M^*(d_M)$, that maximizes this expression. We can write M's resulting payoff as: $V(d_M) - b_{(2)}$. Lemma 3, the formal proof of which is given in the Appendix, follows almost immediately from Lemma 2.

Lemma 3. *There exists a $\hat{v}$ such that, for all $v > \hat{v}$:*

(1) $e_M^*(d_M) > 0$ whenever $d_M \geq 1$.

(2) $V(d_M)$ is strictly increasing in d_M.

Consider the intuition behind Lemma 3. M's payoff is increasing in n; provided M has at least one connection ($d_M \geq 1$), M's effort increases the likelihood of n being large. Since the marginal cost of exerting effort is zero at $e_M = 0$ ($c'(0) = 0$), it is clearly optimal to exert positive effort whenever $d_M \geq 1$. Similarly, for a given level of effort, the likelihood of n being large is increasing in d_M. It follows that $V(d_M)$ is increasing in d_M.

Finally, let us turn back to time 1. Observe that the value of asset A to manager i is $V(d_i)$. Since, from Lemma 3, we know that $V(d)$ is strictly increasing in d, it follows that the most connected manager – or one of the most connected managers – will win the auction. Furthermore, if one manager is strictly more connected than others, he will not only win the auction but also earn a positive rent. This completes the proof of Proposition 1.

2.4 Endogenizing the Network

Thus far, we have taken the network, g, between managers and investors as exogenous. We can endogenize the network by adding an initial period to the game. Assume there are initially no connections between agents. In period 0, each investor chooses one manager to whom he will link. Proposition 2 characterizes the equilibrium of this game. The proof is given in the Appendix.

Proposition 2. *Suppose there are at least three investors ($card(N_I) \geq 3$). Then, there exists a $\hat{v}$ such that, whenever $v > \hat{v}$, all equilibria have the following properties, and moreover, such equilibria exist:*

(1) In period 0, all investors link to one particular manager: Y. Y can be any manager.

(2) Subsequently, Y wins the auction ($Y = M$) and exerts positive effort ($e_Y > 0$).

(3) Y receives a higher expected payoff than other managers.

According to Proposition 2, even though managers are identical *ex ante*, one emerges as most connected in equilibrium. In fact, all investors link to the same manager. This manager consequently wins the auction, moves and shakes the project, and earns a higher payoff than his peers.

While the proof is left for the Appendix, the intuition is as follows. Investors strictly prefer to link to the most connected manager. They prefer to do so because the most connected manager wins the auction; unless an investor links to the auction winner, he has no opportunity to invest in the project. Since investors strictly prefer to link to the most connected manager, all investors end up linking to the same manager in equilibrium.

3 Extensions

We will consider several extensions, from which we obtain additional predictions. In Section 2.4, all managers are equally likely to emerge as most connected (and as the project's mover and shaker). The extensions identify several characteristics that make it more likely a manager will emerge as a mover and shaker: (1) skill at running the project; (2) ability at forming social connections; (3) talent as a communicator; and (4) seed capital.

Skill

Proposition 3, stated below, assumes heterogeneity in managers' skill at running the project. If manager i runs the project, it yields a return $R = \theta + v \cdot K + \alpha_i$, where α_i denotes the skill of manager i. We assume the maximum skill level is greater than or equal to zero: $\alpha_{max} \geq 0$.

Proposition 3 shows that if manager i's skill level is above a cutoff ($\alpha_i \geq \hat{\alpha}$), he can emerge as the most connected manager and as mover and shaker of the project; if manager i's skill level is below the cutoff ($\alpha_i < \hat{\alpha}$), he cannot emerge as mover and shaker.

Proposition 3. *Suppose, in contrast to the model of Section 2.4, some managers are more skilled than others. If manager i runs the project, it yields a return of $R = \theta + v \cdot K + \alpha_i$, where α_i denotes the skill of manager i. We assume $\alpha_{max} = \max_{i \in N_M} \alpha_i \geq 0$. If there are at least three investors, then there exists a $\hat{v}$ such that, for all $v > \hat{v}$:*

(1) In equilibrium, all investors link to one particular manager: Y. Y subsequently wins the auction ($Y = M$) and exerts positive effort ($e_Y > 0$).

(2) There exists $\hat{\alpha} < \alpha_{max}$ such that:

(i) Whenever $\alpha_i \geq \hat{\alpha}$, an equilibrium exists in which manager $i = Y$. Furthermore, manager i receives a strictly higher payoff than other managers provided $\alpha_i > \hat{\alpha}$.

(ii) Whenever $\alpha_i < \hat{\alpha}$, an equilibrium does not exist in which manager $i = Y$.

The formal proof is left for the Appendix, but consider the intuition. In the baseline model, the value manager i placed on asset A depended only upon his social connections (d_i). In this case, the value also depends upon his skill level (α_i). Consequently, a low-skilled manager, even if socially connected, will be outbid in the auction. Moreover, since investors have a preference to link to the eventual auction winner, such a manager will not be socially connected in equilibrium.

Observe that, while the proposition rules out a manager becoming mover and shaker if his skill is below a certain level, the mover and shaker need not be the most skilled manager. Furthermore, even though the mover and shaker may be less skilled than some of his peers, he still receives a higher expected payoff. Movers and shakers are good from an efficiency point of view – in the sense that there would be no investment without the mover and shaker's effort; but it is also true that the outcome will be more or less efficient depending upon how skilled the mover and shaker happens to be. Other mover-and-shaker attributes we will examine in this section (ability to form connections, ability to communicate, and seed money) have similar implications for efficiency.

Ability to form social connections

A natural case to consider is one in which it is more costly for an investor to link to some managers than to others. Proposition 4, stated below, extends the model of Section 2.4 by assuming there is a cost l_i of linking to manager i.[14] One can think of a manager with a low l_i as one with a high ability to form social connections.

Proposition 4 shows that a manager cannot emerge as the project's mover and shaker if his ability to form social connections is low (i.e., l_i is far from l_{min}, the minimum linking cost); he can emerge as mover and shaker if his ability to form connections is high (i.e., l_i is close to l_{min}).

Note that we can show the existence of equilibria in which all investors link to the project's mover and shaker. However, we cannot rule out the existence of equilibria in which only a fraction link to the mover and shaker.[15]

Proposition 4. *Suppose, in contrast to the model of Section 2.4, there is a cost l_i associated with linking to manager i. Let $l_{min} = \min_{i \in N_M} l_i$ denote the minimum linking cost. If there are at least three investors, then there exists a $\hat{v}$ such that, for all $v > \hat{v}$:*

(1) In equilibrium, the auction is won by a manager, Y, with weakly more connections than other managers. Y subsequently exerts positive effort ($e_Y > 0$).

(2) There exists $\hat{\hat{l}} \geq \hat{l} > l_{min}$ such that:

(i) Whenever $l_i \leq \hat{l}$, an equilibrium exists in which $i = Y$ and all investors link to i. Furthermore, manager i receives a strictly higher payoff than other managers.

[14] We assume agents must form a link. If we gave agents the option not to form a link, provided $l_i \leq 0$ for some i, the results would be the same.

[15] There is the possibility of equilibria in which investors split between linking to the auction winner and linking to managers for whom the linking cost is minimal ($l_i = l_{min}$). See the proof of Proposition 4 for further discussion.

(ii) Whenever $l_i > \hat{\hat{l}}$*, there does not exist an equilibrium in which manager* $i = Y$*.*

Ability to communicate

Proposition 5, stated below, extends the model of Section 2.4 by assuming heterogeneity in managers' cost of effort. It assumes the cost of effort for manager i is $c(\frac{e_i}{\gamma_i})$, with $\gamma_i > 0$. One can think of γ_i as manager i's ability to communicate with investors (i.e., ability to make investors aware of the project). For reasons that will become apparent, Proposition 5 also assumes heterogeneity in managers' skill at running the project.

Proposition 5 shows that if manager i's communication ability is above a cutoff ($\gamma_i \geq \hat{\gamma}$), he can emerge as the most connected manager and as mover and shaker of the project; if manager i's communication ability is below the cutoff ($\gamma_i < \hat{\gamma}$), he cannot emerge as mover and shaker.

