IPOs versus Acquisitions and the Valuation Premium Puzzle: A Theory of Exit Choice by Entrepreneurs and Venture Capitalists

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Abstract

We analyze a private firm's choice of exit mechanism between IPOs and acquisitions, and provide a resolution to the "IPO valuation premium puzzle." The private firm is run by an entrepreneur and a venture capitalist (insiders) who desire to exit partially from the firm. A crucial factor driving their exit choice is competition in the product market: while a stand-alone firm has to fend for itself after going public, an acquirer is able to provide considerable support to the firm in product market competition. A second factor is the difference in information asymmetry characterizing the two exit mechanisms. Finally, the private benefits of control accruing post-exit to the entrepreneur and the bargaining power of outside investors versus firm insiders are also different across the two mechanisms. We analyze two different situations: the first, where the entrepreneur can make the exit choice alone (independent of the venture capitalist) and the second, where the entrepreneur can make the exit choice only with the concurrence of the venture capitalist. We derive a number of testable implications regarding insiders' exit choice between IPOs and acquisitions and about the IPO valuation premium puzzle.

I. Introduction

It is well known that taking their firm public through an initial public offering (or "IPO") is an important pathway for entrepreneurs and venture capitalists to diversify their equity holdings in the firm and exit (at least partially), while simultaneously allowing the firm to raise external financing for new investment.[1] However, it is not obvious that an IPO is always the best way to accomplish the above objectives. In fact, an equally (if not more) important pathway for private firms to raise external financing while providing an exit mechanism for entrepreneurs and venture capitalists is agreeing to be acquired by another firm: over the last decade, a private firm was much more likely to have been acquired than to go public.[2] Surprisingly, while the going public decision has been extensively studied in the literature both theoretically (see, e.g., Spiegel and Tookes (2007), Boot, Gopalan, and Thakor (2006), Chemmanur and Fulghieri (1999)) and empirically (see, e.g., Pagano, Panetta, Zingales (1998) or Chemmanur, He, and Nandy (2010)), private firm acquisitions, and the determinants of a firm's choice between IPOs and acquisitions have been relatively unexplored in the literature. In fact, while the empirical literature has recently started to explore this choice (see, e.g., Brau, Francis, and Kohers (2003), Poulsen and Stegemoller (2008)), there has been no theoretical analysis so far of a firm's choice between IPOs and acquisitions. The objective of this paper is therefore to develop the first such theoretical analysis in the literature.

Developing a rigorous theoretical analysis of the factors determining a firm's choice between IPOs

[1] There is an extensive theoretical literature on IPOs: see, e.g., Allen and Faulhaber (1989), Chemmanur (1993), or Welch (1989). See Ritter and Welch (2002) for an excellent review of the various motivations of a firm to go public and of the theoretical and empirical literature on IPOs in general.

[2] According to the National Venture Capital Association (NVCA), there were more exits by venture capitalists through acquisitions than by IPOs in each of the last ten years. The NVCA reports that acquisitions constituted 89% of the value of exits of venture backed firms in 2009: while acquisitions of venture backed firms accounted for $13.53 billion in value, IPOs of venture backed firms accounted for only $1.64 billion.

and acquisitions is important for several reasons. First, the exit decision is one of the most important decisions in the life of a firm, since it typically allows the firm to access the public capital markets for the first time (either as a stand-alone firm, in the case of an IPO, or as part of a large publicly traded firm, if it is acquired by such a firm). Further, it is the first significant opportunity for the entrepreneur and venture capitalist (as well as other private investors) to liquidate some of their holdings in the firm. Therefore, understanding the factors determining the choice between these two exit mechanisms is crucial not only for entrepreneurs, but also for venture capitalists, as well as for investment banks and other financial intermediaries involved in facilitating a firm's IPO or its acquisition.

Second, the ratio of acquisitions to IPOs among private firm exits have increased dramatically in recent years; further, the proportion of firms withdrawing their offerings after filing to make IPOs and choosing to be acquired instead has also risen steadily in the current decade.[3] These trends indicate that the costs to private firms of going public rather being acquired has risen significantly in recent years, a trend blamed by investment bankers and other practitioners on the recent spate of scandals involving analysts, which has reduced the number of analysts and therefore the post-IPO coverage of small firms, and the Sarbanes-Oxley Act, which, they argue, has increased the cost of complying with disclosure and governance regulations after an IPO.[4] An understanding of the factors driving a firm's choice between IPOs and acquisitions is therefore also important for policy makers in deciding what corrective actions (if any) to take to ensure that entrepreneurs and venture capitalists have adequate exit opportunities available to them.

[3]The Wall Street Journal reports that the proportion of stock offers that were withdrawn because issuers began discussions to be acquired instead was 33% in 2005, against 18% in 2004 and 16% in 2003 (*Wall Street Journal*, February 21, 2005, "More Companies Pulling Deals to be Acquired".

[4]See again (*Wall Street Journal*, February 21, 2005, "More Companies Pulling Deals to be Acquired."): "From the perspective of a small company readying itself to go public, getting acquired also avoids an after-market expense: the cost of complying with the Sarbanes-Oxley Act, which requires public companies to audit their internal controls, from inventory tracking to the security of their competitive systems..."

Third, recent empirical research on IPOs versus acquisitions, while still in its infancy, has also raised several interesting questions which highlights the need for a better understanding of a firm's choice between these two exit mechanisms. A stylized fact emerging from this literature is that IPOs are characterized by significantly higher valuations than acquisitions: Brau, Francis, and Kohers (2003) document a "valuation premium" of 22% for IPOs over acquisitions. While an average valuation premium of IPOs over acquisitions is not, by itself, surprising (since IPO firms also tend to be higher growth firms: see Poulsen and Stegemoller (2008)), the above finding would be quite puzzling if the IPO valuation premium persists even after carefully controlling for all firm quality variables (some of which, while unavailable to outsiders at the time of exit, will become available to the econometrician sometime after exit): why would an entrepreneur choose to do an acquisition if he could exit with a much higher payoff through an IPO? Our theoretical analysis is able to explain this "IPO valuation premium puzzle," and generate further testable hypotheses regarding this puzzle.

We study the situation of an entrepreneur managing a private firm backed by a venture capitalist. The entrepreneur and the venture capitalist wish to exit partially from the firm, motivated either by a desire to satisfy their personal liquidity demands, or by the need to raise external financing for investment in the firm's growth opportunity (project), or both. They can accomplish this in one of two ways. They can either take the firm public in an IPO, selling some of their equity holdings in the firm to satisfy their respective liquidity demands, and issuing new equity to raise the required amount for the firm, with the entrepreneur continuing to manage the firm after the IPO. Alternatively, they can sell their private firm to an acquirer, in which case they divest their entire equity holdings in the firm, with the entrepreneur giving up control of the firm to the acquirer.[5] We analyze the firm's choice between

[5]Our assumption is that the liquidity demands of the entrepreneur and the venture capitalist are common knowledge among outside investors so that there will be no Leland and Pyle (1977) style negative signaling effects in the IPO market for insiders selling equity, as long as these agents do not sell more equity than is required to satisfy their (publicly known) liquidity demands. On the other hand, entrepreneurs and VCs selling more equity than is required to meet their liquidity

the above two alternatives. We can think of two cases: first, the case where the choice of exit is made by the entrepreneur alone ("entrepreneur controlled firm"), either because the venture capitalist's equity holdings in the firm are very small, or because his financial contract with the firm does not give him enough power to block any exit decision made by the entrepreneur; second, a scenario, where the exit decision is made by the entrepreneur, but where the venture capitalist has veto power over any exit choice ("jointly controlled firm"), so that the exit decision is negotiated between the entrepreneur and the venture capitalist, with transfers (side payments) made by the entrepreneur to the venture capitalist in case the latter disagrees with the exit choice made by the former.[6] Non-venture backed firms (or firms where venture capitalists have only an insignificant amount of investment) approximate the entrepreneur controlled firms in our model, since in these firms, the exit decisions reflect primarily the incentives of the entrepreneur. Venture backed firms, on the other hand, are similar to the jointly controlled firms in our model: whether such firms are closer to being entrepreneur controlled or jointly controlled depends on how much control venture capitalists have in its governance, which, in turn depends on the extent of venture capitalists' investment in the firm, and the terms of this investment: e.g., extent of board representation held by venture capitalists and the stringency of the contractual provisions in their financial contracts with the firm.[7] Since most real world situations are close to

demand will severely depress their firm's stock price due to Leland and Pyle (1977) style negative signaling effects. Thus, we assume that the amount of new equity issued by the firm is only enough to cover the firm's investment requirements, while the amount of equity sold by the VC and the entrepreneur in this market is just enough to meet their liquidity demands. In contrast, since there is no asymmetric information between these agents and potential acquirers, they can divest their entire equity holdings in the firm in the case of an acquisition.

[6]In the working paper version of this paper, we also analyze the case of a VC controlled firm where the VC can make the exit choice regardless of the preferences of the entrepreneur. Since real world venture backed firms are closer to jointly controlled firms, we will not analyze VC controlled firms here. The results in the case of the "VC controlled firm" are similar to those in the case of the "jointly controlled firm" and are available to interested readers from the authors.

[7]When the venture capitalist invests in the firm using convertible preferred equity (as is common in the U.S.), one contractual provision which gives him considerable power over the private firm's exit decision is the Automatic

either the entrepreneur controlled firm (e.g., non-venture backed firms) or jointly controlled firms (e.g., venture backed firms), we will present the analysis of only these two situations in this paper.

A crucial factor driving a private firm's choice between IPOs and acquisitions is competition in the product market: while a stand-alone firm has to fend for itself after going public, an acquirer may be able to provide considerable support to the firm in the product market, thus increasing its chances of succeeding against competitors and establishing itself in the product market.[8, 9] Further, unlike atomistic investors in the IPO market, who can be expected to be at an informational disadvantage with respect to firm insiders, potential acquirers will be able to value the firm better by virtue of their industry expertise regarding the viability of alternative business models in the product market.[10] On

Conversion provision of the term sheet. This provision specifies two important numbers which determine its stringency: x, "the number of times the original purchase price of the preferred stock will automatically convert into common and facilitate a public offering," and y, "the amount of money that will qualify an IPO as acceptable to the preferred." The larger the numbers x and y, the greater the venture capitalist's power over the exit decision.

[8]Practitioner discussions of IPOs versus acquisitions often refer to such synergies. See, e.g., "The acquisition game" (Austin Business Journal, February 18, 2000). Two examples of private firms which are reported in the above article to have obtained such synergies from an acquisition are Schwab's acquisition of CyBerCorp and Lucent's acquisition of Agere. See also Poulsen and Stegemoller (2008), Table 2, which documents that one of the prevalent reasons given by private firms for choosing to be acquired rather than go public is synergy with the acquirer.

[9]There are several examples of firms which seem to have explicitly considered implications for product market competition when making the choice between going public and being acquired. One example is the optical networking company Cerent Corporation, whose CEO, Carl Russo was about to go public, but eventually decided to be acquired by Cisco Systems based on considerations of product market competition (see the Stanford Business School Case on Cerent (Sigg (2000)). A second example is Google Inc., which almost certainly pondered the competitive threat from Yahoo and Microsoft in the "search" products market (and was approached by Microsoft to be acquired) before deciding to go public despite these threats (see, e.g., *The Economist*, April 27, 2004: "The search for investment paradise"). The above two examples also illustrate the fact that, consistent with the assumption we make in this paper, the product market benefit of an acquisition is greater for firms with business models that are less viable against product market competition.

[10]Unlike acquirers, who can rely on their own industry expertise, the primary source of information for IPO market

the negative side, acquirers can be expected to have considerable bargaining power, allowing them to extract the firm's net present value from insiders. In contrast, atomistic investors in the IPO market would price the firm's equity competitively (so that insiders can retain the entire net present value of the firm's project). Another negative aspect of an acquisition is that an entrepreneur managing a private firm may derive personal benefits from continuing to manage it long term ("private benefits of control"), which he is likely to lose after an acquisition, since, in many acquisitions, the founding entrepreneur of the target firm either leaves the firm shortly after the acquisition or is fired.[11] Even if the entrepreneur continues with the combined firm, his benefits of control will be negligible, since he will only be in charge of one division of the combined firm, and will have to implement the policies formulated by the top management of that firm even with respect to the division he manages. In contrast, the entrepreneur will continue (in the absence of a subsequent takeover) as the CEO of a stand-alone firm after an IPO, and will thus be able to maintain a substantial extent of his benefits of control.[12]

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investors about the viability of alternative business models are financial analysts. To quote the technology industry newsletter *LA Vox* ("Are M&As the new IPOs?", January 21, 2003, www.larta.org): "Bankers have relied for years on the expertise of analysts about what business models are working,....the number of analysts on Wall Street is dropping significantly and the number of companies covered is dropping significantly. That makes it difficult to get companies public and support them once they are public. Until it reverses, we'll not have public markets for new offerings."

