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Getting to know each other: The role of toeholds in acquisitions☆

Paul Povel [a,*], Giorgo Sertsios [b]

[a] Bauer College of Business, University of Houston, Houston, TX 77204, United States
[b] School of Business and Economics, Universidad de los Andes, Santiago, Chile

A R T I C L E I N F O

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A B S T R A C T

We analyze the role of toeholds (non-controlling but significant equity stakes) as a source of information for a bidder. A toehold provides an opportunity to interact with the target and its management and in the process get a better sense of the possible synergies from a merger or takeover. A bidder considering taking over a target will take a toehold beforehand if the informational benefits are large. Our model makes the following predictions: (i) a toehold is more beneficial if a target is opaque, i.e., if it is generally harder to value potential synergies with the target; (ii) a toehold is incrementally more beneficial if a bidder initially finds it harder than others to assess the value of potential synergies; (iii) that incremental benefit is less important, however, if the target is opaque; and (iv) the benefits from having a toehold are smaller if the number of potential rival bidders is higher. We test these predictions using a large sample of majority acquisitions of private and public companies for which we have information regarding whether the acquirer had a toehold in the target company prior to the majority acquisition. We find evidence consistent with our hypotheses, and thus with the idea that potential acquirers of a target use toeholds to improve their information about possible synergies with the target.

1. Introduction

The main threat to the success of a takeover or merger is that synergies expected from a combination are not realized. Targets and acquirers hope to realize synergies from combining operations or distribution networks, because of complementarities, economies of scale and scope, market power, or because of overlaps that can be eliminated. Predicting the value of synergies, however, is far from trivial. Acquisitions are therefore high-risk decisions, and potential acquirers would benefit from being able to improve their estimates of possible synergies.

In this paper, we study the use of toeholds to improve the assessment of possible synergies. Toeholds are non-controlling equity stakes (less than 50% of the outstanding equity of the target), which can give their owner the opportunity to interact with the target or its management in ways that are not available to other bidders. For example, a toeholder may have the right to nominate a director on the target's board, helping her get a better sense of the target's operations and management. A toeholder may also cooperate with the target on the development of a product, or they may combine parts of their distribution networks. After cooperating for a while, the parties should find it easier to tell whether a full combination promises significant synergies, or whether the prospects are bad and a combination should not be attempted.

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* Corresponding author.
E-mail addresses: povel@uh.edu (P. Povel), gsertsios@uandes.cl (G. Sertsios).

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We propose a simple model of competitive bidding in which a potential acquirer can make her estimate of the possible synergies from an acquisition more reliable by first taking a toehold in the target. We study under what conditions a potential acquirer, considering a full takeover of the target, expects the largest informational benefits from having a toehold. Under those conditions, the benefits are most likely to exceed the financial and non-financial costs of acquiring a toehold (costly negotiations, management distraction, possible losses in the value of the toehold if a takeover does not take place, etc.). We test the predictions of the model using a large sample of majority acquisitions of private and public companies for which we have information regarding whether the acquirer had a toehold in the target company prior to the majority acquisition. To the extent that toeholds are more beneficial for potential acquirers, we should also observe a higher proportion of acquirers having a toehold prior to a takeover.

The key assumption in our paper is that toeholds give their owners more reliable information about possible synergies with a target. An initial inspection of our data suggests that the basic conditions for a toehold to improve information are satisfied: Toeholds are large (the average toehold in our sample is 27%) and they are held for fairly long periods of time (75% of the toeholds are held for at least 8 months prior to the majority acquisition).

We derive and test several results. Our first result is very intuitive: Toeholds are more beneficial if it is hard to value the possible synergies from an acquisition. For example, when targets are more opaque and thus generally harder to analyze for outsiders. Consistent with this prediction, we find that acquisitions are more likely to be preceded by toeholds if the target is younger and when it operates in an R&D-intensive industry.

Our second result concerns situations in which a potential acquirer is initially at a disadvantage, because her information about possible synergies with the target is less precise than other potential acquirers' information. We show that the benefit of acquiring a toehold prior to a takeover attempt is higher for such a disadvantaged bidder. The data support this prediction. We find that acquirers operating in different industries or originating from other countries than the target are more likely to have a toehold.

Next, we ask how sensitive a disadvantaged bidder's benefit from a toehold is to the opaqueness of the target. We find that although a less well-informed bidder benefits more from a toehold, the benefit is relatively less important when the target company is opaque. The intuition is that the initial disadvantage of the bidder is less important when the target becomes harder to evaluate for other bidders. Consistent with this prediction, we find that the likelihood that an acquirer from another country and other industry than the target has a toehold decreases when the target is younger and operates in an R&D-intensive industry.

We also consider how the intensity of competition affects our results. We find that the benefits of having a toehold are less important when there are more potential bidders. Intuitively, it is harder to exploit the benefits of more accurate information in a bidding contest when the number of competitors is larger. We use two measures to test this prediction empirically. First, we construct a measure of the potential number of bidders, using data on past acquisitions, both within an industry and across industries, and the number of public companies that operate in each industry. We use the *potential* number of bidders and not the *realized* number of bidders, because the realized number of bidders is endogenous to the toehold decision and because there is no comprehensive source of information for the real number of interested bidders (see Boone and Mulherin, 2007). Our measure of the potential number of bidders tries to capture the fact that a target should attract more potential bidders if it operates in an industry with many companies, or if its industry has historically seen many acquirers from *other* industries with many companies. We also use the target's size as a proxy for the number of potential bidders: The larger a target, the smaller the number of potential bidders, since acquirers are usually larger than their targets. Using either measure, the empirical evidence suggests that more competition makes it less likely that an acquirer has a toehold.

We use the ownership status (publicly traded vs. privately owned) of the targets to test whether alternative explanations exist for our findings. Specifically, we test whether agency considerations can explain our results. Agency problems should be less of a concern in privately held firms, compared with publicly traded firms. Thus, if agency considerations were to explain the coefficients we find on the targets' characteristics, we should expect more significant coefficients for publicly traded firms in our regressions. We find, however, that the coefficients on the targets' characteristics tend to be larger for privately held firms. This suggests that informational concerns are the stronger driver in the decision to take a toehold than agency considerations: The aim is to hold a toehold temporarily, to learn about possible synergies from a combination with the target, and then either to take over the target or to dispose of the toehold.[1]

Our theoretical and empirical results shed new light on the role of toeholds as “strategic stakes” in acquisitions. Our main contribution is to show that toeholds play an important informational role for potential acquirers. This role of toeholds has not been studied before. Most of the literature has focused on the role of toeholds in making a bidder more aggressive (referred to as the “strategic effect” below). In Burkart (1995) and Singh (1998), a toeholder bids above her valuation because doing so increases the price she receives for the toehold if she loses the takeover contest.[2] Their results are derived using auction models with

[1] Equity stakes aimed at resolving agency problems (see, e.g., Shleifer and Vishny, 1986) are usually built up secretly but must be revealed in SEC or FTC filings if they exceed 5% or certain nominal values, typically triggering takeover resistance from the target. The toeholds we observe in our data tend to be much larger, which supports our conclusion that agency concerns do not explain our findings.

[2] For theoretical extensions, see Bulow et al. (1999), Dasgupta and Tsui (2004), and Mathews (2007). For empirical tests of overbidding predictions, see Betton and Eckbo (2000).

perfectly informative signals. As our focus is on the role of the information structure, we require a model in which bidders are not perfectly informed about their valuation. However, we also allow for the strategic effect analyzed in the literature.

Other papers on toeholds explore possible costs of toeholds that may reduce the frequency of their use (see Ravid and Spiegel, 1999; Goldman and Qian, 2005; Betton et al., 2009). The effects studied in those papers arise when information disclosed (as required for large targets) after toehold acquisitions and eventual bids affects the price of the target's shares in the market. The emphasis in these papers is on “hostile” deals, where the typical bidder is a financial buyer and takeovers involve publicly traded targets. However, only a small fraction of takeovers involve publicly traded targets, and few of the toeholds in our sample are near levels that trigger disclosure (5% is an important cut-off).

Our focus, in contrast, is on strategic buyers, who hope to generate synergies in a “friendly” deal and need information about what synergies are feasible. In our setting, a bidder chooses to take a toehold if the informational benefit gained from taking a toehold is larger than the costs (caused by management distraction, costly negotiations and possible losses if a takeover does not take place). Our theoretical results compare how large the informational benefits are under different conditions, e.g., if one bidder is initially less well informed than other bidders; and in those comparisons, the cost of the toehold cancels out.

Earlier empirical papers on minority stakes have focused on a completely different rationale, namely their role in mitigating incentive problems. With an equity stake in a partner, the incentive to act opportunistically can be reduced.[3] We regard the two explanations (toeholds as sources of information vs. minority stakes taken to mitigate hold-up problems) as orthogonal. The underlying assumption in the hold-up rationale is that an optimally sized stake should be held indefinitely. In contrast, our focus is on toeholds that are meant to be temporary in nature: The final goal of a potential acquirer is either the full takeover of a target, or a disposal of the toehold. This distinction justifies our empirical strategy of focusing on acquisitions and asking which of them were preceded by a toehold: These toeholds were likely taken while considering a full acquisition of the target.

More broadly, our results also contribute to the literature that studies the role of information in acquisitions. See Higgins and Rodriguez (2006), who study strategic alliances in the pharmaceutical industry and find that they improve an acquirer's cumulative abnormal return (CAR) around acquisitions; or Cai and Sevilir (2012), who find similar results if acquirers and targets have directors in common. Importantly, while these papers focus on the returns to information in acquisitions, we focus on the endogenous choice to acquire information, prior to an acquisition decision (in our case, through a toehold). This channel has not been studied before.

In sum, our empirical findings support our theory, that toeholds can be used by potential acquirers to gather better information about the benefits of a takeover, before making a full bid. Given that there are other motivations for taking minority stakes, however, other theories may explain why takeovers are sometimes preceded by toeholds. For example, a minority stake may be taken to strengthen a customer–supplier relationship, or to help monitor a contractual counterparty if relationship-specific investments are required, and the owner of the minority stake then discovers that a full takeover would be a good idea. Even though the timing of the decisions in these examples (a toehold is taken, then its owner becomes interested in a full takeover) is different from that in our model, the intuition is consistent with the one we propose: The toehold also leads to an eventual takeover because it gave its owner better information about the benefits of a takeover. There may be other rationales for taking minority stakes, but in order to explain the evidence, the motivation must be linked to a target's opaqueness and to initial informational disadvantages for its acquirer. Thus, any such alternative explanation is likely based on a toehold providing information to its owner, irrespective of why the toehold was acquired.[4]

The rest of the paper proceeds as follows. We present a model with two bidders in Section 2. In Section 3 we examine the benefits from taking a toehold, and we derive empirical implications. Section 4 describes the data used for our empirical tests. We present and discuss the empirical findings (including possible alternative explanations) in Section 5. Section 6 concludes. All proofs are in Appendix A.

2. The model

In this section we introduce and analyze a simple model of competitive bidding to acquire a firm. One of the bidders can take a toehold before the bidding starts, making it easier for her to determine how beneficial the acquisition would be, and also changing her bidding incentives. We first present the model, then we describe the optimal bids, with and without a toehold.

A company (the “target”) is for sale, and the seller values the target at v_0. Two bidders, $i = 1,2$, expect stochastic synergies $t_i \in [l,h]$, $l \geq 0$, if they take over the target. For tractability, we assume that the synergies are uniformly distributed on $[l,h]$, with density $\frac{1}{h-l}$ and expected value $\frac{h+l}{2}$. If bidder i takes over the target, the value of the target is $u_i(t_i) = v_0 + t_i$.

[3] Allen and Phillips (2000) study cumulative abnormal returns (CAR) and changes in operating cash flow and investments of targets after a minority stake is taken. Fee et al. (2006) study equity stakes in upstream firms, allowing them to compare firm pairs with and without minority stakes. Ouimet (2013) compares minority stakes with full takeovers, arguing that full takeovers can create new incentive problems inside the target.

[4] A different possible rationale was suggested by the referee: A family firm may be for sale, but in order to ensure that the acquirer treats the employees well, including any family members retaining management positions, the selling family may insist on a gradual takeover process including an initial toehold. Information transmission here concerns a firm's “culture” instead of financial benefits.

The value of bidder i's synergy t_i is not observable. Instead, bidder i privately observes a noisy signal s_i,

$$s_i = \begin{cases} t_i & \text{with prob } \varphi_i \\ \tau_i & \text{with prob } 1-\varphi_i, \end{cases}$$

where t_i and τ_i are i.i.d., and $\varphi_i \in [0,1]$. Given the realized signal s_i, bidder i's expected valuation of the target is

$$v_i(s_i) = v_0 + \varphi_i s_i + (1-\varphi_i)\frac{h+l}{2}.$$

The variable φ_i measures the informativeness of bidder i's signal. The advantage of this specification is that changes in a signal's informativeness do not change the ex-ante riskiness of the bidder's valuation: The ex-ante distribution of possible valuations is not affected by changes in φ_i.[5]

Bidder 1 has the opportunity to take a toehold in the target, i.e., to own a non-controlling fraction $\alpha \in [0, \frac{1}{2})$ of the target's outstanding shares. We assume that the size of the toehold α is exogenously given. That assumption allows us to focus on changes in the information structure, and it is also consistent with descriptions of cases in our data set: Toeholds become available when a firm needs a certain amount for investment purposes ("growth capital"), and issuing less shares would be useless while issuing more would represent an unnecessary dilution of the existing ownership. Similarly, toeholds sometimes become available because the current owner of a stake wants to liquidate it. Determining the optimal α is relevant if a toehold is built up by buying shares anonymously in the market, with the goal of influencing the management of the target (see Ravid and Spiegel, 1999; Goldman and Qian, 2005; Mathews, 2007; Betton et al., 2009). However, in practice, "strategic buyers" (the focus of our empirical analysis) refrain from doing that, possibly because it creates a counterproductive hostile atmosphere. Our focus is thus on toeholds whose size and availability are not under the control of the bidders.