The cutoff is a function of manager i's skill: $\hat{\gamma}(\alpha_i)$. If manager i's skill level is sufficiently low, no matter how able a communicator he is, he cannot emerge as mover and shaker: $\hat{\gamma}(\alpha_i) = \infty$. On the other hand, if manager i has the maximum skill level, an equilibrium always exists in which i is the mover and shaker: $\hat{\gamma}(\alpha_{max}) = 0$.

Notice that, when there is no heterogeneity in skill, all managers have the maximum skill level. In consequence, all can emerge as movers and shakers regardless of communication ability. We assume heterogeneity in skill in Proposition 5 because only when there is skill heterogeneity does communication ability play a role in determining who can become a mover and shaker.

Proposition 5. *Suppose, in contrast to the model of Section 2.4, the cost of effort for manager* i *is* $c(\frac{e_i}{\gamma_i})$*.* $\gamma_i > 0$ *represents manager* i*'s ability to communicate. Additionally, suppose some managers are more skilled than others. If manager* i *runs the project, it yields a return of* $R = \theta + v \cdot K + \alpha_i$*, where* α_i *denotes the skill of manager* i*. We assume* $\alpha_{max} = \max_{i \in N_M} \alpha_i \geq 0$*. If there are at least three investors, then there exists a* $\hat{v}$ *such that, for all* $v > \hat{v}$*:*

(1) In equilibrium, all investors link to one particular manager: Y*.* Y *subsequently wins the auction (*$Y = M$*) and exerts positive effort (*$e_Y > 0$*).*

(2) There exists $\hat{\gamma}(\alpha_i)$ *such that: whenever* $\gamma_i \geq \hat{\gamma}$*, an equilibrium exists in which manager* $i = Y$*. Furthermore, manager* i *receives a strictly higher payoff than other managers*

provided $\gamma_i > \hat{\gamma}$. Whenever $\gamma_i < \hat{\gamma}$, there does not exist an equilibrium in which manager $i = Y$.

(3) The critical ability level, $\hat{\gamma}(\alpha_i)$, depends upon manager i's skill:

(i) If manager i has the maximum skill level, an equilibrium always exists in which manager $i = Y$: $\hat{\gamma}(\alpha_{max}) = 0$.

(ii) If manager i's skill level is sufficiently low, an equilibrium never exists in which $i = Y$: $\hat{\gamma}(\alpha_i) = \infty$ for α_i sufficiently low.

Seed money

Consider the following extension of Section 2.4's model. Suppose the auction winner can put "seed money" into the project at time 2, before investors decide whether to contribute capital. The amount of seed money available to manager i is $s_i \geq 0$. If the auction winner decides to put seed money into the project, he receives a payoff: $(1-\beta_M \cdot \sum_{j\in S} a_j)R - c(e_M) - b_{(2)}$, where $R = \theta + v \cdot (s_M + \sum_{j\in S} a_j)$. Observe that s_M, in this case, contributes to the project's capital. If the auction winner holds onto his seed money, he receives a payoff: $(1 - \beta_M \cdot \sum_{j\in S} a_j)R + s_M - c(e_M) - b_{(2)}$, where $R = \theta + v \cdot (\sum_{j\in S} a_j)$. In this case, s_M does not contribute to the project's capital. Managers who do not win the auction receive a payoff s_i.

Proposition 6, stated below, shows that provided v is sufficiently large, in equilibrium, all investors link to one particular manager, Y. Y subsequently wins the auction, seeds the project, and exerts effort to move and shake investors. If the amount of seed money available to manager i is above a cutoff ($s_i > \hat{s}$), an equilibrium exists in which $i = Y$; otherwise, manager i cannot emerge as the project's mover and shaker.

The formal proof is left for the Appendix, but the logic is as follows. Seeding is worthwhile and increases the auction winner's payoff for two reasons. First, it directly contributes an amount s_i to the project. Second, and more importantly, seeding indirectly contributes to the project by increasing investors' willingness to provide capital. Therefore, a manager with less seed money than others will be outbid in the auction even if he is socially connected. Furthermore, since investors want to link to the eventual auction winner, such a manager cannot emerge as socially connected in equilibrium.

Proposition 6. *Suppose, in contrast to the model of Section 2.4, manager i has seed money $s_i \geq 0$. At time 2, before investors decide whether to contribute capital, the auction winner decides whether to put his seed money into the project. Let $s_{max} = max_{i \in N_M} s_i$. If there are at least three investors, then there exists a $\hat{v}$ such that, for all $v > \hat{v}$:*

(1) In equilibrium, all investors link to one particular manager: Y. Y subsequently wins the auction ($Y = M$), exerts positive effort ($e_Y > 0$), and seeds the project.

(2) There exists $\hat{s} < s_{max}$ such that:

(i) Whenever $s_i \geq \hat{s}$, an equilibrium exists in which manager $i = Y$. Furthermore, manager i receives a rent from the auction provided $s_i > \hat{s}$.

(ii) Whenever $s_i < \hat{s}$, there does not exist an equilibrium in which manager $i = Y$.

4 Applications

In this section we highlight a number of practical environments where our theory explains observed patterns and contrasts, to some degree, with standard accounts of those environments.

4.1 Real Estate Development

The history of real estate development in North America is replete with rich examples of moving and shaking. We considered one case in the introduction: William Zeckendorf's development of Place Ville Marie. To demonstrate that Zeckendorf's case is far from isolated, let us consider several others.

The late nineteenth and early twentieth centuries saw the development of numerous "railroad suburbs" and "streetcar suburbs" in the United States: such as Riverside, Illinois; Chevy Chase, Maryland; Shaker Heights, Ohio; Brookline, Massachusetts; and Coral Gables, Florida. All provide good examples of moving and shaking.

Take, for instance, the development of Shaker Heights – a suburb of Cleveland – by the Van Sweringen Brothers. The Van Sweringens (Oris P. and Mantis J.) had no capital of their own when they began developing Shaker Heights. They gambled and lost what capital they previously had buying lots in another Cleveland suburb (Lakewood). The Sweringens lacked capital; but they had social connections. Oris had worked for a prominent attorney, Frederick Taft. A childhood friend, Benjamin Jenks, who went into the family lumber business and subsequently became an attorney, was another important associate. In addition to these existing connections, the brothers had a talent for making new ones. Oris was especially magnetic: "timid, but irresistible," as one friend put it.[16] According to Harwood (2003), the Sweringens "gathered in a coterie of mostly young comers in...the city's legal and financial establishment."[17] They managed to charm people such as Joseph Nutt, a leading banker, and Charles Bradley, a third-generation industrialist who, along with his brother Alva, had inherited a Great Lakes shipping company and a Cleveland real estate empire.

The Sweringens became interested in Shaker Heights in 1905. The property – so named because at one time it had been a Shaker religious community – was little more than a 1400-acre expanse of trees and fields. The current owners were a syndicate from Buffalo who had been looking to divest for more than 10 years and were happy to sell to the brothers. The Sweringens envisioned turning Shaker Heights into an upscale, garden community along the lines of Roland Park in Baltimore. They initially sought to develop a small portion, closest to the existing residential community of Euclid Heights. This initial project required the participation of two constituencies: investors, to provide the necessary capital, and additionally, the Electric Railway Company. Unless the Electric Railway agreed to extend its Euclid Heights streetcar line, the area would be inaccessible. Analogous to Zeckendorf's experience, there was an initial reluctance to participate – particularly from the Electric Railway – due to uncertainty that others would participate as well; but, through their moving and shaking, the Sweringens managed to convince both groups.

While it was sufficient for this first project to extend the Euclid Heights streetcar line, to develop the remainder of the property, it would be necessary to construct a new railway line. The brothers tried to convince the Cleveland Railway Company to provide service – but to no avail. Unable to obtain their participation, the Sweringens ended up purchasing their own railroad (the Nickel Plate): effectively converting a problem of

[16]Harwood (2003), p. 5
[17]Ibid., p. 13.

obtaining a railroad's participation into a problem of obtaining investors' participation.