[11] One example of an entrepreneur who left his own firm soon after it was acquired was Sabeer Bhatia, the founder of Hotmail, who left his firm after it was acquired by Microsoft: see, e.g., the HBS case No:899165 on Hotmail. Another reflection of how much entrepreneurs value control is the existence of a dual class share structure in a significant fraction of recent IPOs, for example, in the case of Google. See, e.g., Chemmanur, Paeglis, and Simonyan (2010), who document the presence of this and other anti-takeover provisions in a significant fraction of U.S. IPO firms.

[12] Practitioner discussions of IPOs versus acquisitions often refer to such private benefits of control. See, e.g.,"The acquisition game" (Austin Business Journal, February 18, 2000): "The inherent difficulty of selling a company is giving up control of something over which top management has long labored and developed... A lot of people in startups have invested not just their money but their livelihood...They've invested their heart and soul." Please see also footnote 35

An interesting aspect of our model is that the entrepreneur and the venture capitalist may sometimes disagree on the preferred means of exit in equilibrium. This may be due to two reasons. First, the fact that he is able to retain private benefits of control in an IPO, but not in an acquisition, may motivate an entrepreneur to prefer an IPO over an acquisition (*ceteris paribus*), in contrast to the venture capitalist, who is likely to choose between the above two exit alternatives based on financial considerations ("cash flow benefits") alone. Second, the entrepreneur and the venture capitalist may differ in their investment horizons in the firm (explicitly captured by their respective liquidity demands in our model): while the entrepreneur is typically a long-term investor planning to continue much of his pre-exit equity stake in the firm even after an IPO (low liquidity demand), the venture capitalist may often be a short-term investor planning to liquidate much of his pre-exit stake soon after the IPO (high liquidity demand). This may drive a wedge between the exit preferences of the entrepreneur and venture capitalist, especially during periods of high IPO market valuations: while the entrepreneur, being a long-term investor, may be concerned about the sustainability of these high valuations, the venture capitalist, being a short-term investor, may be less affected by such concerns.

Our analysis generates a number of empirical and policy implications for a private firm's choice of exit mechanism. First, our model predicts that later stage firms with business models more viable against product market competition are more likely to go public, while earlier stage firms, less viable against product market competition, will more likely choose to be acquired. Second, the choice between IPOs and acquisitions will depend on the nature of the industry the firm is operating in: the likelihood of IPOs relative to acquisitions will be greater in more capital intensive industries, and where entrepreneurs obtain greater private benefits from managing the firm; it will be smaller in industries where there is already a dominant firm (where the benefits of being acquired by a larger, established firm are greater). Third, our model predicts that the likelihood of a firm going public rather

for differences in control benefits in financial versus strategic acquisitions.

than being acquired will depend on the prior probability assessment of outsiders that any given firm has a viable business model in the product market, and, through it, IPO market valuations: when IPO market investors assess a larger prior probability that the firm is viable in the product market (higher intrinsic value), IPO market valuations will be higher, and the firm is more likely to be go public; conversely, when this prior probability assessment (and therefore IPO market valuations) are lower, then the firm is more likely to be acquired. The intuition here is that, since there is considerably less information asymmetry between the acquirer and firm insiders compared to that characterizing the IPO market, the acquisition value of a firm is likely to fluctuate considerably less over time compared to its IPO market value (so that the ratio of a firm's IPO value to acquisition value will be greater when IPO market valuations are higher).

Fourth, our model predicts that the *average* valuation of firms going public will be greater than the average value of firms that are acquired. This is because firms going public consist of a mix of higher type and lower type firms, while only lower type firms are acquired, so that the intrinsic value of firms going public is greater. Fifth, our model predicts that, in many cases, entrepreneurs will choose to let their firms be acquired at a lower valuation relative to the value at which it could have gone public (the "IPO valuation premium puzzle"). Based on their private information, these entrepreneurs may realize that their firm may not succeed in the long run against product market competition, so that their IPO market valuations are not sustainable in the long run. Therefore, given that insiders are able to liquidate only a small fraction of equity in the IPO (especially given that most IPOs have lock-up arrangements, which forbid investors from liquidating additional shares in the equity market immediately after IPO), their long-term expected payoff (weighted average of proceeds obtained from selling shares at the time of IPO and long-run value of equity held in the firm) will be lower in the case of an IPO compared to its acquisition value. This motivates many entrepreneurs to choose acquisitions over IPOs even when they can obtain higher equity valuations for their firm in the

IPO market, thereby providing a potential resolution to the IPO valuation premium puzzle.

Sixth, our model develops predictions for the exit choice of venture backed versus non-venture backed firms. Our model predicts that venture backed firms are more likely to go public compared to non-venture backed firms, provided that the venture capitalist divests a much larger fraction of equity in the IPO (or soon after) compared to entrepreneurs, which is likely to be the case in practice. However, if venture capitalists are long-term stakeholders (so that they retain a fraction of equity post-IPO of similar magnitude as entrepreneurs), then our model predicts that venture backed firms are less likely to go public (rather than be acquired) than non-venture backed firms. Further, in the latter scenario, within a sample of venture backed firms, those in which venture capitalists play a greater governance role are more likely to be acquired.[13] Seventh, we develop predictions about the characteristics of firms likely to undergo post-IPO acquisitions: while, given the additional costs involved, such double exits are puzzling, we are able to resolve this puzzle, since double exits emerge as equilibrium behavior in some situations in our model. Finally, we develop predictions for a firm's choice between strategic and financial acquirers. Our model also generates a number of other testable and policy implications, which we detail in section 7.

The rest of the paper is organized as follows. Section 2 reviews the existing literature related to our paper. Section 3 presents the basic features of our model. Section 4 presents the equilibrium of our

[13]The probability of going public of venture backed versus non-venture backed firms in our setting is determined by the trade-off between the "short-term investment horizon effect" (i.e., the fact that venture capitalists have shorter investment horizons in the firm relative to entrepreneurs) and the "private benefits effect" (arising from the fact that the venture capitalist does not obtain any private benefits of control, unlike an entrepreneur). On the one hand, the short-term investment horizon effect makes a venture backed firm more likely to go public than a non-venture backed firm, since the venture capitalist may be tempted to take advantage of short-term IPO valuations to the extent possible, without considering the long-term sustainability of these valuations. On the other hand, the private benefits effect makes a venture capitalist controlled firm less likely to go public (i.e., more likely to be acquired), since the venture capitalist makes his exit decisions purely on financial considerations, unlike an entrepreneur.

basic model and derives results for two different scenarios: the case of the entrepreneur controlled firm is discussed in section 4.3; the case of the jointly controlled firm is discussed in section 4.4. Section 5 and section 6 present extensions to our basic model. Section 7 describes the testable predictions and policy implications of our model. Section 8 concludes. The proofs of all propositions are confined to the appendix.

II. Related Literature

Our paper is related to three strands in the theoretical literature. The first is the literature on the going public decision (e.g., Boot, Gopalan, and Thakor (2006), Chemmanur and Fulghieri (1999), Maksimovic and Pichler (2001)), which focuses on a firm's choice between remaining private and going public. The trade-offs we analyze here are, however, completely different: our focus here is on firms that have decided that they want to have access to external capital, but are deciding on whether to obtain such access by going public or by being acquired by another firm (public or private).

The second literature our paper is related to is the literature on the interactions between the financial and product markets. A recent example of this literature is Spiegel and Tookes (2007), who model the interactions between product market innovation, product market competition, and the going public decision. They show that the private versus public financing decision depends mainly on the magnitude of the firm's technological improvement and the length of time during which private financing extends the innovators' product market advantage. Two other papers in this literature are Stoughton, Wong, and Zechner (2001), who argue that the decision of a firm to go public may signal high quality to the product market, and Chemmanur and Yan (2009), who demonstrate, theoretically and empirically, that the extent of product market advertising undertaken by a firm will affect the extent of underpricing in its IPO.

The third literature our paper is related to is the theoretical literature on venture capital: see, e.g.,

Fulghieri and Sevilir (2009), who study a private firm's choice between alternative sources of venture capital, and Hellmann (2006), who demonstrates that the use of convertible securities in venture capital financing allows the implementation of the ex ante optimal exit policy if the interests of the venture capitalist and entrepreneur diverge ex post. The paper by Fulghieri and Sevilir (2009) analyzing the optimal size of a venture capitalist's portfolio is also related to this paper.

The empirical literature closest to this paper is the one studying a firm's choice between IPOs and acquisitions: see, e.g., Brau, Francis, and Kohers (2003), Poulsen and Stegemoller (2008), Bayar and Chemmanur (2009), and Chemmanur, He, and He (2009). Another closely related empirical literature focuses on the exit decisions of only venture backed firms: e.g., Cumming (2008) and Nahata (2003).

III. The Basic Model

Our basic model consists of two dates (see Figure (1)). At time 0, shares of a private firm are initially held by three types of agents: an entrepreneur, a venture capitalist (VC hereafter), and other private equity investors.[14] The fractions of equity initially held by these investors are denoted by δ_E, δ_V, and δ_o respectively. The firm has monopoly access to a single project which requires a fixed investment of I at time 0. The investment capital can be raised either through going public and issuing new equity or selling the firm to an acquirer. The entrepreneur and the venture capitalist may also sell a fraction of their shares out of their remaining initial equity holdings, α_E and α_V respectively, to satisfy their liquidity demand, to outside investors through a secondary offering in the IPO market. Subsequently, between time 0 and time 1, product market competition takes place between the firm and other incumbent firms in the product market. If an acquisition takes place at time 0, the acquiring firm can help the target firm in the product market, since it is now a division of the acquiring firm. At time 1, final cash flows are realized and the firm is liquidated. The final cash flows V depend on

[14] Angels are an example of other private equity investors.

the exit strategy chosen at time 0, the degree of competition between time 0 and time 1 and firm type (about which insiders have private information). If the project is implemented at time 0 by raising I, the cash flows V can take one of two possible values at time 1:

$$V = \begin{cases} I + V_S & \text{if the firm "succeeds" by time 1,} \\ I + V_F & \text{if the firm "fails" by time 1.} \end{cases} \tag{1}$$

We assume that the firm's intrinsic value is greater if it succeeds: i.e., $0 < V_F < V_S$, and normalize the risk-free rate of return to zero for analytical simplicity.

