Wolf Pack Activism *

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Abstract

Blockholder monitoring is key to good corporate governance, but blockholders large enough to exercise significant unilateral influence are rare. As a result mechanisms that enable small blockholders to exert collective influence are important. It is alleged that institutional blockholders (implicitly) coordinate when intervening in firms, with one acting as the "lead" activist and others as peripheral activists, or "wolf pack" members. We present a model of wolf pack activism. Our model formalizes a source of complementarity across the engagement strategies of activists and highlights the catalytic role played by the leader. We also characterize share acquisition by wolf pack members and the leader, providing testable implications on ownership and price dynamics in wolf pack formation.

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1 Introduction

Starting with Shleifer and Vishny (1986), economists have recognised the key role of blockholder monitoring in ameliorating problems arising from the separation of ownership and control in public corporations. The literature has also emphasized the importance of block size in exerting influence on management. For example, firm value is increasing in the size of the block in Shleifer and Vishny (1986). Subsequent papers including Winton (1993) and Edmans and Manso (2011) have underscored obstacles to influence in ownership structures with multiple blockholders: many small blocks are not automatically equivalent to a single large block. Such obstacles to effective influence over management are also empirically relevant. While blockholding is widely prevalent in the US, most blockholders are not large enough to exert significant unilateral influence. Holderness (2009) documents that 96% of US firms have at least one blockholder with 5% ownership. Yet, LaPorta, Lopes de Silanes, Shleifer, and Vishny (1999) document that 80% of the largest US firms lack any single blockholder who has sufficient holdings to exert effective control. Thus, mechanisms that enable small blockholders to gain collective influence are key to effective monitoring.

Interestingly, market observers allege that institutional investors—who are the majority of blockholders in US corporations today—*do* act in groups to magnify each other's influence over management. Activist hedge funds are leading examples. These funds are widely attributed with creating fundamental change (Brav et al 2008, Klein and Zur 2009), often in the face of hostile managers, while typically owning only around 6% of the company's shares (Brav, Jiang, and Kim 2010). In explaining the disproportionate influence of such relatively small block holders, lawyers have alleged that activist hedge funds implicitly team up with other institutional investors to form so-called "wolf packs" (e.g., Briggs 2006, Nathan 2009, Coffee and Palia 2015). The importance of wolf packs has been recognized by U.S. courts, which have upheld the use of unconventional measures undertaken by corporations to defend against them.[1] The use of this tactic has attracted a great deal of attention. For example, legistlation recently proposed in the U.S. Senate in response to the rise of hedge fund activism (the Brokaw Act) cites protecting businesses from activist wolf packs as a central goal.

Despite the prominence of wolf packs and activist hedge funds, and the broader economic importance of mechanisms generating collective influence in blockholder monitoring, there is no theoretical analysis of such phenomena. In this paper we present the first model of wolf pack activism. We model activism in a target firm by many investors: one large investor and many small ones. Our large investor is intended to represent, for example, an activist hedge fund (e.g., Pershing Square or TCI) which crosses the 5% ownership threshold and files form 13-D. Our small investors may be other hedge funds—activist or otherwise—with smaller stakes or other types of institutional investors (e.g., event-driven funds) who may provide support to the lead activist via soft, "behind the scenes" engagement (McCahery, Sautner, and Starks, forthcoming). These institutions play a smaller, supporting role in the activism process, and we refer to them throughout as small institutions for short.

Our modeling choice of asymmetry amongst activists—a single leader who is significantly larger than her many followers as opposed to a handful of large, equally-sized, co-leaders—is motivated by applied relevance. First, joint interventions amongst multiple large players are rare. Between 1994 and 2011 there were over 2,500 activism events involving hedge funds in the US, but fewer than 10% involved two or more funds with stakes large enough to warrant a 13D filing. Even within this 10%, the median length of time across filings was over 150 days, which is far longer than the short-horizon pack formation described by commentators such as Briggs and Nathan. Second, we have direct evidence that activist hedge funds are supported by other, usually event-driven, institutional investors with much smaller stakes. For example, in conversation with us,

[1] Third Point LLC vs Ruprecht, 2014.

Thomas Kirchner of Quaker Funds, an event-driven fund that buys small stakes in target firms in the immediate aftermath of 13-D filings by activist hedge funds, described the process by which lead and supporting activists interact as follows: "Lead activists are very well aware that there may be followers with smaller stakes like Quaker that will support them in a campaign, yet it's formally uncoordinated. Investors understand the activist's playbook and how their interests are aligned." The lack of formal coordination arises from the legal constraints in the activism process: U.S. disclosure rules (Regulation 13D) require investors to file together as a group when their activities are formally coordinated. Accordingly, our model features no direct communication between players, but rather formalises the origins of implicit, endogenous coordination across stakeholders of different sizes.

Our model consists of two main components. The first is a static model of activism which focuses on the interplay of engagement strategies across the lead activist and small institutions. A key contribution of this component is to provide a theoretical foundation for complementarity across institutional investors in group activism: without some source of complementarity, group activism would be irrelevant. Further, our engagement model highlights the catalytic effect of a lead activist on the strategies of small institutions. The second component of our model provides a dynamic characterization of block building which anticipates the coordinated activism process, and traces how small institutions and the lead activist anticipate each others' actions in making their acquisition decisions.

We start our analysis with the activism stage, taking ownership stakes as given. At this stage, each owner must decide whether to "engage" the target, which we interpret to be exerting influence through talking with management or other (less active) institutional owners, proposing new actions, etc., to try to improve the firm's decisions, and hence its value. McCahery, Sautner, and Starks (forthcoming) document that formal and informal discussions with management and board members is the most commonly used engagement strategy amongst institutional investors. Activism is successful in raising firm value if the measure of ownership that chooses to engage is sufficient to deliver value enhancement given the target firm's fundamentals. Engagement is costly because it requires time and effort. For group activism to be salient, there must be complementarity between different owners, that is, the potential engagement of others must encourage each owner to engage. This requires the existence of some excludable benefit from participation in activism. If share price appreciation—a non-excludable benefit—is the sole source of benefits to activists, then engagement by others actually *discourages* engagement. This is because, if sufficiently many others engage, then engagement succeeds and price appreciation accrues to each owner regardless of engagement, a standard free-rider problem. While private benefits from successful activism (e.g., via board seats acquired during a proxy fight) are apparent for the lead activist, the existence of excludable rents is less obvious for small institutions.

We model such excludable benefits via a reputational mechanism: our small institutions are delegated portfolio managers who care about being viewed as skilled by their investors. Skilled institutions have valuable information-gathering abilities while unskilled institutions do not. Skilled institutions are therefore better able to predict the viability of an activist campaign. An institution's investors observe its engagement choices as well as the overall engagement outcome and make inferences about its ability. They believe that the information-gathering abilities of skilled institutions will result in higher future returns. As a result, a sufficient improvement in perceived ability leads to additional inflow of capital for the institution, which represents an excludable rent. Since reputation for skill is an equilibrium quantity, these rents are *endogenous*. We show that, in equilibrium, reputational rents arise *only* from participating in a *successful* activism campaign. The key reason is that institutions who discover themselves to be unskilled never choose to engage target management, and thus it is only possible to stand out from the crowd by engaging. Engagement, in turn, delivers reputational rewards only in the case in which activism succeeds.

Our model of activism also demonstrates that the presence of a lead activist can have a catalytic effect on engagement. We show that, holding the aggregate size of skilled institutional ownership constant, the presence of a large activist improves the level of coordination and leads to value-increasing engagement more often. An implication of this result is that, even when a significant number of shares are held by potential small activists, the arrival of a "lead" activist who holds a larger block may be a necessary catalyst for a successful campaign, which is consistent with the activist strategies that are well documented in the empirical literature. A related catalytic effect of a large player in a coordination game has been shown to arise in the context of speculative currency attacks by Corsetti, Dasgupta, Morris, and Shin (2004). In that paper, however, complementarity across strategies is exogenous, whereas in ours it arises endogenously.

Our model of engagement takes ownership stakes in the target firm as given. In the second component of our analysis, we develop a simple trading model that builds on our engagement model to characterize target share purchases by the lead activist and small institutions. Market observers highlight the dynamic nature of wolf pack formation, referring to a degree of unusual turnover around the declaration of a campaign by an activist hedge fund. For example, Nathan (2009) writes:

> The market's knowledge of the formation of a wolf pack (either through word of mouth or public announcement of a destabilization campaign by the lead wolf pack member) often leads to additional activist funds entering the fray against the target corporation, resulting in a rapid (and often outcome determinative) change in composition of the target's shareholder base seemingly overnight.

A recent study by Jetley and Ji (2015) shows that a substantial number of firms subject to 13D filings have more than 10% abnormal turnover between the day the filer crosses the 5% threshold and the day the 13D is filed, suggesting there could be some pre-filing information leakage that prompts wolf pack trading.[2] Using activism data from 1994 to 2011, focusing on the ten-day period following 13D filings, we find that for the largest tercile of firms—where activists are most likely to require the support of wolf packs—there is an additional average abnormal turnover of over 30% of the activist's typical stake, suggesting that non-trivial wolf pack trading continues after the public declaration of activism.

Our model generates endogenous turnover in target firm shares because we show that the initial owners of a target firm—before the market becomes aware that the target is amenable to activism—must be institutions who know themselves to be unskilled. Since (as described above) unskilled institutions are never willing to engage management in equilibrium, these initial owners cannot earn reputational rewards. There are thus gains from trade (even in the absence of any market frictions) between these initial owners and potential entrants in the form of institutions who are unsure of whether they are skilled, because the latter assign positive probability to the prospect of earning reputational rewards.

The formation of a wolf pack is therefore synonymous in our model with turnover in the ownership of the target firm. There is evidence that target firms managers themselves view abnormal turnover around 13D filings as evidence of wolf pack formation. In their study of how target managers defend against activist wolf packs, Boyson and Pichler (2016) find that a one standard deviation increase in abnormal turnover is associated with a 22% increase in the probability of the adoption of anti-coordination measures (e.g., introduction or strengthening of poison pills) by target firms.

In addition to microfounding endogenous turnover in wolf pack formation, our

[2]An interesting related issue concerns whether and when a lead activist might want to notify potential wolf pack members of their intentions. In our model this is not a significant issue given that we assume transparent markets. See Kovbasyuk and Pagano (2014) for a theoretical analysis of the optimal strategy for publicizing arbitrage opportunities.

model also makes a number of specific predictions about the timing of purchases by different types of activists. In particular, the disclosure of the acquisition of a position by the lead activist (in effect, a 13D filing) precipitates the immediate entry of a significant additional number of small institutions. While these institutions know about the potential for activism at the firm before the lead activist buys in, they refrain from committing to investigate the firm before they are sure that a lead activist will emerge because, in the absence of a lead activist, their information gathering efforts and capital may be better spent elsewhere. Others with less attractive outside opportunities may be willing to buy in earlier, as the real (but smaller) chance of successful engagement in the absence of a lead activist provides sufficient potential returns.[3] Thus, our model predicts that late entrants to activism will be those who have relatively higher opportunity costs. One potential way to interpret this is that more concentrated, smaller, and more "specialized" vehicles (such as other activist or event-driven funds) may be more inclined to acquire a stake only after the filing of a 13D by a lead activist. This is in keeping with Nathan's description above.

Modeling activism as a coordination game also sheds light on the importance of the wolf pack of small institutions whose actions ultimately support the lead activist. In particular, our analysis of the earlier stake acquisition process reveals an important effect of the availability of wolf pack members on the lead activist's willingness to buy a stake. In particular, the larger is the wolf pack the lead activist can expect to exist at the time of the campaign, the more likely it is that buying a stake will be profitable given the activist's opportunity cost of attention and capital.

Our model also makes relevant predictions about price dynamics in the course of wolf pack formation. First, we predict—in line with several papers in the empirical

[3]Technically, these early entrants are indifferent between entry before and after the lead activist's decision is known. However, including a possibility of small trading profits based on anticipation of the lead activist's purchase decision would break this indifference and bias small institutions toward earlier trading.

literature—that the filing of a 13D by a lead activist leads to a jump in the target price. The reason is that the presence of the large activist has a catalytic effect on activism: she not only adds to the activist base, but also energizes the rest of the institutional owners, leading to a discrete jump in the probability of successful engagement. Second, we predict that the returns experienced by target shareholders in the period following a 13D filing will be increasing in the size of the realized wolf pack. This prediction separates our story from purely informational stories in which some investors pile in by herding behind the lead activist: in such stories followers play no intrinsic role in value enhancement and thus generate no price impact, whereas our wolf pack members are key to the value enhancement process and thus move prices as they enter.