The development of Shaker Heights fits a standard pattern: since virtually all of the suburban development of the period required building new infrastructure. Many developers, like the Sweringens, were also owners of transport companies. Henry M. Whitney, for instance, one of the largest developers of Brookline, Massachusetts, formed the West End Street Railway Company with a syndicate of wealthy friends (see MacGillivray (1979)). Henry Huntington, the developer of Los Angeles, was the nephew and an heir of one of the California Big Four who had built the Union Pacific. As President of the Los Angeles Railway, Huntington would strategically build lines in advance of population, while buying large tracts of land (at subsequent great profit). Both Whitney and Huntington required more capital than either personally had available to invest. Nonetheless, they used their fortunes to good effect as seed money for their projects. In fact, in Huntington's case, he pushed his debt load "close to the edge" (the phrase of his biographer).[18]

Our theory closely aligns with these examples. As in our model, numerous participants were needed to make these development projects successful. The developer, through his social connections, played a moving-and-shaking role: raising awareness of the project among potential participants and making that awareness common knowledge, so each believed others were likely to participate. In our extensions to the basic model, we highlight qualities that movers and shakers are likely to possess: superior ability to form connections and communicate; seed capital; and skill. Notice that some – if not all – of these qualities apply to Zeckendorf, the Van Sweringens, Whitney, and Huntington.

4.2 Seed capital for funds

A common difficulty in raising private equity or venture capital funds is convincing enough limited partners that the fund will be successfully raised. Put differently, potential investors' willingness to invest depends upon whether they believe other potential

[18] Thorpe (1994), p. 213.

investors intend to participate.[19] This suggests that a fund manager with capital of his own might have an easier time raising a fund: since he could use his personal capital as seed money (see Proposition 6). Furthermore, it raises the possibility that a fund manager without personal wealth might seek help in seeding a fund from a large investor.

The case of Blackstone is illustrative in this regard. Blackstone's cofounders, Steve Schwarzman and Pete Peterson, found it enormously challenging to raise their first private equity fund.[20] Schwarzman described the difficulties they faced to the Financial Times[21]:

> "Oh my gosh, that was hard!...Our first 19 best prospects turned us down one after another; 488 potential investors turned us down. There were some crowning moments of embarrassment...We were on the road for a long time and it was hard to be told 'no' by a lot of our friends."

At the end of 1986, after more than a year spent knocking on doors, they were on the verge of declaring defeat; but, by a stroke of good luck, they found an investor willing to provide seed capital. As Schwarzman puts it[22]:

> "Garnett Keith [Prudential Insurance Company's vice-chairman] was eating a tuna salad sandwich. It was a Friday in Newark and I was not expecting success...He took a bite out of his sandwich and said, 'I will give you $100m.' I was shocked into silence: I was so grateful, so appreciative...I knew others would follow."

According to Peterson: "That luncheon was the biggest day of our Blackstone lives."[23] Pledges quickly followed from General Motors ($100 million); the Japanese brokerage firm Nikko Securities ($100 million); and General Electric ($35 million). By the fall of 1987, they had raised over $600 million.

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[19] One reason investors care about the rate of participation is that better capitalized funds can invest in more projects and thus better hedge risks.

[20] The Blackstone Group now has around $30 billion in funds under management and more than 1500 employees.

[21] Smith, Peter, "Reliance on contacts and a preference for corporate partnering," *The Financial Times* 24 April 2007, Retrieved from `http://www.ft.com`.

[22] Ibid.

[23] Carey and Morris (2010), p. 52.

One naturally wonders whether, at least in this instance, a (positive) information cascade occurred. The details that Schwarzman cites about the ordering of prospects suggest otherwise. Schwarzman points to having been turned down by their "19 best prospects." We know from Bikhchandani et al. (1992) that a reversal of a negative cascade into a positive one is very unlikely. What is more plausible is that Prudential's seed capital increased the likelihood the fund would successfully be raised and hence made others more inclined to invest.

Given that Prudential's seeding of the fund was critical to its success, one might expect them to have driven a hard bargain with Blackstone. This was indeed the case. According to Carey and Morris (2010):

> "Prudential insisted that Blackstone not collect a dime of the profits until Prudential and other investors had earned a 9 percent compounded annual return on every dollar they'd pledged to the fund...Prudential also insisted that Blackstone pay investors in the fund 25 percent on the net revenue...from its M&A advisor work, even on deals not connected to the fund...In the end, these were small prices to pay for the credibility the Pru's backing would give Blackstone."

More generally, our model raises the possibility that large investors – such as Prudential – may be able to serve as anchor investors for projects and thereby earn higher rates of return than small investors. In other words, such investors may receive compensation not just for the capital they personally provide to projects but also for the additional capital their investments help attract.[24]

[24]We should mention that there is an existing literature on anchor stores. For instance, Gould et al. (2005) demonstrate empirically that shopping mall store contracts are written to take account of the positive externality that "national brand" stores generate in driving traffic to smaller stores. Bernstein and Winter (2012) derive the structure of the optimal contract in the presence of heterogeneous externalities. Our theory, adapted to such a setting, suggests that anchor stores may receive preferable terms, but for rather different reasons than given in this strand of literature, which typically assumes that only the anchor store imposes (positive) externalities on other stores. By contrast, our model (as applied to stores), involves all stores imposing externalities on one another; these externalities being proportional to size. The argument in, say, Gould et al. (2005) or Bernstein and Winter (2012) as to why there should be a better rental rate for a large store does not apply in our environment. Our theory nonetheless suggests that anchor stores might obtain a better rate: the reason being that their participation helps to secure other stores' participation.

4.3 Returns to venture capital and private equity

According to Kaplan and Schoar (2005), private equity and venture capital funds, on average, yield roughly the same return, net of fees, as the S&P 500; however, certain fund managers consistently outperform the market, achieving higher risk-adjusted returns.

The standard interpretation of this finding is that these fund managers are particularly skilled at originating investment ideas. While this is a possibility, the model suggests a novel explanation. Such fund managers might instead be skilled movers and shakers.

We have already mentioned that raising private equity or venture capital funds involves convincing potential investors of other investors' willingness to participate. An anchor investor – like Prudential in the case of Blackstone – can help in this regard. But, even in the absence of a Prudential, a fund manager who is well connected may be able to raise funds by moving and shaking potential investors. In fact, while Prudential was critical to Blackstone's ability to raise funds, there is an argument that Blackstone's founders nonetheless played a moving and shaking role. Pete Peterson, in particular – a former secretary of commerce and CEO of Lehman Brothers – had valuable connections. According to Carey and Morris: "Peterson, with his entrée to executive suites around the country, would get Blackstone in the door and Schwarzman...would make the deal happen."[25,26]

Relative to our model, one can think of asset A as an investment idea and the mover and shaker as a skilled fund manager. Under this interpretation, the skilled fund manager outperforms the market by purchasing – rather than originating – good investment ideas. He chooses to purchase these ideas because he has a particular talent for raising capital. As highlighted by Proposition 1, there is a return to originating ideas (since the

[25] Carey and Morris (2010), p. 47.

[26] Carey and Morris say that Lehman Brothers hired Peterson specifically as a "rainmaker." He had no experience in finance, but Lehman suspected the connections he developed as commerce secretary would help the firm bring in investors. Financial firms often employ government officials for this reason. A recent example is KKR's hiring of David Petraeus. According to the *New York Times*, "Mr. Petraeus runs what is described as a small research division...but private equity experts said his real value was his Rolodex. 'Petraeus is a kind of door-opener,' said one friend of Mr. Kravis...'If Petraeus helps Henry find a way to $100 million in investments...it's a good deal for both of them.'" (Stolberg, Sheryl Gay, "After Scandal, Petraeus Stays Under Radar but Not Out of the Spotlight," *The New York Times* 27 February 2015, Retrieved from `http://www.nytimes.com`.)

mover and shaker pays to buy asset A), but the idea originator does not capture all of the surplus. The role played by the mover and shaker (the fund manager) is also important and leads him to earn a rent as well.