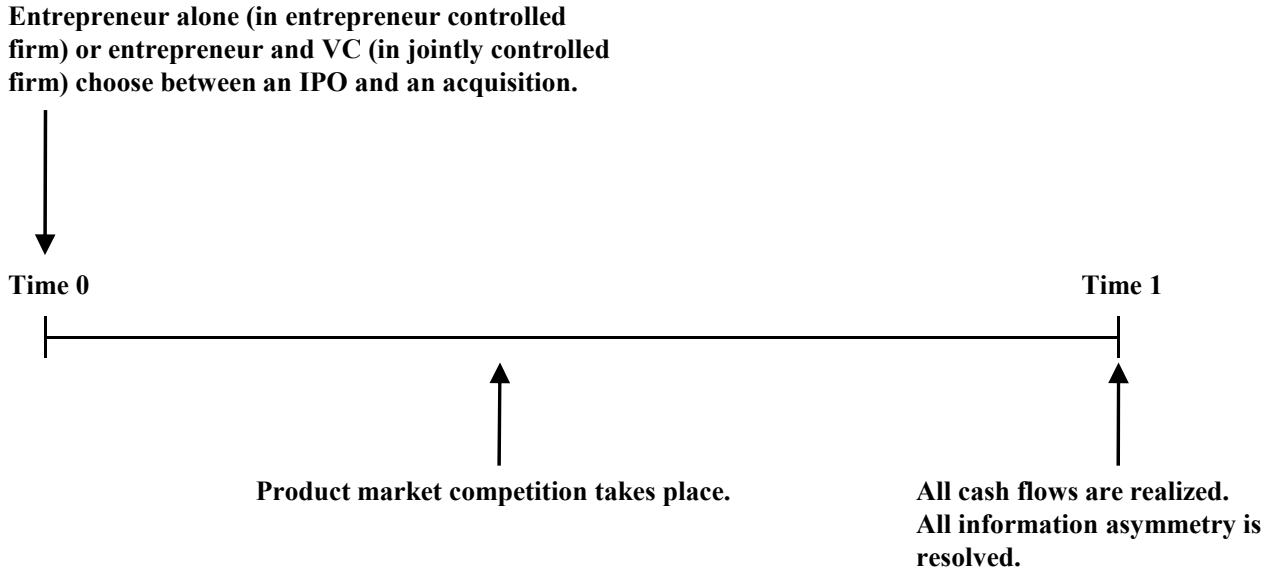

Figure 1: Sequence of Events in the Basic Model

A. The Entrepreneur

It is the entrepreneur (alone, in the case of an entrepreneur controlled firm or jointly with the venture capitalist in the case of a jointly controlled firm) who makes the decision regarding whether to take the firm public or sell it to an acquirer. The entrepreneur, who is risk neutral, has private information about firm type: a high type (H) firm has a viable, sustainable business model and therefore it is

more likely to succeed (probability p_H) as a stand-alone company against the competition in the product markets. A low type (L) firm also has positive NPV growth opportunities but requires more time for product development and further financing to attain a sustainable business model. Hence its probability of success, p_L, against competition is lower than the probability of success, p_H, of a high type firm. The entrepreneur, who initially holds a fraction δ_E of the initial shares outstanding in the firm, derives private benefits of control which we denote by B, in addition to his cash flow benefits from holding equity in the firm. If the firm goes public and new equity is raised to meet the firm's investment demand I, we assume that the entrepreneur will also sell a fraction α_E of his equity holdings in the firm in the IPO to satisfy his personal liquidity demand. If the firm is acquired at time 0, the entrepreneur will be fired from the firm's management and will forfeit his private benefits of control. Since the entrepreneur is risk-neutral, his objective in making the exit decision at time 0 is to maximize the sum of his time 0 cash flow (from selling some of his equity in the firm), his time 1 expected cash flow, and the value of the private benefits of control accruing to him.

B. The Venture Capitalist

The venture capitalist initially owns a fraction δ_V of the firm. Like the entrepreneur, he also has private information about his firm's type and is risk-neutral. In the basic model, we first assume that the private firm is controlled by the entrepreneur and the decision to go public or sell the firm to an acquirer at time 0 will be made by him alone.[15] Later, we also analyze the case where the firm is jointly controlled by the entrepreneur and the VC, so that neither the VC nor the entrepreneur has the absolute control right over the firm, and the entrepreneur can make the exit decision only in consultation with the VC. In this case (which we analyze in section 4.4), if there is disagreement regarding exit choice between the entrepreneur and the VC, one of the parties has to make side

[15]The entrepreneur's initial share of the firm δ_E is assumed to be much larger than the venture capitalist's share δ_V.

payments to the other to convince him to agree with the exit decision made by him. We assume that the VC does not derive any private benefits of control. If the firm goes public and new equity is raised, we assume that the VC will also sell a fraction of α_V of his remaining equity holdings in the firm to satisfy his liquidity demand.[16] Since he is risk-neutral, the VC's objective in making the exit decision at time 0 is to maximize the sum of his time 0 cash flow (from selling some of his equity in the firm) and his time 1 expected cash flow.

C. The IPO Market

If the entrepreneur (jointly with the VC in the case of a jointly controlled firm) decides to take the firm public, the firm issues new equity worth I and the two insiders sell a certain fraction of their initial share holdings at the price P_{ipo} in a competitive IPO market which consists of numerous competitive outside investors. We denote by γ the fraction of shares sold to new shareholders. As discussed before, the entrepreneur and the VC also sell fractions α_E and α_V respectively, of their remaining share holdings, $\delta_E(1-\gamma)$ and $\delta_V(1-\gamma)$ respectively, in a secondary offering (as part of the IPO) to satisfy their respective liquidity demands. We normalize the number of outstanding shares in the firm to 1, so that the total fraction of shares sold in the IPO market is equal to $\gamma + (\delta_E\alpha_E + \delta_V\alpha_V)(1-\gamma)$. The offering price P_{ipo} set by firm insiders for the firm's equity in the IPO will clearly depend on the equilibrium beliefs they conjecture outsiders will form about the type of the firm, since this price has to be such that investors in the competitive IPO market at least break even if they invest in the firm's equity. At the same time, IPO market investors will form their beliefs about firm type after observing

[16] Differences in the liquidity demands of entrepreneurs and VCs can create a wedge in their exit preferences. One could expect that the liquidity demand of the venture capitalist is at least as high as the entrepreneur's liquidity demand, i.e. $\alpha_V \geq \alpha_E$. For more on this, see the discussion after Proposition 5. While our results depend on the magnitudes of these liquidity demands, our analysis can also accommodate the special case where the entrepreneur's and venture capitalist's liquidity demands are zero.

the fraction of equity sold by the firm and its insiders, the price they set for these shares in the IPO, and consistent with the equilibrium strategies of firm insiders. As discussed before, outside investors in the IPO market have less information than entrepreneurs and venture capitalists about the true quality (type) of the firm approaching them for capital. The prior probability assessment of outside investors in the IPO market about firm type is denoted as follows: $\Pr(q = H) = \theta,\ \Pr(q = L) = (1-\theta)$. The prior probability assessment of outside investors about firm type reflects the proportion of type H firms available in the industry that are ready to exit: if this proportion is high, the unconditional probability assessment θ of outsiders that a firm is of type H will also be high.

D. The Acquiring Firm and the Product Market

Upon an evaluation of the firm's assets and future prospects, we assume that the acquirer will correctly infer the type of the firm: i.e., there is no information asymmetry between the entrepreneur and the acquirer.[17] Since the acquirer has considerable bargaining power, he will pay only a fraction ρ of the intrinsic net present value of the firm to the target firm's insiders. After the takeover, the acquirer owns the entire firm, provides the capital I for new investment, and the firm's management is replaced. For both high and low type firms, an acquisition adds value in the sense that the acquirer helps the target firm in the product market, so that the probability of success in competition with incumbent firms increases to p_A, where we assume that $1 > p_A > p_H > p_L$. Thus, the increase in the probability of success in product market competition as a result of an acquisition is higher for a type L firm.[18]

[17]Note that the assumption of symmetric information between the entrepreneur and the acquiring firm is made only for modeling simplicity. All our results go through qualitatively unchanged as long as the extent of private information between the entrepreneur and acquiring firm is significantly less than that between the entrepreneur and IPO market investors. The latter seems to be a reasonable assumption, given the industry expertise of the acquiring firm's management.

[18]The assumption that the probability of success of a type H and type L firm in product market competition is the same after an acquisition is made only for simplicity. Our results go through qualitatively unchanged even if this success

Clearly, the expected time 1 cash flow of a type H or type L firm after an acquisition is then given by $I + p_A V_S + (1 - p_A)V_F$.

IV. Equilibrium of the Basic Model

The equilibrium concept we use is that of Perfect Bayesian Equilibrium (PBE) satisfying the Cho-Kreps Intuitive Criterion. An equilibrium consists of (i) a choice of exit strategy by the entrepreneur (jointly with the VC in the case of a jointly controlled firm) at time 0 between going public and selling the firm to an acquiring firm; (ii) a decision by the investors about whether to bid in the IPO at the price P_{ipo} or not for a firm that is going public; (iii) a decision by the acquiring firm about the acquisition price P_{acq}.

Each of the above choices and beliefs of the private firm's insiders, outside investors, and the acquiring firm has to satisfy the following requirements: (a) the choices of each party maximizes his objective, given the equilibrium beliefs and choices of others; (b) the beliefs of all parties are consistent with the equilibrium strategies of the others; further, along the equilibrium path, these beliefs are formed using Bayes' rule; (c) any deviation from his equilibrium strategy by any party is met by beliefs by other parties which yield the deviating party a lower expected payoff compared to that obtained in equilibrium.

We can think of equilibria in two different situations depending on which party, the entrepreneur alone or the entrepreneur jointly with the VC, is making the exit decision of the private firm: (1) equilibrium in an entrepreneur controlled firm, studied in section 4.3, (2) equilibrium in a jointly controlled firm, studied in section 4.4. We define an entrepreneur controlled firm as one where the VC does not have significant control rights, so that the exit choice is made by the entrepreneur alone, and

probability is higher for a type H firm than for a type L firm, as long as the increase in success probability is greater for a type L firm than for a type H firm.

the VC essentially goes along with the entrepreneur's decision; we define a jointly controlled firm as one where both the entrepreneur and the VC have substantial control rights, so that the exit decision cannot be implemented without the convergence of both parties. In this case, we allow for one of the parties (say, the entrepreneur) to make side payments to the other (say, the VC) to induce him to converge with the exit decision made by him.

In each of the two situations above, we have determined that there are four broad categories of equilibria that may exist depending on parameter restrictions: (i) type H firms strictly prefer to go public whereas type L firms play a mixed strategy (chooses to go public with some probability, and chooses to be acquired with the remaining probability); (ii) both types of firms strictly prefer to go public; (iii) type H firms strictly prefer to go public whereas type L firms strictly prefer acquisitions; (iv) both types of firms strictly prefer acquisitions. In our setting, we have proved that four other categories of potential equilibria do not exist: (v) type L firms strictly prefer acquisitions whereas type H firms play a mixed strategy; (vi) type L firms strictly prefer to go public whereas type H firms play a mixed strategy; (vii) type L firms strictly prefer to go public whereas type H firms strictly prefer acquisitions; (viii) both types of firms play a mixed strategy. Equilibria of categories (ii) and (iv) exist for only extreme values of our model's parameter space. Moreover, equilibria of categories (ii) and (iii) can be thought of as special (corner) special cases of equilibria of category (i), where the mixing probability of the type L firm is one or zero, respectively. We will also show that, under reasonable parametric restrictions, this is the *unique equilibrium* of our model. Therefore, in the rest of the paper, we will focus only on equilibria of category (i), since it is not only unique under reasonable parametric restrictions, but is also the most interesting and economically relevant equilibrium. This equilibrium also nicely captures the details of the trade-offs driving firms' exit choice between IPOs and acquisitions. In the rest of the paper, we therefore characterize the conditions for the existence of an equilibrium of type (i) in the case of entrepreneur controlled and jointly controlled firms, and

obtain comparative statics results for such an equilibrium.[19]

A. Analysis of the Entrepreneur's Problem

The entrepreneur faces the following trade-off between an IPO and an acquisition: First, depending on the IPO market conditions and the intrinsic value of his own firm, the entrepreneur might be able to benefit from a high IPO valuation of his firm, denoted by P^E_{ipo}. Recall that in the event of an IPO, the entrepreneur will sell a fraction α_E of shares, out of his remaining equity holdings $\delta_E(1-\gamma)$, after the firm issues a fraction γ of new shares in the IPO.[20] Second, he will retain a fraction $\delta_E(1-\gamma)(1-\alpha_E)$ of the outstanding shares of the public firm with an expected net present value of $V_q = V(p_q) = p_q V_S + (1-p_q)V_F$, where q stands for firm type, $q \in \{H, L\}$ and $0 < p_L < p_H < 1$. The entrepreneur will also continue to enjoy his private benefits of control, $B > 0$, between time 0 and time 1, if he chooses an IPO, but not if his firm is acquired. In the case of an acquisition, the acquiring firm will help to improve the competitive position of his firm such that after an acquisition at time 0, the success probability of either type of firm will be increased to p_A. The acquired firm's project's net present value is given by $V_A = p_A V_S + (1-p_A)V_F$. If the entrepreneur decides to take the firm public, denoted by the indicator variable $a = 1$, the IPO valuation of the firm denoted by P^E_{ipo} will be determined according to the updated beliefs of outside investors in the equilibrium by using Bayes' rule:

$$P^E_{ipo} = I + \Pr(q = H \mid a = 1)V_H + \Pr(q = L \mid a = 1)V_L. \tag{2}$$

[19] Proofs of nonexistence of equilibria of type (v), (vi), (vii), and (viii) and the details of equilibria of categories (ii), (iii), and (iv) are available to interested readers upon request.