Our analysis is related to the past theoretical literature on the influence of blockholders in corporate governance. Papers in this literature tend to focus either on blockholders who, as in our model, exercise "voice" by directly intervening in the firm's activities (Shleifer and Vishny, 1986; Kyle and Vila, 1991; Burkart, Gromb, and Panunzi, 1997, Bolton and von Thadden, 1998; Maug, 1998; Kahn and Winton, 1998; Faure-Grimaud and Gromb, 2004), or those who use informed trading, also called "exit," to improve stock price efficiency and encourage correct actions by managers (Admati and Pfleiderer, 2009; Edmans, 2009). Dasgupta and Piacentino (2015) show that the ability to use exit as a governance mechanism is hindered when the blockholder is a flow-motivated fund manager. Flow motivations, modeled via reputation concerns, also a play a key role in our paper. In contrast to Dasgupta and Piacentino (2015), in our paper reputational concerns play a positive role in creating a basis for group activism. Piacentino (2013) also demonstrates a positive role of reputational concerns in corporate finance in the context of feedback effects of prices on investment decisions. Some other papers suggest that blockholders improve decisions by directly providing information to decision makers (see Cohn and Rajan, 2012; Edmans, 2011). Our paper is distinct from all of these in its focus on implicit coordination between different block investors in their value creating activity.[4]

Several existing papers discuss the implications of having multiple blockholders, but from very different perspectives. Zwiebel (1995) models the sharing of private control benefits as part of a coalitional bargaining game, and derives the equilibrium number and size of blockholders who try to optimally capture these benefits. Noe (2002) studies a model in which strategic traders may choose to monitor management, which improves value. In the model, monitoring activities by different investors are perfect substitutes (i.e., if any one investor monitors, the full improvement in value is achieved), and the strategic investors play mixed strategies, where they generally mix between monitoring and buying vs not monitoring and selling. Instead of studying coordination among these monitors, therefore, Noe focuses on showing that there can be multiple monitors despite the substitutability because of the financial market trading opportunities. Edmans and Manso (2011) model a group of equal-size block holders and ask whether their impact on corporate governance through both exit and voice is larger or smaller than if the same block were held by a single entity. Their main result is that while having a disaggregated stake makes voice less productive due to free rider problems, it helps make the exit channel more effective since the blockholders trade more aggressively when competing for trading profits. We take a very different perspective, asking how the activities of blockholders of different size affect their ability to implicitly coordinate around a target, and how it affects their initial decision to buy a block.

[4]Doidge, Dyck, Mahmudi, and Virani (2015) document explicit coordination among institutional investors in Canadian firms through an organization named the Canadian Coalition for Good Governance, and show that such coordinated action can have significant effects.

2 The Model

Consider a publicly traded firm which may become a target for shareholder activists, i.e., the firm may become "amenable" to activism in that value can be created by inducing a change in management's policies. Such a change can be induced only if activist investors own or acquire shares and successfully engage with management. There are four dates: $t = 0, 1, 2, 3$.

The firm has a continuum of shares outstanding of measure 1, of which a measure $\bar{A} \in (0, 1)$ represents the "free float". The remaining shares can be thought to be owned by insiders, say management or founders, who are committed to the current operating strategy and never sell. Shares in the free float of the firm can be traded at any time at fair prices that reflect expected cash flows.

The firm enters the model in a state of "non-amenability" wherein it is commonly understood that no improvements can be made to its current operating strategy. Firm value at the end of period $t = 3$ is P_ℓ in that state and there is no scope for profitable activism. At the beginning of $t = 0$ there may be a shift in the firm's state: there is a small probability p_A that a public signal will arrive indicating that the firm has become "amenable" to activism, in which case the current strategy is found to be suboptimal and there is scope for activism to improve value by changing strategy. If the firm shifts to the amenable state, then it is characterized by a stochastic fundamental η which measures the degree of difficulty in implementing changes in strategy. A natural source of such difficulty—which may vary across firms—is the willingness of the current management team to fight any proposed changes (e.g., by influencing the board, adopting poison pills, or piling pressure on institutional shareholders who have business ties with the firm). We therefore refer to η as *entrenchment* throughout the paper.

Activism takes the form of engaging management behind the scenes to modify corporate strategy and succeeds if and only if a sufficient number of shareholders engage, given η. McCahery, Sautner, and Starks (forthcoming) document that such behind the scenes dialogue with managers and directors is the preferred engagement strategy of a majority of institutional investors. We assume that engagement succeeds if the measure of shares that engage, e, is no smaller than η: if $e \geq \eta$, the firm's value at the end of $t = 3$ will rise to $P_h > P_\ell$. This "threshold" characterisation is meant to capture the idea that, for any given level of entrenchment, there is some level of pressure from shareholders that will induce target management to modify strategy, i.e., to "settle" with activists (instead of fighting them), perhaps because they become convinced that ultimate victory is unlikely enough should a formal proxy fight arise.[5] Bebchuk et al (2016) document that a large and increasing number of activist campaigns result in such settlements rather than in formal proxy fights. Since $e \in \left[0, \bar{A}\right]$, conditional on the amenable state, activism has some chance of being successful if and only if $\eta \leq \bar{A}$.

The firm fundamental η and our threshold characterisation can be more broadly interpreted. For example, η could measure the technological feasibility or complexity of making changes to the firm's strategy, while activist investors are those whose ideas are valuable in overcoming such technological challenges. Then, again, for a given technological hurdle, if sufficiently many valuable ideas are brought to the table, then the difficulties can be overcome.

To emphasize the difference between the ex ante certainty of the (stable) firm in the non-amenable state and the uncertainty introduced by the possibility of value enhancing activism, we model the public signal of amenability as being highly noisy (in terms of the conditional variance of firm value) by assuming that $\eta \sim N\left(\bar{A}, \frac{1}{\alpha_\eta}\right)$, where α_η is the precision of η, implying that conditional on the arrival of the amenability signal, there is a 50% chance that activism has some possibility of success.[6]

There are two types of investors in the model: a large pool of institutional investors

[5] Accordingly, η does not necessarily correspond to a particular voting threshold.

[6] Our qualitative results do not require that η has a mean of $\bar{A}$. This is further dicussed in section 6.2.

who can each devote only relatively little capital to the firm, and a large activist institution, L, who is able to devote comparatively larger amounts of capital. Note that while we model the institutional investors as a continuum, we think of them empirically as small blockholders owning a non-trivial amount of stock in the target firm. The continuum assumption is justified by the idea that they are dispersed enough to make explicit coordination difficult (or costly from a legal standpoint), and small enough not to have a unilaterally pivotal impact on the outcome of engagement. This is consistent with the characterizations of wolf packs discussed in the introduction.

The large activist, L, is available for activism with probability p_L, in which case she enters the model at $t = 1$ and considers whether to acquire a stake in the firm. L faces a capital constraint $A_L << \bar{A}$. Conditional on being available for activism, L has an opportunity cost of k_L (i.e., what she could earn by using her attention and capital elsewhere). If L is not available for activism, nothing happens at $t = 1$. The events at $t = 1$ are publicly observed.

Institutional investors all have the potential to be small activists, and exist ex ante in two pools: a large pool of unskilled institutions (who know they are unskilled), and a pool of measure 1 of *potentially* skilled institutions. More concretely, all institutional investors are one of two types: $\theta \in \{G, B\}$. Type G institutions who acquire a position in the firm observe η with small amounts of idiosyncratic noise at the beginning of $t = 3$. The noise in observing entrenchment can be thought to be the result of (potentially imperfect) due diligence (research) carried out by each institution into the target firm. Each type G institution i receives a private signal $x_{s,i} = \eta + \frac{1}{\alpha_s}\epsilon_i$ where ϵ_i is standard normal, independent of η, and iid across institutions. The parameter α_s measures the precision of the signal. Type G institutions also have the potential to find profitable outside investment opportunities if they (instead) invest their capital and information gathering effort on something other than the target firm. The expected value of these outside opportunities is Δk_i, where $k_i \in \left[\underline{k}, \overline{k}\right]$ is uniformly distributed across the population of type G institutions (and each potentially skilled institution knows their k_i), and $\Delta \in \{1-\delta, 1+\delta\}$ represents an aggregate shock to outside opportunities, where $\delta \in [0,1)$.[7] The realization of Δ, which equals $(1+\delta)$ with probability p_Δ, is publicly revealed at $t = 2$. The opportunity cost is sunk immediately upon the purchase of target shares by an institution. Type B (bad) institutions cannot find useful signals about fundamentals, and have no profitable outside opportunities. The large pool of unskilled institutions know that they are type B ex ante. The pool of potentially skilled institutions do not know their type, but are known to have probability γ of being type G.[8]

Small institutions are aware that there is a date $t = 1$ when L may enter and seek to establish a position in the firm. They may, in turn, trade shares in the firm, either before they know whether L will be available for activism but after observing that the firm is amenable to activism, i.e. at $t = 0$, or after they know whether L is available for activism and whether she has established a position in the firm, i.e., at $t = 2$. Each institution may only acquire shares once, but those institutions who do not acquire shares at $t = 0$ have the option of acquiring shares at $t = 2$.

At $t = 3$, each outside owner of shares, whether small or large, has the option of engaging ($a_s = E$ or $a_L = E$) or not engaging ($a_s = N$ or $a_L = N$) firm management in order to induce value enhancing changes in the firm. Not engaging is a costless action for both large and small owners.

Small institutions can potentially enjoy private benefits from acquiring a reputation for being type G. If they own a stake at time $t = 3$ then their own investors will update their beliefs about the institution's type to some posterior $\widehat{\gamma}$ after they observe the outcome of the activism game and the institution's individual action (engage or

[7] Aggregate uncertainty in outside opportunities allows us to provide empirically relevant predictions on the relationship between wolf pack size and price dynamics, as discussed in section 5.2.

[8] For parsimony we do not consider investors who already know they are type G. Including a mass of such agents would not affect the model's qualitative results.

not). If the posterior is sufficiently higher than the prior, that is, $\hat{\gamma} \geq B$ for some $B \in (\gamma, 1)$, the institution gets private benefit R from participating in the game. Otherwise, the institution gets zero private benefits from participating in the game. The reputational benefit R could arise, for example, from fees on additional funds invested in the institution by existing investors, who believe that skilled institutions' information gathering abilities will translate into higher returns in the future.[9] See Dasgupta and Prat (2008) for a micro-foundation of such a benefit. In addition to these private benefits, the institution receives a payoff of P_h if engagement is successful—capturing a free rider benefit in case they did not themselves engage—and a payoff of P_ℓ otherwise.

Choosing to engage the target costs c_s. There are at least two natural interpretations for this. The first—which we use in the baseline model—is that c_s represents the effort cost for formulating and articulating arguments for changes in target strategy, or—in the case of a campaign led by a large activist—the effort cost for conducting research to support the effort of the lead activist and of credibly communicating support for the campaign to target management. An alternative interpretation—which we discuss in Section 6.1—is that c_s captures portfolio diversification costs associated with holding a concentrated position in the target firm over the course of the activism stage, which in real life could take many months.

If the large activist does not engage she receives a payoff of $A_L P_h$ if any engagement by others is successful, and a payoff of $A_L P_\ell$ otherwise. Engagement entails a private effort cost of c_L. This may represent effort spent on pressuring management via discussion, visible publicity campaigns, and proxy proposal formulation and sponsorship. If the large activist engages she receives an additional payoff of β_L if the engagement is successful, where $\beta_L > c_L$ represents the excludable benefits earned from successful

[9] Given this interpretation of the reputation benefit, the requirement for a non-trivial update can be viewed as the result of some small transaction cost for investing additional capital in a given institution. Note that B can be arbitrarily close to γ.

engagement. For example, if an activist campaign succeeds in appointing new board members, these board members are more likely to be friendly to the lead activist who installed them. In many cases, activist hedge funds managers appoint themselves to corporate boards as part of a successful campaign. This can then also endow them with soft information that leads to valuable trading strategies or other private benefits.[10] The large activist observes η perfectly at the beginning of $t = 3$, reflecting the fact that she specializes in activist strategies and enjoys an information advantage relative to smaller institutions.