For our analysis, the exact cost (financial and non-financial) of a given toehold is not crucial. In our main results (which we test empirically), we compare the net benefit of acquiring a toehold of a given size in different circumstances. Thus, the cost of acquiring a toehold cancels out. For simplicity, we therefore assume that the price of a toehold is αv_0, reflecting the target's stand-alone value.

We assume that owning a toehold makes the toeholder's signal more informative, i.e., $0 \leq \varphi_2 < \varphi_1 \leq 1$. The underlying assumption is that the toehold has a significant size, such that the toeholder is one of the largest shareholders and therefore has access to information that would not be available otherwise.[6] Often, toehold acquisitions explicitly include the right to appoint a director. In other cases, toehold acquisitions are part of a plan to cooperate on some level, say, marketing the target's or the toeholder's products or services, giving both sides information about the possible synergies from combining the operations.[7] In many ways, we expect a toeholder to have access to information that helps her determine whether a combination with the target (a merger or an acquisition) would be beneficial or not. There may be large synergies, from cost-cutting (because of overlaps in production or marketing, say), from cross-selling, from access to new distribution channels, or from a realization that the two firms' R&D efforts are highly complementary. If the toeholder's interaction with the target suggests that significant synergies can be realized, the toeholder becomes a strong bidder. If instead she realizes that the potential for synergies is limited or inexistent, she will prefer to dispose of the toehold. One way to do so is to put the target "in play," fail to put up resistance when other bidders show interest, and then lose the bidding contest.

Of course, a toeholder needs time to discover information about the promises of an acquisition. While having a significant stake may give a shareholder access to confidential data, the synergies we have in mind require information of a softer nature: The firms need to cooperate for a while to find out how successful their cooperation is, for example. We thus expect that the *informational* benefits from a toehold accrue with a delay. That is not the case for the purely strategic effects emphasized in the literature: A bidder's incentives are changed immediately upon becoming the owner of a toehold. The empirical evidence we discuss below (in Section 4) supports our emphasis on the informational benefits, since the median delay between taking a toehold and the majority acquisition is 15 months (the 25th percentile is 8 months; similar findings are reported in Betton et al. (2009)).

After the bidders observe their signals, the target is sold in a second-price sealed-bid auction. If the toeholder wins, she purchases the shares she does not yet own at a price that equals the second-highest (losing) bid. If the non-toeholder wins, she buys all shares, including the toeholder's. Ties are resolved in favor of the non-toeholder (this is without loss of generality but simplifies the analysis).[8] The second-price sealed-bid auction has several benefits: It is easy to analyze (non-toeholders have

[5] Like many earlier papers in the takeover literature (see, e.g., Fishman, 1988; Burkart, 1995; Singh, 1998; Daniel and Hirshleifer, 1998; Ravid and Spiegel, 1999), we use a "private values" auction setup, i.e., we focus on "strategic" bidders, who hope to realize idiosyncratic synergies. Auction models with noisy valuations are relatively rare. Our information structure (private values, noisy signals) has been used in Povel and Singh (2010), to analyze stapled finance, i.e., optional seller financing in takeovers.

[6] That is consistent with what we observe in the data: The average toehold size is 27% (see below, in Section 4).

[7] Here are a few examples: (1) In 2009 *Standard Microsystems Corp.* (*SMSC*) provided growth capital for *Symwave Inc.* The president of *SMSC* joined *Symwave*'s board of directors; the majority acquisition was 15 months later. (2) In 2009 *Meredith Corp.* acquired a minority equity stake in *The Hyperfactory*; the parties agreed that *The Hyperfactory* would work with *Meredith*'s integrated marketing unit; the majority acquisition happened 1 year later. (3) In 2010 *Kinross Gold Corporation* made a PIPE investment in *Red Back Mining*; *Kinross* had the right to appoint one director; the majority acquisition happened 3 months later.

[8] Without this assumption, the toeholder would sometimes prefer to bid an infinitesimal amount less than the equilibrium bids derived below, which requires that we introduce discrete currency units.

dominant strategies), and in our private values setup, it is strategically equivalent to an ascending auction, in which bids are publicly raised until all but one bidder have withdrawn from the bidding. While takeover auctions often have more complicated structures, in practice, bidders can usually top any existing bid, and the current legal practice requires that a target's directors permit and consider unsolicited bids. In other words, for all practical purposes, takeover contests resemble ascending auctions, which can be analyzed using the language of second-price sealed-bid auctions.[9]

We now derive the optimal bids, with and without a toehold, and we discuss how a toehold affects its owner's expected payoff. (For details of the derivation of the expected payoff functions, see Appendix A.3).

2.1. Optimal bids

Bidders without a toehold have a dominant strategy:

Lemma 1. *Without a toehold, it is a weakly dominant strategy to bid the valuation, given the observed signal.*

We assume that bidder 1 has the option of taking a toehold, while bidder 2 cannot do so. Thus, when describing bids or payoffs in the absence of a toehold, we use a subscript 2, for clarity. Lemma 1 describes bidder 2's equilibrium bid, which is strictly increasing in her signal. The inverse of her bid function is:

$$\beta_2(b) = \frac{b - v_0 - (1-\varphi_2)\dfrac{h+l}{2}}{\varphi_2} \quad \text{if} \;\; b \in [v_2(l), v_2(h)].$$

Finding the toeholder's (bidder 1's) optimal bids is not as straightforward. Her possible valuations are more dispersed, since her signal is more informative. The condition $\varphi_2 < \varphi_1$ implies that $v_1(l) < v_2(l) \le \frac{h+l}{2} \le v_2(h) < v_1(h)$. The toeholder's valuation (with a signal s_1) equals the nontoeholder's valuation with a signal s_2 if $s_1 = \sigma_1(s_2)$, defined as:

$$\sigma_1(s_2) = \frac{\varphi_2}{\varphi_1} s_2 + \frac{\varphi_1 - \varphi_2}{\varphi_1} \frac{h+l}{2}.$$

That creates a need for case distinctions, but it also allows for realistic problems: With a low signal, the toeholder is unlikely to win, since her less well-informed rival's expected valuation is likely to be higher than hers. On the other hand, with a high signal, the toeholder's valuation is higher, so she is willing to bid higher than the rival, and she wins with a high probability.

Lemma 2. *Define* $\hat{s}_1 = \sigma_1(l - \alpha(h-l))$. *The function*

$$b_1^*(s_1) = \begin{cases} v_2(l) & \text{if} \quad s_1 \le \hat{s}_1 \\ v_1(s_1) + \dfrac{\alpha}{1+\alpha}(v_2(h) - v_1(s_1)) & \text{if} \quad \hat{s}_1 < s_1 \le \sigma_1(h) \\ v_1(s_1) & \text{if} \quad \sigma_1(h) \le s_1 \end{cases}$$

describes optimal bids for the toeholder, given signals s_1.

With a low signal, $s_1 \le \hat{s}_1$, the toeholder's valuation is certainly lower than the rival's, so she prefers to lose with certainty. The optimal bid is $v_2(l)$, which maximizes the price she will receive for her toehold (notice that $v_2(l)$ is higher than $v_1(s_1)$ for such signals, so the toeholder overbids). With intermediate signals, $\hat{s}_1 < s_1 < \sigma_1(h)$, she bids above her valuation because this increases the price of her toehold if she loses, but she risks overpaying if she wins. Obviously, the larger the toehold α, the more attractive it is to overbid in this intermediate range of signals (more shares are sold at a higher price if she loses, and less shares must be purchased at a possibly excessive price if she wins). With high signals, $s_1 \ge \sigma_1(h)$, there is no benefit from overbidding, since the toeholder is certain to win with any bid larger than $v_2(h)$, so bidding the valuation $v_1(s_1)$ is optimal.

2.2. How a toehold affects its owner's expected payoff

A toehold has two effects on the toeholder's situation: It improves the toeholder's information about possible synergies with the target, so she puts more emphasis on her own information; and the toeholder's bid increases because she is partly a seller, so her bid acts as a reserve price if she loses. The latter is the “strategic effect” analyzed in Burkart (1995) and Singh (1998), using setups with perfectly informative signals. Our aim is to explore the effects of changes to the information structure, while allowing for the strategic effect.

To better understand the effect of improved information, we can “switch off” the strategic effect temporarily, by assuming that the toehold is of negligible size, $\alpha \approx 0$. Doing so allows us to focus entirely on changes in the information structure. A toehold improves a bidder's information about the benefits from taking over a target. More precise information improves a bidder's ability to earn rents, as we show in the next result. Interestingly, a bidder also benefits if her *rival* becomes better informed.

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[9] All results hold if $\alpha \approx 0$. Under that assumption, it is also straightforward to analyze a setup with both private-value and common-value components: If the payoff depends on both true synergies, $u_i(t_i) = v_0 + \pi t_i + (1-\pi)t_j$, with $\pi \in (\frac{1}{2}, 1)$, the results are unchanged.

Lemma 3. *Absent any toeholds, a bidder's expected payoff increases if her own signal becomes more informative; it also increases if her rival's signal becomes more informative.*

The beneficial effect of increases in the informativeness of the *rival*'s signal may initially seem counter-intuitive: A bidder benefits if her rival becomes better informed, irrespective of which bidder initially has the more informative signal. The intuition is that a better-informed rival has more dispersed possible valuations, so if bidder 1 wins, the price is likely to be lower; while if she loses, the payoff is unchanged (in the absence of a toehold).

This effect is amplified when we reintroduce the strategic effect (i.e., $0 < \alpha < \frac{1}{2}$): If the toeholder loses against a better informed rival, the expected price received for the toehold increases, since the rival's bids are more dispersed. The more informative the toeholder's signal, the better she can take advantage of this second benefit.[10] Notice, though, that all our results hold even if $\alpha \approx 0$, so they do not rely on the strategic effect.

3. The benefits of taking a toehold

How attractive is it for firms to take a toehold in another firm, given different information structures? Arguably, taking a toehold involves costs, both financial and non-financial (costly negotiations, management distraction, risks of information leakage, etc.) A bidder will take a toehold only if the benefits are larger than the costs. We now analyze what determines the benefits of taking a toehold and thus what makes a bidder more likely to take a toehold.

Proposition 1. *If both bidders initially have signals with equal informativeness φ_2, a reduction in φ_2 makes it more beneficial for a bidder to take a toehold.*

A change in φ_2 affects the toeholder's payoff, but it also affects the payoff that this bidder could earn if no bidder had a toehold. If φ_2 decreases, the payoff in the absence of a toehold is reduced, since less well-informed bidders find it harder to earn rents. The possibility of gaining better information through a toehold therefore becomes more important.

Thus, if outsiders find a target difficult to analyze, then taking a toehold becomes more attractive. And after taking into consideration the possible costs of taking a toehold, we are more likely to observe toeholders in targets that are more opaque and generally harder to analyze and value. Two standard proxies for the difficulty to analyze targets are firm age (younger firms have less data that can be analyzed) and R&D intensity (R&D projects may be hard to evaluate for outsiders). Thus, target age is an inverse proxy for φ_2, and industry R&D-intensity is a proxy for φ_2, and we can derive the following empirical implications:

Hypothesis 1. *If a target is young or is operating in an industry with a high R&D ratio, then it is more likely that its acquirer has a toehold.*

In some cases, all non-toeholders have access to information of comparable quality. In other cases, some bidders may be at a disadvantage, because the information to which they have access is less reliable than that of other bidders. Assume that bidder 1 has — in the absence of a toehold — access only to inferior information about the target. Specifically, the informativeness of her signal is $\varphi_0 < \varphi_2$. If bidder 1 takes a toehold, however, she leap-frogs her rival's degree of informativeness (a toeholder's signal has informativeness $\varphi_1 > \varphi_2$).

Proposition 2. *The benefit from taking a toehold is larger for a bidder with inferior information.*

This is a very intuitive result: A bidder with particularly unreliable information will find it more beneficial to become informed than a rival whose information is more reliable to begin with. This suggests that after taking into consideration all costs of taking a toehold, the bidders most likely to benefit from it are bidders whose information is less reliable. Examples include bidders from different industries or bidders that are headquartered in different countries. Arguably, such bidders should find it harder to evaluate a target, and to assess the synergies that can be realized after a takeover, and they should thus be more likely to take a toehold than rival bidders that operate in the same industry or country as the target.[11]

Hypothesis 2. *Acquirers operating in different industries or originating from other countries than the target are more likely to have a toehold.*

We now ask how the incremental benefit from a toehold for an initially disadvantaged bidder depends on the informativeness of the other bidders' signals. Fig. 1 illustrates what we are asking. First, bidders may initially be symmetric,

[10] If both bidders could buy a toehold each, our results would remain unchanged. Intuitively, if the rival has a toehold, the effect of key parameters on the benefit from taking a toehold are qualitatively the same. Another possible extension is to allow for competition for a single toehold before the signals are observed. That would reduce the bidders' rents, but the benefit from a toehold, once acquired, is unchanged, so our results continue to hold.

[11] Foreign bidders may be at a disadvantage, because it could be harder to integrate a target from a different country. So the synergies could be lower than for domestic bidders. However, the synergies could also be higher, because the target gets access to new, foreign markets, or to new technology. Thus, the main difference between foreign and domestic bidders may be that the uncertainty about the possible synergies is larger for foreign bidders. If so, their incentive to take a toehold is increased, which reinforces our result.

i.e., both bidders' signals have informativeness φ_2, and bidder 1 can improve her information by taking a toehold (she can increase her signal's informativeness to $\varphi_1 > \varphi_2$). Second, bidder 1 can initially be at an informational disadvantage, because her signal's informativeness is $\varphi_0 < \varphi_2$ (the rival's signal has informativeness φ_2), but, again, she can take a toehold and increase the informativeness to $\varphi_1 > \varphi_2$. We are interested in how the size of the benefit from a toehold changes in both cases, if we vary φ_2.

Proposition 3. *Changes in φ_2 have a stronger effect on the benefit from taking a toehold if the bidders are initially symmetric than if bidder 1 initially has a less informative signal.*

The intuition for this result is simple: If it becomes harder for non-toeholders to assess possible synergies, then the initial disadvantage of a less well-informed bidder becomes less relevant. With either initial degree of informativeness, the benefit from taking a toehold increases if φ_2 decreases; but the benefit for an initially disadvantaged bidder increases by less, since the initial disadvantage is reduced (the initial degrees of informativeness, φ_2 and φ_0, become more similar), so the *extra* benefit from taking a toehold is smaller.