[20] If the firm is controlled by the entrepreneur and the exit decision is made by him, we will denote the IPO price by P^E_{ipo}. Similarly, if the firm is jointly controlled by the entrepreneur and the VC, we will denote the IPO price by P^J_{ipo}.

Since the IPO market is competitive, the newly issued shares will be worth I which is equal to the price paid by the outside investors, i.e, if γ denotes the fraction of shares hold by new shareholders, we have $P^E_{ipo}\gamma = I$.

If the entrepreneur decides to sell the firm to an acquiring firm (a = 0), the acquiring firm will invest I in the target firm's project, and assess a value V_A for the firm equal to the net present value of the firm's project. However, since the acquirer has bargaining power, the entrepreneur and the venture capitalist of a type H or a type L firm do not get the full share of the firm's net present value; they are offered only a fraction ρ of the intrinsic net present value V_A. Thus, the incremental cash flow from an acquisition accruing to the insiders of a private target firm at time 0 is equal to $\rho V_A - V_q$, $q \in \{H, L\}$. Therefore, the acquisition price P_{acq} for both type L and type H firms will then be given by $P_{acq} = I + \rho V_A$.

Given the setting described above, in an entrepreneur-controlled firm the exit choice is made by the entrepreneur who solves the following maximization problem for a given firm type $q \in \{H, L\}$:

$$\max_{a\in\{0,1\}} a \cdot \left[\delta_E(1-\gamma)(\alpha_E P^E_{ipo} + (1-\alpha_E)(I+V_q)) + B\right] + (1-a)\cdot\delta_E\rho V_A \ , \tag{3}$$

where a denotes the exit choice; $a \in \{0, 1\}$ according as the firm goes public or accepts the acquisition offer respectively. An acquisition will help both types of firms in the product market competition taking place between time 0 and time 1, and it will improve their projects' intrinsic net present value to V_A. Thus, the expected gain from an acquisition for both types of firms translates into an increase in the intrinsic value given by the difference of the expected time 1 cash flows: $V_A - V_q$, $q \in \{H, L\}$.

Next, for type L firms we define the quantity Q:

$$Q \equiv \rho V_A - V_L - \frac{B}{\delta_E}. \tag{4}$$

If we normalize the pre-exit fraction of shares of the entrepreneur, δ_E, to 1, we can think of Q as the net long-term benefit of an acquisition to the type L firm's entrepreneur accounting for the fact that he also has to give up his private benefits of control after an acquisition. The first term $\rho V_A - V_L$ is the improvement in the long-term fundamental value of the firm after an acquisition, which accrues to the target firm's entrepreneur after taking into account the acquiring firm's bargaining power. The second term $\frac{B}{\delta_E}$ accounts for the control benefits of the entrepreneur that are foregone after an acquisition. Throughout the paper, we assume that the net benefit of an acquisition to the type L firm's entrepreneur is positive, i.e., $Q > 0$. Otherwise, an exit through an acquisition would not be under consideration at all, since the type L firm's entrepreneur would always be better off from going public.

By substituting the fraction of newly issued shares γ by $\frac{I}{P^E_{ipo}}$, we can rewrite the type L entrepreneur's objective function as follows:

$$\max_{a\in\{0,1\}} a \cdot \delta_E \left(\alpha_E + (1-\alpha_E)\frac{I}{P^E_{ipo}}\right)(P^E_{ipo} - V_L - I) + (1-a)\cdot(\delta_E(\rho V_A - V_L) - B), \tag{5}$$

From (5), we can see that the type L entrepreneur will make his choice by comparing the value premium paid by the acquiring firm (net of his private benefits of control) given by $\delta_E Q = \delta_E(\rho V_A - V_L) - B$ from (4) and the premium $\delta_E(\alpha_E + (1-\alpha_E)\frac{I}{P^E_{ipo}})(P^E_{ipo} - V_L - I)$ paid by the IPO investors at time 0 for the type L firm over its intrinsic value V_L. If the IPO market conditions are more favorable (θ is relatively high), an IPO will be a more advantageous exit route from the type L entrepreneur's perspective since type L firms will be temporarily overvalued in the IPO market at time 0 due to the presence of asymmetric information between firm insiders and outside investors, and the firm's equity will be priced in a competitive IPO market where outside investors have no bargaining power against the entrepreneur. In addition, the entrepreneur will enjoy private benefits of control by managing the firm after the IPO whereas he will lose these benefits of control after an acquisition.

If a type L firm goes public through an IPO, the insiders' ownership of the firm will be diluted, since the firm will issue new equity worth I to finance its investment project. However, new equity issued by type L firms will be overvalued in the IPO market. Thus, the entrepreneur of the type L firm will not only benefit from selling a fraction α_E of his existing equity holdings in the firm at an overvalued price (due to his liquidity demand), but he will also benefit from the fact that his firm is selling overvalued equity in the IPO to new shareholders to raise the required investment amount I. One should note that, the greater the fraction $\gamma = \frac{I}{P^E_{ipo}}$ of newly issued shares in an IPO, a larger portion of the total IPO overvaluation ($P^E_{ipo} - V_L - I$) of a type L firm will accrue to the entrepreneur, since he will effectively be selling a larger fraction of shares in the IPO at an overvalued price.

In contrast to a type L firm, the trade-offs faced by a type H firm are as follows. First, while the type H firm also has a synergy benefit from being acquired by another firm in the product market, this benefit is significantly lower for a type H firm than for a type L firm, since a type H firm already has a viable business model. On the other hand, going public has the advantage that the entrepreneur of the type H firm is able to retain his private benefits of control, unlike in an acquisition, where he will lose these benefits. An IPO also has the advantage that the type H firm's equity is priced in a competitive equity market; in contrast, in an acquisition, the acquirer will retain some of the firm's net present value. The last two benefits of an IPO over an acquisition have to be balanced against the fact that, given the greater extent of information asymmetry faced by IPO market investors (compared to the acquirer, who is able to assess the type of the firm at its true value, given his industry expertise), the type H firm's equity may be undervalued in the IPO market (since IPO market investors will value the firm at the average value of the pool of firms going public, which may consist of both type H and type L firms in equilibrium).

B. Analysis of the Venture Capitalist's Problem

The wedge between the objectives of the entrepreneur and the VC comes from two sources. First, the VC does not enjoy private benefits of control after the IPO, and second, the liquidity demands α_E and α_V of the entrepreneur and the VC could be different in an IPO. If the VC had the control of the private firm, he would solve the following maximization problem for a given firm type $q \in \{H, L\}$:

$$\max_{a\in\{0,1\}} a \cdot \left[\delta_V(1-\gamma)(\alpha_V P^V_{ipo} + (1-\alpha_V)(I+V_q))\right] + (1-a)\cdot\delta_V \rho V_A, \tag{6}$$

where a denotes the exit choice; $a \in \{0, 1\}$ according as the firm goes public or accepts the acquisition offer respectively. By substituting the fraction of newly issued shares γ by $\frac{I}{P^V_{ipo}}$, we can rewrite the VC's objective function as follows:

$$\max_{a\in\{0,1\}} a \cdot \delta_V \left(\alpha_V + (1-\alpha_V)\frac{I}{P^V_{ipo}}\right)(P^V_{ipo} - V_q - I) + (1-a)\cdot\delta_V(\rho V_A - V_q). \tag{7}$$

From (7), we can see that the VC will make his decision by comparing the premium $(\rho V_A - V_q)$ paid by the acquiring firm and the premium $(\alpha_V + (1-\alpha_V)\frac{I}{P^V_{ipo}})(P^V_{ipo} - V_q - I)$ paid by IPO market investors at time 0.

C. Equilibrium in an Entrepreneur Controlled Firm

First, we study the case where the entrepreneur is in control of the private firm and makes its exit choice, and the VC has no veto power over his exit decision.

Proposition 1 ***(Choice between IPO and Acquisition in an Entrepreneur Controlled Firm)*** *If $K_L < Q = \rho V_A - V_L - \frac{B}{\delta_E} < K_H$ (K_L and K_H are characterized in the appendix), then:*[21]

(i) ***The type H firm:*** *The entrepreneur takes the firm public with probability 1.*

[21] The out-of-equilibrium beliefs supporting the above equilibrium are as follows. Outside investors in the IPO market infer that any IPO firm setting a price P^E_{ipo} other than the equilibrium value P^{E*}_{ipo}, offering a fraction γ of new shares

The type L firm: *The entrepreneur takes the firm public with probability*

$$\beta_E = \frac{\theta(I + V_H - P_{ipo}^{E^*})}{(1-\theta)(P_{ipo}^{E^*} - (I + V_L))}, \tag{8}$$

or chooses an acquisition with probability $(1 - \beta_E)$*. The equilibrium IPO price* $P_{ipo}^{E^*}$ *is characterized in closed form in* (A3)*.*

(ii) It is always privately optimal for a VC involved with a type H firm for it to go public rather than be acquired. On the other hand, it is privately optimal for a VC involved with a type L firm for it to go public only if the fraction of shares α_V *sold by him is greater than*

$$\alpha_V > \hat{\alpha}_V \equiv \alpha_E + \frac{B}{\delta_E(P_{ipo}^{E^*} - I - V_L)(1 - \frac{I}{P_{ipo}^{E^*}})}. \tag{9}$$

Otherwise, it is privately optimal for the VC of a type L firm to be acquired.

In the equilibrium above, the type L firm's entrepreneur follows a mixed strategy between going public and being acquired, so that he is indifferent between the two pure strategy choices he can make, i.e., going public or being acquired. Thus, even though the type L firm is overvalued (relative to its intrinsic value) in the IPO market, and the entrepreneur receives private benefits of control managing his firm after going public, he is indifferent between an IPO and an acquisition in equilibrium, since the benefits of an IPO at time 0 are counterbalanced by the long-term benefits of an acquisition in the product market competition between time 0 and time 1. Therefore, in equilibrium, the following

other than $(I/P_{ipo}^{E^*})$, and any IPO firm in which the entrepreneur and the VC sell fractions of shares other than α_E and α_V, respectively, of their remaining equity holdings, is a type L firm with probability 1. The out-of-equilibrium beliefs supporting the equilibrium in the case of a jointly controlled firm are very similar. Therefore, we will not discuss such out-of-equilibrium beliefs in connection with future propositions in detail. These are available to interested readers upon request.

indifference condition holds:[22]

$$\delta_E(I + \rho V_A - (I + V_L)) - B = \delta_E \left(\alpha_E + (1 - \alpha_E) \frac{I}{P_{ipo}^{E^*}} \right) (P_{ipo}^{E^*} - V_L - I), \tag{10}$$

The IPO price that makes the type L entrepreneur indifferent between an IPO and an acquisition is the equilibrium price $P_{ipo}^{E^*}$.[23] In equilibrium, outside investors' beliefs in the IPO market about the firm types are updated using Bayes' rule as follows:

$$\Pr(q = H \mid a = 1) = \frac{\theta}{(1-\theta)\beta_E + \theta}, \tag{11}$$

$$\Pr(q = L \mid a = 1) = \frac{(1-\theta)\beta_E}{(1-\theta)\beta_E + \theta}. \tag{12}$$

Then, using (11) and (12) in (2), the IPO market will value a firm going public at the following price

$$P_{ipo}^{E^*} = I + \frac{(1-\theta)\beta_E(1-p_L) + \theta(1-p_H)}{(1-\theta)\beta_E + \theta} V_F + \frac{\beta_E(1-\theta)p_L + \theta p_H}{(1-\theta)\beta_E + \theta} V_S. \tag{13}$$

In summary, the equilibrium IPO price $P_{ipo}^{E^*}$ and the equilibrium mixing probability β_E of the type L firm satisfy (10) and (13) simultaneously. Since the type L firm is overvalued in the IPO market, the IPO price $P_{ipo}^{E^*}$ will be decreasing in the equilibrium mixing probability β_E of the type L entrepreneur taking his firm public. That is, the higher the fraction of type L firms going public in equilibrium (and pooling with type H firms), the lower the IPO price. The acquisition value P_{acq} of a type H or

[22] Because of partial pooling between the two types of firms in equilibrium, the IPO price $P_{ipo}^{E^*}$ is greater than the intrinsic value of the stand-alone type L firm for any value of $\beta_E \in [0, 1]$ such that $P_{ipo}^{E^*} > I + V_L$. The IPO overvaluation (undervaluation) of a type L (type H) firm also depends on the prior probability assessment of outside investors in the new issues markets that the firm is of type H.