We now solve the game by backward induction. We first take as given the ownership structure of the firm, and solve for the activism game at $t = 3$. Subsequently, we solve for the endogenous stake purchase and sale decisions of each type of owner. Before doing so, we outline two natural parameter restrictions:

Assumption 1.

a. $R \in (c_s, 2c_s)$

b. $(1+\delta)\,\underline{k} < \frac{R-c_s}{2} < (1-\delta)\,\overline{k}$.

Assumption 1(a) ensures that the potential reputational rents are commensurate to the effort required for activism. Assumption 1(b) ensures that small institutions with the lowest opportunity costs prefer to buy into the target firm, while those with the highest opportunity costs prefer not to do so. These parameter restrictions are further discussed in Section 6.2.

[10]While β_L can also be interpreted, similar to the above, as reputational benefits that accrue to a large activist hedge fund manager from leading a successful activist campaign, we do not explicitly model a reputation mechanism for the large activist since there are likely many sources of private benefits for a successful lead activist.

Our model requires no restriction on the relative values of β_L and R and of c_L and c_s. However, we believe that a natural interpretation is that β_L and c_L are larger than R and c_s respectively. This is because leading an activist campaign is likely to be both more costly and more rewarding than simply participating in one.

3 Activism

In this section we analyze the engagement game. We focus throughout on the interesting case in which the target firm is in the amenable state (i.e., a public signal of amenability arrived at $t = 0$). When analysing engagement, we take the ownership structure of the firm as given. However, we begin with a simple preliminary characterisation of initial ownership of the firm. Given the set of agents in our model, the ownership of the free float of the target firm when it enters the model can, in principle, be made out of potentially skilled institutions or institutions that know themselves to be unskilled. We first show:

Lemma 1. *As long as $p_A < \frac{2(1-\delta)k}{R-c_s}$, the initial owners of the free float $\bar{A}$ are institutions that know themselves to be unskilled.*

All proofs are in the appendix. Intuitively, since potentially skilled institutions have expected opportunity costs, they will buy into the target firm if and only if their potential payoffs from doing so exceed these opportunity costs. If amenability is rare (p_A is small), it will not be in the interest of potentially skilled institutions to buy before amenability is known. As a result, the initial free-float of the target must be held by institutions that know themselves to be unskilled. The condition $p_A < \frac{2(1-\delta)k}{R-c_s}$ is sufficient to guarantee that the upper bound on payoffs from ownership prior to learning amenability for potentially skilled institutions is smaller than the lower bound on their opportunity costs. This assumption is not essential for our qualitative analysis, but for ease of exposition we maintain this upper bound on p_A throughout the paper.[11]

In characterising the engagement game, for technical reasons we assume that a small measure λ of the bad types who were ex ante potentially skilled non-strategically randomise in the coordination game, engaging with probability 1/2. In the sequel to

[11]If p_A is larger than this bound, it is feasible for some potentially skilled institutions to be initial owners of the target free float. This would simply reduce the quantitative size of the turnover characterised in Section 4 without changing the qualitative properties of our analysis.

Proposition 1 we let $\lambda \to 0$. The introduction of these randomising types ensures that an unskilled type can never gain reputation by taking the *wrong* action (i.e., engaging when engagement fails).[12]

Let A_s denote the measure of potentially skilled institutions who purchased shares at $t = 0$ or $t = 2$. Apart from the large activist, if present, there are then four groups of owners of the firm at $t = 3$: (i) Skilled institutions ($\theta = G$) in measure $A_s\gamma$, (ii) unskilled ($\theta = B$) strategic institutions in measure $A_s(1-\gamma)(1-\lambda)$, (iii) unskilled randomizing institutions in measure $A_s(1-\gamma)\lambda$, and (iv) initial owners that have not yet had an opportunity to sell, in measure $\bar{A} - A_s$. By Lemma 1, these initial owners are institutions who know themselves to be unskilled. Since agents in groups (ii) and (iv) are therefore identical (none of them receive signals), we refer to them jointly as "unskilled institutions".

We look for equilibria in monotone strategies—each skilled institution i engages if and only if his private signal $x_{s,i}$ is weakly below some threshold—and allow for arbitrary symmetric strategies for unskilled institutions.

Proposition 1. *For* $\lambda < \min\left[\frac{2\gamma(1-B)}{(1-\gamma)B}, \frac{2(B-\gamma)}{(1-\gamma)B}\right]$*, there exists a* $\underline{\alpha}(\lambda) \in \mathbb{R}_+$ *such that for all* $\alpha_s \geq \underline{\alpha}(\lambda)$ *in equilibrium:*
(i) unskilled small institutions never engage
(ii) skilled small institutions engage iff their signal is below a unique threshold x_s^**,*
(iii) engagement succeeds iff the target fundamental is below a unique threshold η_s^* *and*
(iv) the large activist, if present, engages if and only if $\eta \leq \eta_s^*$*.*

[12] When skilled players have noise in their signals of η, with some probability they will make a mistake and engage when engagement fails. If in a proposed equilibrium all unskilled types are supposed to *not* engage, then choosing to engage can result in the inference that you are a good type even when you took the wrong action, i.e., that you are a skilled type who happened to get an incorrect signal. Adding a small amount of randomization that is commensurate with the amount of noise in the signals eliminates this unrealistic possibility.

In the limit as $\alpha_s \to \infty$, the thresholds are given by:

$$x_s^* = \eta_s^* = \mathbf{1}_L A_L + \gamma A_s \left(1 - \frac{c_s}{R}\right) + \frac{1}{2} A_s (1-\gamma)\lambda.$$

We provide intuition for the result in the limiting case in which $\alpha_s \to \infty$. We first note that whenever skilled institutions employ monotone strategies with threshold x_s^*, there exists a critical threshold level of η, which we label η_s^*, such that engagement succeeds if and only if $\eta \leq \eta_s^*$. Further, it is easy to check that as $\alpha_s \to \infty$, $x_s \to \eta$ and $x_s^* \to \eta_s^*$. In other words, in threshold equilibria, skilled institutions always make correct choices in the limit as noise vanishes. This means that unskilled institutions can never earn reputational rents by engaging when engagement fails or not engaging when it succeeds.

Now consider the possibility that unskilled institutions always engage in equilibrium. Then, when engagement succeeds, the only non-engaging owners are the randomising unskilled institutions. When λ is small enough, almost all institutions, whether skilled or unskilled, choose to engage. Thus, the posterior update to reputation from engaging in the case engagement succeeds is very small, and not enough to generate reputational rents R. Yet, since skilled institutions never engage when engagement fails as $\alpha_s \to \infty$, there are also no reputational rents arising from engagement in case of failure. In effect, there are no reputational rents to be earned from engaging. Given that security benefits are non-exclusive, and do not require engagement, this implies that no unskilled institution would wish to pay the positive cost of engaging. Thus, it cannot be an equilibrium for unskilled institutions to always engage in equilibrium.

Next, consider the possibility that unskilled institutions never engage in equilibrium. Then, by a similar argument to the previous case, there are no reputational rents to non-engagement as $\alpha_s \to \infty$ and for small enough λ. Engaging however, does deliver reputational rewards in case of success, because all skilled institutions engage in this case if $\alpha_s \to \infty$, whereas, for small λ, essentially no unskilled institution does. Thus, unskilled institutions would wish to deviate and engage if the expected reputational

Excludable payoffs	Engagement succeeds	Engagement fails
Engage	$R - c_s$	$-c_s$
Not Engage	0	0

Table 1: Excludable payoffs for skilled institutions

benefit from engagement exceeds its cost. Viewed from the perspective of uninformed unskilled institutions, the expected benefit is never larger than $\Pr\left(\eta \leq \bar{A}\right) R = R/2$, however, whereas the cost is c_s. Thus, since $R < 2c_s$, the deviation is unattractive, and it is indeed an equilibrium for unskilled instutions to never engage. The key intuition is that for those institutions who decided to gamble on establishing a reputation for being skilled (i.e., those whose expected opportunity costs were not too high), but subsequently discovered themselves to be unskilled, the best bet is to sit tight and not expend any resources on trying to "pretend" to be skilled. An important economic implication of this is that reputational rents can be achieved only by participating in a successful activism campaign. There are never rents for remaining inactive, even when activism fails. The proof in the appendix also shows that no mixed equilibria can arise.

We now turn to the skilled institutions. As a first step, we consider the case where the large activist is absent, or—equivalently—where $A_L = 0$. The choice whether to engage or not is only affected by the reputational payoffs associated with these choices. As explained above, since unskilled institutions never engage in equilibrium, skilled institutions can only earn reputational rewards by engaging when engagement succeeds. As a result, their repuational rents can be summarised as in Table 1.

The payoffs in Table 1 take the form of a standard binary action coordination game. If it were common knowledge that $\eta \in (0, \gamma A_s)$, so that the engagement of the available skilled institutions could overcome entrenchment, then—given these payoffs—there would be multiple equilibria, one in which *all* skilled institutions engage, and one in which *none* do. However, with incomplete information about η as in our game, the equilibrium behavior of skilled institutions is uniquely pinned down. To understand why this is the case, it is important to recognize that the payoffs of any given skilled institution are determined jointly by the exogenous fundamental, η, and the endogenous measure of other skilled institutions who engage, which we label e_s. In other words, both uncertainty about firm fundamentals and uncertainty about the actions of other skilled institutions, i.e., *strategic uncertainty*, is relevant to each institution. When η is common knowledge, there is neither uncertainty about firm fundamentals nor strategic uncertainty. In the $\alpha_s \to \infty$ limit, uncertainty about firm fundamentals vanishes. However, strategic uncertainty does *not* vanish. As $\alpha_s \to \infty$, each skilled institution remains highly uncertain about his *relative* ranking in the population of skilled institutions. In particular, each skilled institution has *uniform* beliefs over the *proportion* of skilled institutions who have received signals about η which are lower than his own. The presence of such strategic uncertainty limits the precision with which skilled agents can coordinate with each other and eliminates multiplicity. This insight derives from the literature on global games (Carlsson and van Damme 1993, Morris and Shin 1998). In the global games literature, however, complementarities across players' strategies is taken as given. In our model, complementarities arise *endogenously* via the reputational concerns of small institutions: the payoffs for skilled institutions in Table 1 arise as a result of the equilibrium behavior of unskilled institutions.

Using the characterization of strategic uncertainty in the $\alpha_s \to \infty$ limit delivers a heuristic method for computing the threshold η_s^*, as follows. The skilled institution with signal x_s^* must be indifferent between engaging and not engaging. Further, all skilled institutions with signals lower than his will wish to engage. Thus, the proportion of skilled institutions with signals lower than his is simply e_s. In the limit as $\alpha_s \to \infty$, the skilled institution with signal x_s^* believes that $e_s \sim U(0,1)$. Consider the case where the large activist is absent and $\lambda \to 0$, so that there are now no randomising unskilled institutions. Then, since unskilled institutions do not engage, this skilled institution's evaluation of the probability of successful engagement is simply $\Pr(\gamma A_s e_s \geq \eta_s^*)$. Since $e_s \sim U(0,1)$ this can be rewritten as $1 - \frac{\eta_s^*}{\gamma A_s}$, giving rise to the indifference condition:

$$R\left(1 - \frac{\eta_s^*}{\gamma A_s}\right) = c_s,$$

which immediately implies that $\eta_s^* = \gamma A_s\left(1 - \frac{c_s}{R}\right)$, which is exactly the value of η_s^* in Proposition 1 for $\mathbf{1}_L = \lambda = 0$.

Finally, we turn to the large activist. While the strategy of the large activist is trivial, since she knows η, the effect of her presence on smaller skilled institutions is not. Does the presence of a large activist have a tangible effect on the probability of successful engagement over and above the impact arising from the presence of dispersed skilled institutions? In order to isolate the potential effect cleanly we must control for total holdings by those owners who may engage—the large activist and the potentially skilled institutions—which we refer to as the "activist base". In other words, we must consider the change in the efficacy of activism when, for a given activist base, we replace the large activist by an equal measure of dispersed potentially skilled institutions.