While fund managers often purchase projects/ideas outright, it is also common to purchase a share of a project. This is the standard model in venture capital. A VC firm will take an equity stake in a startup; then, it will move and shake on the company's behalf (in particular, helping the startup find additional investors). For example, Andreessen Horowitz, one of the preeminent Silicon Valley VC firms, "maintains a network of twenty thousand contacts and brings two thousand established companies a year to its executive briefing center to meet its startups." According to Marc Andreessen, "we give our founders...networking superpower."[27]

It is not a matter of indifference to a startup, of course, which VC firm invests. A startup would rather take money from a VC who is better at moving and shaking. Lower-ranked VCs, in consequence, find it hard to compete. Andreesen puts it this way: "Deal flow is everything...If you're a second-tier firm, you never get a chance at that great company."[28]

A number of Silicon Valley's most prominent venture capitalists have also founded companies: such as Marc Andreesen (Netscape), Peter Thiel (Paypal), and Reid Hoffman (Paypal and LinkedIn). A possible explanation is that the same basic talent is required: an ability to move and shake. Sean Parker's case is illustrative in this regard. His skill as a mover-and-shaker allowed him to move fluidly between roles. Parker's first venture was Napster, a file-sharing service he co-founded in 1999. After just a year, he left to start Plaxo, a website for managing contacts. Parker raised millions, but quickly ran afoul of the investors and was pushed out. This was his position in 2004 when he reached out to Mark Zuckerberg, founder of the then-fledgling Facebook.[29] Parker offered to help Zuckerberg by introducing him to potential investors. According to David Kirkpatrick: "[Parker] specialized in networking...He knew a lot of people in the Valley

[27]Friend, Tad, "Tomorrow's Advance Man," *The New Yorker* 18 May 2015, Retrieved from `http://www.newyorker.com`.

[28]Ibid.

[29]On their first meeting, Parker was so broke, in fact, that he overdrew his bank account to pay for dinner.

and understood how to get their ear."[30] Zuckerberg made him Facebook's President and rewarded him with a substantial equity stake that, in due course, would be worth billions. Parker's next turn was as a VC. He joined Peter Thiel's Founder's Fund, where once again he would play a moving and shaking role: on behalf of start-ups such as the new music-streaming service Spotify.[31]

In summary, fund managers who consistently outperform the market may do so because of skill at originating investment ideas; but, they may also do so because they are in a position to move and shake. Our extensions highlight some of the qualities one would expect to see in successful fund managers if they indeed play a moving and shaking role: ability to form social connections, ability as communicators, and seed capital.

4.4 Entrepreneurship

Founding a business often requires moving and shaking. Our model thus speaks to the topic of entrepreneurship. One can think of real estate developers, whom we have already discussed, as a type of entrepreneur (as well as founders of tech companies, whom we have mentioned briefly). It is useful to consider the model's application to entrepreneurship more generally.

A number of ideas have been advanced regarding entrepreneurs' function. Schumpeter (1934), for instance, stresses their role as innovators involved in "creative destruction"; Knight (1921) sees them primarily as risk-takers; Rajan and Zingales (1998) highlight their role in regulating access to resources. Others, such as Baumol (2010), bemoan that, despite economists' longstanding interest, "[entrepreneurs] are almost entirely excluded from our standard theoretical models."[32] Our theory offers a new perspective, stressing entrepreneurs' role as movers and shakers.

The aspect of entrepreneurship captured by our model is new to economics, but it

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[30] Kirkpatrick (2011), p. 50.

[31] The main challenge faced by Spotify was securing the participation of the four big music companies: E.M.I., Sony, Warner Music, and Universal. The company's founder and CEO, Daniel Ek, had managed to get E.M.I and Sony on board, but he was having trouble with the others. According to John Seabrook, "Parker was more persuasive. 'He did know a lot of people,' one top label executive said. 'Daniel Ek didn't.'" (Seabrook, John, "Revenue Streams," *The New Yorker* 24 November 2014, Retrieved from `http://www.newyorker.com`.)

[32] Baumol (2010), p. 2.

closely aligns with theoretical perspectives in sociology. Ronald Burt argues that entrepreneurs exploit network position. In his terminology, they bridge "structural holes." He writes that "bringing together separate pieces [of a network] is the essence of entrepreneurship."[33]

The history of Federal Express, to which we now turn, offers an especially vivid example of the role of moving and shaking in starting a business. When Fred Smith founded the company in 1971, there were already a number of airmail services – Emery, Airborne, and REA Express – but none offered consistent, reliable overnight delivery. Smith intended to solve the problem by building an airline devoted exclusively to the shipment of time-sensitive packages.[34] While it was realistic to believe there would be demand for such a service, starting a company that could deliver it posed formidable challenges. Many things needed to be in place before Fed Ex could open its doors: a fleet of jets (Dassault Falcon 20's); a central hub with sorting facilities; pickup and delivery operations in twenty-five cities; and several hundred trained employees.[35] Moreover, it could expect to lose money for a considerable period of time while business was growing (in its first three years, the company ended up losing 40 million dollars).

Therefore, several forms of participation were required. First and foremost, Smith needed participation from investors. Additionally, he needed to assemble a talented management team and find a city willing to serve as a hub.[36]

While anyone would find it difficult to move and shake all these elements together, Smith was well positioned to do so. First, he had financial resources he could use as seed money, having received a substantial inheritance when his father passed away in 1948.[37] Smith was also socially connected. A graduate of Yale, he had been a member of Skull and Bones, where he befriended both George W. Bush and John Kerry; and he established valuable contacts in the airline industry running, with his stepfather, a

[33]Burt (2001), p. 210.

[34]Outgoing packages would be flown to a central hub; there, a large team of workers would sort them; they would then be flown overnight to various destination cities.

[35]Fed Ex initially serviced twenty-five cities, but the network expanded quickly. By 1974, they had operations in sixty-one cities. This growth was critical: since they could only make a profit if the network was large.

[36]Arguably, he also needed participation from regulators: since changes needed to be made to existing rules.

[37]His father, an entrepreneur as well, was founder of the Memphis-based Smith Motor Coach Company and the Toddle House restaurant chain.

business that bought and sold jets. Finally, Smith was a talented communicator and salesman. As one early Fed Ex employee put it: “Fred turned on the charm in a way that few others can match.”[38]

The initial sources of capital were Smith’s trust fund and loans from banks in Memphis and Little Rock. Henry “Brick” Meers, vice chairman of the investment bank White, Weld & Company, agreed to help Smith obtain additional funding (effectively, serving as a second mover and shaker for the project). He and Smith travelled the country in an effort to attract venture capital; but they met with little success. The situation became dire: airports threatened to impound planes for failure to pay landing fees; creditors threatened to stop supplying materials.[39] It looked like Fed Ex would become a failed startup; but, in a last ditch effort, they met with Henry Crown of General Dynamics. He agreed to help – by guaranteeing a 23.7 million dollar loan from Chase – but extracted tough terms, including an option to buy Federal Express. Crown’s help convinced the venture capitalist Charlie Lea of New Court Securities to raise further capital. Lea thus became a third mover and shaker for the project. According to Lea, the process of obtaining investor participation was “like herding cats.”[40] He agreed to invest New Court’s own money in the project to help attract investors. Finally, in November of 1973, Lea finalized a deal that provided Fed Ex with an additional 52 million dollars of capital. It was now relatively clear the company would succeed. A third round of financing proved considerably easier. In July of 1975, Fed Ex had its first profitable month, after which it was able to finance its own continued expansion.

Of course, financial participation was only one piece of the puzzle. Smith also managed to secure Memphis as a hub, convincing Ned Cook, chairman of the airport board, to provide three hangars, acres of ramp space, and financing for a sort facility. He also attracted top talent to his management team. Most left secure jobs and took considerable pay cuts: such as Art Bass, who left a position as president of a Manhattan consulting firm, and Mike Fitzgerald, vice president of a New York-based warehousing company.

[38] Frock (2006), p. 62.

[39] One week, the financial situation was so dire it seemed they would be unable to fly. They needed 24,000 dollars to buy jet fuel; they only had 5,000 dollars in the bank. Smith took the 5,000 dollars and headed to Las Vegas. Fortunately, he won big: 27,000 dollars. His stroke of luck may have saved the company.

[40] Frock (2006), p. 105.

Most agreed to join the fledgling firm because others had agreed to participate. According to Roger Frock, Fed Ex's COO: "How could I even consider joining Fred in his crazy scheme?...I...knew that Art's broad vision and mellow personality would be tremendous assets for Federal Express."[41] Similarly, Fitzgerald remarked: "I was not sure [Smith] understood all the practical matters, but I could sense he was determined to find people that might make up the shortfall."[42]

Thus, as the case of Federal Express demonstrates, obtaining participation is one of the key challenges in starting a business and entrepreneurs often play a moving-and-shaking role. Our model captures this aspect of entrepreneurship.