[23] The indifference equation (10) is quadratic in the equilibrium IPO price $P_{ipo}^{E^*}$ and has therefore two roots. We choose the positive root and dismiss the smaller negative root. See the appendix for the closed-form solution of the equilibrium IPO price, $P_{ipo}^{E^*}$, in (A3) which solves this indifference equation.

type L firm is given by $I + \rho V_A$.

Type H firms are more viable as stand-alone public companies than type L firms, since the probability of success of a type L firm after the IPO is lower than that of a type H firm ($p_A > p_H > p_L$). Therefore, the long-term benefit of being acquired for product market competition between time 0 and time 1 is significantly smaller for a type H firm. Moreover, the type H firm's entrepreneur will not be able to fully extract these long-term synergy benefits, since the acquirer has considerable bargaining power and therefore extracts a significant fraction of the net present value of the firm. Thus, in the above equilibrium, type H firms' entrepreneurs strictly prefer IPOs over acquisitions as an exit route at time 0, since the following strict inequality holds in equilibrium:[24]

$$\delta_E(I + V_H - (I + \rho V_A)) + B > \delta_E \left(\alpha_E + (1 - \alpha_E) \frac{I}{P_{ipo}^{E*}} \right) (I + V_H - P_{ipo}^{E*}). \tag{14}$$

In the left-hand side of the above inequality, $\delta_E(I + V_H - (I + \rho V_A))$ gives the difference in the intrinsic value of a stand-alone type H firm and its value to the entrepreneur in an acquisition; if $V_H > \rho V_A$, then the stand-alone firm has greater value to the type H entrepreneur compared to the acquisition value, since any synergy benefits from the acquisition are swamped by the fraction of the firm's NPV extracted by the acquirer. Similarly, the right-hand side of the inequality gives the undervaluation in the IPO of the type H firm's equity sold by the entrepreneur relative to its intrinsic value. Thus, the inequality (14) implies that the sum of the net value loss to the entrepreneur from an acquisition and the entrepreneur's private benefits of control lost in the acquisition will be greater than the undervaluation of the type H entrepreneur's equity in the IPO market, thus implying that,

[24]Since type L firms choose IPO with positive probability in equilibrium, i.e., $\beta_E > 0$, the IPO price will be strictly less than the intrinsic value of a type H firm, i.e., $P_{ipo}^{E*} < I + V_H$. The condition $Q < K_H$ also implies that the acquisition value of a type H firm will be strictly less than the intrinsic value of a type H firm, i.e., $I + \rho V_A < I + V_H$. The indifference condition (10) of the type L firm's entrepreneur implies that the IPO price P_{ipo}^{E*} exceeds $I + \rho V_A - \frac{B}{\delta_E}$.

in equilibrium, the opportunity cost of an acquisition is always greater than that of an IPO for the entrepreneur of a type H firm. Thus, since (14) holds in equilibrium, even though the IPO price P_{ipo}^{E*} is less than the long-term fundamental value $I + V_H$ of a type H firm after the IPO, the entrepreneur of a type H firm finds it worthwhile to choose an IPO over an acquisition with probability 1.

In the equilibrium of an entrepreneur controlled firm, the VC is assumed not to have sufficient control or voting rights to influence or block the exit decision of the entrepreneur. For instance, it might be the case that the initial share of equity δ_V of the VC is too small relative to the entrepreneur's initial share of the firm δ_E. However, we can still find the range of the parameters for which each type of VC would find the entrepreneur's exit choice to be privately optimal by analyzing the VC's objective function given by (6). By partially pooling with type H firms when going public, a type L firm's VC also benefits from the overvaluation of his firm's equity in the IPO market at time 0. If the entrepreneur of a type L firm takes his firm public with probability β_E, the type L firm's VC would agree with this decision only if the equilibrium IPO price P_{ipo}^{E*} is higher than the acquisition price P_{acq}, because unlike the entrepreneur, the VC receives no additional private benefits after the IPO, and must be compensated by a higher valuation. Moreover, for this to occur, the fraction of shares sold, α_V, by the VC must be higher than the threshold value $\hat{\alpha}_V$, which is strictly greater than the fraction of shares α_E sold by the entrepreneur. The intuition here is that, since the type L firm is overvalued in the IPO market at time 0, and the long-term benefit of an acquisition to a type L firm's VC is positive, the type L firm's VC would prefer an IPO over an acquisition only if he could sell a sufficiently high fraction of his shares, i.e., $\alpha_V > \hat{\alpha}_V$, in the IPO (so that the profit from selling equity at time 0 exceeds the long-term benefit of the acquisition). By the same reasoning, the type L firm's VC would agree with the decision of a type L firm's entrepreneur to sell the firm to an acquirer only

if the fraction of shares he sells in the IPO is less than $\hat{\alpha}_V$.[25] Since the long-term synergy benefit of an acquisition is significantly smaller for a type H firm, the VC of a type H firm always agrees with the entrepreneur's decision to take his firm public.

The partially pooling equilibrium we characterize in Proposition 1 is unique under the parameter condition $K_L < Q = \rho V_A - V_L - \frac{B}{\delta_E} < K_H$ given in Proposition 1. Recall that Q is the net benefit of an acquisition (long-term value improvement in the product market competition net of private benefits of control foregone after an acquisition) captured by the entrepreneur of a type L firm. The restriction, $Q > K_L$, rules out pooling equilibria of type (ii) mentioned above, where both types of firms go public through an IPO: if $Q \leq K_L$, the benefits of an acquisition are so small that a type L firm would also choose to go public with probability 1, leading to the above pooling equilibrium. On the other hand, the restriction $Q < K_H$ rules out fully separating equilibria of type (iii) mentioned above: if the long-term benefits of an acquisition that can be captured by the entrepreneur are sufficiently high for a type L firm, but the value of the acquired firm captured by the entrepreneur is still less than the intrinsic value of a type H firm, fully separating equilibria of type (iii) will exist. The restriction $Q < K_H$ also rules out pooling equilibria of type (iv): if the long-term product market benefits of an acquisition are extremely high, and the bargaining power of the acquiring firm is low, so that Q is very high, both types of firms will choose to be acquired rather than to go public, leading to pooling equilibria of type (iv). Finally, one should note that pooling equilibria of type (ii) and separating equilibria of type (iii) can be thought of as corner cases of the partially pooling equilibrium we characterized in Proposition 1 (with $\beta_E = 1$ and $\beta_E = 0$, respectively).

The above equilibrium survives the Intuitive Criterion of Cho and Kreps (1987). For an equilibrium to survive the Cho-Kreps Intuitive Criterion, the requirement (as applied to our model setting) is that

[25] We show in the appendix that the threshold value $\hat{\alpha}_V$ of the fraction of shares sold by the VC is smaller than 1 if and only if $P_{ipo}^{E^*} > P_{acq}$.

there be no out-of-equilibrium move that can be made by the informed party (firm insiders in our case) that satisfies the following two conditions *simultaneously* (see Cho and Kreps (1987)): (1) The out-of-equilibrium move is such that, regardless of whatever beliefs investors may form in response to such an out-equilibrium move, the type L firm does not have an incentive to undertake such a move; and (2) by making the above out of equilibrium move, the type H firm obtains a higher expected payoff than its equilibrium payoff, under outsider-beliefs revised such that they infer that the firm making the above out-of-equilibrium move is a type H firm. In our setting, there are no out-of-equilibrium moves that satisfy these two conditions *simultaneously* for two reasons. First, the number of possible out-of-equilibrium moves is limited, since both going public and being acquired are equilibrium strategies. Second, for the out-of-equilibrium moves that do exist, either (1) or (2), or both are not satisfied (in other words, both conditions are never simultaneously satisfied). For details of why the out-of-equilibrium moves that do exist do not satisfy the above two conditions, please see the proof of Proposition 1.

Proposition 2 ***(Comparative Statics of the Exit Choice between IPOs and Acquisitions in an Entrepreneur Controlled Firm)*** *The equilibrium probability of going public β_E of an entrepreneur controlled type L firm is: (a) increasing in the control benefits B of the entrepreneur after the IPO; (b)increasing in the bargaining power of the acquiring firm, $(1-\rho)$; (c) decreasing in the synergy benefits of a type L firm from an acquisition, $(p_A - p_L)$; (d) increasing in the IPO market's prior probability assessment θ of a firm being type H; (e) increasing in the fraction of the shares α_E sold by the entrepreneur in the IPO; (f) increasing in the investment level I.*

We can better understand the trade-offs determining the entrepreneur's exit choice by observing how the probability of going public of the type L firm's entrepreneur is changing as a result of changes in various parameter values. Result (a) follows from the fact that the entrepreneur does not get any control benefits after an acquisition, while he retains these in an IPO. Result (b) follows from the fact that the acquisition price P_{acq} is decreasing in the bargaining power of the acquiring firm.

Further, as the synergy benefit of a type L firm, $(p_A - p_L)$ increases, the gain from an acquisition to a type L firm in product market competition increases, which yields us the result (c). If the prior probability assessment θ of IPO market investors that a firm is of type H is higher, than the type L firm's entrepreneur has more of an incentive to pool with a type H firm in the IPO market and benefit from the overvaluation of equity, which gives the result (d). As the fraction of shares α_E that the entrepreneur sells in a potential IPO increases, he cares less about the long-term value of the firm at time 1 and chooses to go public with a higher probability at time 0, leading to result (e). Finally, if the investment capital I required to implement the firm's project at time 0 increases, the type L firm's entrepreneur's benefit from selling overvalued equity in the IPO market increases (since the firm is selling a larger fraction of equity to raise the larger required investment amount) and this yields the result (f).

Proposition 3 ***(IPO Price versus Acquisition Price in an Entrepreneur Controlled Firm)***

(i) Let the control benefits of an entrepreneur be not too large such that the following condition holds:

$$\delta_E(1-\alpha_E)(\rho V_A - V_L) > B\left(1 + \frac{I}{\rho V_A}\right). \tag{15}$$

Then, the equilibrium IPO price $P_{ipo}^{E^*}$ is higher than the acquisition price P_{acq}.

(ii) The equilibrium IPO price $P_{ipo}^{E^*}$ is: a) decreasing in the fraction of shares α_E sold by the entrepreneur; b) decreasing in the control benefits B of the entrepreneur; c) increasing in the firm's investment requirement I; d) decreasing in the bargaining power of the acquiring firm, $(1-\rho)$; e) increasing in the type L firm's synergy benefits from an acquisition, $(p_A - p_L)$.

The intuition behind part (i) is as follows. First, the synergy benefits from an acquisition adds to the value of a type L firm, thereby resulting in its true value in an acquisition being higher than in the case where it goes public. However, the pool of firms going public consists of a mixture of type H and type L firms, whereas only type L firms are acquired in equilibrium. Thus, the overall intrinsic value

of the pool of firms going public will be higher than that of firms being acquired. Second, the investors in the IPO market, lacking any bargaining power, price equity competitively, while an acquirer would use his bargaining power to price the equity in such a way as to extract a fraction of the firm's project's NPV. The above two factors ensure that the IPO price is always higher than the acquisition price in equilibrium, provided that condition (15) is satisfied.

The intuition behind part (ii) is as follows. Result (a) follows from the fact that a type L firm will choose to go public (and pool with type H firms in the IPO market) with a higher probability if its entrepreneur has a higher liquidity demand, since the type L firm's entrepreneur's benefit from selling overvalued equity in the IPO market is greater in this case. Result (b) follows from the fact that a type L firm's entrepreneur is more likely to choose an IPO over an acquisition, if the control benefits an entrepreneur would enjoy after an IPO (which are lost after an acquisition) are higher. When the investment amount raised I by a firm is greater, there are two effects. First, the type L firm sells more equity in a potential IPO, increasing its probability of going public (since its benefits from selling overvalued equity in the IPO market is greater), reducing the average quality of the pool of firms going public. Second, the intrinsic value of firms going public increases, since the scale of the firm is larger. The second effect dominates the first, resulting in a higher IPO price. This gives the result (c). If the acquirer has more bargaining power, type L firms will have more of an incentive to pool with type H firms in the IPO market, reducing the IPO price, yielding the result (d). Finally, if the synergy gain of an acquisition in the firm's product market competition is higher, type L firms will go public with a lower probability, raising the quality of the pool of firms in the IPO market, giving result (e).