In our dynamic model, the share acquisition decisions of small institutions at $t = 0$ anticipate the potential arrival of the large activist which—if it occurs—may potentially spur further share acquisitions by other dispersed institutions. Thus, fixing an initial set of parameters, it is never the case in equilibrium that the total size of the activist base is identical with and without the presence of the large activist. Nevertheless, our model provides the basis for carrying out a comparative statics exercise which pinpoints the impact of the large activist. We compare the efficacy of activism under two potential ownership structures. Under the first ownership structure there are only small institutions in a total measure A^T (i.e., $A_s = A^T$). Under the second ownership structure a measure A_L of the small institutions are replaced by the single large activist L, so that $A_s + A_L = A^T$. For simplicity, let $\lambda \to 0$. By using Proposition 1, we can compare the fundamental levels below which activism succeeds under the two ownership structures:

Corollary 1. *There exists a range of fundamentals of measure* $A_L\left[1-\gamma\left(1-\frac{c_s}{R}\right)\right]$ *for which engagement is successful in a target firm if and only if a large activist is present.*

The result follows from comparing η_s^* (for $A_s = A^T$) and η_L^* (for $A_s = A^T - A_L$):

$$\eta_L^* - \eta_s^* = A_L + \gamma\left(A^T - A_L\right)\left(1-\frac{c_s}{R}\right) - \gamma A^T\left(1-\frac{c_s}{R}\right) = A_L\left[1-\gamma\left(1-\frac{c_s}{R}\right)\right] > 0.$$

In words, fixing the size of the activist base, if a measure of dispersed potentially skilled institutions is replaced by a single large activist, activism becomes more effective. To appreciate the forces behind this result, let us compare the engagement threshold of the skilled institutions. Under the ownership structure with only small institutions, this engagement threshold is $\gamma A^T\left(1-\frac{c_s}{R}\right)$, i.e., skilled institutions engage only when they (correctly) believe $\eta < \gamma A^T\left(1-\frac{c_s}{R}\right)$. Under the alternative ownership structure where a measure A_L of potentially skilled institutions are replaced by a single large activist, the engagement threshold *rises* to $A_L + \gamma\left(A^T - A_L\right)\left(1-\frac{c_s}{R}\right)$. In other words, the presence of a large activist in their midst makes skilled institutions more aggressive in their engagement strategy, and more so the larger is the lead activist's stake, A_L. That is, the presence of a large activist has a catalytic effect on smaller skilled institutions.[13] Intuitively, replacing a measure A_L of small institutions with a single lead activist has two effects. First, the lead activist unilaterally controls the engagement strategy of A_L shares and therefore eliminates any coordination problems within that block of shares. Second, since the lead activist is well-informed, small institutions know that she will engage whenever engagement succeeds. The combination of these two factors makes small institutions more aggressive in their own engagement strategies.

[13] Here we have assumed that part of the pool of *potentially* skilled institutions is replaced by the large activist. Qualitatively similar results are obtained if we assume part of the pool of *ex post* skilled institutions is replaced by the large activist.

4 Trading Dynamics

We now turn to trading dynamics prior to the activism game. Throughout we focus on the limiting equilibrium from above where $\alpha_s \to \infty$ and $\lambda \to 0$. We model trading at all dates as a reduced form transparent market, where all participants share common information about the game and identity of all traders, and shares change hands at their expected non-excludable value. For example, this could be modeled as a Kyle (1985) type market with a risk neutral market maker and no noise trade.

Despite the transparency of our market and the absence of noise, trade arises endogenously, as a consequence of two results proved above. First, as we show in Lemma 1, the free float of $\bar{A}$ is initially owned by institutions who know themselves to be unskilled. Second, given the results in Proposition 1, these unskilled institutions know that they will never choose to engage the target, and can thus realize only the non-excludable value of the shares. In contrast, potentially skilled institutions, upon learning that the target firm is amenable to activism, will attach positive probability to earning repuational rents if they own shares in the firm. As a result, the valuation of such potential buyers for target shares will be strictly higher than those of the initial owners, giving rise to trade.

4.1 Following the Lead Activist

We proceed backward, beginning with potential trading among institutional investors at $t = 2$, after it is known whether the large activist has entered or not. In particular, potentially skilled institutions who did not acquire a position in the firm at $t = 0$ have the option of doing so at $t = 2$. The strategy of these institutions at $t = 2$ is conditioned on the actions of the large activist, who chooses at $t = 1$, and on the realized aggregate shock to their outside opportunities Δ. Institutions do not yet know their type and, as a result, their realized opportunity cost. Since the incentive to acquire is decreasing in the $t = 2$ expectation of such opportunity costs, $\Delta\gamma k_i$, we focus on strategies in which small institutions acquire if and only if $\Delta\gamma k_i$ is below some threshold value, i.e., monotone strategies (as in the activism game). Accordingly, we characterize two thresholds: $K_2^*(A_L, \Delta)$ and $K_2^*(0, \Delta)$, representing the cases where the large activist holds a position in the firm and where she does not, respectively, and the thresholds clearly depend on the realization of Δ.

What about the potentially skilled institutions who acquired shares at $t = 0$, before knowing whether L would enter or not, and before knowing the realization of Δ? As will become clear later, an institution will buy shares at $t = 0$ only if his worst case expected opportunity cost, $(1+\delta)\gamma k_i$, is below the minimum $t = 2$ purchase threshold. Thus, using the same reasoning as above, denote the threshold for purchase at $t = 0$ by K_0^*. We guess (and later verify) that $K_0^* \leq \min\{K_2^*(A_L, \Delta), K_2^*(0, \Delta)\}$, i.e., it is only institutions with strictly lower worst case opportunity costs who will choose to acquire positions before they know Δ and whether L enters or not. Further, we assume that if any institution is indifferent between entry at $t = 0$ and $t = 2$, they enter at $t = 0$. For example, this could be because there are small trading profits available if these institutions trade prior to the 13D announcement because they are better able than unskilled institutions to predict the availability of the lead activist. For parsimony, we do not model this asymmetric information trading game, but we believe it would not significantly alter the model's qualitative results.

From Lemma 1, we know that institutions who acquire a position in the firm at any date t purchase their shares from unskilled institutions. Since the unskilled institutions are rational, share the same information at the point of acquisition (recall that the skilled institutions' private signals are only received at the beginning of $t = 3$), and are only willing to trade at fair value, the sole source of gains for potentially skilled institutions arises from their net private reputational rents $(R - c_s)$ from successful activism. In other words, any potentially skilled institutions who choose to purchase shares and participate in the activism game do so solely to determine and advertise their type in an attempt to gain reputation. In turn, since the activism game at $t = 3$ is played with vanishing noise, institutions who turn out to be skilled engage only when engagement is successful. Thus, a potentially skilled institution can expect to receive $R - c_s$ in the event that they turn out to be skilled and engagement is successful, and nothing other than the fair non-excludable value of their shares otherwise. Engagement succeeds whenever the level of entrenchment is below the relevant threshold, which in turn depends on the size of the activist base.

In case L is present, under our maintained hypothesis that $K_0^* \leq \min\left\{K_2^*\left(A_L, \Delta\right), K_2^*\left(0, \Delta\right)\right\}$, the mass of potentially skilled small institutions is given by

$$A_s = \Pr\left(\Delta\gamma k_i \leq K_2^*\left(A_L, \Delta\right)\right) = \frac{\frac{K_2^*(A_L,\Delta)}{\Delta\gamma} - \underline{k}}{\overline{k} - \underline{k}}$$

Proposition 1 implies that the entrenchment threshold in the activism game is then $A_L + \gamma \frac{\frac{K_2^*(A_L,\Delta)}{\Delta\gamma} - \underline{k}}{\overline{k}-\underline{k}}\left(1 - \frac{c_s}{R}\right)$, so that the expected payoff from share acquisition for any given potentially skilled institution is:

$$\gamma \Pr\left(\eta \leq A_L + \gamma \frac{\frac{K_2^*(A_L,\Delta)}{\Delta\gamma} - \underline{k}}{\overline{k} - \underline{k}}\left(1 - \frac{c_s}{R}\right)\right)(R - c_s)$$

while his opportunity cost is $\Delta\gamma k_s^i$. For consistency with the monotone strategy with threshold $K_2^*\left(A_L, \Delta\right)$, the potentially skilled institution with opportunity cost $K_2^*\left(A_L, \Delta\right)$ must be exactly indifferent, i.e., $K_2^*\left(A_L, \Delta\right)$ is implicitly determined by

$$\gamma \Pr\left(\eta \leq A_L + \gamma \frac{\frac{K_2^*(A_L,\Delta)}{\Delta\gamma} - \underline{k}}{\overline{k} - \underline{k}}\left(1 - \frac{c_s}{R}\right)\right)(R - c_s) = K_2^*\left(A_L, \Delta\right). \qquad (1)$$

It is easy to see that as long as there is sufficient volatility in entrenchment levels, there exists a unique such threshold $K_2^*\left(A_L, \Delta\right)$:

Lemma 2. *There exists a $\overline{\alpha}_\eta \in \mathbb{R}_+$ such that if $\alpha_\eta \leq \overline{\alpha}_\eta$ there is a unique solution to (1).*

The intuition for uniqueness is as follows: Both sides of the equation implicitly defining $K_2^*\left(A_L, \Delta\right)$ are increasing in $K_2^*\left(A_L, \Delta\right)$. Under these circumstances, a sufficient condition for uniqueness is that rates of change with respect to $K_2^*\left(A_L, \Delta\right)$ are strictly ranked. The left hand side is a scaled probability in η. As long as the density function of η is sufficiently spread out, the left hand side will always increase slower than the right hand side (the 45 degree line), giving rise to uniqueness. The economic interpretation of this condition is that sufficient variation in potential entrenchment levels prevents small changes in the mass of activists from having too much influence on success probabilities.

Sufficient variation in entrenchment levels is sufficient but not necessary for our qualitative results. We believe this is an economically reasonable assumption, as it implies that there is sufficient uncertainty over how large a wolf pack is needed. In situations where this uncertainty is low, we might expect to see a different type of activism in equilibrium. For example, a lead activist could be more willing to invest more capital herself and obviate the need for a wolf pack if she is more certain about exactly how large a stake will do the job. Thus, the more uncertain situations are likely those where wolf packs are most salient.

In case L is absent, as long as $K_0^* \leq \min\{K_2^*(A_L,\Delta), K_2^*(0,\Delta)\}$, the mass of activists is given by $\frac{\frac{K_2^*(0,\Delta)}{\Delta\gamma}-\underline{k}}{\overline{k}-\underline{k}}$. Given this mass of activists, Proposition 1 implies that the entrenchment threshold in the activism game is $\gamma\frac{\frac{K_2^*(0,\Delta)}{\Delta\gamma}-\underline{k}}{\overline{k}-\underline{k}}\left(1-\frac{c_s}{R}\right)$, so that $K_2^*(0,\Delta)$ is implicitly defined by:

$$\gamma \Pr\left(\eta \leq \gamma\frac{\frac{K_2^*(0,\Delta)}{\Delta\gamma}-\underline{k}}{\overline{k}-\underline{k}}\left(1-\frac{c_s}{R}\right)\right)(R-c_s) = K_2^*(0,\Delta). \tag{2}$$

The sufficient condition for the uniqueness of $K_2^*(0,\Delta)$ is similar to that for $K_2^*(A_L,\Delta)$. Thus, we state without proof:

Lemma 3. *There exists a $\widehat{\alpha}_\eta \in \mathbb{R}_+$ such that if $\alpha_\eta \leq \widehat{\alpha}_\eta$ there is a unique solution to (2).*

From this point onward, we assume that $\alpha_\eta \leq min\left(\overline{\alpha}_\eta, \widehat{\alpha}_\eta\right)$. Given Lemmas 2 and 3, we can now compare the thresholds $K_2^*(A_L,\Delta)$ and $K_2^*(0,\Delta)$ to determine the effect of the entry of the large activist on subsequent entry by potentially skilled institutions. We show:

Proposition 2. $K_2^*(A_L, \Delta) > K_2^*(0, \Delta)$ *for all* Δ.