5 Concluding remarks

We have analyzed a model with two types of agents – managers and investors – and an investment project, whose return is a function both of its underlying quality and aggregate investment. Managers and investors form social connections. Managers then bid to buy control of the project, and the winning manager exerts effort to raise awareness of the project among investors. Finally, investors who become aware of the project receive private signals of its quality and decide whether to invest.

We first analyze the model taking the social network as exogenous. Connections increase a manager's ability to raise capital. Consequently, the most connected manager wins the auction, exerts effort to move and shake the project, and, provided he is strictly most connected, earns a positive rent. When we endogenize the network, we find that all investors link to one particular manager. Therefore, even though all managers are *ex ante* identical, one emerges as most connected in equilibrium, becomes the project's mover and shaker, and receives a higher expected payoff than his peers.

We also considered various elaborations of our baseline model, which are useful in making our theory predictive and operational, as the illustrations in Section 4 highlight. We identified several attributes that make it more likely a manager will become a mover and shaker: (1) skill at running the project; (2) ability at forming social connections; and

[41] Ibid., p. 95.
[42] Ibid., p. 62.

(3) talent as a communicator. Additionally, we showed that it is worthwhile to seed projects since it increases investors' willingness to participate. Seed capital also makes it more likely a manager will emerge as a mover and shaker.

There are a number of implications of our theory and potential avenues for future work. Here, we briefly sketch three.

One notable feature of our model is that rents earned by managers do not correspond to their "marginal product" – at least not in the conventional usage of that term. In our setting, rents are derived from social position. The mover and shaker is socially useful, to be sure, but can derive "outsize" rewards. Furthermore, the model suggests that it is easy to misattribute a mover and shaker's success to his skill at running the project. In fact, a mover and shaker may succeed in spite of – rather than because of – his skill. The broad debate about rising inequality (see Piketty (2014) for a notable recent contribution) has focused to a large degree on returns to capital versus labor, but relatively little on what might be termed "returns to social position." Our theory differs from existing accounts of the drivers of inequality because technological factors play a secondary role. Empirical tests of the relative importance of network position versus marginal product may be informed by the structure of our model.

Second, political campaigns have many of the features of our model. They are "projects"; people make contributions (financial and non-financial); and there are strong complementarities. Moreover, beliefs about what others will do seem to matter a lot. Donors often worry about what other donors are contributing, and it is common wisdom that voters typically like to vote for winning candidates. The strong momentum effects in, for example, US Presidential Primaries (see Knight and Schiff (2010) for persuasive empirical evidence) may be explained, in part, by considerations present in our theory.

Finally, there is a burgeoning literature on "persistent performance differences" in organizations. Most models seeking to rationalize differences among otherwise identical organizations involve some kind of equilibrium theory where *ex ante* identical organizations end up in different positions ex post. In, for example, Chassang (2010) and Ellison and Holden (2014) this wedge is due to dynamics. Our model suggests an alternative explanation for persistent performance differences that does not involve dynamics. In our theory, agents/investors focus their attention on one particular manager; that manager may be more skilled or less skilled.

6 Appendix

Proof of Lemma 1. Consider the global game investors in set S play at time 4. In Section 3 of Morris and Shin (2003), it is shown that, in such a game, provided $\frac{\sigma^2}{\tau^4}$ is sufficiently small, there is a unique equilibrium in which investors follow strategies of the form: invest if and only if $\overline{\theta}_j > \kappa$, where $\overline{\theta}_j = \frac{\sigma^2 \cdot \mu + \tau^2 \cdot x_j}{\sigma^2 + \tau^2}$ denotes investor j's posterior on θ. We are focused on the case where $\sigma \to 0$, so $\frac{\sigma^2}{\tau^4}$ is indeed small. Furthermore, $\overline{\theta}_j \to x_j$ as $\sigma \to 0$, so in the limit, the cutoff rule becomes: invest if and only if $x_j > \kappa$.

Let us now solve for the cutoff (κ). If investor j invests, his expected payoff will be:

$$\begin{aligned}
\text{Payoff from investing} &= \beta_M \cdot E(R|x_j, \text{j invests}) \\
&= \beta_M \cdot E(\theta + vK|x_j, \text{j invests}) \\
&= \beta_M \cdot [\overline{\theta_j} + v(1 + (n-1) \cdot \Pr(\overline{\theta}_k > \kappa|x_j))] \\
&= \beta_M \cdot \left[\overline{\theta_j} + v\left(1 + (n-1) \cdot \Pr\left(x_k > \kappa + \left(\frac{\sigma^2}{\tau^2}\right)(\kappa - \mu) \;\middle|\; x_j\right)\right)\right].
\end{aligned}$$

Observe that investor j's posterior on θ is that it is distributed normally with mean $\overline{\theta_j}$ and with variance $\frac{\sigma^2\tau^2}{\sigma^2+\tau^2}$. Since $x_k = \theta + \varepsilon_k$, j's posterior on x_k is that it is distributed normally with mean $\overline{\theta_j}$ and with variance $\frac{\sigma^2\tau^2}{\sigma^2+\tau^2} + \sigma^2$ (or, simplifying, with variance $\frac{2\sigma^2\tau^2+\sigma^4}{\sigma^2+\tau^2}$). Consequently:

$$\begin{aligned}
\Pr\left(x_k > \kappa + \left(\frac{\sigma^2}{\tau^2}\right)(\kappa - \mu) \;\middle|\; x_j\right) &= \Pr\left(\frac{x_k - \overline{\theta}_j}{\sqrt{\frac{2\sigma^2\tau^2+\sigma^4}{\sigma^2+\tau^2}}} > \frac{(\kappa - \overline{\theta}_j) + \left(\frac{\sigma^2}{\tau^2}\right)(\kappa - \mu)}{\sqrt{\frac{2\sigma^2\tau^2+\sigma^4}{\sigma^2+\tau^2}}} \;\middle|\; x_j\right) \\
&= 1 - \Phi\left(\frac{(\kappa - \overline{\theta}_j) + \left(\frac{\sigma^2}{\tau^2}\right)(\kappa - \mu)}{\sqrt{\frac{2\sigma^2\tau^2+\sigma^4}{\sigma^2+\tau^2}}}\right),
\end{aligned}$$

where $\Phi(\cdot)$ is the cdf of the standard normal distribution.

At the cutoff (that is, when $\overline{\theta}_j = \kappa$), investor j should be indifferent between investing and not. Hence, the payoff from investing should be equal to 1. This gives us the following formula:

$$\beta_M \cdot \left[\kappa + v\left(1 + (n-1)\cdot\left(1 - \Phi\left(\frac{\kappa - \mu}{\sqrt{\left(\frac{\tau^4}{\sigma^4}\right)\frac{2\sigma^2\tau^2+\sigma^4}{\sigma^2+\tau^2}}}\right)\right)\right)\right] = 1.$$

As $\sigma \to 0$, $\Phi\left(\frac{\kappa-\mu}{\sqrt{\left(\frac{\tau^4}{\sigma^4}\right)\frac{2\sigma^2\tau^2+\sigma^4}{\sigma^2+\tau^2}}}\right) \to \Phi(0) = \frac{1}{2}$. Hence, the formula simplifies to:

$$\beta_M \cdot \left[\kappa + v\left(\frac{n+1}{2}\right)\right] = 1.$$

Rearranging terms, we find:

$$\kappa = \frac{1}{\beta_M} - v\left(\frac{n+1}{2}\right).$$

This completes the proof.

□

Proof of Lemma 2. Recall that:

$$\Pi_M(n,\beta) = \mu + v \cdot n(1-\beta n)\cdot \Pr(\theta > \kappa) - \beta n \cdot E(\theta|\theta > \kappa)\cdot \Pr(\theta > \kappa),$$

where $\kappa = \frac{1}{\beta} - v\left(\frac{n+1}{2}\right)$.