Hypothesis 3. *Acquirers operating in different industries or originating from other countries than the target are less likely to have a toehold if the target is younger or is operating in industries with higher R&D ratios.*

The benefit from a toehold should also depend on how many rival bidders a potential toeholder faces, since an increase in the number of rivals changes the strength of the strongest competitor. Specifically, the expected highest rival bid increases with the number of rivals. That should affect the toeholder's payoff, and therefore the benefits from taking a toehold. With a high (but not very high) signal, the chances of winning decrease if the number of rivals increases, and the chances of winning at a low price also decrease. Both effects decrease the toeholder's payoff. On the other hand, the expected price at which the toehold is sold after losing the auction increases, which increases the toeholder's payoff.

It is straightforward to adapt our analysis to the case with two or more rival bidders; for details, see Appendix A.8. The optimal bid function is the same as the optimal bid function in the case of only one rival. Even though the toeholder's optimal bid is easy to characterize, analyzing changes to her payoff as n increases is difficult. We cannot derive general results algebraically. However, the case with infinitely many rival bidders *can* be analyzed algebraically. In the limit as $n \to \infty$, the rivals' highest and second-highest bids converge probabilistically to $v_2(h)$. So with a signal $s_1 \leq \sigma_1(h)$, the toeholder's chances of winning decrease in n, but the price that she expects to receive for her shares increases. If the realized signal is $s_1 > \sigma_1(h)$, the toeholder is certain to win with any n (with a bid that equals her expected valuation, $v_1(s_1)$). The price she expects to pay for the remaining shares increases with n, so her payoff is reduced, although that price does not depend on her bid. Thus, in the limit as $n \to \infty$, the toeholder's optimization problem simplifies: If $s_1 > \sigma_1(h)$, she bids $v_1(s_1)$ and wins; and if $s_1 \leq \sigma_1(h)$, she bids $b_1^*(s_1)$ and loses against a highest bid of $v_2(h)$. Without any toeholds, the payoffs for all bidders converge to zero as $n \to \infty$. We can now compare the benefits of taking a toehold with either one or many rivals.

Proposition 4. *If $\varphi_2 < \frac{1-9\alpha}{(1+\alpha)(1-2\alpha)}\varphi_1$, the benefit of having a toehold is smaller in the limit as $n \to \infty$ than in the one-rival case.*

We also studied numerical examples for finite numbers of rival bidders. The results are qualitatively similar to those for the limit case: With more rival bidders, the likelihood that the toeholder wins at a low price decreases; however, the likelihood that she loses at a high price increases, which is beneficial if she can get a good price for the toehold. The net benefit of increased competition depends on the size of the toehold and on the informativeness of the rival bidders' signals: The less informative their signals, the less dispersed their bids are, implying that the expected highest rival bid is lower.

Both the limit case and the examples we looked at suggest that if the toeholder's signal is sufficiently more informative than those of her rivals, the benefit from taking a toehold is larger with less rivals. Assuming that the informational benefit from a toehold is large, this implies the following:

Hypothesis 4. *An acquirer is less likely to have a toehold if she faced a larger number of rival potential bidders.*

In the following, we describe our data set and then test Hypotheses 1 to 4 empirically.

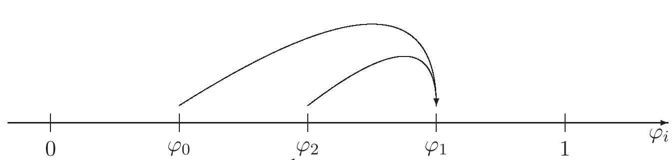

Fig. 1. Information structure, effects of changes in φ_2. The informativeness of a bidder's signal improves from φ_2 or $\varphi_0 < \varphi_2$ to $\varphi_1 > \varphi_2$ if she takes a toehold. The non-toeholding rival's informativeness remains at φ_2. An increase from $\varphi_0 < \varphi_2$ to $\varphi_1 > \varphi_2$ creates a larger benefit than an increase from φ_2 to $\varphi_1 > \varphi_2$, but the effect is smaller if φ_2 is low.

4. Data

4.1. Data sources

Our main data source is Capital IQ, a web-based information service that provides information on companies' financials and deals. Capital IQ started its coverage of acquisitions in 1998. One important advantage over other traditional data sources, such as SDC, is that it contains more information on private companies, such as the value of their assets and the year they were founded. We collect information on majority acquisitions of US and Canadian targets — public and private — from Capital IQ for the years 1998–2010.[12] We exclude LBO deals,[13] acquisitions of carveout companies, deals with missing data on the target or the acquirer's industry, and deals in which the target is acquired out of bankruptcy (Chapter 11). There are 100,528 majority acquisitions that satisfy these criteria.

Capital IQ contains information regarding the nature of the acquisition. In case the acquirer had a toehold prior to the acquisition of the majority stake, Capital IQ classifies the deal as "Minority Shareholders Purchasing remaining Share" or "Minority Shareholders Increasing Ownership Stake" with "Change of Control." There are 1,001 deals in which a prior minority ownership is reported. We supplement Capital IQ data with SDC data. In SDC we find another 242 majority acquisition deals that were preceded by toeholds.[14] We restrict our final sample to observations for which there is information regarding the year target firms were founded, as without this information we cannot compute their age at the time they were acquired. The year the target company was founded is available in Capital IQ for 647 acquisitions where the acquirer had a toehold and for 48,066 majority acquisitions where the acquirer had no prior equity stake. We supplement the information on the year the target was founded for acquisitions preceded by toeholds through internet searches, finding information for an additional 297 observations. Our final sample consists of 49,010 majority acquisitions; for 944 of these acquisitions the acquirer had a toehold in the target company.[15]

4.2. Empirical strategy

Our empirical tests study the likelihood that an acquirer (i.e., a winner of a takeover contest) had a toehold before an acquisition. Our main variable of interest is the dummy Toehold, which takes a value of 1 if the acquirer had a toehold in the target company prior to the majority acquisition, and zero otherwise. We ask under what conditions the dummy Toehold is more likely to take a value of 1. Thus, we estimate variations of the following probit model:

$$Toehold_i = \alpha + \beta'\mathbf{X}_i + \gamma'\mathbf{Z}_i + \varepsilon_i \quad (1)$$

where the subscript i indexes acquisitions, $\mathbf{X}_i$ is a vector of explanatory variables that we use to test the four hypotheses derived from our model, and $\mathbf{Z}_i$ is a vector of control variables.

Notice that while our model makes predictions about the likelihood of having a toehold with the intention of acquiring the target in the future, the dummy Toehold captures that likelihood times the ratio of probabilities of winning a takeover contest with and without a toehold. Thus, in our empirical setting, if the explanatory variables we use affect the ratio of probabilities of winning — with and without a toehold — in a systematic way, this could bias our estimates, leading to wrong conclusions about the validity of our model. We address this concern by studying whether variations in the informational benefits from a toehold could change the ratio of probabilities of winning. The derivations are in Appendix B.[16] For some of our predictions, the ratio of probabilities does not change; while for our other predictions, the probability ratio biases our results *against* finding the predictions of our model. Thus, if the empirical results we present support our theoretical predictions, it is in spite of a small bias towards accepting the null hypothesis of *no-effect* of some explanatory variables.[17]

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[12] We define a majority acquisition as one where the final stake of the acquirer is larger than 50%, and the acquisition implied a change of control in the target company. We only consider acquisitions where the buyer is catalogued as "strategic buyer" by Capital IQ.

[13] LBO deals represent 9% of the majority acquisitions in the sample period.

[14] Out of the 242 majority acquisitions preceded by toeholds reported by SDC that were not reported by Capital IQ, 132 (55%) correspond to deals executed during the first 4 years of Capital IQ's coverage (1998–2001). This indicates that Capital IQ coverage was not as comprehensive in its earlier years. In recent years, Capital IQ has more coverage than SDC. For instance, in 2010, Capital IQ registers 84 acquisitions preceded by toeholds not registered by SDC, while SDC only registers 16 such deals not included in Capital IQ.

[15] Capital IQ provides information about previous joint-ventures/strategic alliances between the target and the acquirer. In our final sample there are 231 majority acquisitions that were preceded by joint-ventures/strategic alliances. For 38 observations the acquirer has both a toehold and a joint-venture/strategic alliance with the target before the majority acquisition. All our results hold if we drop these observations.

[16] There is some evidence that toehold bidding increases the probability of winning the target (see Walkling, 1985; Betton et al., 2009). However, there is no evidence regarding how the ratio of probabilities is affected by variables related to the parameters of our model, which account for a toehold's informational benefit.

[17] To perfectly test our model empirically would require a more comprehensive data set, with information about all companies that are potentially interested in a target, in addition to those that actually acquired a target. Unfortunately, such data are not available. Traditional datasets, such as SDC, only report official bids, although the number of companies with initial intentions of participating in a takeover acquisition can be much larger (see Boone and Mulherin, 2007). SDC reports that more than 90% of the acquisitions of publicly traded targets have only one official bidder (Betton et al., 2009), and for private targets this number is close to 100%. Therefore, SDC bidding data would only provide a minimal improvement in our empirical setting, with the important drawback of having less information about the targets' characteristics.

4.3. Explanatory variables

We classify the variables that affect the likelihood that an acquirer has a toehold into 3 categories. The first category relates to the opacity of the target firm. The benefit from having a toehold before a majority acquisition increases when the target is more opaque, as having a toehold increases the precision of the acquirer's signal of the true synergies (Hypothesis 1). The second category is the initial informational disadvantage of the acquirer. Acquirers with a priori less precise information than other potential buyers are more likely to benefit from having a toehold before the majority acquisition and overcoming their initial informational disadvantage (Hypothesis 2). This effect, however, is expected to be less important when the target is more opaque (Hypothesis 3). The third category is the competitiveness of the contest. When a contest is highly competitive, the benefit of having more precise information on the value of the synergies — by acquiring a toehold — is reduced (Hypothesis 4).

We use two variables that capture the difficulty in evaluating a target from the perspective of any potential acquirer (i.e., the target's opacity). The first variable is the target's age. The younger the target, the less likely it is that an acquirer has been able to gather valuable information about it. We construct this variable as the difference between the year of the majority acquisition and the year the target company was founded. The second variable that measures the difficulty in evaluating a target is the target's industry R&D/Asset ratio.[18] Firms that operate in industries where R&D plays an important role are more difficult to evaluate, as the values of projects depend largely on intangibles. We measure the R&D/Asset ratio at the industry level rather than at the firm level, as for many targets there is no information about assets or R&D expenses. We define 48 industries following Fama and French (1997).[19] The industry-year R&D/Asset ratio was constructed using all publicly traded companies in Compustat.

The second set of variables measure the acquirers' ex-ante informational disadvantage relative to other potential bidders. The first of these variables is a dummy that takes a value of 1 if the acquisition was cross-border, and zero otherwise. When the acquirer and the target are from different countries, it is more likely that the acquirer has more noisy information about the target (and possible synergies with it) than other potential acquirers that operate in the same country as the target. The second variable that measures the acquirer's ex-ante informational disadvantage is a dummy that takes a value of 1 if the target and the acquirer belong to different industries and zero otherwise. The intuition is that a potential buyer finds it easier to analyze the target when she is more familiar with the industry.

We use two variables to measure the ex-ante competitiveness of a potential takeover contest. Our first measure is the number of potential bidders in the takeover contest. The higher the potential number of bidders, the more competitive the takeover contest is (Boone and Mulherin, 2008). The *potential* number of bidders is more likely to capture the competitiveness of the takeover contest than the *realized* number of bidders for two reasons. First, the potential number of bidders is not endogenous to the selling procedure or the toehold decision. Second, the data reported by traditional datasets, such as SDC, on the number of bidders only reflect official bids, ignoring the companies that were originally interested in the target but did not submit official bids (see Boone and Mulherin, 2007).

We construct the variable Potential Bidders for each target at the industry level. The computation is as follows. First, we construct the probability that a company in industry i is acquired by a company from industry j using data on majority acquisitions from our sample. For example, we find that 44% of the acquirers of firms in the computer industry also belong to the computer industry; 28% belong to the business service industry; 4.5% belong to the electrical equipment industry, etc. Additionally, from Compustat, we obtain the number of public firms by industry-years.[20] Then, for each industry i we multiply the probability that an acquirer belongs to industry j times the number of public companies in industry j two years before the majority acquisition takes place. Summing these products across industries yields our proxy for potential bidders for a target in industry i in year t. Implicit in its computation is the assumption that the real number of firms interested in a target is proportional to the number of public companies in the target's industry and related industries. We use the number of public companies 2 years prior to the majority acquisition, to better capture the scenario that the acquirer might be facing at the time she decides whether to purchase a toehold or not.

Ideally, the variable Potential Bidders should adjust for firms' size as acquirers are typically larger than targets, and thus the number of potential bidders larger than a target is decreasing in the target's size. However, as our sample is composed of many privately held targets, the data on targets' assets is far from comprehensive, and we would have lost many observations when adjusting the variable Potential Bidders for firms' size. To account for the fact that the number of firms interested in acquiring a target typically decreases with the target's size, we utilize the size of the target as our second measure of competitiveness in a takeover. We obtain the target's book value of assets for 8,605 firms in the sample. Assets are expressed in 2010 $ millions. The advantage of using 2 separate variables for competitiveness is that we do not limit our tests of the competition hypothesis to a subset of the sample; we can use our complete sample when using the Potential Bidders variable, and we limit our sample size only when we include both variables together, Potential Bidders and Assets.

Finally, as a control, we also include a dummy variable that indicates whether the target company is privately held or publicly traded. In our setting, the dummy Private captures two opposite effects. On the one hand, it is harder to acquire equity stakes in

[18] We do not consider other variables previously used to capture opacity, analyst coverage and the dispersion of analyst earnings forecasts, as 87% of the target firms in our sample are private firms.

[19] Capital IQ provides its own industry classification. Our results are qualitatively unaltered when we use this alternative classification.