The intuition for this result can be understood as follows. The reason potentially skilled institutions may acquire shares in the firm even though they trade with rational traders who charge the full expected continuation value is due to their expected future net reputational benefits from successful coordinated engagement. Such benefits must be offset against their opportunity costs, $\Delta\gamma k_s^i$, giving rise to a threshold level of opportunity costs below which share acquisition occurs and above which it does not. Anything that increases expected reputational benefits, increases incentives to acquire blocks and moves the opportunity cost threshold upwards.

Consider the potentially skilled institution with opportunity cost $K_2^*(0, \Delta)$. This institution is exactly indifferent between acquiring a share and not acquiring a share if the large activist does *not* participate, in which case—by monotonicity—exactly $\frac{\frac{K_2^*(0,\Delta)}{\Delta\gamma} - \underline{k}}{\overline{k} - \underline{k}}$ institutions will participate, giving rise to a expected net benefit from share acquisition of

$$\gamma \Pr\left(\eta \leq \gamma \frac{\frac{K_2^*(0,\Delta)}{\Delta\gamma} - \underline{k}}{\overline{k} - \underline{k}} \left(1 - \frac{c_s}{R}\right)\right)(R - c_s).$$

However, imagine now that the large activist *does* participate. *Even if skilled institutions did not change their behavior*, the probability of successful engagement would rise to $\Pr\left(\eta \leq A_L + \gamma \frac{\frac{K_2^*(0,\Delta)}{\Delta\gamma} - \underline{k}}{\overline{k} - \underline{k}} \left(1 - \frac{c_s}{R}\right)\right)$, and thus the institution with opportunity cost $K_2^*(0, \Delta)$ would no longer be exactly indifferent between acquiring a share or not: He would strictly prefer to acquire shares. By continuity, this means that some institutions with strictly higher opportunity costs would strictly prefer to participate. In other words, the threshold level of opportunity cost would increase since the value of gathering information about the target has increased.

The implication of this result is that the entry of a large activist spurs additional entry by potentially skilled institutions, that is, a wolf pack expands, given the presence of a leader.

4.2 The Lead Activist

Given our earlier analysis, we know that if L enters, the size of the activist base will increase to $A_L + \frac{\frac{K_2^*(A_L,\Delta)}{\Delta\gamma} - \underline{k}}{\overline{k} - \underline{k}}$, giving rise to an expected payoff for entry of:

$$(1 - p_\Delta) \left[A_L \Pr \left(\eta \leq A_L + \gamma \frac{\frac{K_2^*(A_L,1-\delta)}{(1-\delta)\gamma} - \underline{k}}{\overline{k} - \underline{k}} \left(1 - \frac{c_s}{R} \right) \right) (\beta_L - c_L) \right]$$
$$+ p_\Delta \left[A_L \Pr \left(\eta \leq A_L + \gamma \frac{\frac{K_2^*(A_L,1+\delta)}{(1+\delta)\gamma} - \underline{k}}{\overline{k} - \underline{k}} \left(1 - \frac{c_s}{R} \right) \right) (\beta_L - c_L) \right] \qquad (3)$$

which will be compared to L's opportunity cost k_L. We show

Proposition 3. *For a given* $(A_L, k_L, \beta_L, c_L, R, c_s, \gamma)$ *the large activist enters only if* $\overline{k}$ *and* $\underline{k}$ *are small enough.*

The smaller are $\overline{k}$ and $\underline{k}$, the larger is the expected size of the wolf pack of skilled institutions, because (i) fixing $\underline{k}$, reducing $\overline{k}$ reduces the mass of potentially skilled institutions with high opportunity costs who would not wish to buy in, while (ii) fixing $\overline{k}$, reducing $\underline{k}$ increases the mass of potentially skilled institutions with low opportunity costs who are mostly likely to buy in. Accordingly, the result shows that the large activist will enter only if the anticipated skilled institutional ownership is large enough.

4.3 Anticipating the Lead Activist

At $t = 0$ institutions have the option of buying into the firm before they know whether L will enter, or to wait until uncertainty over both L's presence and Δ is resolved. Note that since there is a $1 - p_L$ probability that L is unavailable for activism, there is always ex ante uncertainty with regard to L's presence. The behavior of potentially skilled institutions is characterized by a threshold: institutions with worst case opportunity costs, $(1+\delta)\gamma k_i$, below K_0^* will enter early (by our tie-breaking assumption) and those with higher opportunity costs will wait until $t = 2$. Note that, since it is costless to wait and verify whether L is present (because the transaction price for share acquisition is always fair and the reputational benefits are received after $t = 3$) and to learn Δ, a potentially skilled institution can only wish to buy a share at $t = 0$ if his k_i is low enough that he would prefer to own regardless of whether L enters or not, and in the worst case cost scenario where $\Delta = (1 + \delta)$. In other words, K_0^* is defined by:

$$\gamma \Pr \left(\eta \leq \gamma \frac{\frac{K_2^*(0,1+\delta)}{(1+\delta)\gamma} - \underline{k}}{\overline{k} - \underline{k}} \left(1 - \frac{c_s}{R}\right) \right) (R - c_s) = K_0^*,$$

which has a unique solution if $\alpha_\eta \leq \widehat{\alpha}_\eta$. But notice that this condition is identical to (2) when we set $\Delta = (1 + \delta)$, and thus $K_0^* = K_2^* (0, (1 + \delta))$. Now note that $K_2^* (0, (1 + \delta)) < K_2^* (0, (1 - \delta))$ is immediate, and from Proposition (2) we know that $K_2^* (0, \Delta) < K_2^* (A_L, \Delta)$. Thus, we have $K_0^* \leq \min \{K_2^* (A_L, \Delta), K_2^* (0, \Delta)\}$ as conjectured above.

5 Wolf Pack Formation

In this section, we summarize the empirical implications of our model for the dynamics of wolf pack formation. Our predictions can be classified into implications for ownership dynamics and price dynamics.

5.1 Ownership dynamics

In the unique equilibrium of our model:

- Some small institutions (those with low worst case opportunity costs) acquire positions in the target firm at $t = 0$ in potential anticipation of the large activist's arrival.

- If the large activist is available for activism at $t = 1$, she acquires a stake in the firm if and only if she predicts that there will be a sufficiently large activist base given her opportunity cost (i.e., if she believes that the total expected mass of small institutions at $t = 3$ is large enough).
- Conditional on the large activist's entry at $t = 1$ there will be additional entry by small institutions with higher opportunity costs.

Imagine that the entry of the large activist is synonymous with the filing of a 13D. Then, combining these dynamic implications delivers several empirical implications:

Remark 1. Firms in which 13Ds are filed will have substantially higher activist presence (measure $A_L + \frac{\frac{K_2^*(A_L,\Delta)}{\Delta\gamma} - \underline{k}}{\overline{k} - \underline{k}}$) than firms in which they are not ($\frac{\frac{K_2^*(0,\Delta)}{\Delta\gamma} - \underline{k}}{\overline{k} - \underline{k}}$).

The empirical content of this depends on our definition of an activist. If we define an activist to be an institutional investor, as in the model, then this result captures the Brav et al (2008) finding that firms in which activist hedge funds file 13Ds have high institutional ownership.

Remark 2. There will be significant additional accumulation of activist shares following a 13D filing (a measure $\frac{\frac{K_2^*(A_L,\Delta)}{\Delta\gamma} - \underline{k}}{\overline{k} - \underline{k}} - \frac{\frac{K_0^*}{(1+\delta)\gamma} - \underline{k}}{\overline{k} - \underline{k}}$ of additional small institutions will enter conditional on the large activist's entry).

Thus, one should expect abnormal turnover in target shares following a 13D filing. Further, there may be differences in institutions who buy into a target firm's shares before and after a 13D filing:

Remark 3. Late entrants to wolf packs have higher opportunity costs than early entrants.

5.2 Price dynamics

To examine the dynamics of prices in our model we first set up some additional notation. Let P_t denote the equilibrium price of an amenable firm at t. Then, P_t is the date-t expected terminal ($t = 3$) value of the firm, taking into account the expected probability of successful engagement given the information available at t, and therefore $P_t \in [P_\ell, P_h]$. It is straightforward to show that the price reacts to information in the model as follows:

- At $t = 0$, uncertainty over whether the firm will be amenable to activism is resolved. The price is $P_0 = P_\ell$ if the firm is not in the amenable state (in which case $P_t = P_\ell$ for all t), and is strictly greater than P_ℓ if the firm is in the amenable state.

Conditional on the firm being amenable:

- At $t = 1$, uncertainty on whether a large activist will be available is resolved. There are two cases:
  - Case (A) The large activist will not acquire a stake even if she arrives (e.g., because the expected size of the wolf pack is too small). In this case the arrival of the large activist is immaterial and$P_1 = P_0$.
  - Case (B) The large activist will acquire a stake if she arrives. In this case, if the large activist arrives and acquires a stake the price rises (i.e., $P_1 > P_0$). If the large activist is not available, the price falls (i.e., $P_1 < P_0$).

- At $t = 2$, uncertainty on the aggregate shock to the opportunity costs of information gathering for small institutions resolves. The price rises if opportunity costs fall and many small institutions enter (i.e., $P_2 > P_1$). The price falls if opportunity costs rise and few small institutions enter (i.e., $P_2 < P_1$).

- At $t = 3$, uncertainty on the level of entrenchment, and therefore the outcome of engagement, resolves. The price rises if engagement succeeds (i.e., $P_3 = P_h > P_2$) and falls otherwise (i.e., $P_3 = P_l < P_2$).

As above, if the entry and acquisition of a large activist is synonymous with the filing of a 13D, then we have the following empirical implications.

Remark 4. Targets experience positive returns upon the filing of a 13D (i.e., conditional on the entry of a large activist, $P_1 > P_0$).

This implication has wide support in the empirical literature on hedge fund activism. A significant number of papers find that targets experience positive abnormal short-term returns conditional on the filing of a 13D (see Brav et al 2010 for a survey of this literature).

Remark 5. Target returns following the filing of a 13D are increasing in the size of the wolf pack (i.e., $P_2 - P_1$ is decreasing in Δ).

We are aware of no systematic evidence for this implication, which therefore represents a testable prediction of our model. Further, this implication separates our story from purely information-based stories of institutional share acquisition following a 13D filing. In such a story, the post-13D entrants add no value to the target and should have no price impact. In our model, the post-13D entrants are key participants in the value enhancement process and thus the price reacts positively to higher levels of entry.

6 Discussion

6.1 Alternative Interpretations of Engagement

Throughout the paper we have maintained the interpretation that engagement on the part of both large and small activists entails "behind the scenes" discussions with management or other shareholders, or other influence activities designed to increase pressure on management. An alternative interpretation is that wolf pack members "engage" by maintaining their presence as continued small blockholders of the firm's shares who support the lead activist and will vote with her if the engagement process leads to a proxy contest. Since activist campaigns can last many months, this is a costly action to small institutions that may have an outsized portion of their capital committed to the target and thus suffer from underdiversificaiton or further opportunity costs (in addition to those paid to initially buy shares and investigate the firm) to remaining invested throughout the campaign.

The only change required in our model to accommodate such an interpretation would be the addition of a final trading round after institutions receive their signals, at which point they must simultaneously choose whether to exit (not engage) or maintain their investment in the target's shares (engage). Formally, since there is a continuum of institutions, a threshold equilibrium in which those with signals below the threshold sell and those with signals above the threshold hold will fully reveal the firm's fundamental and the number of engaging institutions. Thus, the price at this trading round will be exactly equal to the post-engagement firm value. Each institution at the margin has no influence on the price or success probability, so will, as in the current model, choose its engagement strategy without taking into account any potential trading profits or any marginal effect on the probability of success, and will thus trade off its underdiversification cost against the potential reputational benefit of engaging when engagement is successful. Semantically, one could argue that it is unrealistic to assume that institutions have no chance to change their minds once the fundamental has been revealed through the price, but this trading round is meant to represent private trading decisions that take place over a significant length of time in a noisy market. Thus, we think this alternative specification is reasonable. Also note that engagement in this model is visible as long as potential investors can see changes in institutions' holdings over some reasonable time window.