Observe that $E(\theta|\theta > \kappa)\cdot\Pr(\theta > \kappa)$ is bounded between 0 and μ. Therefore, $\frac{1}{v}\Pi_M(n,\beta) \to n(1-\beta n)\cdot\Pr(\theta > \kappa)$ as $v \to \infty$. So, in the limit as $v \to \infty$, M's problem becomes one of choosing β to maximize $\tilde{\Pi}_M(n,\beta) = n(1-\beta n)\cdot \Pr(\theta > \kappa)$. To show $\Pi_M(n,\beta^*(n))$ is strictly increasing in n for v large, it will be sufficient to show $\tilde{\Pi}_M(n,\tilde{\beta}^*(n))$ is strictly increasing in n for v large, where $\tilde{\beta}^*(n) = \arg\max_\beta \tilde{\Pi}_M(n,\beta)$.

We can apply the Envelope Theorem to differentiate $\tilde{\Pi}_M(n,\tilde{\beta}^*(n))$ with respect to n:

$$\frac{d\tilde{\Pi}_M(n,\tilde{\beta}^*(n))}{dn} = n(1-\tilde{\beta}^*(n)n)\cdot\frac{vf(\kappa)}{2} + (1-2\tilde{\beta}^*(n)n)\cdot\Pr(\theta > \kappa),$$

where $\kappa = \frac{1}{\tilde{\beta}^*(n)} - v\left(\frac{n+1}{2}\right)$ and $f(\cdot)$ denotes the pdf of the $N(\mu, \tau^2)$ distribution. We see that, provided $\tilde{\beta}^*(n)n < \frac{1}{2}$, $\frac{d\tilde{\Pi}_M(n,\tilde{\beta}^*(n))}{dn} > 0$.

We can show, by contradiction, that $\tilde{\beta}^*(n)n < \frac{1}{2}$ for v large. In fact, we can show $\tilde{\beta}^*(n)n < \rho$ for any $\rho > 0$. Suppose $\tilde{\beta}^*(n)n \geq \rho$. The first-order condition for $\tilde{\beta}^*$ is:

$$n(1 - \tilde{\beta}^* n) f(\kappa) \left(\frac{1}{\tilde{\beta}^*}\right)^2 - n^2 \Pr(\theta > \kappa) = 0,$$

where $\kappa = \frac{1}{\tilde{\beta}^*} - v\left(\frac{n+1}{2}\right)$. Observe that $\kappa \to -\infty$ as $v \to \infty$ if $\tilde{\beta}^* n \geq \rho$. But, when $\kappa \to -\infty$, the left-hand side of the first-order condition converges to $-n^2$. The first-order condition is consequently violated, which is a contradiction. This proves the lemma.

$\square$

Proof of Lemma 3. From Lemma 2, we know that $\Pi_M(n, \beta^*_M(n))$ is strictly increasing in n. We also know that, when $d_M > 0$, $B(d_M, e_M)$ is strictly stochastically increasing in e_M (in the first-order stochastic dominance sense). It immediately follows that $E[\Pi_M(n, \beta^*_M(n))|n \sim B(d_M, e_M)]$ is an strictly increasing in e_M when $d_M > 0$.

Since $E[\Pi_M(n, \beta^*_M(n))|n \sim B(d_M, e_M)]$ is an strictly increasing in e_M when $d_M \geq 1$ and $c'(0) = 0$, we conclude that $e^*_M(d_M) > 0$ whenever $d_M > 0$. This proves the first part of the lemma.

Now, let us prove the second part. For the purposes of the proof, we will treat d_M as a continuous variable. Applying the Envelope Theorem, it follows that $V'(d_M) = \frac{\partial}{\partial d} E[\Pi_M(n, \beta^*_M(n))|n \sim B(d, e)]\Big|_{(d,e)=(d_M, e^*_M(d_M))}$. $B(d, e)$ is strictly stochastically increasing in d whenever $e > 0$. Since $e^*_M > 0$ for all $d_M > 0$, it follows that $V'(d_M) > 0$ for all $d_M > 0$. This proves the second part of the lemma.

$\square$

Proof of Proposition 2. Observe that, if investor j does not link at time 0 to the eventual auction winner, he earns a payoff of 1 for sure: since there is no chance he will be in set S and have an opportunity to invest in the project.

Now, consider an investor j who does link to the eventual auction winner. From proposition 1, we know that the eventual auction winner will exert positive effort, so j

will be in set S with positive probability. If investor j is in set S and has the opportunity to invest, j earns an expected payoff strictly greater than 1. The reason is as follows. Recall from the proof of Lemma 1 that, when $x_i \leq \kappa$, j earns a payoff of 1 but when x_i is strictly greater than κ, j earns an expected payoff strictly greater than 1. Since we assumed $\sigma \to 0$, $\Pr(x_i > \kappa) = \Pr(\theta > \kappa)$. $\Pr(\theta > \kappa) > 0$ since θ is distributed $N(\mu, \tau^2)$. Hence, we conclude that an investor connected to the eventual auction winner earns an expected payoff strictly greater than 1.

It is now straightforward to show both existence and uniqueness of the equilibria described in Proposition 2:

Existence. To prove existence, we need to show that, in linking to manager Y at time 0, investors are best-responding. Suppose investor j deviates at time 0 and links to another manager. There are at least 3 investors, so even when j deviates, Y is still the most connected manager and wins the auction. Consequently, in deviating, j switches from linking to a manager who wins the auction (which yields a payoff strictly greater than 1) to a manager who does not (which yields a payoff equal to 1). Hence, j's deviation is not profitable. We conclude that players are indeed best responding in linking to Y.

Uniqueness. Suppose there is an investor j who does not link at time 0 to the eventual auction winner, Y. Investor j earns a payoff of 1. Now suppose j deviates and links to Y. Investor j's deviation makes Y more connected than he was previously, so Y still wins the auction. Consequently, the deviation yields a payoff for j strictly greater than 1. Since the deviation is profitable, it follows that all players must link to the eventual auction winner in equilibrium. This establishes uniqueness.

□

Proof of Propositions 3 and 5. Consider a game with the setup of Proposition 5. Note that this nests the setup of Proposition 3.

We can use backwards induction to analyze the game. Observe that the project yields a return $R = \theta + v \cdot K + \alpha_M = \tilde{\theta}_M + v \cdot K$, where $\tilde{\theta}_M = \theta + \alpha_M$. $\tilde{\theta}_M$ is distributed $N(\mu + \alpha_M, \tau^2)$.

Consider time 4 of the game. Clearly, Lemma 1 still characterizes investors' behavior: since all we have done to change the game is substitute $\tilde{\theta}_M$ for θ.

Now, consider time 3. Previously, we wrote M's expected share of the project's return as $\Pi_M(n, \beta_M)$. Since, in this case, M's share depends also on α_M, we will write M's expected share of the project's return as $\Pi_M(n, \beta_M, \alpha_M)$. The following is a formula for $\Pi_M(n, \beta_M, \alpha_M)$ (which we obtain by substituting $\tilde{\theta}_M$ for θ in our previous formula for $\Pi_M(n, \beta_M)$):

$$\Pi_M(n, \beta_M, \alpha_M) = (\mu + \alpha_M) + vn(1 - \beta_M n)\Pr(\tilde{\theta}_M > \kappa) - \beta_M n E(\tilde{\theta}_M | \tilde{\theta}_M > \kappa)\Pr(\tilde{\theta}_M > \kappa),$$

where $\kappa = \frac{1}{\beta} - v\left(\frac{n+1}{2}\right)$.

As before, M will choose β_M to maximize Π_M: $\beta_M^*(n, \alpha_M) = \arg\max_\beta \Pi_M(n, \beta_M, \alpha_M)$. Observe that Lemma 2 carries over, since all we have done is substitute $\tilde{\theta}_M$ for θ. So, $\Pi_M(n, \beta_M^*(n, \alpha_M), \alpha_M)$ is strictly increasing in n for v large.

It will be useful to show that $\Pi_M(n, \beta_M^*(n, \alpha_M), \alpha_M)$ is strictly increasing in α_M for v large. Let $\alpha' = \alpha_M + \delta$, where $\delta > 0$. To show $\Pi_M(n, \beta_M^*(n, \alpha_M), \alpha_M)$ is strictly increasing in α_M, it is sufficient to show that there exists β' such that $\Pi_M(n, \beta', \alpha') > \Pi_M(n, \beta_M^*(n, \alpha_M), \alpha_M)$.