[20] We use the world-wide number of public firms by combining Compustat North America and Compustat Global. When only considering North American companies all our results hold.

Table 1
Summary statistics.

This table shows descriptive statistics of our sample, which is composed of 49,010 majority acquisitions for US and Canadian targets, from 1998 to 2010. The data contains all majority acquisitions reported in Capital IQ, excluding LBO deals, deals in which the target company was bankrupt, and deals for which the target's founding year was not available, or its industry classification could not be obtained. This data was supplemented with data on acquisitions preceded by toeholds from SDC. The variable Toehold takes a value of 1 if the acquirer had a toehold in the target prior to the majority acquisition, and zero otherwise. The variable Private takes a value of 1 if the target company is a private company, and 0 if it is publicly traded at the time of the acquisition. The variable Age shows the age of the target company, in years, at the time of the majority acquisition. The variable R&D/Assets shows the ratio of R&D expenses over total assets by industry-year for the industry of the target company in the year it was acquired. The industry-year R&D ratio was constructed by averaging the R&D to Assets ratio from all companies in Compustat. The industry definitions follow the 48 industry classifications in Fama and French (1997). The variable Cross-Border takes a value of 1 if the target and the acquirer are from different countries, and zero otherwise. The dummy Different Industry takes a value of 1 if the target and the acquirer operate in different industries, and zero otherwise. The variable Potential Bidders is a weighted average of the total number of public companies that operate in industries that are likely to acquire companies in the target's industry. Total Assets is the book value of targets' assets at the time of the acquisition in 2010 US$ millions. The variable Toehold Size is the fraction of the target company owned by the acquirer before the majority acquisition for acquisitions preceded by toeholds. Final Ownership Stake is the fraction of the target company that the acquirer owns after a majority acquisition that was preceded by a toehold.

Variable	Mean	Median	Pctile 10	Pctile 90	SD	N
Toehold	0.02	0.0	0.00	0.00	0.14	49,010
Private	0.87	1.0	0.00	1.00	0.34	49,010
Age	21	13	3	54	21	49,010
R&D/Assets (%)	0.04	0.02	0.00	0.11	0.05	49,010
Cross Border	0.14	0.0	0.00	1.00	0.35	49,010
Different Industry	0.43	0.0	0.00	1.00	0.50	49,010
Potential Bidders	629.1	559	266.7	1,071.8	307.3	49,010
Total Assets (millions)	297.7	31.40	0.035	1,062.9	587.02	8,605
Toehold Size	27.19	26.00	7.30	49.00	14.72	858
Final Ownership Stake	93.61	100.00	66.50	100.00	14.07	920

companies whose shares are not publicly traded. Thus, we should observe less toeholds being taken when the target company is private. We call this the "liquidity" effect. Second, private companies are typically more opaque. According to Hypothesis 1, toeholds are more likely to be taken in opaque targets. We call this the "opacity" effect. The net effect is theoretically ambiguous, and the relevance of practical (liquidity) vs. informational concerns for privately held targets is therefore an empirical question.

4.4. Summary statistics

The summary statistics for the variables described above are presented in Table 1.[21] The first takeaway from Table 1 is that acquirers with a toehold in the target firms prior to the takeover account for 2% of the majority acquisitions. This number is smaller than what has been shown in other papers (e.g., Bates et al., 2006; Betton et al., 2009). This difference is due to the fact that previous papers only study toeholds in publicly traded targets, where toeholds are more common. In our sample, 87% of the targets are private companies. The fraction of acquirers who had a toehold is 1.4% in privately held targets. For publicly traded targets, this ratio much higher, at 5.4%. Thus, when considering publicly traded targets, our statistics are in line with those of previous papers in the literature.

The mean age of a target at the time of its takeover is 21 years; 14% of the acquirers are from a different country than the target company; and 43% of the acquirers operate in an industry different from that of the target. As mentioned above, we have information regarding the targets' book value of assets (at the time of their takeover) for 8,605 observations, only. The mean size of a target's assets is close to $300 million. Although not shown in the table, it is worth noticing that 3197 out of the 8,605 asset observations correspond to private companies. Thus, when including assets as an explanatory variable in a regression setting, we are considering both private and public firms. Moreover, there is substantial variation in the dummy Toehold both for public and private companies within the subsample for which there is data on targets' assets. This implies that in a regression setting we can control for the target's ownership status and asset size at the same time. Regarding the frequency of publicly traded acquirers in our sample, it is highly dependent on the ownership structure of target companies: when targets are publicly traded firms, 64% of acquirers are publicly traded companies; while when targets are privately held, the composition reverts, with only 36% of acquirers being publicly traded companies.[22]

From SDC and Capital IQ we are able to obtain information regarding the toehold size for 858 out of the 944 acquisitions where the acquirer had a toehold. We also find the final ownership stake for 920 of these acquisitions. We show the summary statistics for these variables in the bottom two rows of Table 1. The average toehold size is quite substantial at 27%, and the average final stake is 94%, very close to full ownership. To better understand the distribution of these variables, we plot them in Fig. 2. The main takeaway from these distributions is that acquirers' toeholds have substantial variation in their size, with large toeholds (near 50%) being slightly more frequent. The final ownership stake, on the other hand, is concentrated on the right of the distribution.

[21] Targets' age, assets and potential number of bidders are winsorized at the 5% level, to avoid obtaining results driven by outliers. Our results are not modified by this procedure.
[22] In unreported results, we have rerun all our regressions controlling for the ownership structure of the acquirer. All the results hold.

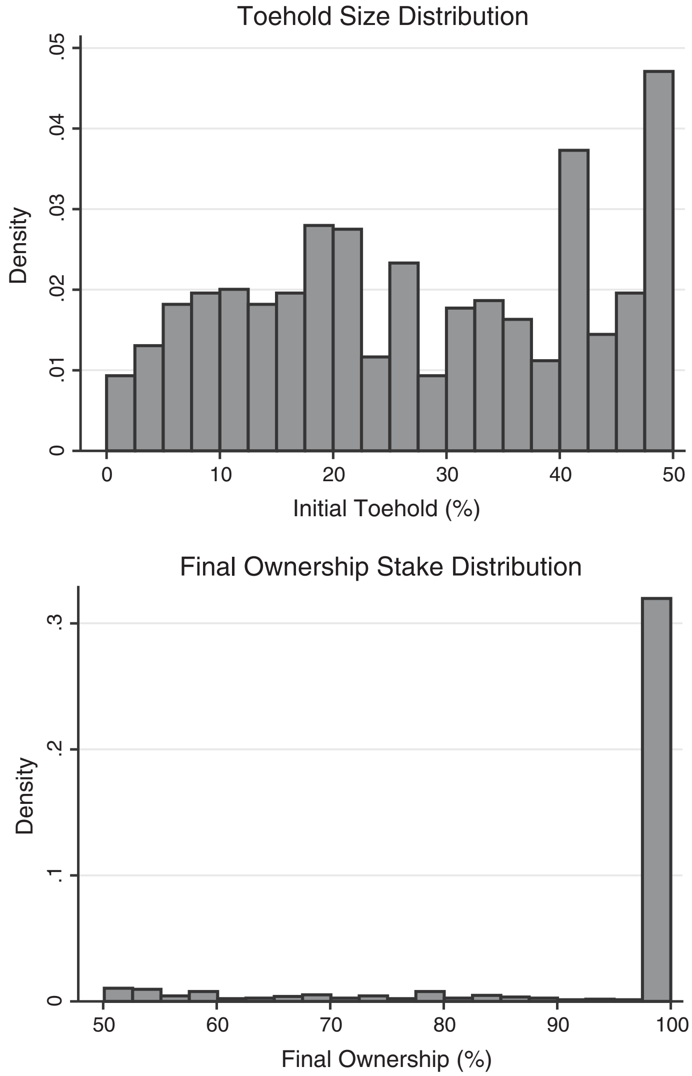

Fig. 2. Toehold and final ownership distribution. Panel A shows the size of the toehold that preceded an acquisition, and Panel B the size of the final ownership stake, for 858 acquisitions preceded by a toehold. The toehold size is dispersed and on average quite high (the mean toehold size is 27%). The final stake is close to full ownership for most deals (94% on average, 100% in four out of the five deals). Panel A: Toehold ownership distribution. Panel B: Final ownership distribution.

Eighty percent of the deals have a final ownership of 100%.[23] That is, most of the deals in our sample end with a complete acquisition of the target company.

To understand how toeholds came into place in our sample, we look for information about the toehold transaction itself in Capital IQ for the deals in which the toeholder ends up acquiring the company. We find descriptions for 155 such deals. Table 2, Panel A, presents this information. The left column of this table shows the form in which the toehold was taken and column II shows the number of deals we observe for each toehold form. Ninety five deals are categorized as acquisitions of minority stakes (61 in private targets and 34 in publicly traded targets), representing 61% of the 155 deals for which we have information. The rest of the toehold transactions take different forms: There are 26 deals in which the initial stake was bought in a PIPE transaction; 22 deals in which the initial stake was part of a VC transaction; 11 initial stakes were part of private equity deals; and for one deal the initial equity stake was obtained by a strategic buyer in a LBO of the target company. Also, the average initial stake in these deals varies with the toehold form. The mean toehold size in a minority stake acquisition is 31%, while toeholds acquired in PIPEs, VC and Private Equity transactions are about 20% of the target company. These patterns highlight that there is important heterogeneity in how acquirers obtain toeholds in targets. They also highlight that the sizes of the equity stakes are highly dependent of the context or form in which they were acquired.

Where we have information about the form of how a toehold was taken, we also have information about how long the toehold was held until a full acquisition. We tabulate the number of months that passed between the toehold acquisition and the majority acquisition by percentiles in Panel B of Table 2. As can be seen, only 10% of the toeholds in the sample occurred in the 3 months

[23] In some takeovers, the target's management retains an equity stake. If we exclude deals where final ownership is not 100%, all our results hold.

Table 2
Toehold form and months to final acquisition.

Panel A shows the manner in which the toehold was acquired for 155 of the majority acquisition deals that were preceded by toeholds (i.e., the deals for which data on the toehold transaction is available). Column I describes the type of toehold transaction; column II shows the number of deals per toehold form; columns III and IV show these numbers separately for privately held and publicly traded targets; column V shows the fraction of the 155 deals that each category represents; and column VI shows the mean toehold size observed in each category. Panel B shows the number of months that elapsed between the acquisition of the toehold and the majority acquisition, sorted by different percentiles of the distribution.

Panel A

Toehold form	N	N private targets	N public targets	% of deals	Toehold Size
Acquisition of minority equity stake	95	61	34	61%	31%
PIPE	26	0	26	17%	18%
Venture capital	22	22	0	14%	19%
Growth capital/private equity	11	11	0	7%	20%
LBO	1	1	0	1%	33%
Total	155	95	60	100%	

Panel B

Months to majority acquisition	Percentile
3	10%
8	25%
15	50%
28	75%
49	90%

Table 3
Univariate analysis.

This table shows the variables Private, Age, R&D/Assets, Cross-Border, Different Industry, Potential Bidders and Total Assets, sorted by the dummy Toehold. The differences in the mean of the variables are presented in column III. Significant at: *10%, **5% and ***1%.

Variable	Toehold = 1	Toehold = 0	Difference (Toehold = 1 − Toehold = 0)
Private	0.62 (N = 944)	0.87 (N = 48,066)	−0.25***
Age	17 (N = 944)	21.1 (N = 48,066)	−4***
R&D/Assets (%)	0.047 (N = 944)	0.045 (N = 48,066)	0.002*
Cross Border	0.244 (N = 944)	0.141 (N = 48,066)	0.103***
Different Industry	0.457 (N = 944)	0.429 (N = 48,066)	0.0285*
Potential Bidders	570.6 (N = 944)	630.3 (N = 48,066)	−59.7***
Total Assets (millions)	450 (N = 367)	290.9 (N = 8,488)	159.1***

prior to the majority acquisition; while 50% of the final acquisitions occurred at least 15 months prior from the toehold acquisition. The fact that toeholds are not held for short periods of time is consistent with toeholds being useful to gather information about the target company.[24]

5. Results

5.1. Univariate analysis

In Table 3, we compare the variable means for acquisitions with and without a prior toehold. Acquirers are more likely to have a toehold in the target when the target company is potentially more difficult to analyze for outsiders: When it is younger and when it operates in a R&D-intensive industry. We also observe that acquirers are more likely to have a toehold in the target when the acquirer is potentially less informed than other potential acquirers; namely, when the acquirer operates in a different country or in a different industry than the target. Additionally, we observe that the number of potential bidders is lower in deals where the acquirer had a toehold than in deals were the acquirer did not, while acquirers of larger targets (in terms of assets) are more likely to have a toehold in the target.

[24] The patterns in Table 2, Panel B, are likely to be underestimating the true time that passes between the acquisition of the toeholds and the majority acquisition, as Capital IQ did not register transactions prior to 1998. Thus, older majority acquisitions in our data are more likely to be missing toehold information if toeholds are old enough.

Table 4
Regression analysis.

Panel A shows 4 probit regressions where the dependent variable is the Toehold dummy. The base case specification uses information for 49,010 majority acquisitions. The explanatory variables are the dummy Private, Age, R&D/Assets, the dummies Cross-Border and Different Industry, the number of Potential Bidders and year fixed effects. The second column additionally includes the logarithm of the target's assets as explanatory variable, reducing our sample to 8,605 majority acquisitions. Columns III and IV replicate columns I and II, but replacing the variable Age for two dummies: Young (Age ≤10) and Intermediate (10 < Age < 21). The omitted category is Old (Age >20). In Panel B, column I, we compute the marginal effects of the main explanatory variables, using the specification from column II and evaluating all variables at their mean. In column II (III) we compute the predicted probability that a majority acquisition is preceded by a toehold if the variable on the left is evaluated at the 10th (90th) percentile of its distribution. Significant at: *10%, **5% and ***1%. Standard errors are adjusted for heteroscedasticity and clustered at the industry level.