6.2 Parameter Constraints

A key parameter constraint we have imposed throughout is that the reward to reputation not be too large relative to the cost of engagement, i.e. Assumption 1(a), $R \in (c_s, 2c_s)$. The purpose of this constraint is to ensure that unskilled institutions will never find it optimal to deviate from the pure strategy equilibrium in which they never engage. If $R > 2c_s$ then for some parameter constellations there would be no pure strategy equilibrium for the unskilled types, which would significantly complicate the analysis. As a result we use the sufficient (but not necessary) condition $R \in (c_s, 2c_s)$ to maintain tractability. In addition, we believe that this constraint is economically reasonable as it simply states that the rewards to gaining reputation are not excessive compared to the costs. This should generally be true in settings where reputation is a useful mechanism in equilibrium, as otherwise it would be extremely difficult to prevent unskilled types from trying to mimic skilled types, i.e, the reputation mechanism would break down. We should also note that this restriction is tied to the prior distribution of our entrenchment variable $\eta \sim N\left(\bar{A}, \frac{1}{\alpha_\eta}\right)$. If we allow for $R > 2c_s$ but raise the prior mean of η commensurately, our analysis will be unchanged: even with the prospect of higher reputational gain will be offset by the lower probability of successful engagement (from the perspective of uninformed institutions) and thus leave their behavior unchanged.

We have also assumed $(1+\delta)\underline{k} < \frac{R-c_s}{2} < (1-\delta)\overline{k}$ (Assumption 1(b)). This is to avoid corner solutions whereby there are either no institutions who want to buy into the target firm, or all institutions do. This does not affect our qualitative results. Similarly, our assumption that the probability with which targets become amenable to activism is not very high, i.e., $p_A < \frac{2(1-\delta)\underline{k}}{R-c_s}$, is used to highlight the endogenous trading motive, wherein institutions who want to demonstrate their skill will displace existing holders with no such motive. Changing this assumption would simply make that dynamic less stark; there could be some initial owners who are potentially skilled, but a mass of unskilled initial owners would still be displaced in equilibrium.

7 Conclusion

The possibility of coordinated engagement by shareholders has important implications for corporate governance. In this paper we show that implicit coordination amongst institutional shareholders can play a powerful role in activist campaigns. As a result of the phenomenal growth of the money management industry in recent decades, fund managers now own the majority of corporate equity. The incentives of fund managers may therefore affect the nature of shareholder engagement. We show that money managers' competition for investor capital can give rise to strong strategic complementarity in their engagement strategies, providing a basis for coordinated shareholder activism.

Our analysis provides a lens through which to view a controversial tactic, wolf pack activism, often attributed to activist hedge funds. In an activist wolf pack, a loose coalition of institutional investors is alleged to coalesce around the leadership of an activist hedge fund to seek change in a target firm. In addition to providing a theoretical basis for implicit coordination amongst wolf pack members, we also demonstrate that the emergence of a lead activist has an important catalytic effect on the aggressiveness of other institutional shareholders. Finally, we show that empirically demonstrated trading dynamics are consistent with our model of implicit coordination, and provide further testable hypotheses.

Our results should enable empirical researchers to better study the mechanics and implications of wolf pack tactics. Future work could also examine the role that explicit collusion or intentional information leakage might play in either substituting for or complementing the implicit coordination mechanism we model.

Appendix

Proof of Lemma 1: Since all trades occur at fair prices, before amenability is known, an upper bound on the returns from buying a share in the firm is given by the product of the probability of amenability (p_A), the maximum probability that engagement is successful ($Pr\left(\eta \leq \overline{A}\right) = 1/2$ since activist ownership is bounded above by $\overline{A}$), and the net reputational payoff from successful engagement conditional on engaging only when engagement succeeds ($R - c_s$), i.e., $p_A \frac{1}{2}\left(R - c_s\right)$. A lower bound on the expected opportunity cost for buying a share is $\left(1-\delta\right)\underline{k}$. Since $p_A < \frac{2(1-\delta)\underline{k}}{R-c_s}$, the lower bound is always higher than the upper bound, and hence no potentially skilled institution would own the firm.

Proof of Proposition 1: Denote by $\mathbf{1}_L$ the indicator function that is equal to 1 if the large activist is present. Denote the probability with which each unskilled institution engages by $p_e \in [0,1]$. p_e is formally a function of $\mathbf{1}_L$, but we suppress this dependence here for notational brevity as we shall show below that the strategies of the small unskilled institutions are independent of the presence of the large activist in equilibrium. The strategies of the skilled small institutions will depend on $\mathbf{1}_L$, p_e and λ. Denote the threshold by $x_s^*\left(\mathbf{1}_L, p_e, \lambda\right)$. Finally, define $\hat{A} = \bar{A} - \mathbf{1}_L A_L$, the measure of shares that is jointly owned by small institutions, skilled or unskilled. Since $x_{s,j}|\eta \sim N\left(\eta, \frac{1}{\alpha_s}\right)$, for each η, the measure of engagement by small institutions is given by

$$A_s \gamma \Pr\left(x_{s,j} \leq x_s^*\left(\mathbf{1}_L, p_e, \lambda\right)|\eta\right) + \left(A_s\left(1-\gamma\right)\left(1-\lambda\right) + \left(\hat{A} - A_s\right)\right)p_e + A_s\left(1-\gamma\right)\frac{\lambda}{2}.$$

The large activist will engage if present if and only if

$$A_L + A_s \gamma \Pr\left(x_{s,j} \leq x_s^*\left(\mathbf{1}_L, p_e, \lambda\right)|\eta\right) + \left(A_s\left(1-\gamma\right)\left(1-\lambda\right) + \left(\hat{A} - A_s\right)\right)p_e + A_s\left(1-\gamma\right)\frac{\lambda}{2} \geq \eta.$$

Thus, engagement is successful if and only if

$$\mathbf{1}_L A_L + A_s \gamma \Phi\left(\sqrt{\alpha_s}\left(x_s^*\left(\mathbf{1}_L, p_e, \lambda\right) - \eta\right)\right) + \left(A_s\left(1-\gamma\right)\left(1-\lambda\right) + \left(\hat{A} - A_s\right)\right)p_e + A_s\left(1-\gamma\right)\frac{\lambda}{2} \geq \eta.$$

The LHS is decreasing in η, the RHS is increasing in η, so there exists $\eta_s^*(p_e, \lambda)$ such that engagement is successful if and only if $\eta \leq \eta_s^*(p_e, \lambda)$, where $\eta_s^*(p_e, \lambda)$ is defined by

$$\begin{array}{c} \mathbf{1}_L A_L + A_s\gamma\Phi\left(\sqrt{\alpha_s}\left(x_s^*\left(\mathbf{1}_L, p_e, \lambda\right) - \eta_s^*\left(\mathbf{1}_L, p_e, \lambda\right)\right)\right) + \\ \left(A_s\left(1-\gamma\right)\left(1-\lambda\right) + \left(\hat{A} - A_s\right)\right) p_e + A_s\left(1-\gamma\right)\frac{\lambda}{2} \end{array} = \eta_s^*\left(\mathbf{1}_L, p_e, \lambda\right). \tag{4}$$

Which implies that

$$x_s^*\left(\mathbf{1}_L, p_e, \lambda\right) = \begin{array}{c} \eta_s^*\left(\mathbf{1}_L, 0, \lambda\right) + \\ \frac{1}{\sqrt{\alpha_s}}\Phi^{-1}\left(\frac{\eta_s^*(\mathbf{1}_L, 0, \lambda) - \mathbf{1}_L A_L - \left(A_s(1-\gamma)(1-\lambda) + \left(\hat{A} - A_s\right)\right)p_e - A_s(1-\gamma)\frac{\lambda}{2}}{A_s\gamma}\right) \end{array}.$$

Note that this implies that as $\alpha_s \to \infty$, $x_s^*\left(\mathbf{1}_L, p_e, \lambda\right) \to \eta_s^*\left(\mathbf{1}_L, 0, \lambda\right)$.

We now compute the posterior reputation of each small institution in equilibrium. Since individual small institutions may engage (E) or not (N), and engagement may succeed ($S := \{\eta \leq \eta_s^*(p_e, \lambda)\}$) or fail ($F := \{\eta > \eta_s^*(p_e, \lambda)\}$), there are four possible posterior reputations: $\hat{\gamma}(S, E), \hat{\gamma}(F, E), \hat{\gamma}(S, N)$, and $\hat{\gamma}(F, N)$.

$$\begin{aligned}
\hat{\gamma}(S, E) &= \Pr\left(\theta = G | S, E\right) \\
&= \frac{\frac{A_s\gamma}{\hat{A}}\Pr\left(S, E|\theta = G\right)}{\frac{A_s\gamma}{\hat{A}}\Pr\left(S, E|\theta = G\right) + \frac{A_s(1-\gamma)(1-\lambda)}{\hat{A}}\Pr\left(S\right)p_e + \frac{A_s(1-\gamma)\lambda}{\hat{A}}\frac{1}{2} + \frac{\hat{A} - A_s}{\hat{A}}\Pr\left(S\right)p_e} \\
&= \frac{A_s\gamma\Pr\left(x_s \leq x_s^*\left(\mathbf{1}_L, p_e, \lambda\right), S\right)}{A_s\gamma\Pr\left(x_s \leq x_s^*\left(\mathbf{1}_L, p_e, \lambda\right), S\right) + \left(A_s\left(1-\gamma\right)\left(1-\lambda\right) + \hat{A} - A_s\right)\Pr\left(S\right)p_e + A_s\left(1-\gamma\right)\Pr\left(S\right)\frac{\lambda}{2}} \\
&= \frac{A_s\gamma\Pr\left(x_s \leq x_s^*\left(\mathbf{1}_L, p_e, \lambda\right)|S\right)}{A_s\gamma\Pr\left(x_s \leq x_s^*\left(\mathbf{1}_L, p_e, \lambda\right)|S\right) + \left(A_s\left(1-\gamma\right)\left(1-\lambda\right) + \hat{A} - A_s\right)p_e + A_s\left(1-\gamma\right)\frac{\lambda}{2}}.
\end{aligned}$$

By analogy

$$\begin{aligned}
\hat{\gamma}(F, E) &= \frac{A_s\gamma\Pr\left(x_s \leq x_s^*\left(\mathbf{1}_L, p_e, \lambda\right)|F\right)}{A_s\gamma\Pr\left(x_s \leq x_s^*\left(\mathbf{1}_L, p_e, \lambda\right)|F\right) + \left(A_s\left(1-\gamma\right)\left(1-\lambda\right) + \hat{A} - A_s\right)p_e + A_s\left(1-\gamma\right)\frac{\lambda}{2}}, \\
\hat{\gamma}(S, N) &= \frac{A_s\gamma\Pr\left(x_s > x_s^*\left(\mathbf{1}_L, p_e, \lambda\right)|S\right)}{A_s\gamma\Pr\left(x_s > x_s^*\left(\mathbf{1}_L, p_e, \lambda\right)|S\right) + \left(A_s\left(1-\gamma\right)\left(1-\lambda\right) + \hat{A} - A_s\right)\left(1-p_e\right) + A_s\left(1-\gamma\right)\frac{\lambda}{2}}, \\
\hat{\gamma}(F, N) &= \frac{A_s\gamma\Pr\left(x_s > x_s^*\left(\mathbf{1}_L, p_e, \lambda\right)|F\right)}{A_s\gamma\Pr\left(x_s > x_s^*\left(\mathbf{1}_L, p_e, \lambda\right)|F\right) + \left(A_s\left(1-\gamma\right)\left(1-\lambda\right) + \hat{A} - A_s\right)\left(1-p_e\right) + A_s\left(1-\gamma\right)\frac{\lambda}{2}}.
\end{aligned}$$

Denoting by I the information set of a given player and by $\mathbf{1}$ the indicator function which is equal to one if its argument is true, the payoffs from engagement are given by:

$$\Pr(S|I)\left[\mathbf{1}\left(\hat{\gamma}(S,E) \geq B\right)R + P_h\right] + \left(1 - \Pr(S|I)\right)\left[\mathbf{1}\left(\hat{\gamma}(F,E) \geq B\right)R + P_l\right] - c_s,$$

whereas the payoffs from non-engagement are given by:

$$\Pr(S|I)\left[\mathbf{1}\left(\hat{\gamma}(S,N) \geq B\right)R + P_h\right] + \left(1 - \Pr(S|I)\right)\left[\mathbf{1}\left(\hat{\gamma}(F,N) \geq B\right)R + P_l\right].$$

First consider the unskilled small institutions, so that $I = \varnothing$. We first show that:

Lemma 4. *For $\lambda < \min\left[\frac{2\gamma(1-B)}{(1-\gamma)B}, \frac{2(B-\gamma)}{(1-\gamma)B}\right]$ there exists $\underline{\alpha}_{III}(\lambda) \in \mathbb{R}_+$ such for all $\alpha_s \geq \underline{\alpha}_{III}(\lambda)$, unskilled small institutions must choose $p_e = 0$ in equilibrium.*

Proof of Lemma: First we show that for sufficiently precise signals, $p_e = 0$ is a best response by unskilled institutions to a monotone strategy with threshold $x_s^*(0,\lambda)$ used by skilled institutions. For $p_e = 0$ the posteriors are as follows:

$$\hat{\gamma}(S,E) = \frac{\gamma \Pr\left(x_s \leq x_s^*(\mathbf{1}_L, 0, \lambda)|S\right)}{\gamma \Pr\left(x_s \leq x_s^*(\mathbf{1}_L, 0, \lambda)|S\right) + (1-\gamma)\frac{\lambda}{2}} \underset{\alpha_s\to\infty}{\to} \frac{\gamma}{\gamma + (1-\gamma)\frac{\lambda}{2}}.$$

For $\lambda < \frac{2\gamma(1-B)}{(1-\gamma)B}$, $\frac{\gamma}{\gamma+(1-\gamma)\frac{\lambda}{2}} > B$, and thus there exists $\underline{\alpha}_1(\lambda) \in \mathbb{R}_+$ such that for $\alpha_s \geq \underline{\alpha}_1(\lambda)$, $\hat{\gamma}(S,E) \geq B$.

$$\hat{\gamma}(F,E) = \frac{\gamma \Pr\left(x_s \leq x_s^*(\mathbf{1}_L, 0, \lambda)|F\right)}{\gamma \Pr\left(x_s \leq x_s^*(\mathbf{1}_L, 0, \lambda)|F\right) + (1-\gamma)\frac{\lambda}{2}} \underset{\alpha_s\to\infty}{\to} 0.$$

Thus, for any λ, there exists $\underline{\alpha}_2(\lambda) \in \mathbb{R}_+$ such that for $\alpha_s > \underline{\alpha}_2(\lambda)$, $\hat{\gamma}(F,E) < B$.

$$\hat{\gamma}(S,N) = \frac{A_s\gamma \Pr\left(x_s > x_s^*(\mathbf{1}_L, 0, \lambda)|S\right)}{A_s\gamma \Pr\left(x_s > x_s^*(\mathbf{1}_L, 0, \lambda)|S\right) + \left(A_s(1-\gamma)(1-\lambda) + \hat{A} - A_s\right) + A_s(1-\gamma)\frac{\lambda}{2}} \underset{\alpha_s\to\infty}{\to} 0.$$

Thus, for any λ, there exists $\underline{\alpha}_3(\lambda) \in \mathbb{R}_+$ such that for $\alpha_s \geq \underline{\alpha}_3(\lambda)$, $\hat{\gamma}(S,N) < B$.

$$\begin{aligned}
\hat{\gamma}(F,N) &= \frac{A_s\gamma \Pr\left(x_s > x_s^*\left(\mathbf{1}_L,0,\lambda\right)|F\right)}{A_s\gamma \Pr\left(x_s > x_s^*\left(\mathbf{1}_L,0,\lambda\right)|F\right) + \left(A_s\left(1-\gamma\right)\left(1-\lambda\right)+\hat{A}-A_s\right) + A_s\left(1-\gamma\right)\frac{\lambda}{2}} \\
&\underset{\alpha_s\to\infty}{\to} \frac{A_s\gamma}{A_s\gamma + \left(A_s\left(1-\gamma\right)\left(1-\lambda\right)+\hat{A}-A_s\right) + A_s\left(1-\gamma\right)\frac{\lambda}{2}} \\
&= \frac{\gamma}{\gamma+\left(1-\gamma\right)\left(1-\frac{\lambda}{2}\right)+\frac{\hat{A}}{A_s}-1} \le \frac{\gamma}{\gamma+\left(1-\gamma\right)\left(1-\frac{\lambda}{2}\right)}, \text{ since } \hat{A}\ge A_s.
\end{aligned}$$

For $\lambda < \frac{2(B-\gamma)}{(1-\gamma)B}$, $\frac{\gamma}{\gamma+(1-\gamma)\left(1-\frac{\lambda}{2}\right)} < B$, and thus there exists $\underline{\alpha}_4(\lambda) \in \mathbb{R}_+$ such that for $\alpha_s > \underline{\alpha}_4(\lambda)$, $\hat{\gamma}(F,N) < B$. Now, setting

$$\underline{\alpha}_I(\lambda) := \max\left[\underline{\alpha}_1(\lambda), \underline{\alpha}_2(\lambda), \underline{\alpha}_3(\lambda), \underline{\alpha}_4(\lambda)\right],$$

for $\alpha_s \ge \underline{\alpha}_I(\lambda)$, we can write the payoffs for unskilled small institutions from engaging as follows:

$$\Pr(S)\left(R+P_h\right) + (1-\Pr(S))P_l - c_s,$$

whereas payoffs from not engaging are

$$\Pr(S)\,P_h + (1-\Pr(S))P_l.$$

Thus, $p_e = 0$ is optimal whenever

$$\Pr(S) \le \frac{c_s}{R},$$

which is always satisfied because $\Pr(S) = \Pr(\eta \le \eta_s^*(0,\lambda)) < \Pr(\eta \le 1) = \frac{1}{2}$ since $\eta_s^*(0,\lambda) < 1$, whereas $\frac{c_s}{R} \ge \frac{1}{2}$ since $R \le 2c_s$.

Next we show that $p_e = 1$ cannot arise in equilibrium. For $p_e = 1$ the posteriors are as follows:

$$\begin{aligned}
\hat{\gamma}(S,E) &= \frac{A_s\gamma \Pr\left(x_s \le x_s^*\left(\mathbf{1}_L,1,\lambda\right)|S\right)}{A_s\gamma \Pr\left(x_s \le x_s^*\left(\mathbf{1}_L,p_e,\lambda\right)|S\right) + A_s\left(1-\gamma\right)\left(1-\lambda\right)+\hat{A}-A_s + A_s\left(1-\gamma\right)\frac{\lambda}{2}} \\
&\underset{\alpha_s\to\infty}{\to} \frac{A_s\gamma}{A_s\gamma + A_s\left(1-\gamma\right)\left(1-\lambda\right)+\hat{A}-A_s + A_s\left(1-\gamma\right)\frac{\lambda}{2}} \\
&= \frac{\gamma}{\gamma+\left(1-\gamma\right)\left(1-\frac{\lambda}{2}\right)+\frac{\hat{A}}{A_s}-1} \le \frac{\gamma}{\gamma+\left(1-\gamma\right)\left(1-\frac{\lambda}{2}\right)}.
\end{aligned}$$

This is identical to the case for $p_e = 0$ and $\hat{\gamma}(F,N)$. Thus, for $\alpha_s > \underline{\alpha}_4(\lambda)$, $\hat{\gamma}(S,E) < B$. Similarly it is easy to see that for $\alpha_s > \underline{\alpha}_3(\lambda)$, $\hat{\gamma}(F,E) < B$ while for $\alpha_s > \underline{\alpha}_2(\lambda)$, $\hat{\gamma}(S,N) < B$. Finally,

$$\hat{\gamma}(F,N) = \frac{\gamma \Pr(x_s > x_s^*(\mathbf{1}_L, 1, \lambda) | F)}{\gamma \Pr(x_s > x_s^*(\mathbf{1}_L, 1, \lambda) | F) + (1-\gamma)\frac{\lambda}{2}} \underset{\alpha_s \to \infty}{\to} \frac{\gamma}{\gamma + (1-\gamma)\frac{\lambda}{2}},$$

which is again identical to the case for $p_e = 0$ and $\hat{\gamma}(S,N)$. Thus, for $\alpha_s \geq \underline{\alpha}_1(\lambda)$, $\hat{\gamma}(F,N) \geq B$. Now, for $\alpha_s \geq \underline{\alpha}_I(\lambda)$, we can write the payoffs for unskilled institutions from engaging as follows:

$$\Pr(S) P_h + (1 - \Pr(S)) P_l - c_s,$$

whereas payoffs from not engaging are

$$\Pr(S) P_h + (1 - \Pr(S))(P_l + R).$$

Since $\Pr(S) P_h + (1 - \Pr(S))(P_l + R) > \Pr(S) P_h + (1 - \Pr(S)) P_l$, $p_e = 1$ can never be a best response to $x_s^*(1, \lambda)$.

Finally, we show that $p_e \in (0,1)$ also cannot arise in equilibrium. For $p_e \in (0,1)$ the posteriors are given by the general expressions above. Note that since $\hat{\gamma}(F,E)$ and $\hat{\gamma}(S,N)$ are bounded in p_e, there exist $\underline{\alpha}_5(\lambda) \in \mathbb{R}_+$ and $\underline{\alpha}_6(\lambda) \in \mathbb{R}_+$ such that, for any p_e, for $\alpha_s \geq \underline{\alpha}_5(\lambda)$, $\hat{\gamma}(F,E) < B$ and for $\alpha_s \geq \underline{\alpha}_6(\lambda)$, $\hat{\gamma}(S,N) < B$. Now consider $\alpha_s \geq \underline{\alpha}_{II}(\lambda) := \max[\underline{\alpha}_5(\lambda), \underline{\alpha}_6(\lambda)]$. For any $p_e \in (0,1)$, λ:

$$\lim_{\alpha_s \to \infty} \hat{\gamma}(S,E) = \frac{A_s \gamma}{A_s \gamma + \left(A_s(1-\gamma)(1-\lambda) + \hat{A} - A_s\right) p_e + A_s(1-\gamma)\frac{\lambda}{2}}.$$

Either:

Case A: there exists a $\overline{p}_e > 0$ such that $\lim_{\alpha_s \to \infty} \hat{\gamma}(S,E) > B$ for $p_e \leq \overline{p}_e$ or

Case B: There exists no such $\overline{p}_e > 0$.

First, consider Case B. Note first that since $\hat{\gamma}(S,E)$ is increasing in $\Pr(x_s \leq x_s^*(\mathbf{1}_L, p_e, \lambda) | S)$ and $\Pr(x_s \leq x_s^*(\mathbf{1}_L, p_e, \lambda) | S)$ is increasing in α_s, $\hat{\gamma}(S,E) < B$ for all α_s. Thus, for any

$\alpha_s > \underline{\alpha}_{II}(\lambda)$, the payoff to engaging is $\Pr(S) P_h + (1 - \Pr(S))P_l - c_s$. But the payoff to not engageing is never less than $\Pr(S) P_h + (1 - \Pr(S))P_l$. Thus, $p_e \in (0, 1)$ cannot arise in equilibrium.

Now consider Case A. Given the argument for Case B, $p_e > \overline{p}_e$ cannot arise in equilibrium either. The only possibility is that $p_e \in (0, \overline{p}_e]$. Fix such a p_e, and suppose there exists some $\alpha_s \geq \underline{\alpha}_{II}(\lambda)$ such that for such a pair (p_e, α_s) we have $\hat{\gamma}(S, E) > B$. There are two possibilities:

Either for that (p_e, α_s), $\hat{\gamma}(F, N) \leq B$, in which case the payoffs to engaging are:

$$\Pr(S)(R + P_h) + (1 - \Pr(S))P_l - c_s,$$

whereas payoffs from not engaging are

$$\Pr(S) P_h + (1 - \Pr(S))P_l.$$

Having, $p_e \in (0, 1)$ requires that

$$\Pr(S) = \frac{c_s}{R},$$

which is impossible because $\Pr(S) < \frac{1}{2}$ and $\frac{c_s}{R} \geq \frac{1}{2}$.

The other possibility is that for that (p_e, α_s), $\hat{\gamma}(F, N) > B$ in which case the payoffs to engaging are

$$\Pr(S)(R + P_h) + (1 - \Pr(S))P_l - c_s,$$

whereas payoffs from not engaging are

$$\Pr(S) P_h + (1 - \Pr(S))(P_l + R).$$

Having, $p_e \in (0, 1)$ requires that

$$\begin{aligned} \Pr(S) R - c_s &= (1 - \Pr(S))R \\ \text{i.e., } \Pr(S) &= \frac{1}{2} + \frac{c_s}{2R}, \end{aligned}$$

which is again impossible because $\Pr(S) < \frac{1}{2}$. Thus, for any λ and $\alpha_s \geq \underline{\alpha}_{II}(\lambda)$, $p_e \in (0, 1)$ cannot arise in equilibrium.