Consider $\beta' = \frac{1}{\delta + \frac{1}{\beta_M^*(n, \alpha_M)}}$. Let κ' denote the value of κ corresponding to β' and let κ^* denote the value of κ corresponding to $\beta_M^*(n, \alpha_M)$. $\kappa' = \frac{1}{\beta'} - v\left(\frac{n+1}{2}\right) = \delta + \left[\frac{1}{\beta_M^*(n, \alpha_M)} - v\left(\frac{n+1}{2}\right)\right] = \delta + \kappa^*$. This allows us to write $\Pi_M(n, \beta', \alpha')$ as follows:

$$\begin{aligned}
\Pi_M(n, \beta', \alpha') &= (\mu + \alpha_M + \delta) + vn(1 - \beta' n) \cdot \Pr(\tilde{\theta}' > \kappa') - \beta' n \cdot E(\tilde{\theta}' | \tilde{\theta}' > \kappa') \cdot \Pr(\tilde{\theta}' > \kappa') \\
&= (\mu + \alpha_M + \delta) + vn(1 - \beta' n) \cdot \Pr(\tilde{\theta}_M > \kappa) - \beta' n \cdot E(\tilde{\theta}_M + \delta | \tilde{\theta}_M > \kappa) \cdot \Pr(\tilde{\theta}_M > \kappa) \\
&= (\mu + \alpha_M + \delta) + vn(1 - \beta' n) \cdot \Pr(\tilde{\theta}_M > \kappa) - \beta' n \cdot [E(\tilde{\theta}_M | \tilde{\theta}_M > \kappa) + \delta] \cdot \Pr(\tilde{\theta}_M > \kappa) \\
&= \Pi_M(n, \beta_M^*(n, \alpha_M), \alpha_M) + (1 - \beta' n \Pr(\tilde{\theta}_M > \kappa))\delta \\
&\quad + (\beta_M^*(n, \alpha_M) - \beta') \cdot n(vn - E(\tilde{\theta}_M | \tilde{\theta}_M > \kappa)) \cdot \Pr(\tilde{\theta}_M > \kappa).
\end{aligned}$$

Or:

$$\begin{aligned}
&\Pi_M(n, \beta', \alpha') - \Pi_M(n, \beta_M^*(n, \alpha_M), \alpha_M) = \\
&(1 - \beta' n \Pr(\tilde{\theta}_M > \kappa))\delta + (\beta_M^*(n, \alpha_M) - \beta') \cdot n(vn - E(\tilde{\theta}_M | \tilde{\theta}_M > \kappa)) \cdot \Pr(\tilde{\theta}_M > \kappa).
\end{aligned}$$

We would like to show that the sum of the two terms on the right-hand side is strictly greater than zero. First, observe that $\beta' < \beta_M^*(n, \alpha_M)$. Hence, $(1 - \beta' n \Pr(\tilde{\theta}_M > \kappa))\delta >$

$(1 - \beta^* n \Pr(\tilde{\theta}_M > \kappa))\delta$. Recall that we showed in the proof of Lemma 2 that $\beta^* n < \frac{1}{2}$ for v large. We therefore conclude that the first term is strictly greater than zero when v is large. Turning to the second term, $\beta' < \beta^*$ implies $\beta^* - \beta' > 0$. We also see that $n(vn - E(\tilde{\theta}_M | \tilde{\theta}_M > \kappa)) \cdot \Pr(\tilde{\theta}_M > \kappa)$ is equal to zero if $n = 0$; it is greater than zero if $n > 0$ and v is large. Hence, the second term is greater than or equal to zero when v is large. This proves $\Pi_M(n, \beta^*_M(n, \alpha_M), \alpha_M)$ is strictly increasing in α_M for v large.

Notice that the formula for $\Pi_M(n, \beta_M, \alpha_M)$ implies that $\lim_{\alpha_M \to -\infty} \Pi_M(n, \beta_M, \alpha_M) = -\infty$ for all n and β_M. It follows that $\lim_{\alpha_M \to -\infty} \Pi_M(n, \beta^*_M(n, \alpha_M), \alpha_M) = -\infty$. This result will also be useful.

Now, consider time 2 of the game. When M exerts effort e_M, his expected payoff is: $E[\Pi_M(n, \beta^*_M(n, \alpha_M), \alpha_M) | n \sim B(d_M, e_M)] - c(\frac{e_M}{\gamma_M}) - b_{(2)}$, where $B(d_M, e_M)$ is the binomial distribution with parameters d_M and e_M. M will choose the level of effort, $e^*_M(d_M, \alpha_M, \gamma_M)$, that maximizes this expression. We can write M's resulting payoff as: $V(d_M, \alpha_M, \gamma_M) - b_{(2)}$.

Lemma 3 clearly carries over. So, $e^*_M(d_M, \alpha_M, \gamma_M) > 0$ whenever $d_M \geq 1$, and V is increasing in d_M. Since, $\Pi_M(n, \beta^*_M(n, \alpha_M), \alpha_M)$ is increasing in α_M, the Envelope Theorem implies that V is increasing in α_M. The Envelope Theorem also implies that V is increasing in γ_M when $d_M > 0$.

We also know that, when $d_M = 0$, $V(d_M, \alpha_M, \gamma_M) = \mu + \alpha_M$: since it is optimal to exert zero effort and $n = 0$ with probability 1. Similarly, as $\gamma_M \to 0$, $e^*_M(d_M, \alpha_M, \gamma_M) \to 0$ and $\Pr(n = 0) \to 1$: so, $V(d_M, \alpha_M, \gamma_M) \to \mu + \alpha_M$.

Furthermore, we showed that $\lim_{\alpha_M \to -\infty} \Pi_M(n, \beta^*_M(n, \alpha_M), \alpha_M) = -\infty$ for all n. It follows that $\lim_{\alpha_M \to -\infty} V(d_M, \alpha_M, \gamma_M) = -\infty$.

Turning back to time 1, we know that the value manager i places on asset A is $V(d_i, \alpha_i, \gamma_i)$. The manager with the highest valuation – or one of the managers with the highest valuation – will win the auction. Furthermore, if there is a manager who values the auction strictly more than others, he earns a strictly higher payoff than other managers.

Now, let us consider time 0. Suppose there is an investor j who does not link to the eventual auction winner, Y. Investor j earns a payoff of 1 (since there is no chance he will have an opportunity to invest in the project). Now suppose j deviates and links to

Y. Investor j's deviation makes Y more connected than he was previously. Y's valuation of asset A therefore rises while the valuations of other managers (weakly) fall. So, Y still wins the auction. The deviation yields a payoff for j strictly greater than 1 (since, with some probability, j has an opportunity to invest in the project). Since the deviation is profitable, it follows that all players must link to one manager, Y, in equilibrium.

Now, let us consider whether an equilibrium exists in which manager $i = Y$. We will divide our discussion into two cases.

Case 1: All investors have the same ability to communicate ($\gamma_i = 1$ for all i).

It will be an equilibrium for all investors to link to manager i if and only if, conditional on being linked to all the investors, manager i wins the auction. Or, put another way, an equilibrium exists in which $i = Y$ if and only if manager i values asset A weakly more than other managers when he is linked to all the investors: $V(card(N_I), \alpha_i, 1) \geq \max_{i' \neq i} V(0, \alpha_i, 1) = \mu + \max_{i' \neq i} \alpha_{i'}$, where $card(N_I)$ denotes the total number of investors.

Since V is strictly increasing in α, there must be a cutoff $\hat{\alpha}$ such that the condition is satisfied if and only if $\alpha_i \geq \hat{\alpha}$. We know that, when $\alpha_i = \alpha_{max}$, the inequality is strict: $V(card(N_I), \alpha_i, 1) > \mu + \max_{i' \neq i} \alpha_{i'}$. Hence, the cutoff must be strictly less than α_{max}: $\hat{\alpha} < \alpha_{max}$. We also know that $lim_{\alpha_i \to -\infty} V(card(N_I), \alpha_i, 1) < \mu + \max_{i' \neq i} \alpha_{i'}$. So, the cutoff must be finite: $\hat{\alpha} > -\infty$. This proves Proposition 3.

Case 2: Investors have different abilities to communicate.

An equilibrium exists in which $i = Y$ if and only if manager i values asset A weakly more than other managers when he is linked to all the investors: $V(card(N_I), \alpha_i, \gamma_i) \geq \max_{i' \neq i} V(0, \alpha_i, \gamma_i) = \mu + \max_{i' \neq i} \alpha_{i'}$.