Panel A

Variable	Toehold	Toehold	Toehold	Toehold
Private	−0.5867***	−0.3834***	−0.5898***	−0.3891***
	(0.0592)	(0.0955)	(0.0587)	(0.0942)
Age	−0.0044***	−0.0041**		
	(0.0013)	(0.0018)		
R&D/Assets (%)	0.3826	0.7267	0.3791	0.8039
	(0.7109)	(0.7906)	(0.7089)	(0.7819)
Cross Border	0.2344***	0.1634*	0.2346***	0.1608*
	(0.0392)	(0.0860)	(0.0395)	(0.0870)
Different Industry	0.0176	0.0924	0.0148	0.0933
	(0.0512)	(0.0909)	(0.0512)	(0.0913)
Potential Bidders	−0.0003*	−0.0006**	−0.0003*	−0.0006**
	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Log(Assets)		0.1029***		0.1009***
		(0.0183)		(0.0178)
Young (Age <10)			0.2563***	0.1827**
			(0.0560)	(0.0851)
Intermediate (10 < Age < 21)			0.1178**	0.1306*
			(0.0471)	(0.0738)
Year fixed effects	Yes	Yes	Yes	Yes
Industry cluster	Yes	Yes	Yes	Yes
R-squared	0.059	0.095	0.062	0.095
N	49,010	8,605	49,010	8,605

Panel B

	Marginal effect	Predicted probability, LHS variable at pctile 10, other variables at their mean	Predicted probability, LHS variable at pctile 90, other variables at their mean
Age	−0.00034**	0.0345***	0.0216***
	(0.00016)	(0.0062)	(0.00349)
R&D/Assets (%)	0.06	0.0279***	0.0333***
	(0.062)	(0.0055)	(0.00426)
Cross Border	0.0136**	0.028***	0.0402***
	(0.0068)	(0.004)	(0.0071)
Different Industry	0.0077	0.027***	0.0338***
	(0.0074)	(0.005)	(0.0052)
Potential Bidders	−0.00005***	0.05***	0.0164***
	(0.00002)	(0.006)	(0.0062)
Log(Assets)	0.0086***	0.013***	0.0646***
	(0.002)	(0.0023)	(0.0135)

The mean comparisons shown in Table 3 are consistent with toeholds playing an important role in providing information to acquirers when it is more valuable to them. All the differences are statistically significant at the 1% level, except for the differences in the variables Different Industry and R&D/Assets, which are statistically significant at the 10% level.

We now turn to study the impact of targets' opacity, the acquirer's pre-toehold informational disadvantage, and the expected competitiveness of the takeover contest on the probability that an acquirer had a toehold in the target company prior to the takeover, in a multivariate setting.

5.2. Regression analysis

Table 4, Panel A, shows the results for the estimation of Eq. (1). Column I uses all explanatory variables, except the logarithm of total assets, as the number of observations for this variable is more limited. Column II includes the logarithm of total assets as an explanatory variable. In both regressions we use year fixed effects to control for macro shocks such as merger waves. Also, in both estimations, the standard errors are clustered at the target industry level, as the potential number of bidders and R&D intensity are computed at the industry level. In these specifications we do not include interaction terms, so we can only test Hypotheses 1, 2 and 4. Standard errors are shown in parentheses, below the coefficients.

The results from Table 4 confirm those of Table 3. We find that younger targets and targets that operate in R&D-intensive industries are more likely to be purchased through sequential acquisitions, although only the result for Age is statistically significant. These results are consistent with Hypothesis 1, that toeholds are more beneficial for acquirers when it is harder to analyze a target and therefore the synergies that can be expected from a full takeover.

We also find that when the acquirer operates in a different country than the target company, or in a different industry, it is more likely that the acquirer takes a minority stake in the target company before taking over the company. The result for the Cross-Border dummy is statistically significant at the 1% level. The result for the Different Industry dummy, however, is not statistically significant. Overall, these two results are in agreement with Hypothesis 2, that the acquirer is more likely to take a toehold in the potential target when she is potentially ex-ante less well informed than other potential bidders.

Consistent with a decreasing value of information when the takeover contest is expected to be more competitive (Hypothesis 4), we find that the potential number of bidders is negatively related to the likelihood of acquiring a toehold before a takeover. Also consistent with this argument, the likelihood of a toehold increases with the size of the target's assets (acquirers tend to be larger than targets, so a larger target has less potential acquirers). Thus, the takeover contest is potentially less competitive and this increases the value of obtaining more precise information about the synergies with the target through a toehold. Both the logarithm of assets and the potential number of bidders are statistically significant. Overall, the evidence on the competitiveness of takeover contests favors the hypothesis that informational benefits explain the use of toeholds before a majority acquisition.

Finally, the control variable Private is negative and statistically significant at the 1% level, indicating that acquisitions of private targets are less likely to be preceded by a toehold. This implies that liquidity reasons (i.e., purchasing a toehold in a private company is not as simple as in a public company, given that their shares are less liquid) are empirically more important than informational issues in the estimation of the parameter of the dummy Private. The result that majority acquisitions are less likely to be preceded by toeholds when the target is private is consistent with the findings presented by Ouimet (2013). She finds that minority acquisitions are less likely to occur in private companies.

Table 5
Regression analysis with interaction terms.

This table shows 4 regressions where the dependent variable is the Toehold dummy. The first 3 columns show results from probit regressions. The base case specification uses information for 49,010 majority acquisitions. The explanatory variables are the dummy Private, Age, R&D/Assets, the dummies Cross-Border and Different Industry, the number of Potential Bidders, the interaction between Age and Cross-Border, Different Industry and Age, Cross-Border and R&D/Assets, Different Industry and R&D/Assets, and year fixed effects. The second column additionally includes the logarithm of the target's assets as an explanatory variable, reducing the sample to 8,605 majority acquisitions. The third column additionally includes the interaction of the dummy Private and the variables Cross Border and Different Industry. The last column presents the results of a linear probability model using the same regressors as in column III. Significant at: *10%, **5% and ***1%. Standard errors are adjusted for heteroscedasticity and clustered at the industry level.

	Probit	Probit	Probit	Linear prob. model
Variable	Toehold	Toehold	Toehold	Toehold
Private	−0.5858***	−0.3759***	−0.2285**	−0.0163
	(0.0598)	(0.0992)	(0.1044)	(0.0103)
Age	−0.0060***	−0.0046**	−0.0046**	−0.0004*
	(0.0013)	(0.0020)	(0.0019)	(0.0002)
R&D/Assets (%)	0.5477	1.4078*	1.3706*	0.1183*
	(0.9280)	(0.7438)	(0.7567)	(0.0636)
Cross Border	0.1687**	0.0539	0.0528	0.0102
	(0.0665)	(0.1361)	(0.1355)	(0.0135)
Different Industry	0.0101	0.2556**	0.3418***	0.0349***
	(0.0745)	(0.1174)	(0.1250)	(0.0126)
Potential Bidders	−0.0003*	−0.0006***	−0.0006***	−0.0000***
	(0.0002)	(0.0002)	(0.0002)	(0.0000)
Log(Assets)		0.1080***	0.1099***	0.0100***
		(0.0179)	(0.0175)	(0.0019)
Cross Border × Age	0.0035**	0.0019	0.0020	0.0003
	(0.0014)	(0.0029)	(0.0029)	(0.0004)
Different Industry × Age	0.0017	0.0001	−0.0002	0.0000
	(0.0016)	(0.0020)	(0.0020)	(0.0002)
Cross Border × R&D/Assets (%)	−0.0128	1.0069	1.1213	0.1345
	(0.6365)	(0.7985)	(0.7967)	(0.1040)
Different Industry × R&D/Assets (%)	−0.4845	−3.5500***	−3.4904***	−0.3211***
	(0.7996)	(1.0133)	(0.9900)	(0.0803)
Cross Border × Private			−0.0803	−0.0194
			(0.1866)	(0.0131)
Different Industry × Private			−0.3483***	−0.0235**
			(0.1343)	(0.0104)
Year fixed effects	Yes	Yes	Yes	Yes
Industry cluster	Yes	Yes	Yes	Yes
R-squared	0.06	0.101	0.104	0.0364
N	49,010	8,605	8,605	8,605

One potential concern regarding the results presented in Table 4 (Panel A) is that the negative coefficient on the variable Age is not capturing target opaqueness, but rather something else, given that the average target in our sample is not particularly young (21 years). This concern is ameliorated when looking at the overall distribution of the targets' age. The distribution is highly skewed: 50% of the acquired targets were 13 years old, or younger (see Table 1). To further alley concerns we test for the following intuition: If Age is related to opacity, the impact of Age on the likelihood of taking a toehold should be particularly large for very young companies. Thus, we classify targets into 3 categories according to their age at the time of acquisition. We classify targets as Young if they were no more than 10 years old, Intermediate if their age was between 11 and 20 years, and Old if they were older than 20 years. The results are presented in columns III and IV of Table 4 (Panel A). Old is the omitted category. Consistent with toeholds being particularly beneficial when the target is opaque, we find that the coefficient of Young is positive and strongly significant. Moreover, this coefficient is between 40% and 120% larger than the coefficient of Intermediate. This suggests that the negative coefficient of the variable Age shown in columns I and II is driven, to a large extent, by very young companies, which are the most likely to be opaque. In the remainder of the paper, we continue to use the variable Age instead of age categories, for simplicity.

In Table 4, Panel B, we report the marginal effect of a change in one unit in the explanatory variables on the probability of an acquisition being preceded by a toehold. To compute the marginal effects, we use the results from column II, as in that specification we use a continuous measure of targets' age and also control for targets' assets. The signs and statistical significance of the marginal effects coincide with those of the coefficients estimated in the probit regression. To assess the economic impact of a change in the explanatory variables on the predicted probability of a majority acquisition being preceded by a toehold, we compute the predicted probabilities evaluated at the 10th and 90th percentile of a given variable, with all other variables evaluated at their means. We find that although the probability of an acquisition being preceded by a toehold is small (around 2%), the changes in this predicted probability are quite substantial. For instance, if a 3 year old target is acquired (this is equivalent to the 10th percentile of the variable Age, see Table 1), the acquisition has a 3.5% chance of being preceded by a toehold. In contrast, if a 54 year old target is acquired (90th percentile), the probability of the acquisition being preceded by a toehold is 2.2%. This represents a 37% reduction in the predicted probability.

In Table 5, we include interaction terms for the variables that capture the targets' opacity and the variables that capture the acquirers' ex-ante informational disadvantage, to test the prediction from Hypothesis 3. As in Table 4, column I does not include Assets as an explanatory variable, while column II does. Column I shows that all four coefficients for the interaction terms are consistent with Hypothesis 3: When the target firm is younger and when it operates in an R&D-intensive industry, the variable Cross-Border has less of a positive impact on the likelihood that an acquirer has a toehold prior to the majority acquisition. This is also the case for acquirers belonging to a different industry than the target. Although all the coefficients have the expected sign, only the interaction between Cross-Border and Age is statistically significant. The fact that the variable R&D/Assets and its interaction terms all have coefficients in agreement with the predictions of the theory but are not statistically significant is likely a consequence of having a noisy proxy for firm-level R&D (recall that we use R&D/Assets at the industry level due to lack of firm individual data). Column II shows similar results. Overall, Hypothesis 3 seems to find some support in the data.

In column III of Table 5, we additionally include the interactions between the dummy Private and the variables Cross-Border and Different Industry. We include these interactions to test whether the dummy Private captures some of the targets' opacity. Our interpretation of our earlier coefficients for the dummy Private is that $\beta^{\text{Private}} = \beta^{\text{Liquidity}} + \beta^{\text{Opacity}}$, where $\beta^{\text{Liquidity}} < 0$ and $\beta^{\text{Opacity}} > 0$, and the first effect dominates the second one. If this is the case we can further decompose β^{Opacity} as a stand-alone effect, and two interaction effects: $\beta^{\text{Opacity}} = \beta_0^{\text{Opacity}} + \beta_1^{\text{Opacity}} \times$ Cross-Border $+ \beta_2^{\text{Opacity}} \times$ Different Industry. Hypothesis 3 implies that $\beta_1,\beta_2 < 0$, and, as a consequence, $\beta^{\text{Opacity}} < \beta_0^{\text{Opacity}}$. This is exactly what we find. Comparing the specifications in columns II and III, the parameter of the dummy Private increases significantly (from -0.38 to -0.23), and both interaction terms are negative, although only the interaction between Private and Different Industry is statistically significant. This provides additional support for Hypothesis 3.

One possible concern regarding the interpretation of our results is that, due to the nonlinearities of the probit estimation, the true cross derivatives (of the dummy Toehold with respect to the interacted variables) can have a sign and statistical significance different from the estimated coefficients we report. That is not the case in our estimations, however. To show this, we estimate a linear probability model using all the control variables from column III, which contains all the interaction terms. The results are shown in column IV of Table 5. The coefficients of the interaction effects of the linear probability model, which can be interpreted straightforwardly as cross derivatives, are almost always of the same sign and statistical significance as the coefficients obtained in the probit estimation. Moreover, in unreported results (available upon request), we computed the true marginal effect of the interacted variables for the probit model using the methodology proposed by Ai and Norton (2003),[25] obtaining similar results.

5.3. Agency considerations

Our paper studies under what conditions the benefits of acquiring a toehold prior to a majority acquisition are larger. So far, we have found evidence consistent with the use of toeholds prior to majority acquisitions when better information about the target is particularly valuable. In this subsection, we address the possibility that our results could be driven by alternative explanations, specifically, explanations based on agency considerations.

[25] See Powers (2005) for a corporate finance application.

Table 6
Private vs. public targets.

This table shows 3 probit regressions. The first column uses data on both privately held and publicly traded targets, while the second (third) column uses data exclusively on privately held (publicly traded) companies. The explanatory variables are the dummy Private, Age, R&D/Assets, the dummies Cross-Border, Different Industry, the number of Potential Bidders, the logarithm of the targets' book value of assets, and year fixed effects. Column I additionally includes interactions between the dummy Private and other variables. Significant at: *10%, **5% and ***1%. Standard errors are adjusted for heteroscedasticity and clustered at the industry level.