D. Equilibrium in Jointly Controlled Firms

In the previous section we assumed that the entrepreneur makes the IPO versus acquisition decision and that the VC has to accept whatever choice is made by the entrepreneur even though this exit choice might not be in the VC's best interest. In this section we allow for the possibility of the VC being able to hold up the firm's exit choice in the case of a disagreement between himself and the entrepreneur, and explore how conflicts of interest may be resolved through voluntary wealth transfers (side payments) in equilibrium. We refer to this situation as a "jointly controlled" firm. Disagreements between the entrepreneur and the VC of a type L firm could arise in various cases as discussed in previous sections. In the following analysis, we assume that the entrepreneur is initially in control of the firm, but the VC can veto his exit decision (it can be shown that the case where the VC is initially in control of the firm, but the entrepreneur can veto his exit decision will lead to an identical outcome in equilibrium when side payments between the VC and the entrepreneur are allowed).

Proposition 4 ***(The Choice between IPO and Acquisition in a Jointly Controlled Firm)*** *Suppose the entrepreneur is initially in control of the firm, and let* $K_L < Q < K_H$ *and* $K_L < \rho V_A - V_L < K_H$. *Then:*

(i) ***The type H firm:*** *The entrepreneur takes the firm public with probability 1, and the VC always concurs with the entrepreneur's exit choice.*

(ii) ***The type L firm:*** *The entrepreneur takes the firm public with probability*

$$\beta_J = \frac{\theta(I + V_H - P^J_{ipo})}{(1-\theta)(P^J_{ipo} - (I + V_L))}, \tag{16}$$

or chooses an acquisition with probability $(1-\beta_J)$. *The equilibrium IPO price* $P^{J^*}_{ipo}$ *is characterized in closed form in* (A31).

(iii) If the type L firm's entrepreneur's choice is to take his firm public, the VC agrees with the entrepreneur, and allows the transaction to proceed without any transfers from the entrepreneur,

if the fraction of equity sold by the VC in a potential IPO $\alpha_V \geq \hat{\alpha}_V$, given by (9)*. If, however, $\alpha_V < \hat{\alpha}_V$, the VC insists on a transfer T_1 from the entrepreneur (which the entrepreneur makes in equilibrium) before he allows the firm to go public.*

(iv) If the type L firm's entrepreneur's choice is to sell his firm to an acquirer, the VC agrees with the entrepreneur, and allows the transaction to proceed without any transfers from the entrepreneur, if $\alpha_V \leq \hat{\alpha}_V$. If, however, $\alpha_V > \hat{\alpha}_V$, the VC insists on a transfer T_2 from the entrepreneur (which the entrepreneur makes in equilibrium) before he allows the firm to be acquired.

The intuition behind a jointly controlled type H firm choosing to go public with probability 1 and a type L firm choosing to play a mixed strategy between choosing to go public and being acquired is similar to that behind Proposition 1. The potential disagreement in the above equilibrium between the entrepreneur and the VC of a type L firm may arise from two sources. First, given that the VC has a shorter investment horizon in the firm than the entrepreneur, he is likely to have a larger liquidity need, and therefore, sell a larger fraction of equity than the entrepreneur in a potential IPO. In this case, the benefit to the VC from selling overvalued equity in the IPO is greater than that to the entrepreneur. Second, unlike the entrepreneur, the VC does not receive any private benefits of control from running the firm, unlike the entrepreneur, who receives such benefits, and will lose them in the event of an acquisition. If the first effect dominates the second (this is the case if $\alpha_V \geq \hat{\alpha}_V$), then the VC prefers going public more than the entrepreneur, so that the two do not disagree if the entrepreneur decides to take the firm public. In this case, the VC disagrees with the entrepreneur only if the entrepreneur chooses to sell the firm to an acquirer, in which case the entrepreneur has to make a side payment T_2 to the VC to let the firm proceed with an acquisition. If, on the other hand, the second effect above dominates the first (this is the case if $\alpha_V \leq \hat{\alpha}_V$), then the VC prefers the firm to be acquired (rather than to go public) to a greater extent than the entrepreneur. In this case, the two do not disagree, if the entrepreneur decides to sell the firm to an acquirer. If, however, the entrepreneur's decision is to take the firm public in this case, the VC disagrees with him, and the

entrepreneur has to make a side payment T_1 to the VC to let the firm go public.

We now discuss the determination of the side payments (wealth transfers) between the entrepreneur and the VC. In equilibrium, both the entrepreneur and the VC running a type L firm must be indifferent between an IPO and an acquisition *ex ante*. We first discuss the case where the fraction of shares α_V sold by the VC in a potential IPO is greater than or equal to the threshold value $\hat{\alpha}_V$. In this case, as discussed above, the VC prefers to go public even more than the entrepreneur, so that he agrees with the entrepreneur if he decides to take the firm public. If, however, the entrepreneur chooses to sell the firm to an acquirer, the VC disagrees with him, and the entrepreneur has to make a transfer T_2 to the VC to let the acquisition proceed. The indifference condition of the entrepreneur of a type L firm, which determines (analogous to the indifference condition (10) in an entrepreneur controlled firm) his probability of taking his firm public, now has to reflect this potential transfer he has to make to the VC in the case of an acquisition, and is given by:

$$\delta_E \rho V_A - T_2 = \delta_E(\alpha_E + (1-\alpha_E)\frac{I}{P_{ipo}^{J^*}})(P_{ipo}^{J^*} - V_L - I) + \delta_E V_L + B. \tag{17}$$

where the left-hand side of (17) is the entrepreneur's expected payoff from an acquisition, and the right-hand side is his expected payoff from the IPO. In this case, since the VC prefers to go public in the absence of any transfer from the entrepreneur, the transfer T_2 makes him just indifferent between an IPO and an acquisition as well. The VC's indifference condition is thus given by:

$$\delta_V \rho V_A + T_2 = \delta_V(\alpha_V + (1-\alpha_V)\frac{I}{P_{ipo}^{J^*}})(P_{ipo}^{J^*} - V_L - I) + \delta_V V_L. \tag{18}$$

Substituting T_2 from (18) in (17) gives the combined equilibrium condition given by:

$$(\delta_E\alpha_E + \delta_V\alpha_V + (\delta_E(1-\alpha_E) + \delta_V(1-\alpha_V))\frac{I}{P_{ipo}^{J^*}})(P_{ipo}^{J^*} - V_L - I) + B = (\delta_E + \delta_V)(\rho V_A - V_L). \tag{19}$$

The equilibrium IPO price $P_{ipo}^{J^*}$ and the equilibrium mixing probability β_J of a type L firm going public are the values which satisfy (19) and the IPO market investors' valuation condition (13) simultaneously. The equilibrium transfer T_2 can then be solved from (17).

We now come to the case where $\alpha_V \leq \hat{\alpha}_V$, so that, while the VC agrees with the entrepreneur if he chooses to sell the firm to an acquirer, the VC disagrees with the entrepreneur if he chooses to take the firm public, and insists on a transfer T_1 in this case to let the firm's IPO proceed. The determination of the transfer T_1 is similar to the determination of T_2 discussed in detail above, with the difference that, in the indifference condition of the entrepreneur (analogous to (17)), the transfer T_1 will be subtracted from his IPO payoff; we will not discuss the determination of T_1 in detail here.

Proposition 5 ***(Exit Choice in Entrepreneur Controlled versus Jointly Controlled Firms)*** *Suppose the VC can veto the entrepreneur's exit choice in the case of a disagreement. Then:*

(i) If the liquidity demand of the VC is large enough, such that $\alpha_V > \hat{\alpha}_V$, the entrepreneur of a jointly controlled type L firm goes public more often in equilibrium than in the case of an entrepreneur controlled firm (Proposition 1) and the IPO valuation is lower.

(ii) If the liquidity demand of the VC is not too large, such that $\alpha_V < \hat{\alpha}_V$, the entrepreneur of a jointly controlled type L firm goes public less often than in the case of an entrepreneur controlled firm and the IPO valuation is higher.

In contrast to an entrepreneur controlled firm, where the VC has no veto rights and therefore cannot affect the firm's exit choice, the VC can veto the entrepreneur's exit choice in a jointly controlled firm. This means that the VC needs to be compensated with wealth transfers whenever the exit choice made by the entrepreneur is not privately optimal for the VC. The intuition behind parts (i) and (ii) of the above proposition is that the need to make such transfers tilts an entrepreneur controlled firm's exit choice toward the exit choice preferred by the VC. Thus, in the equilibrium characterized in Proposition 1, we showed that if the fraction of shares α_V sold by the VC in a potential IPO is greater than the threshold fraction $\hat{\alpha}_V$, the VC of a type L firm will disagree with the entrepreneur if

he chooses an acquisition over an IPO. In this case, Proposition 5 shows that, since in the case of a jointly controlled firm, the disagreement will be resolved by compensating the VC with a side payment, the type L firm's entrepreneur will go public with a higher probability in a jointly controlled firm than he does in an entrepreneur controlled firm. Moreover, the IPO valuation of a jointly controlled firm will be lower than that of an entrepreneur controlled firm, since, in equilibrium, type L firms will pool with type H firms to a greater extent in the IPO market.

Similarly, we showed earlier in Proposition 1 that, in the case of an entrepreneur controlled firm, if the fraction of shares α_V sold by the VC in a potential IPO is less than the threshold fraction $\hat{\alpha}_V$, the VC of a type L firm will disagree with the entrepreneur's exit choice if he decides to take the firm public.[26] Proposition 5 shows that, when $\alpha_V < \hat{\alpha}_V$, since the disagreement will be resolved by compensating the VC with a side payment in the case of a jointly controlled firm, the type L firm's entrepreneur will take his firm public with a lower probability when the firm is jointly controlled firm than he does when it is entrepreneur controlled. Therefore, in this case, the IPO valuation of a jointly controlled firm will be higher than that of an entrepreneur controlled firm, since type L firms will pool with type H firms to a lesser extent in the IPO market.

[26]Note that, the greater the entrepreneur's control benefit B, the greater the range of the values of α_V where the VC disagrees with the entrepreneur's decision to go public. As the size of control benefits B goes up, the type L entrepreneur can tolerate a lower IPO price P^E_{ipo} and a lower overvaluation premium $(P^E_{ipo} - I - V_L)$ paid by the IPO investors so that he is indifferent between an IPO and an acquisition. However, the VC obtains no control benefits after exit. Therefore, in an entrepreneur controlled firm, the greater the private benefits of the entrepreneur, the greater is the range of values of α_V where the VC will favor an acquisition over an IPO and disagree with the entrepreneur in case he chooses to go public.

V. Post-IPO Acquisitions

As an extension to the basic model, in this section we model the possibility of an acquisition after an IPO. We extend the model to three dates, with the sequence of events shown in Figure 2. We discuss in detail only the case where the firm is still effectively controlled by the entrepreneur after the IPO.[27] Now, the product market competition takes place between time 1 and time 2, and the final cash flows are realized at time 2. In our basic model, we assumed that the firm remains stand-alone after the IPO and that the probability of success in the product market competition for a type H and type L firm was exogenously given by p_H and p_L respectively. In this section, we further explore the competitive dynamics of the game and take into account the option of a post-IPO acquisition which could take place in the near future (at time 1 in the extended model) and help the firm in its competitive product market competition with rivals by time 2. Such an option is obviously valuable both ex-post (time 1) and ex-ante (time 0) because if the firm (and the markets) observes negative public signals from the product market about the strategic positioning of the firm's competition between time 0 and time 1 (for example, the competition establishing a toehold in the product market), it could choose to be acquired after the IPO at time 1 in order to improve its long-term competitiveness.

For the entrepreneur or the VC of a type L firm, one might *a priori* conjecture that, ex-ante, it would be always a strictly preferable strategy to go public at time 0 and then decide at time 1 whether to remain a stand-alone public firm or to be acquired depending on the signals from the product market. A competitive threat from product market rivals could then be fought more successfully with the help of an acquiring firm. If there were no costs of waiting for being acquired between time 0 and time 1, this would indeed be the case. The type L firm would first go public and issue overvalued equity at time 0 and in case it observes a significant competitive threat before time 1, it would go ahead with a post-IPO acquisition. However, if waiting for a post-IPO acquisition is costly in the sense

[27]The analysis of the case where the VC is in control is broadly similar, and is available to interested readers upon request.