Since V is strictly increasing in γ, there must be a cutoff $\hat{\gamma}(\alpha_i)$ such that the condition is satisfied if and only if $\gamma_i \geq \hat{\gamma}(\alpha_i)$. We know that, when $\alpha_i = \alpha_{max}$, the condition is always satisfied: $V(card(N_I), \alpha_{max}, \gamma_i) \geq \mu + \max_{i' \neq i} \alpha_{i'}$ for all γ_i. Hence, the cutoff must equal to zero when $\alpha_i = \alpha_{max}$: $\hat{\gamma}(\alpha_{max}) = 0$. We also know that $lim_{\alpha \to -\infty} V(card(N_I), \alpha, \gamma_i) < \mu + \max_{i' \neq i} \alpha_{i'}$. So, for α_i sufficiently low, the condition is always violated. Hence, for α_i sufficiently low: $\hat{\gamma}(\alpha_i) = \infty$. This proves Proposition 5.

$\square$

Proof of Proposition 4. Observe that, from time 1 onwards, the game is the same as the baseline model from Section 2. Hence, Proposition 1 tells us that the eventual auction winner, Y, will be weakly more connected than other managers, exert positive effort ($e_Y > 0$), and receive a weakly higher payoff than other managers. It also tells us that, if Y is strictly more connected than other managers, Y receives a strictly higher expected payoff.

Now, let us consider whether an equilibrium exists in which all investors link to manager i at time 0. Investors linked to i have a chance to invest in the project so receive a payoff of $r(card(N_I)) - l_i$, where $r(card(N_I)) > 1$. Now suppose investor j deviates and links to another manager: i'. Because there are at least three investors, investor j's deviation does not change who wins the auction: manager i is still most connected. Hence, investor j does not have a chance to invest when he deviates so receives a payoff of $1 - l_{i'}$. We see that the deviation with the highest payoff is the one in which j links to the player with the lowest linking cost. This yields a payoff of: $1 - \min_{i' \neq i} l_{i'}$. If manager i's linking cost is minimal ($l_i = l_{min}$), there is no profitable deviation since $r(card(N_I)) - l_i > 1 - l_i \geq 1 - \min_{i' \neq i} l_{i'}$. Now suppose i's linking cost is not minimal. An equilibrium still exists in which all investors link to i provided $r(card(N_I)) - l_i \geq 1 - l_{min}$. Let $\hat{l} = (r(card(N_I)) - 1) + l_{min}$. We see that, if $l_i \leq \hat{l}$, $r(card(N_I)) - l_i \geq 1 - l_{min}$, so an equilibrium exists in which all investors link to i.

Now, let us consider whether any equilibrium exists in which manager i wins the auction. We will assume manager i's linking cost is not minimal ($l_i \neq l_{min}$) since we already know an equilibrium exists when i's linking cost is minimal. If i wins the auction, he must be weakly more connected than other managers. Hence, at least one investor, j, must link to him. Investor j receives a payoff of $r(n_i) - l_i$ when he links to manager i, where n_i denotes the total number of investors who link to i. Suppose investor j deviates and links to a manager whose linking cost is minimal. This ensures a payoff weakly greater than $1 - l_{min}$ (the reason the payoff is potentially greater than $l - l_{min}$ is that j's deviation might change who wins the auction). Let $\hat{\hat{l}} = [\max_{n_i} r(n_i) - 1] + l_{min}$. Observe that $l_i > \hat{\hat{l}}$ ensures that it is always profitable for investor j to deviate. Hence, no equilibrium exists in which $i = Y$ when $l_i > \hat{\hat{l}}$. This completes the proof.

□

Proof of Proposition 6. We can show that, provided v is sufficiently large, managers always find it optimal to put their seed money into the project if they win the auction.

For now, take this claim to be true. Then, the effect of seed money is that it increases the project's return, R, by an amount $v \cdot s_i$ when manager i runs the project. Hence, having seed money s_i is equivalent to having skill $\alpha_i = v \cdot s_i$. Given the equivalence between seed money and skill, the proposition follows immediately from Proposition 3.

Therefore, it simply remains to establish the claim. To do so, we will show that, for any value of n, M's payoff is higher if he seeds the project rather than holds onto his money. First, observe that, if $s_M = 0$, he receives a payoff of $\Pi(n, \beta_M^*(n))$ no matter what. More generally, if he does not seed the project, he receives a payoff of $\Pi(n, \beta_M^*(n)) + s_M$. M's payoff is increasing at a rate of one per unit of seed money. Let us show that, if M does seed the project, his payoff increases at a rate strictly greater than one. This will prove the claim.

Recall from the proof of Propositions 3 and 5 that, if M has skill α_M, his payoff is given by the following formula:

$$\begin{aligned}\Pi_M(n, \beta_M, \alpha_M) &= (\mu + \alpha_M) + vn(1 - \beta_M n)\Pr(\tilde{\theta}_M > \kappa) - \beta_M n E(\tilde{\theta}_M|\tilde{\theta}_M > \kappa)\Pr(\tilde{\theta}_M > \kappa) \\ &= (\mu + \alpha_M) + [vn(1 - \beta_M n) - \beta_M n \alpha_M]\Pr(\theta_M > \kappa - \alpha_M) \\ &\quad - \beta_M n E(\theta_M|\theta_M > \kappa - \alpha_M)\Pr(\theta_M > \kappa - \alpha_M),\end{aligned}$$

where $\kappa = \frac{1}{\beta_M} - v\left(\frac{n+1}{2}\right)$. We argued that, when M seeds the project, it is equivalent to having skill $\alpha_M = vs_M$. Substituting for α_M, we obtain the following formula for M's payoff when he seeds the project:

$$\begin{aligned}\Pi_M(n, \beta_M, s_M) = (\mu + vs_M) &+ vn(1 - \beta_M n - \beta_M s_M)\Pr(\theta_M > \kappa - vs_M) \\ &- \beta_M n E(\theta_M|\theta_M > \kappa - vs_M)\Pr(\theta_M > \kappa - vs_M),\end{aligned}$$

where $\kappa = \frac{1}{\beta_M} - v\left(\frac{n+1}{2}\right)$.

Observe that $E(\theta_M|\theta_M > \kappa - vs_M)\Pr(\theta_M > \kappa - vs_M)$ is bounded between 0 and μ. Therefore, $\frac{1}{v}\Pi_M(n, \beta_M, s_M) \to s_M + n(1 - \beta_M n - \beta_M s_M) \cdot \Pr(\theta > \kappa - vs_M)$ as $v \to \infty$.

So, in the limit as $v \to \infty$, M's problem becomes one of maximizing $\tilde{\Pi}_M(n, \beta_M, s_M) = s_M + n(1 - \beta_M n - \beta_M s_M) \cdot \Pr(\theta > \kappa - v s_M)$. Let $\tilde{\beta}^*_M = \arg\max_{\beta_M} \tilde{\Pi}_M(n, \beta_M, s_M)$. Applying the Envelope Theorem, we find:

$$\frac{d\tilde{\Pi}_M(n, \tilde{\beta}^*_M, s_M)}{ds_M} = 1 + nv(1 - \tilde{\beta}^*_M n - \tilde{\beta}^*_M s_M) f(\kappa - v s_M) - \tilde{\beta}^*_M \cdot \Pr(\theta > \kappa - v s_M),$$

where $\kappa = \frac{1}{\beta^*_M} - v\left(\frac{n+1}{2}\right)$. Recall from the proof of Lemma 2 we showed, for v sufficiently large, $\tilde{\beta}^*_M n < \rho$ for any $\rho > 0$. Or, put another way, $\tilde{\beta}^*_M n \to 0$ as $v \to \infty$. The same argument applies here. Therefore, the second term is positive for v large. The third term converges to zero as $v \to \infty$. Hence, for v large, $\frac{d\tilde{\Pi}_M(n, \tilde{\beta}^*_M, s_M)}{ds_M} \geq 1$.

We conclude that, for v large, $\frac{d\Pi_M(n, \beta^*_M, s_M)}{ds_M} \geq v$. So, it is indeed the case that, if M seeds the project, his payoff increases in s_M at a rate strictly greater than one. This completes the proof.

□

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