		Private target	Public target
Variable	Toehold	Toehold	Toehold
Private	−0.8979***		
	(0.2064)		
Age	−0.0033*	−0.0082*	−0.0033*
	(0.0018)	(0.0042)	(0.0018)
R&D/Assets (%)	−0.0989	3.4298***	−0.1143
	(0.8289)	(0.8404)	(0.8508)
Cross Border	0.1548*	0.0441	0.1696*
	(0.0872)	(0.1888)	(0.0980)
Different Industry	0.1073	−0.1887	0.1903*
	(0.0915)	(0.1225)	(0.1022)
Potential Bidders	−0.0008***	−0.0002	−0.0008***
	(0.0003)	(0.0002)	(0.0003)
Log(Assets)	0.1064***	0.1010**	0.1104***
	(0.0197)	(0.0400)	(0.0195)
Age × Private	−0.0047		
	(0.0045)		
R&D/Assets × Private	3.5528***		
	(0.6718)		
Potential Bidders × Private	0.0007***		
	(0.0002)		
Log(Assets) × Private	0.0081		
	(0.0327)		
Year fixed effects	Yes	Yes	Yes
Industry cluster	Yes	Yes	Yes
R-squared	0.105	0.08	0.09
N	8,605	3,197	5,408

The literature on toeholds in the presence of agency problems focuses on disciplinary takeovers. Shleifer and Vishny (1986) argue that a toehold may be the main source of profit for a “raider,” which implies that targets suffering from agency problems are more likely to be acquired by a toeholder. In other words, the presence of agency problems in a target makes it more likely that toeholds are used to acquire it. We therefore ask what variables describing the target might be related to agency problems. An agency view might argue that a target's opaqueness increases the likelihood of finding agency problems. However, the type of targets that we classify as more opaque — younger and more R&D-intensive firms — are less likely to suffer from certain agency problems than older and more mature firms. An agency view might also focus on the size of a target, arguing that larger firms are more likely to have weak corporate governance. Thus, agency considerations, in principle, could explain the positive coefficient on the targets' assets that we find in our regressions. As can be inferred from these examples, agency problems can generate predictions that can either go in the opposite direction of our findings or they can potentially explain them. Therefore, to test whether agency considerations can indeed explain our results, we take a simple approach which does not rely on any particular agency theory: We study the differential effect of the targets' characteristics on the likelihood of acquiring a toehold according to the targets' ownership status.

Arguably, agency problems are a smaller concern for privately held firms. Publicly traded firms have a more dispersed share ownership and are therefore missing an important channel for corporate governance. Thus, if agency problems were driving the decision to take a toehold, the estimated coefficients should be larger and more significant for publicly traded targets than for privately held targets, regardless of the underlying agency-based explanation. To test whether this is the case, we analyze the differential impact of Age, R&D/Assets, Potential Bidders and Assets for publicly traded and privately held targets. If the coefficient of Age and Potential Bidders is more negative for publicly traded targets, and the coefficients of R&D/Assets and Assets are more positive, then we cannot reject the alternative hypothesis, that our results are driven by agency considerations. However, if that is not the case, we can be more confident that our results are not explained by agency problems. We present the results in Table 6, column I.

We find that the coefficients of Age and Assets are more pronounced for privately held firms than for publicly traded firms, suggesting that agency problems are unlikely to explain our results. Moreover, the coefficient on R&D/Assets is more positive for privately held targets, and this difference is statistically significant, further diminishing the likelihood of an agency explanation.

More to the point, the difference in R&D/Assets for publicly traded and privately held companies is actually consistent with an informational story, as privately held firms tend to be more opaque, too.[26]

For the variable Potential Bidders, however, we find that the coefficient is more pronounced for public firms than for private firms. In particular, we find that the negative effect of the potential number of bidders is statistically significant only for public firms. For private firms the positive coefficient on the interaction term almost completely offsets the negative effect of Potential Bidders on the likelihood of taking a toehold. Although it is possible to come up with agency explanations for this finding, we believe the most reasonable explanation derives from the form in which the variable Potential Bidders is constructed. This variable is a weighted average of the number of public companies that operate in the target's industry and related industries. Given that 2/3 of acquirers of publicly traded targets are publicly traded, while only 1/3 of the acquirers of privately owned targets are publicly traded, our measure of the potential number of bidders better reflects the expected competitiveness of the takeover environment for publicly traded targets than for privately owned targets. Therefore, it is natural for our measure of potential bidders to have a stronger impact on publicly traded targets.

We also report the regression coefficients separately for privately held and publicly traded companies in columns II and III of Table 6. The results presented in those columns are in line with coefficients of the interaction terms presented in column I. Overall, we do not find evidence that our results are driven by agency explanations.

6. Conclusion

Acquisitions can fail for many reasons. Well-designed plans may be executed poorly, or bad luck may play a role. An important reason, though, is that acquirers often overestimate the synergies they can expect from a takeover, so even the best “execution” cannot deliver the promised value.

Information about possible synergies from a takeover is important for firms considering an acquisition, and potential acquirers need to use any source of information available. As we argue, one way to improve this information is to take a toehold in the target firm, before making a full takeover offer. Taking a toehold allows the potential acquirer to interact with the target and its management. It gives the acquirer better insight into the operations of the target, and how an acquisition could improve them. A toehold does not represent a commitment to eventually take over the target. It opens the doors to a takeover, and it allows for a more informed decision. If the better information is negative, the toehold can easily be undone.

Taking a toehold is costly, of course. Our focus in this paper is on the circumstances under which taking a toehold prior to bidding is particularly beneficial, compared with a direct takeover offer. We find that toeholds are particularly beneficial if information about the target is generally hard to obtain, if a bidder considering a takeover is initially less well-informed than other potential bidders, and if there are less potential rival bidders for a target.

The empirical evidence is consistent with these predictions: Our data set on acquisitions of both privately held and publicly traded North-American targets includes information on non-controlling equity stakes held by the eventual acquirer before the acquisition. We find that acquirers are more likely to have owned a toehold if the target is opaque (hard to analyze); if the acquirer found it harder than other bidder to analyze the target (cross-border and cross-industry acquisitions); and if the number of potential bidders was smaller.

The takeover literature has so far focused on distortions to a toeholder's bidding in takeover contests. We show that there is more to it. Information seems to play an important role in the decision to take a toehold, and also in subsequent takeover contests.

Exactly what information is learnt by a toeholder, or how exactly toeholds facilitate takeovers, is not something we can explore using the Capital IQ data, but it would be an interesting question for future research. We make some suggestions: A toehold often likely opens the door to a more intensive cooperation between the toeholder and the target, such that the toeholder learns more about the target's operations and prospects than regular suppliers or customers could hope to discover (without a toehold). That may happen because the toeholder negotiates the right to nominate one or more directors, who have direct access to the target's executives (a non-toeholder would not have that option), or through cooperation at the level of operations (by sharing production facilities or distribution networks). More detailed data on what firms learn when they open up such communication channels should lead to interesting future research (see, e.g., Schwartz-Ziv and Weisbach, 2013).

Appendix A. Proofs

Appendix A.1. Proof of Lemma 1

For the non-toeholder (bidder 2), bidding strictly less than her valuation is dominated by bidding her valuation. If she wins either way or loses either way, the payoff is unaffected. But she would be strictly worse off if she lost with the lower bid, since with a slightly higher bid she could have bought all shares at a price below her valuation, instead of losing. Bidding higher is a dominated strategy, too: If doing so makes her win, she will have overpaid; and if she loses, her payoff is unchanged.

[26] Private firms' financial constraints (cash needs) may also explain why firms sell minority stakes to other firms. However, it is unlikely that cash needs drive subsequent majority acquisitions, so our results are not likely to be affected by cash needs.

Appendix A.2. Proof of Lemma 2

Bidder 1's probability of winning is zero with any bid $b_1 \le v_2(l)$, so it is optimal to bid at least $v_2(l)$, to maximize the price she will receive for her shares if she loses. If $s_1 > \sigma_1(h)$, then the toeholder's valuation is higher than that of the nontoeholder, and it is optimal to bid the valuation, $v_1(s_1)$. With lower signals, the optimal bid is determined by a trade-off between the expected payoffs from winning and from losing (the stake α is sold to the winner). The optimal bid lies in the interval $[v_2(l), v_2(h)]$. The objective function is

$$\max_{b_1} \int_l^{\beta_2(b_1)} \Big(v_1(s_1) - (1-\alpha)v_2(s_2)\Big)\frac{1}{h-l}\mathrm{d}s_2 + \int_{\beta_2(b_1)}^h \alpha b_1 \frac{1}{h-l}\mathrm{d}s_2.$$

The F.O.C. is

$$0 = \Big(v_1(s_1) - (1-\alpha)v_2(\beta_2(b_1))\Big)\frac{1}{h-l}\frac{1}{\varphi_2} + \int_{\beta_2(b_1)}^h \alpha \frac{1}{h-l}\mathrm{d}s_2 - \alpha b_1 \frac{1}{h-l}\frac{1}{\varphi_2}.$$

(It is easily verified that he S.O.C. is satisfied.) Rearrange, and replace $v_2(\beta_2(b_1)) = b_1$,

$$\begin{aligned}(b_1 - v_1(s_1))\frac{1}{h-l}\frac{1}{\varphi_2} &= \alpha\frac{h-\beta_2(b_1)}{h-l}\\ (b_1 - v_1(s_1))\frac{1}{\varphi_2} &= \alpha\left(h - \frac{b_1 - v_0 - (1-\varphi_2)\frac{h+l}{2}}{\varphi_2}\right)\\ b_1 &= v_1(s_1) + \frac{\alpha}{1+\alpha}(v_2(h) - v_1(s_1)).\end{aligned}$$

This function is continuous at $s_1 = \sigma_1(h)$: Since $v_1(\sigma_1(h)) = v_2(h)$, we must have $v_1(\sigma_1(h)) + \frac{\alpha}{1+\alpha}(v_2(h) - v_1(\sigma_1(h))) = v_1(\sigma_1(h))$. Next, the function is increasing in s_1, and

$$\begin{aligned}&v_1(\hat{s}_1) + \frac{\alpha}{1+\alpha}(v_2(h) - v_1(\hat{s}_1))\\ &= \frac{v_0 + \varphi_1\left(\frac{\varphi_2}{\varphi_1}(l - \alpha(h-l)) + \frac{\varphi_1-\varphi_2}{\varphi_1}\frac{h+l}{2}\right) + (1-\varphi_1)\frac{h+l}{2} + \alpha\left(v_0 + \varphi_2 h + (1-\varphi_2)\frac{h+l}{2}\right)}{1+\alpha}\\ &= v_0 + \varphi_2 l + (1-\varphi_2)\frac{h+l}{2}\\ &= v_2(l).\end{aligned}$$

Thus, since it is optimal to bid at least $v_2(l)$, the optimal bid for all $s_1 < \hat{s}_1$ is $v_2(l)$.
Note that $\varphi_2 > \frac{1}{1+2\alpha}\varphi_1 \Leftrightarrow \alpha > \frac{\varphi_1-\varphi_2}{2\varphi_2}$ implies that

$$\begin{aligned}\hat{s}_1 &= \frac{\varphi_2}{\varphi_1}(l - \alpha(h-l)) + \frac{\varphi_1-\varphi_2}{\varphi_1}\frac{h+l}{2}\\ &< \frac{\varphi_2}{\varphi_1}\left(l - \frac{\varphi_1-\varphi_2}{2\varphi_2}(h-l)\right) + \frac{\varphi_1-\varphi_2}{\varphi_1}\frac{h+l}{2}\\ &= l,\end{aligned}$$

so there cannot be any signal realizations $s_1 \le \hat{s}_1$ if $\varphi_2 > \frac{1}{1+2\alpha}\varphi_1$. ■

Appendix A.3. Derivation of the expected payoff functions

If both bidders' signals are of equal informativeness φ_2 and no bidder has a toehold, their expected payoff is

$$\mathcal{U}_1^{\text{noTH}} = \int_l^h \int_l^{s_1} (v_2(s_1) - v_2(s_2))\frac{1}{h-l}\mathrm{d}s_2 \frac{1}{h-l}\mathrm{d}s_1 = \int_l^h \int_l^{s_1} \varphi_2(s_1 - s_2)\frac{1}{h-l}\mathrm{d}s_2\frac{1}{h-l}\mathrm{d}s_1 = \frac{1}{6}\varphi_2(h-l).$$

If bidder 1 is better informed ($\varphi_1 > \varphi_2$), but no bidder has a toehold,

$$\begin{aligned}\mathcal{U}_{1,\varphi_1>\varphi_2}^{\text{noTH}} &= \int_l^h \int_{\sigma_1(s_2)}^h (v_1(s_1) - v_2(s_2))\frac{1}{h-l}\mathrm{d}s_1\frac{1}{h-l}\mathrm{d}s_2\\ &= \int_l^h \int_{\sigma_1(s_2)}^h (v_1(s_1) - v_1(\sigma_1(s_2)))\frac{1}{h-l}\mathrm{d}s_1\frac{1}{h-l}\mathrm{d}s_2 = \int_l^h \int_{\sigma_1(s_2)}^h \varphi_1(s_1 - \sigma_1(s_2))\frac{1}{h-l}\mathrm{d}s_1\frac{1}{h-l}\mathrm{d}s_2 = \frac{3\varphi_1^2 + \varphi_2^2}{24\varphi_1}(h-l).\end{aligned}$$

If bidder 1's signal is of informativeness $\varphi_0 < \varphi_2$, and no bidder has a toehold,

$$\mathcal{U}^{noTH}_{1,\varphi_0<\varphi_2} = \int_l^h \int_l^{\xi_2(s_1)} (v_0(s_1) - v_2(s_2)) \frac{1}{h-l} ds_2 \frac{1}{h-l} ds_1$$
$$= \int_l^h \int_l^{\xi_2(s_1)} (v_2(\xi_2(s_1)) - v_2(s_2)) \frac{1}{h-l} ds_2 \frac{1}{h-l} ds_1 = \int_l^h \int_l^{\xi_2(s_1)} \varphi_2(\xi_2(s_1) - s_2) \frac{1}{h-l} ds_2 \frac{1}{h-l} ds_1 = \frac{\varphi_0^2 + 3\varphi_2^2}{24\varphi_2}(h-l),$$

where $\xi_2(s_1)$ is defined implicitly by $v_0(s_1) = v_2(\xi_2(s_1))$,

$$\xi_2(s_1) = \frac{\varphi_0}{\varphi_2} s_1 + \frac{\varphi_2 - \varphi_0}{\varphi_2} \frac{h+l}{2} \Leftrightarrow v_0(s_1) = v_2(\xi_2(s_1)).$$