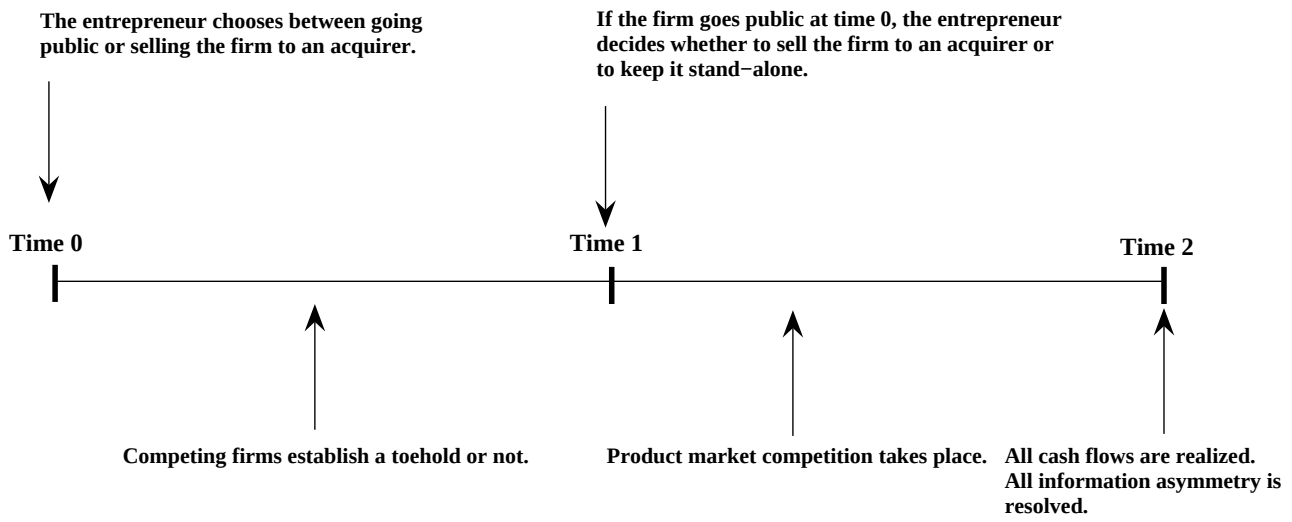

Figure 2: Sequence of Events in the Extended Model

that the value of the increase in the firm's probability of success in the product market an acquiring firm can bring about decreases after the competition has established a toehold after time 0, then it could make sense to choose an acquisition at time 0 when the expected value of the improvement of an acquisition is relatively higher than that of an acquisition at time 1.[28] We denote the event that the competition has established a toehold by $e = E$ and the case of no toehold by $e = N$. At time 0, the probability of the competition entering the market and establishing a toehold between time 0 and time 1 is ω. The success probabilities of stand-alone type H and type L firms conditional on the public signal e and the firm type q are specified as ϕ_H and ϕ_L if $e = E$, and ψ_H and ψ_L if $e = N$ respectively.

We assume that if the competition establishes a toehold in the product market by time 1, the probability of success of stand-alone firms decreases:$\phi_H < \psi_H$ and $\phi_L < \psi_L$. Type H firms are also assumed to compete better than type L firms under any condition, so that $\phi_H > \phi_L$ and $\psi_H > \psi_L$. As

[28]This seems to be a reasonable assumption. Consider, for example, the case of Netscape, which had a successful IPO when its web browser was dominant in the product market, and was acquired soon after by AOL. However, by the time Netscape was acquired by AOL, Microsoft's "Internet Explorer" web browser had established a significant toehold in the product market, so that Netscape's probability of success in the product market competition was not significantly enhanced by the AOL acquisition.

discussed in the basic model, for both types of firms, an acquisition at time 0 helps the target firm in the product market between time 1 and time 2, so that the probability of success is increased to p_A. A post-IPO acquisition at time 1 also helps the firm, but the probability of success depends on whether the competition has established a toehold or not by time 1. If the competition has established itself in the product market strongly by time 1, the probability of success between time 1 and time 2 is increased to p_E for both types of firms, whereas if the competition is still weak by time 1, the success probability of the acquired firm increases to p_N, where $p_N > p_E$. In summary, we assume that, if the competition has established a toehold, while a post-IPO acquisition (at time 1) is less beneficial in terms of product market success compared to an earlier acquisition (at time 0), it never the less increases the target firm's success probability over that of a stand-alone firm: i.e., $p_E > \phi_H > \phi_L$. A post-IPO acquisition is helpful in increasing product market success even in the absence of the competition establishing a toehold, though the incremental benefit over the success probability of a stand-alone firm, while positive, is smaller in this case: $p_N > \psi_H > \psi_L$. Note also that there is a cost of delaying the acquisition from time 0 to time 1, since the probability of success p_A of a pre-IPO acquisition is greater than the expected probability of success of a post-IPO acquisition $\omega p_E + (1-\omega)p_N$ at time 0. We also assume that, after going public at time 0, the entrepreneur can enjoy only a fraction $k < 1$ of his expected private benefits B between time 0 and time 1 if the firm is acquired at time 1, while he can enjoy his entire private benefits B if the firm remains stand-alone after time 1. Finally, we assume that if the entrepreneur decides to remain stand-alone at time 1, he as well as the VC sell fractions $\alpha_E^{'}$ and $\alpha_V^{'}$ respectively of their remaining shares in the firm to satisfy their liquidity demands.

Proposition 6 ***(The Choice between IPO and Acquisition in an Entrepreneur Controlled Firm when there is a post-IPO acquisition option)*** *If* $V_p^L < Z_p - I < V_p^H$ *and* $\alpha_E^{'}\theta(1-\psi_H) + (1-\alpha_E^{'}\theta)(1-\psi_L) < \bar{\psi}$*, then:*

(i) ***The type H firm:*** *The entrepreneur takes the firm public at time 0 with probability 1.*

The type L firm: *The entrepreneur takes the firm public at time 0 with probability β_p given by* (A43) *or chooses an acquisition with probability* $(1-\beta_p)$.

(ii) The ***Post-IPO market****: If the competition has established a toehold after an IPO at time 0, the type H firm remains stand-alone at time 1 whereas the type L firm remains stand-alone with probability η given by* (A37) *or chooses a post-IPO acquisition with probability* $(1-\eta)$*. Otherwise, the entrepreneurs of both type H and type L firms prefer to remain stand-alone at time 1.*

The above proposition shows that if the marginal improvement of an acquisition is high when the competition has already established a toehold in the product market by time 1 ($e = E$), then the type L firm will optimally choose a post-IPO acquisition at time 1 with probability $(1-\eta)$. This is because the type L firm needs the help of an acquiring firm at those times where its survival pressure in the product market is at its highest level. On the other hand, if there is no toehold and the threat of competition is negligible, the increase in intrinsic firm value $V(p_N) - V(\psi_L)$ of a post-IPO acquisition is relatively small for type L firms as well and the incremental private benefits $(1-k)B$ that the entrepreneur can enjoy from a stand-alone firm and the acquisition discount ρ together tilt the decision of type H and type L firms' entrepreneurs to remaining stand-alone after time 1. After going public, a type H firm always remains stand-alone since the marginal contribution of an acquisition to the success of such a firm is small even if the competition has established a toehold in the product market.

Conditional on an IPO at time 0, investors' beliefs at time 1 about the public firm's type are updated as follows:

$$\hat{\theta} \equiv \Pr(q = H \mid a = 1) = \frac{\theta}{(1-\theta)\beta_p + \theta}. \tag{20}$$

Thus the posterior beliefs about firm type depend on the equilibrium probability β_p of a type L firm going public at time 0. If the threat of competition at time 1 is negligible, $e = N$, the firm will be valued by investors at the price V_n^1. In this case, both type H and type L firms remain stand-alone because the expected payoff of remaining independent is strictly larger than the payoff of a post-IPO

acquisition. Since both firms remain stand-alone when there is no toehold by the competition, the market value of the firm will be given by:

$$V_n^1 = I + (1 - \hat{\theta})V(\psi_L) + \hat{\theta}V(\psi_H). \tag{21}$$

On the other hand, if the threat of competition at time 1 is very strong, $e = E$, the type L firm will choose to be acquired with some positive probability $(1 - \eta)$ so that the firm will protect itself against the competition and obtain a higher value. The market value V_e^1 of the firm which makes the entrepreneur of a type L firm indifferent between a post-IPO acquisition and remaining independent at time 1 is given by :

$$V_e^1 = I + V(\phi_L) + \frac{\rho V(p_E) - V(\phi_L) - \frac{(1-k)B}{\delta_E(1-\gamma)(1-\alpha_E)}}{\alpha_E^{'}}. \tag{22}$$

From the market valuation of the firm by outside investors, one can then infer the probability η of a type L firm remaining stand-alone. The type L firm is more likely to be acquired, if the improvement in success probability in product market competition due to the acquisition $p_E - \phi_L$ is larger and the entrepreneur's private benefits of control are smaller. Given the equilibrium strategies in the post-IPO acquisition market at time 1, we solve backwards for the overall equilibrium at time 0 which determines the entrepreneur's exit choice between an IPO and acquisition. The entrepreneur, investors in the financial markets and the acquiring firm have rational expectations. Hence, the intrinsic net present value of the firm to the entrepreneur conditional on going public at time 0 is will be denoted by V_p^L and V_p^H respectively and these values are inferred for each type of firm from their equilibrium choices at time 1. The entrepreneur of a type L firm is indifferent between an IPO or an acquisition

at time 0 if the following indifference condition holds:

$$\delta_E(\rho V_A - V_p^L) = \delta_E(\alpha_E + (1-\alpha_E)\frac{I}{V_p^E})(V_p^E - V_p^L - I) + B(k + ((1-\omega) + \omega\eta)(1-k)). \tag{23}$$

If there is a cost of delaying an acquisition, then choosing an acquisition at time 0 is valuable for the entrepreneur of the type L firm and the net payoff ρV_A from a pre-IPO acquisition is larger than the net intrinsic value V_p^L of a type L public firm. In addition to the valuation effect of timing an acquisition, the IPO exit route is also attractive to a type L firm because of IPO overvaluation due to information asymmetry and the private benefits to the entrepreneur after the IPO. Hence, the type L firm's entrepreneur would compare the net acquisition benefit Q_p defined by

$$Q_p \equiv (\rho V_A - V_L^p) - B(k + ((1-\omega) + \omega\eta)(1-k))/\delta_E, \tag{24}$$

with the IPO overvaluation premium of a type L firm given by the expression $(\alpha_E + (1-\alpha_E)\frac{I}{V_p^E})(V_p^E - V_p^L - I)$. The IPO price V_p^E is greater than the long-term intrinsic value $I + V_p^L$ of the type L firm and therefore the type L entrepreneur has an incentive to profit from the IPO overvaluation arising from pooling with the type H firm in addition to the expected private benefits after an IPO. In equilibrium, he is indifferent between the expected value improvement $\delta_E Q_p$ of an acquisition paid to him by the acquiring firm at time 0 and the overvaluation premium paid by IPO investors. The equilibrium outcomes of V_p^E, β_p, V_e^1, V_n^1 and η are determined by a simultaneous system of equations because the posterior time-1 probability $\hat{\theta}$ depends on the probability of going public β_p at time 0 and since the agents are forward-looking (so that the expected IPO payoff at time 0 depends on the probability η of remaining stand-alone at time 1).

One should note that the type L firm is more likely to go public at time 0 compared to the equilibrium in the basic model, where we did not allow the firm to be acquired post-IPO. This is

because post-IPO acquisitions increase the intrinsic value of an IPO, by giving the firms that go public at time 0 an option to better compete against other firms in the product market at time 1 through being acquired by a larger firm post-IPO. Since the long term product market benefits of an acquisition at time 0 or at time 1 for a type H firm is always less than that of a type L firm, the type H firm's entrepreneur prefers to go public with probability 1 at time 0. The type H firm has already a sound and viable business plan, so pre-IPO or post-IPO acquisitions do not add much further value to that firm.