Defining $\underline{\alpha}_{III}(\lambda) := \max\left[\underline{\alpha}_{I}(\lambda), \underline{\alpha}_{II}(\lambda)\right]$ completes the proof of the Lemma.□

For the remainder of the proof, consider $\lambda < \min\left[\frac{2\gamma(1-B)}{(1-\gamma)B}, \frac{2(B-\gamma)}{(1-\gamma)B}\right]$ and $\alpha \geq \underline{\alpha}_{III}(\lambda)$, so that we can use the above characterisation of the strategies of unskilled institutions. Consider the putative equilibrium thresholds for the skilled institutions which are given by $x_s^*(0,\lambda)$. The payoffs from engagement are given by:

$$\Pr\left(\eta \leq \eta_s^*\left(\mathbf{1}_L, 0, \lambda\right)|x_{s,j}\right)\left(R + P_h\right) + \left(1 - \Pr\left(\eta \leq \eta_s^*\left(\mathbf{1}_L, 0, \lambda\right)|x_{s,j}\right)\right)P_l - c_s,$$

whereas the payoffs from non-engagement are given by:

$$\Pr\left(\eta \leq \eta_s^*\left(\mathbf{1}_L, 0, \lambda\right)|x_{s,j}\right)P_h + \left(1 - \Pr\left(\eta \leq \eta_s^*\left(\mathbf{1}_L, 0, \lambda\right)|x_{s,j}\right)\right)P_l.$$

Thus, the net expected payoff from engagement is given by

$$\Pr\left(\eta \leq \eta_s^*\left(\mathbf{1}_L, 0, \lambda\right)|x_{s,j}\right)R - c_s$$

which is clearly decreasing in $x_{s,j}$. The existence of the dominance regions and continuity jointly imply that there exists $x_s^*(0,\lambda) \in \mathbb{R}$ such that

$$\Pr\left(\eta \leq \eta_s^*\left(\mathbf{1}_L, 0, \lambda\right)|x_s^*\left(\mathbf{1}_L, 0, \lambda\right)\right)R - c_s = 0.$$

Further, since $\eta|x_{s,j} \sim N\left(\frac{\alpha_\eta\mu_\eta + \alpha_s x_{s,j}}{\alpha_\eta + \alpha_s}, \frac{1}{\alpha_\eta + \alpha_s}\right)$, we have the following condition:

$$\Phi\left(\sqrt{\alpha_\eta + \alpha_s}\left(\eta_s^*\left(\mathbf{1}_L, 0, \lambda\right) - \frac{\alpha_\eta\mu_\eta + \alpha_s x_s^*\left(\mathbf{1}_L, 0, \lambda\right)}{\alpha_\eta + \alpha_s}\right)\right) = \frac{c_s}{R}. \quad (5)$$

Solving (4) for $x_s^*\left(\mathbf{1}_L, 0, \lambda\right)$ at $p_e = 0$ gives

$$x_s^*\left(\mathbf{1}_L, 0, \lambda\right) = \eta_s^*\left(\mathbf{1}_L, 0, \lambda\right) + \frac{1}{\sqrt{\alpha_s}}\Phi^{-1}\left(\frac{\eta_s^*\left(\mathbf{1}_L, 0, \lambda\right) - \mathbf{1}_L A_L - A_s\left(1-\gamma\right)\frac{\lambda}{2}}{A_s\gamma}\right).$$

Substituting into (5) gives:

$$\Phi\left(\sqrt{\alpha_\eta + \alpha_s}\left(\eta_s^*\left(\mathbf{1}_L, 0, \lambda\right) - \frac{\alpha_\eta\mu_\eta + \alpha_s\left(\eta_s^*\left(\mathbf{1}_L, 0, \lambda\right) + \frac{1}{\sqrt{\alpha_s}}\Phi^{-1}\left(\frac{\eta_s^*\left(\mathbf{1}_L, 0, \lambda\right) - \mathbf{1}_L A_L - A_s(1-\gamma)\frac{\lambda}{2}}{A_s\gamma}\right)\right)}{\alpha_\eta + \alpha_s}\right)\right) = \frac{c_s}{R},$$

$$\text{i.e., } \Phi\left(\eta_s^*\left(\mathbf{1}_L, 0, \lambda\right)\frac{\alpha_\eta}{\sqrt{\alpha_\eta + \alpha_s}} - \frac{\alpha_\eta\mu_\eta}{\sqrt{\alpha_\eta + \alpha_s}} - \frac{\sqrt{\alpha_s}}{\sqrt{\alpha_\eta + \alpha_s}}\Phi^{-1}\left(\frac{\eta_s^*\left(\mathbf{1}_L, 0, \lambda\right) - \mathbf{1}_L A_L - A_s\left(1-\gamma\right)\frac{\lambda}{2}}{A_s\gamma}\right)\right) = \frac{c_s}{R}. \quad (6)$$

Taking the derivative of this relative to $\eta_s^*(\mathbf{1}_L, 0, \lambda)$ we obtain:

$$\phi\left(\eta_s^*(\mathbf{1}_L,0,\lambda)\frac{\alpha_\eta}{\sqrt{\alpha_\eta+\alpha_s}}-\frac{\alpha_\eta\mu_\eta}{\sqrt{\alpha_\eta+\alpha_s}}-\frac{\sqrt{\alpha_s}}{\sqrt{\alpha_\eta+\alpha_s}}\Phi^{-1}\left(\frac{\eta_s^*(\mathbf{1}_L,0,\lambda)-\mathbf{1}_L A_L-A_s(1-\gamma)\frac{\lambda}{2}}{A_s\gamma}\right)\right)\times$$
$$\left(\frac{\alpha_\eta}{\sqrt{\alpha_\eta+\alpha_s}}-\frac{\sqrt{\alpha_s}}{\sqrt{\alpha_\eta+\alpha_s}}\frac{1/A_s\gamma}{\phi\left(\Phi^{-1}\left(\frac{\eta_s^*(\mathbf{1}_L,0,\lambda)-\mathbf{1}_L A_L-A_s(1-\gamma)\frac{\lambda}{2}}{A_s\gamma}\right)\right)}\right).$$

As $\alpha_s \to \infty$ the above expression reduces to

$$\phi\left(-\Phi^{-1}\left(\frac{\eta_s^*(\mathbf{1}_L,0,\lambda)-\mathbf{1}_L A_L-A_s(1-\gamma)\frac{\lambda}{2}}{A_s\gamma}\right)\right)\left(-\frac{1/A_s\gamma}{\phi\left(\Phi^{-1}\left(\frac{\eta_s^*(\mathbf{1}_L,0,\lambda)-\mathbf{1}_L A_L-A_s(1-\gamma)\frac{\lambda}{2}}{A_s\gamma}\right)\right)}\right)<0.$$

Continuity in α_s implies that there exists an $\underline{\alpha}_{IV}(\lambda) \in \mathbb{R}_+$ such that for $\alpha \geq \underline{\alpha}_{IV}(\lambda)$, the left hand side of (6) is monotone in $\eta_s^*(\mathbf{1}_L, 0, \lambda)$. Thus there can be only one solution $\eta_s^*(\mathbf{1}_L, 0, \lambda)$. Existence of a solution can be verified by taking the limit of (6) as $\alpha_s \to \infty$:

$$\Phi\left(-\Phi^{-1}\left(\frac{\eta_s^*(\mathbf{1}_L,0,\lambda)-\mathbf{1}_L A_L-A_s(1-\gamma)\frac{\lambda}{2}}{A_s\gamma}\right)\right)=\frac{c_s}{R},$$

so that

$$\eta_s^*(\mathbf{1}_L,0,\lambda)=\mathbf{1}_L A_L+A_s\gamma\left(1-\frac{c_s}{R}\right)+A_s(1-\gamma)\frac{\lambda}{2}.$$

The proof is completed by setting $\underline{\alpha}(\lambda) := \max\left[\underline{\alpha}_{III}(\lambda), \underline{\alpha}_{IV}(\lambda)\right]$.■

Proof of Lemma 2: Define $\sigma_\eta^2 = \frac{1}{\alpha_\eta}$. The proof of existence is as follows. For $K_2^*(A_L, \Delta) = \gamma\Delta\underline{k}$ the left hand side is given by

$$\gamma Pr(\eta \leq A_L)(R-c_s)=\gamma\Phi\left(\frac{A_L-\overline{A}}{\sigma_\eta}\right)(R-c_s)\underset{\sigma_\eta\to\infty}{\longrightarrow}\frac{1}{2}\gamma(R-c_s).$$

Since $\underline{k} < \frac{R-c_s}{2(1+\delta)}$, this is bigger than the right hand side. For $K_2^*(A_L, \Delta) = \gamma\Delta\overline{k}$ the left hand side is given by

$$\gamma Pr\left(\eta \leq A_L+\gamma\left(1-\frac{c_s}{R}\right)\right)(R-c_s)<\frac{1}{2}\gamma(R-c_s).$$

Since $\overline{k} > \frac{R-c_s}{2(1-\delta)}$, the left hand side is smaller than the right hand side. Continuity then implies that there exists at least one crossing point.

The proof of uniqueness is as follows. Since $\eta \sim N\left(\overline{A}, \sigma_\eta^2\right)$, Taking the derivative with respect to $K_2^*\left(A_L, \Delta\right)$ of the left hand side gives:

$$\frac{\gamma}{\Delta\left(\overline{k}-\underline{k}\right)} \frac{\left(R-c_s\right)^2}{R} \phi_{\overline{A},\sigma_\eta^2}\left(A_L + \gamma \frac{\frac{K_2^*(A_L,\Delta)}{\Delta\gamma} - \underline{k}}{\overline{k}-\underline{k}} \left(1-\frac{c_s}{R}\right)\right) > 0.$$

Since $\phi_{\overline{A},\sigma_\eta^2}(\cdot) < \frac{1}{\sqrt{2\pi}\sigma_\eta}$, for any given Δ, $\overline{k}$, $\underline{k}$, R, γ, and c_s, there exists a $\underline{\sigma}_\eta \in \mathbb{R}_+$ (and correspondingly, an $\overline{\alpha}_\eta \in \mathbb{R}_+$) such that if $\sigma_\eta \geq \underline{\sigma}_\eta$ (i.e., if $\alpha_\eta \leq \overline{\alpha}_\eta$) the rate of increase of the left hand side is strictly smaller than 1, the rate of increase of the right hand side. Then, the intersection point is unique.■

Proof of Proposition 2: When $\alpha_\eta \leq min\left(\overline{\alpha}_\eta, \widehat{\alpha}_\eta\right)$, $K_2^*\left(0, \Delta\right)$ is uniquely defined by (2) while $K_2^*\left(A_L, \Delta\right)$ is uniquely defined by (1). Note first that for $A_L = 0$, (2) coincides with (1), so that

$$K_2^*\left(A_L, \Delta\right)|_{A_L=0} = K_2^*\left(0, \Delta\right).$$

Further note that the left hand side and right hand side of (1) are both increasing in $K_2^*\left(A_L, \Delta\right)$ but only the left hand side is increasing in A_L. This implies that $\frac{dK_2^*(A_L,\Delta)}{dA_L} > 0$, so that $K_2^*\left(A_L, \Delta\right) > K_2^*\left(0, \Delta\right)$.■

Proof of Proposition 3: We first show that the threshold $K_2^*\left(A_L, \Delta\right)$ is decreasing in $\overline{k}$ and $\underline{k}$. Consider (1) which implicitly defines $K_2^*\left(A_L, \Delta\right)$. The result follows since the left hand side is decreasing in $\overline{k}$ and $\underline{k}$, and increasing in $K_2^*\left(A_L, \Delta\right)$, while the right hand side is unaffected by $\overline{k}$ and $\underline{k}$.

Now note that each term in (3) is decreasing in $\overline{k}$ and $\underline{k}$, and increasing in $K_2^*\left(A_L, \Delta\right)$, which in turn is decreasing in $\overline{k}$ and $\underline{k}$.■

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