If bidder 1 is better informed because she has a toehold, and $\varphi_2 > \frac{1}{1+2\alpha}\varphi_1$ (so $b_1^*(s_1) > v_2(l)$ for all s_1),

$$\mathcal{U}^{TH}_{1+} = -\alpha v_0 + \int_l^{\sigma_1(h)} \left(\int_l^{\beta_2(b_1^*(s_1))} (v_1(s_1) - (1-\alpha) v_2(s_2)) \frac{1}{h-l} ds_2 \right) \frac{1}{h-l} ds_1$$
$$+ \int_l^{\sigma_1(h)} \left(\int_{\beta_2(b_1^*(s_1))}^h \alpha b_1^*(s_1) \frac{1}{h-l} ds_2 \right) \frac{1}{h-l} ds_1 + \int_{\sigma_1(h)}^h \left(v_1(s_1) - (1-\alpha) v_2\left(\frac{h+l}{2}\right) \right) \frac{1}{h-l} ds_1 = \frac{(\varphi_1+\varphi_2)^3}{48\varphi_1\varphi_2(1+\alpha)}(h-l) + \alpha\frac{h+l}{2}.$$

If bidder 1 is better informed because she has a toehold, and $\varphi_2 \le \frac{1}{1+2\alpha}\varphi_1$ (so $b_1^*(s_1) = v_2(l)\ \forall\ s_1 \le \hat{s}_1$),

$$\mathcal{U}^{TH}_{1-} = -\alpha v_0 + \int_l^{\hat{s}_1} \alpha v_2(l) \frac{1}{h-l} ds_1 + \int_{\hat{s_1}}^{\sigma_1(h)} \left(\int_l^{\beta_2(b_1^*(s_1))} (v_1(s_1) - (1-\alpha) v_2(s_2)) \frac{1}{h-l} ds_2 \right) \frac{1}{h-l} ds_1$$
$$+ \int_{\hat{s_1}}^{\sigma_1(h)} \left(\int_{\beta_2(b_1^*(s_1))}^h \alpha b_1^*(s_1) \frac{1}{h-l} ds_2 \right) \frac{1}{h-l} ds_1$$
$$+ \int_{\sigma_1(h)}^h \left(v_1(s_1) - (1-\alpha) v_2\left(\frac{h+l}{2}\right) \right) \frac{1}{h-l} ds_1 = \frac{(\varphi_1+\varphi_2)^3 - (\varphi_1 - (1+2\alpha)\varphi_2)^3}{48\varphi_1\varphi_2(1+\alpha)}(h-l) + \alpha\frac{h+l}{2}.$$

Appendix A.4. Proof of Lemma 3

Note first that $lim_{\varphi_1 \to \varphi_2} \mathcal{U}^{noTH}_{1,\varphi_1>\varphi_2} = lim_{\varphi_0 \to \varphi_2} \mathcal{U}^{noTH}_{1,\varphi_0<\varphi_2} = \mathcal{U}^{noTH}_1$. If bidder 1's signal is initially more informative than the rival's,

$$\frac{\partial}{\partial\varphi_1} \mathcal{U}^{noTH}_{1,\varphi_1>\varphi_2} = \frac{3\varphi_1^2 - \varphi_2^2}{24\varphi_1^2}(h-l) > 0,$$
$$\frac{\partial}{\partial\varphi_2} \mathcal{U}^{noTH}_{1,\varphi_1>\varphi_2} = \frac{\varphi_2}{12\varphi_1}(h-l) > 0.$$

If bidder 1's signal is initially less informative than the rival's,

$$\frac{\partial}{\partial\varphi_0} \mathcal{U}^{noTH}_{1,\varphi_0<\varphi_2} = \frac{\varphi_0}{12\varphi_2}(h-l) > 0,$$
$$\frac{\partial}{\partial\varphi_2} \mathcal{U}^{noTH}_{1,\varphi_0<\varphi_2} = \frac{3\varphi_2^2 - \varphi_0^2}{24\varphi_2^2}(h-l) > 0.$$

■

Appendix A.5. Proof of Proposition 1

Compare the expected payoffs $\mathcal{U}^{TH}_{1+}$ and $\mathcal{U}^{TH}_{1-}$ with $\mathcal{U}^{noTH}_1$, and take derivatives w/r/t φ_2. If $\varphi_2 > \frac{1}{1+2\alpha}\varphi_1$,

$$\frac{\partial}{\partial\varphi_2}\left(\mathcal{U}^{TH}_{1+} - \mathcal{U}^{noTH}_1\right) = \frac{-\varphi_1^3 - 5\varphi_1\varphi_2^2 + 2\varphi_2^3 - 8\alpha\varphi_1\varphi_2^2}{48\varphi_1\varphi_2^2(\alpha+1)}(h-l),$$

which is negative. If $\varphi_2 \le \frac{1}{1+2\alpha}\varphi_1$,

$$\frac{\partial}{\partial\varphi_2}\left(\mathcal{U}^{TH}_{1-} - \mathcal{U}^{noTH}_1\right) = \frac{-2\varphi_1 + \varphi_2 - 3\alpha\varphi_1 + 2\alpha\varphi_2 + 4\alpha^2\varphi_2}{12\varphi_1}(h-l),$$

That is increasing in φ_2 and negative for $\varphi_2 = \frac{1}{1+2\alpha}\varphi_1$, so it is negative for all $\varphi_2 \le \frac{1}{1+2\alpha}\varphi_1$. ■

Appendix A.6. Proof of Proposition 2

De-compose the payoff increase into going from $\mathcal{U}^{\text{noTH}}_{1,\varphi_0<\varphi_2}$ to $\mathcal{U}^{\text{noTH}}_{1}$, and then going from $\mathcal{U}^{\text{noTH}}_{1}$ to $\mathcal{U}^{\text{TH}}_{1+}$ or $\mathcal{U}^{\text{TH}}_{1-}$ — i.e., going from a situation in which the informativeness φ_0 of bidder 1's signal is less than that of bidder 2's signal (φ_2) to a situation in which both signals are of informativeness φ_2, and then on to a situation in which bidder 1 owns a toehold and her signal's informativeness is $\varphi_1 > \varphi_2$. Going from $\mathcal{U}^{\text{noTH}}_{1,\varphi_0<\varphi_2}$ to $\mathcal{U}^{\text{noTH}}_{1}$ (both bidders' informativeness is φ_2) increases bidder 1's expected payoff, cf. Lemma 3 ($\frac{\partial}{\partial\varphi_0}\mathcal{U}^{\text{noTH}}_{1,\varphi_0<\varphi_2}>0$); improving the informativeness to $\varphi_1 > \varphi_2$ additionally increases her payoff, cf. Lemma 3 ($\frac{\partial}{\partial\varphi_1}\mathcal{U}^{\text{noTH}}_{1,\varphi_1>\varphi_2}>0$); and owning a non-zero toehold increases the payoff further, because a larger toehold increases the toeholder's payoff. Compare two different toehold sizes, α_1 and $\alpha_2 > \alpha_1$. With a toehold α_2, the toeholder could imitate the bids she would submit with the smaller toehold α_1, yielding, ceteris paribus, a smaller cash outflow if she wins (she buys less shares) and a larger cash inflow if she loses (she sells more shares). Using the same bids, she is thus better off with a larger toehold. Choosing the bids optimally, given α_2, can only increase her payoff further. ■

Appendix A.7. Proof of Proposition 3

Compare the derivatives w/r/t φ_2 of the benefits from taking a toehold. We have analyzed the initially-symmetric case in Proposition 1. The analysis of the setup in which bidder 1 is initially disadvantaged is similar. If $\varphi_2>\frac{1}{1+2\alpha}\varphi_1$,

$$\frac{\partial}{\partial\varphi_2}\left(\mathcal{U}^{\text{TH}}_{1+}-\mathcal{U}^{\text{noTH}}_{1,\varphi_0<\varphi_2}\right)=\frac{-\varphi_1^3-3\varphi_1\varphi_2^2+2\varphi_2^3+2\varphi_0^2\varphi_1+2\alpha\varphi_0^2\varphi_1-6\alpha\varphi_1\varphi_2^2}{48\varphi_1\varphi_2^2(\alpha+1)}(h-l),$$

which is negative. If $\varphi_2\leq\frac{1}{1+2\alpha}\varphi_1$,

$$\frac{\partial}{\partial\varphi_2}\left(\mathcal{U}^{\text{TH}}_{1-}-\mathcal{U}^{\text{noTH}}_{1,\varphi_0<\varphi_2}\right)=\frac{2\varphi_2^3+8\alpha^2\varphi_2^3+4\alpha\varphi_2^3+\varphi_0^2\varphi_1-3\varphi_1\varphi_2^2-6\alpha\varphi_1\varphi_2^2}{24\varphi_1\varphi_2^2}(h-l)$$
$$<\frac{2\varphi_2^3+8\alpha^2\varphi_2^3+4\alpha\varphi_2^3+\varphi_2^2\varphi_1-3\varphi_1\varphi_2^2-6\alpha\varphi_1\varphi_2^2}{24\varphi_1\varphi_2^2}(h-l),$$

which is increasing in φ_2 and negative for $\varphi_2=\frac{1}{1+2\alpha}\varphi_1$, so the derivative is negative for all $\varphi_2\leq\frac{1}{1+2\alpha}\varphi_1$.

Now compare the derivatives w/r/t φ_2 of the benefits from taking a toehold, recalling that these derivatives are negative. If $\varphi_2>\frac{1}{1+2\alpha}\varphi_1$,

$$\frac{\partial}{\partial\varphi_2}\mathcal{U}^{\text{TH}}_{1+}-\frac{\partial}{\partial\varphi_2}\mathcal{U}^{\text{noTH}}_{1}<\frac{\partial}{\partial\varphi_2}\mathcal{U}^{\text{TH}}_{1+}-\frac{\partial}{\partial\varphi_2}\mathcal{U}^{\text{noTH}}_{1,\varphi_0<\varphi_2}$$
$$-\frac{1}{6}(h-l)<-\frac{3\varphi_2^2-\varphi_0^2}{24\varphi_2^2}(h-l),$$

which is satisfied since $\varphi_0<\varphi_2$. If $\varphi_2\leq\frac{1}{1+2\alpha}\varphi_1$,

$$\frac{\partial}{\partial\varphi_2}\mathcal{U}^{\text{TH}}_{1-}-\frac{\partial}{\partial\varphi_2}\mathcal{U}^{\text{noTH}}_{1}<\frac{\partial}{\partial\varphi_2}\mathcal{U}^{\text{TH}}_{1-}-\frac{\partial}{\partial\varphi_2}\mathcal{U}^{\text{noTH}}_{1,\varphi_0<\varphi_2}$$
$$-\frac{1}{6}(h-l)<-\frac{3\varphi_2^2-\varphi_0^2}{24\varphi_2^2}(h-l),$$

which, again, is satisfied. So the derivatives are more negative in the initially-symmetric case. ■

Appendix A.8. Proof of Proposition 4

Assume that there are $n+1$ bidders, including the toeholder. Adapting the analysis is straightforward because in the second-price auction setup, it is sufficient to focus on the two highest realized signals. Denote by $G_n(s)=\left(\frac{s-l}{h-l}\right)^n$ the probability that with n rival bidders, all signals these rivals observe are below s. The corresponding density is $g_n(s)=n\left(\frac{s-l}{h-l}\right)^{n-1}\frac{1}{h-l}$. Probability mass for this highest signal realization by a rival is shifted to the right as n increases: G_{n+1} has first-order dominance over G_n.

We first show that the optimal bid is unchanged; then we prove Proposition 4.

Lemma 4. *The toeholder's optimal bid does not depend on the number of rivals.*

Proof. The toeholder should always bid at least $v_2(l)$. Define $\hat{s}_{1,n}$ as the cut-off signal such that with any $s_1 < \hat{s}_{1,n}$, the toeholder's optimal bid is $v_2(l)$. Consider a signal $s_1 \in (\hat{s}_{1,n,}\sigma_1(h))$, such that the toeholder prefers to bid strictly above $v_2(l)$. The expected payoff, given a bid b_1, is

$$\max_{b_1} \int_l^{\beta_2(b_1)} \Big(v_1(s_1) - (1-\alpha)v_2(s_2)\Big) g_n(s_2)\mathrm{d}s_2 + \alpha b_1 \left(n \cdot \frac{h-\beta_2(b_1)}{h-l} \cdot G_{n-1}(\beta_2(b_1))\right)$$
$$+\alpha \cdot n \cdot \int_{\beta_2(b_1)}^{h} \left(\int_{\beta_2(b_1)}^{s_2} v_2(s_3) g_{n-1}(s_3)\mathrm{d}s_3\right) \frac{1}{h-l}\mathrm{d}s_2.$$

The first term is the payoff if all n rivals realize signals below $\beta_2(b_1)$. The second term is the payoff if one rival realizes a signal above $\beta_2(b_1)$, but the others are below. The last term is the payoff if two or more rivals realize a signal above $\beta_2(b_1)$. The first-order condition is

$$0 = \Big(v_1(s_1) - (1-\alpha)v_2(\beta_2(b_1))\Big) g_n(\beta_2(b_1)) \frac{1}{\varphi_2}$$
$$+ \alpha n \left(\frac{G_{n-1}(\beta_2(b_1))}{h-l}\left(h - \beta_2(b_1) - \frac{b_1}{\varphi_2}\right) + \frac{h-\beta_2(b_1)}{h-l} g_{n-1}(\beta_2(b_1)) \frac{b_1}{\varphi_2}\right)$$
$$-\alpha n \int_{\beta_2(b_1)}^{h} v_2(\beta_2(b_1)) g_{n-1}(\beta_2(b_1) \frac{1}{\varphi_2}\frac{1}{h-l}\mathrm{d}s_2 - \alpha n \int_{\beta_2(b_1)}^{\beta_2(b_1)} v_2(s_3) g_{n-1}(s_3)\mathrm{d}s_3 \frac{1}{h-l}\frac{1}{\varphi_2}.$$

Replace $g_n(s) = nG_{n-1}(s)\frac{1}{h-l}$ and $v_2(\beta_2(b_1)) = b_1$, and simplify,

$$0 = v_1(s_1) - b_1 + \varphi_2 \alpha \frac{h - \beta_2(b_1)}{h-l}(h-l).$$

(It is easily checked that the second-order condition is satisfied.) Replace $\beta_2(b_1) = \frac{b_1 - v_0 - (1-\varphi_2)\frac{h+l}{2}}{\varphi_2}$ and rearrange, to obtain $b_1^*(s_1)$, the optimal bid function when facing one rival (derived in Lemma 2). So the cut-off signal is the same, $\hat{s}_{1,n} = \hat{s}_1 = \sigma_1(l - \alpha(h-l))$. ■

Now we prove Proposition 4. The toeholder's expected payoff is

$$\mathcal{U}_1^{n\to\infty} = -\alpha v_0 + \int_l^{\sigma_1(h)} \alpha v_2(h) \frac{1}{h-l}\mathrm{d}s_1 + \int_{\sigma_1(h)}^{h} \Big(v_1(s_1) - (1-\alpha)v_2(h)\Big)\frac{1}{h-l}\mathrm{d}s_1 = \frac{(\varphi_1 - \varphi_2)^2 + 4\alpha\varphi_1\varphi_2}{8\varphi_1}(h-l) + \alpha\frac{h+l}{2}.$$

Note that $\frac{1-9\alpha}{(1+\alpha)(1-2\alpha)} < \frac{1}{1+2\alpha}$. If $\varphi_2 > \frac{1}{1+2\alpha}\varphi_1$, then $\left(\mathcal{U}_1^{n\to\infty} - \mathcal{U}_{\text{sym}}^{n\to\infty}\right) - \left(\mathcal{U}_{1+}^{\text{TH}} - \mathcal{U}_1^{\text{noTH}}\right)$ equals

$$-(\varphi_1 - \varphi_2)\frac{(\varphi_1-\varphi_2)^2 + 4\varphi_2^2}{48\varphi_1\varphi_2(1+\alpha)}(h-l) + \frac{3\varphi_1^2 + 3\varphi_2^2 + 10\varphi_1\varphi_2 + 12\alpha\varphi_1\varphi_2}{24\varphi_1(1+\alpha)}(h-l).$$

That term is increasing in α. The restriction $\varphi_2 > \frac{1}{1+2\alpha}\varphi_1$ is equivalent to $\alpha > \frac{\varphi_1-\varphi_2}{2\varphi_2}$. Substitute $\alpha = \frac{\varphi_1-\varphi_2}{2\varphi_2}$ in the equation, to find that it is positive, so it is positive for any larger α. If $\varphi_2 \leq \frac{1}{1+2\alpha}\varphi_1$,

$$\left(\mathcal{U}_1^{n\to\infty} - \mathcal{U}_{\text{sym}}^{n\to\infty}\right) - \left(\mathcal{U}_{1-}^{\text{TH}} - \mathcal{U}_1^{\text{noTH}}\right) = \varphi_2 \frac{\varphi_1(9\alpha - 1) + \varphi_2(1+\alpha)(1-2\alpha)}{12\varphi_1}(h-l),$$

which is negative if $\varphi_2 < \frac{1-9\alpha}{(1+\alpha)(1-2\alpha)}\varphi_1$. ■

Appendix B. The probability of winning

This appendix shows how changes in our parameters of interest — φ_0, φ_2 and n — affect the ratio of probabilities of winning a takeover contest — with and without a toehold. We show that variations in the parameters of interest either do not affect the probability ratio — introducing no bias in the sample selection — or they affect it in the *opposite direction* as our theoretical results predict, generating a sample selection that biases our estimations *against* finding results consistent with our theory. Specifically, if our theory predicts that a certain change in the parameters makes it more beneficial to take a toehold, the ratio of probabilities of winning — with and without a toehold — decreases or is unchanged; and vice versa.

Our first hypothesis focuses on the informativeness of a non-toeholder's signal: The less informative (the lower φ_2), the more beneficial a toehold becomes. In contrast, a less informative non-toeholder signal (a lower φ_2) reduces the probability that a toeholder wins, compared with the probability of winning in a setup without any toeholds.

Proposition 5. *The probability of winning is larger with a toehold, and the difference increases with* φ_2.

Proof. Without a toehold, the bidders are symmetric, so the probability of winning is

$$\mathcal{P}_1^{\text{noTH}} = \int_l^h \int_l^{s_1} \frac{1}{h-l} \mathrm{d}s_2 \frac{1}{h-l} \mathrm{d}s_1 = \frac{1}{2}.$$

If $\varphi_2 > \frac{1}{1+2\alpha}\varphi_1$ (so $b_1^*(s_1) > v_2(l)$ for all s_1), the toeholder's probability of winning is

$$\mathcal{P}_{1+}^{\text{TH}} = \int_l^{\sigma_1(h)} \int_l^{\beta_2(b_1^*(s_1))} \frac{1}{h-l} \mathrm{d}s_2 \frac{1}{h-l} \mathrm{d}s_1 + \int_{\sigma_1(h)}^h \frac{1}{h-l} ds_1 = \frac{-\varphi_1^2 - \varphi_2^2 + 6\varphi_1\varphi_2 + 8\alpha\varphi_1\varphi_2}{8\varphi_1\varphi_2(\alpha+1)}.$$

It increases with φ_2:

$$\frac{\partial}{\partial \varphi_2} \mathcal{P}_{1+}^{\text{TH}} = \frac{\varphi_1^2 - \varphi_2^2}{8\varphi_1\varphi_2^2(\alpha+1)} > 0.$$

Evaluated at $\varphi_2 = \frac{1}{1+2\alpha}\varphi_1$,

$$\mathcal{P}_{1+}^{\text{TH}}\Big|_{\varphi_2 = \frac{1}{1+2\alpha}\varphi_1} = \frac{1}{2} + \frac{\alpha}{2(1+2\alpha)} > \frac{1}{2},$$

so $\mathcal{P}_{1+}^{\text{TH}} > \frac{1}{2}$ for all $\varphi_2 \geq \frac{1}{1+2\alpha}\varphi_1$. If $\varphi_2 \leq \frac{1}{1+2\alpha}\varphi_1$ (so $b_1^*(s_1) = v_2(l)\ \forall\ s_1 \leq \hat{s}_1$),

$$\mathcal{P}_{1-}^{\text{TH}} = \int_{\hat{s_1}}^{\sigma_1(h)} \int_l^{\beta_2(b_1^*(s_1))} \frac{1}{h-l} \mathrm{d}s_2 \frac{1}{h-l} \mathrm{d}s_1 + \int_{\sigma_1(h)}^h \frac{1}{h-l} \mathrm{d}s_1 = \frac{\varphi_1 + \alpha\varphi_2}{2\varphi_1} \quad \frac{\partial}{\partial \varphi_2} \mathcal{P}_{1-}^{\text{TH}} = \frac{\alpha}{2\varphi_1} > 0.$$

Also, $\mathcal{P}_{1-}^{\text{TH}} = \frac{1}{2} + \frac{\alpha\varphi_2}{2\varphi_1} > \frac{1}{2}$, so the probability of winning is larger than in the symmetric case. ■

The intuition for this result is that the strategic effect raises the toeholder's bid above $v_1(s_1)$ for all signals $s_1 < \sigma_1(h)$ (above $\sigma_1(h)$, the toeholder is certain to win, so there is no benefit or cost from overbidding). Consider the extreme case in which $\varphi_2 = 0$. In that case, the toeholder's optimal bid is $\frac{h+l}{2}$ if $s_1 \leq \frac{h+l}{2}$ and $v_1(s_1)$ otherwise. The toeholder overbids with a low signal because she cannot win without overpaying, so she prefers to lose at the highest possible price. Now consider an increase in φ_2. The rival's possible bids are dispersed around $\frac{h+l}{2}$, and this makes it optimal for the toeholder to overbid in the vicinity of $\frac{h+l}{2}$. As φ_2 increases, the area of overbidding around $\frac{h+l}{2}$ grows, and the extent of overbidding increases except for low signals, $s_1 < \hat{s}_1$. An increase in φ_2 also affects the rival's bid, which is lower for low signals s_2 and higher for high signals s_2. The rival is thus more likely to bid low and lose against the toeholder's increased (or slightly reduced) bids with low signals s_1; on the other hand, while the rival's bid increases with high signals s_2, the toeholder's bid also increases with high signals s_1. So the effect on the probability of winning is not symmetric — it increases if the toeholder's signal is low, and it may increase or decrease with a high signal. Overall, the probability of winning increases. In contrast, with an infinitesimal toehold $\alpha \approx 0$, the probabilities of winning do not change if φ_2 increases: With a low signal s_2, the rival's bid is lower, and she is more likely to lose; she is more likely to win with a high signal s_2; the changes are symmetric, and the net effect is nil ex ante (for details, see the proof of the next result, Proposition 6).

Proposition 5 implies that $\frac{\partial}{\partial \varphi_2} \frac{\mathcal{P}_{1+}^{\text{TH}}}{\mathcal{P}_1^{\text{noTH}}} > 0$ and $\frac{\partial}{\partial \varphi_2} \frac{\mathcal{P}_{1-}^{\text{TH}}}{\mathcal{P}_1^{\text{noTH}}} > 0$. In other words, the relative probability of winning (compared with the no-toeholds setup) is increasing in φ_2. This implies that observations in which a target is classified as more opaque, a toeholder's probability of winning is *lower* than with less opaque targets. So if we observe a *higher* incidence of toeholds held by acquirers of more opaque targets, that must be due to significant informational benefits, since the increase in the chances of winning is actually not as high as in the case of less opaque targets.

Our second hypothesis focuses on bidders whose information is initially (without a toehold) less reliable than that of other bidders. Such bidders benefit more from having a toehold, but, as we show now, a toehold does not improve their probability of winning by more than it does for other bidders.

Proposition 6. *The no-toehold informativeness of a bidder's signal does not affect her probability of winning.*

Proof. We first show that without a toehold, the probability of winning is $\frac{1}{2}$, irrespective of the informativeness of a bidder's signal. Assume that bidder i's informativeness is φ_i and bidder j's is φ_j. W.l.o.g., let $\varphi_i > \varphi_j$. Neither bidder has a toehold, so the dominant strategy is to bid the expected valuation, given the realized signal. Bidder i's probability of winning is

$$\mathcal{P}^{\text{noTH}}_{i,\varphi_i>\varphi_j} = \int_l^h \int_{\sigma_i(s_j)}^h \frac{1}{h-l} \text{d}s_i \frac{1}{h-l} \text{d}s_j = \frac{1}{2}.$$

So Bidder j's probability equals $1-\mathcal{P}^{\text{noTH}}_{i,\varphi_i>\varphi_j} = \frac{1}{2}$. Thus, if Bidder 2's signal is of informativeness φ_2, then whether the informativeness of Bidder 1's signal is either φ_2 or $\varphi_0 < \varphi_2$ does not affect her probability of winning — it is always $\frac{1}{2}$.

Next, if a bidder takes a toehold, the initial informativeness of her signal is replaced by φ_1, so the probability of winning does not depend on the initial informativeness. ■

This implies that the relative increase in the probability of winning due to taking a toehold is identical for all bidders, irrespective of the initial informativeness of their signal. Hence, the likelihood of observing a certain bidder in our data set (successful acquirers) does not depend on how reliable their information about the value of synergies is in the absence of a toehold. As before, an increase in the informativeness of one bidder's signal reduce her probability of winning with low signals, while it increases her probability of winning with high signals, and ex ante, the effects cancel out. Even a completely uninformed bidder, who always bids the unconditional expected value $\frac{h+l}{2}$, wins with probability $\frac{1}{2}$, since a better informed rival (without a toehold) bids higher if and only if her signal is above $\frac{h+l}{2}$.

Our third hypothesis compares the benefits of a toehold for initially disadvantaged or not disadvantaged bidders, and how that benefit depends on the target's opaqueness. Since the effects on the relative probabilities of winning are identical for both types of bidders, there cannot be a difference caused by changes in opaqueness (variations in φ_2), either.

Finally, our fourth hypothesis is that the benefit from a toehold decreases with the number of rival bidders. In contrast, the ratio of probabilities of winning (with a toehold, compared with the no-toeholds setup) *increases* with the number of bidders. This is easiest to see when comparing the limit case as $n \to \infty$.

Proposition 7. *The relative increase in the probability of winning with a toehold is unbounded in the limit as $n \to \infty$.*

Proof. In the limit as $n \uparrow \infty$, the toeholder's probability of winning is

$$\lim_{n\to\infty} \mathcal{P}^{\text{TH}}_{1,n} = \lim_{n\to\infty} \int_{max\{\hat{s}_1,l\}}^{\sigma_1(h)} \frac{G_n(\beta_2(b_1^*(s_1)))}{h-l} \text{d}s_1 + \int_{\sigma_1(h)}^h \frac{1}{h-l} \text{d}s_1 = \frac{h-\sigma_1(h)}{h-l}.$$

Without a toehold, the probability of winning,

$$\mathcal{P}^{\text{noTH}}_{1,n} = \int_l^h G_n(s_1) \frac{1}{h-l} \text{d}s_1,$$

decreases with n, and in the limit as $n \to \infty$ it converges to zero. So $\lim_{n\to\infty} \frac{\mathcal{P}^{\text{TH}}_{1,n}}{\mathcal{P}^{\text{noTH}}_{1,n}} = \infty$. ■

The same result holds for finite n: Adding one more rival increases the ratio $\frac{\mathcal{P}^{\text{TH}}_{1,n}}{\mathcal{P}^{\text{noTH}}_{1,n}}$. Deriving these results is a little more involved, since it requires a comparison of the relative probabilities of winning with n and $n + 1$ bidders, for each value of n separately; so these results are not reproduced here.

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