VI. Strategic versus Financial Acquirers

As a second extension to our basic model, we consider the distinction between financial acquirers and strategic acquirers. One can think of financial acquirers as private equity/buyout firms which help finance and structure young growth companies with the hope of selling them in the near future for a profit once they have proven their competitive edge in the product markets. Strategic acquirers, on the other hand, are assumed to be well-established public firms who are long-term strategic players in the product market and they are interested acquiring the private firm from the entrepreneur, the VC, and other shareholders since they are expected to better help the young firm in the product market by realizing synergies, efficiently utilizing firm resources against the competition, and thus creating long-term value. Therefore, we assume that a strategic acquirer can bring about a larger increase in the net present value of the firm than a financial acquirer.

The setup of the extended model is the same as in our basic model before except that in addition to choosing between an IPO and an acquisition (as in our basic model), the insiders of the private firm choose between strategic and financial acquirers (if they choose to sell out the firm to an acquirer). The entrepreneur is assumed to have the control of the firm and makes the exit decision at time 0. The probability of success of the firm acquired at time 0 by a strategic acquirer is denoted by p_s. The

probability of success of a firm acquired by a financial acquirer is denoted by p_f. From the discussion in the preceding paragraph it follows that we assume $p_s > p_f > p_H$.

We also assume that if the firm is acquired by a financial acquirer at time 0, the entrepreneur and the current management team do not need to be replaced and that the entrepreneur continues to enjoy some private benefits of control b after acquisition, where $b < B$ (recall that B denotes the control benefits of the entrepreneur if the firm goes public and thus continues operation as a stand-alone firm). If the firm is acquired by a strategic acquirer, however, the entrepreneur quits the management and enjoys no control benefits thereafter.

Proposition 7 ***(The Choice between IPO and Acquisition and between Strategic and Financial Acquirers)*** *If $\theta V_H + (1-\theta)V_L < Z_E - I < V_H$, $\theta V_H + (1-\theta)V_L < Z_f - I < V_H$, then:*

(i) The choice between an IPO and an acquisition at time 0 is similar to that in Proposition 1. The type L firm's entrepreneur chooses to go public with probability β_A or chooses acquisition by an acquirer with probability $(1-\beta_A)$, $A \in \{s, f\}$; depending on whether the acquirer chosen is strategic (s) or financial (f). The type H firm's entrepreneur chooses to go public with probability 1.

(ii) If the incremental long term benefits of a strategic acquisition are relatively small and the private benefits of the entrepreneur under a financial acquirer are large, i.e., $(p_s - p_f) < \frac{b}{\delta_E \rho(V_S - V_F)}$, the type L or type H entrepreneur would decide to sell the firm to a financial acquirer. Otherwise, the firm is sold to a strategic acquirer.

(iii) If the bargaining power is the same for both types of acquirers, a strategic acquirer will pay more for the private firm compared to a financial acquirer.

Compared to the equilibrium characterized in the basic model (Proposition 1), the entrepreneur has three exit choices in the above setting: a strategic acquisition, a financial acquisition, or an IPO. The entrepreneur works backward, first choosing between a strategic and a financial acquisition, and then goes on to choose between the form of acquisition chosen and an IPO. The entrepreneur's choice between strategic and financial acquisitions will be driven by the magnitude of the incremental synergy benefits in product market competition (which will be greater in a strategic acquisition) versus the incremental control benefits he will be able to retain in a financial acquisition (unlike in a strategic acquisition, where the entrepreneur will lose all his control benefits). The entrepreneur chooses that

type of an acquisition which will maximize his objective with probability 1. The entrepreneur then chooses between an IPO and the acquisition (of the type chosen earlier) based on the trade-offs discussed in detail under Proposition 1.

If the bargaining power of both types of acquirers are the same, a strategic acquirer will pay always more for the firm than a financial acquirer. This is because the increase in the success probability of the firm against product market competition (i.e., incremental synergy created) is always higher under a strategic acquirer, so that the value of the post-acquisition firm will be greater under a strategic acquirer.

VII. Empirical and Policy Implications

Our model has several empirical and policy implications, which we describe below.

1. *Choice between IPOs and acquisitions:* Our model has several predictions regarding a private firm's choice between IPOs and acquisitions.

First, our model predicts that among a pool of private firms whose qualities are indistinguishable, higher quality firms, which are more viable in the face of product market competition, are more likely to go public, while lower quality firms (less viable in the face of competition) are more likely to be acquired. Thus, after controlling for the potential synergy contribution of acquiring firms and applying a propensity score-based matching based on observable, pre-exit private firm characteristics, our model predicts that the post-exit performance of IPO firms will be better than the post-exit performance of matched firms that are acquired. Empirical evidence consistent with this prediction is provided by Chemmanur, He, and, He (2009), who make use of the Longitudinal Research Database of the U.S. Census Bureau to do a plant-level study of firms that went public versus those that were acquired. They find that IPO firms have higher total factor productivity and higher sales growth than similar

acquired firms in the three years after their exit events.[29]

Second, our model implies that the likelihood of IPOs relative to acquisitions will be smaller in more concentrated industries where there is already a dominant firm so that the benefits of being acquired by a larger, established firm are greater. Thus, the likelihood of a firm going public rather than being acquired is predicted to be decreasing in the market share enjoyed by the dominant firm (if any) in the firm's industry. Note also that part (c) of Proposition 2 implies that the likelihood of a firm going public rather than being acquired is decreasing in the extent of synergy with potential acquirers, which is expected to be larger in more concentrated industries where there is a dominant firm, provided that the bargaining power of the acquiring firm is not so large that the acquirer is able to extract the entire value of the synergy benefits obtained from the acquisition.

Third, Proposition 2 of our model predicts that the likelihood of a firm going public rather than being acquired is increasing in the private benefits of control enjoyed by management in the industry the firm is operating in. As we discussed earlier, these control benefits are much more likely to be retained after an IPO, whereas they will be lost or heavily diluted after an acquisition. Consistent with this prediction, Bayar and Chemmanur (2009) find that firms operating in industries characterized by greater private benefits of control are more likely to go public rather than to be acquired. In order to measure cross sectional variation in private benefits of control across different industries, Bayar and Chemmanur (2009) construct an industry-wide dummy variable inspired by Rajan and Wulf (2006), who study perk consumption by firm executives (CEOs and divisional managers) of a large sample

[29]Poulsen and Stegemoller (2008) and Bayar and Chemmanur (2009) find that firms characterized by higher pre-exit sales growth are more likely to go public rather than be acquired. Poulsen and Stegemoller (2008) also document that IPO firms tend to be more capital constrained than acquired firms suggesting that IPO firms have exit motivations based on a higher future growth potential. Brau, Francis, and Kohers (2003), Poulsen and Stegemoller (2008), and Bayar and Chemmanur (2009) also document that IPO firms tend to be larger, which is consistent with firm size being a proxy for the firm's viability in product market competition.

of public firms.[30] Rajan and Wulf rank CEO perk consumption and CEO-Divisional Manager perk consumption differentials across different industries in their sample at the two-digit SIC level; high values of this differential indicate that the CEO values his or her perks as unique privilege. Bayar and Chemmanur (2009) define their "private benefits" dummy variable to be equal to 1 if a private firm's industry is among the top 5 CEO perk consumption industries of Rajan and Wulf (2006) and the CEO-Divisional Manager differential in the Rajan-Wulf perk consumption score is greater than 1.

Fourth, in our model, potential acquirers have industry and product market expertise and can value the private firm better than IPO market investor, so that private firm insiders have no information advantage against acquiring firms. Hence, firms with lower intrinsic value will be correctly valued in an acquisition. In contrast, given that IPO market investors have less information than firm insiders, lower intrinsic value firms can get potentially higher valuations in the IPO market by pooling with higher intrinsic value firms in equilibrium (Propositions 1 and 4). Due to this difference in adverse selection across the two exit mechanisms, our model predicts that lower quality firms facing an IPO market where outsiders assess a higher probability that any given firm has higher intrinsic value (i.e., in an IPO market where valuations are higher) are more likely to choose an IPO over an acquisition. Consistent with this prediction, Bayar and Chemmanur (2009) find that firms with less tangible assets and firms in industries with higher average analyst forecast error are more likely to go public rather than be acquired.

Fifth, Proposition 2 also predicts that the likelihood of a firm going public rather than being acquired is increasing in the investment amount required to fund the firm's project (capital intensity of the firm's industry), which leads to the hypothesis that firms operating in more capital intensive industries are more likely to choose an IPO over an acquisition. Poulsen and Stegemoller (2008) report

[30] The types of perquisite consumption enjoyed by high level executives and analyzed in Rajan and Wulf (2006) include the use of company plane, chauffer service, and country club membership.

that firms with better growth opportunities, and more capital constrained firms are more likely to go public through an IPO rather than to be acquired. Poulsen and Stegemoller (2008), and Bayar and Chemmanur (2009) also find that firms with higher capital expenditures (scaled by assets) are more likely to choose an IPO over an acquisition.

2. *Exit choices in venture backed versus non-venture backed firms:* First, our model predicts that, controlling for viability in the product market, firms that are venture backed (jointly controlled firms) are more likely to choose to go public rather than to be acquired relative to those that are non-venture backed (provided that the venture capitalist divests a significantly larger fraction of equity in the IPO or soon after compared to entrepreneurs, which is usually the case in practice). Venture capitalists typically have shorter investment horizons because they need to raise capital for other projects or have to return capital to their limited partners for liquidity or diversification reasons. Evidence supporting this prediction is provided by Poulsen and Stegemoller (2008), Bayar and Chemmanur (2009), and Chemmanur, He, and He (2009). However, if venture capitalists are in fact long-term stakeholders (so that they retain a fraction of equity post-IPO of similar magnitude as entrepreneurs), then our model predicts that venture backed firms are less likely to go public rather than be acquired than non-venture backed firms. Further, in the latter scenario, within a sample of venture backed firms, our model predicts that firms in the governance of which venture capitalists have greater control (measured by the extent of their ownership, or their board representation in the firm, or due to the strength of various provisions in their financial contracts with the firm) are less likely to go public. Cumming (2008) provides evidence consistent with this prediction based on the exit decisions of firms in a number of European countries. He finds that financial contracts which give venture capitalists or other private investors greater control over the governance of firms increase the likelihood of these firms to be acquired rather than to go public.

3. *Average firm valuation in IPOs versus acquisitions:* The existing empirical evidence indicates

that the average valuation of firms going public is higher than that of firms that are acquired: see, e.g., Brau, Francis, and Kohers (2003), who document that sellers in acquisitions receive payoffs equal to only 78% of those in IPOs, and Poulsen and Stegemoller (2008), who document that IPO firms have higher valuation multiples relative to those that are acquired. Our model predicts that, if the entrepreneur's control benefits are not too large, the average valuation across firms going public will be higher than the average valuation of firms that are acquired. Our analysis suggests that this IPO valuation premium is primarily driven by the differences in quality (intrinsic value) between the pool of firms that go public (all high quality firms plus a proportion of low quality firms) versus the pool of firms that are acquired (only low quality firms).

Therefore, truly testing for the existence of an IPO valuation premium requires controlling for various factors affecting a firm's choice between IPOs and acquisitions which we have mentioned above (some of which may be unobservable to the econometrician at the time of exit). Our arguments above lead to the following hypothesis: If we can control (adjust) for industry, time of transaction, and other characteristics (including intrinsic firm value) affecting the choice of a firm between IPOs and acquisitions, there will exist no IPO valuation premium. Consistent with this prediction, Bayar and Chemmanur (2009) find that, if one controls for the factors affecting a firm's endogenous choice between IPOs and acquisitions, the IPO valuation premium is significantly reduced.

4. *A resolution to the "IPO valuation premium puzzle":* In our setting, low quality firm insiders have private information that their firm's business model is not as viable as that of high quality firms in the face of aggressive competition in the product market, so that the higher valuations that they are able to obtain by pooling with high quality firms in the IPO market may not be sustained in the long run. Given that entrepreneurs and venture capitalists are able to liquidate only a small fraction of their equity holdings in the firm in the IPO (especially given that most IPOs have lock-up arrangements, which forbid investors from liquidating additional shares in the equity market immediately after IPO),

insiders can benefit from higher IPO valuations only if this valuation is sustained in the long run.[31] In contrast, firm insiders are able to liquidate much of their equity position in their private firm in the event of an acquisition, thus realizing their firm's value immediately.[32] Therefore, insiders choosing between an IPO and an acquisition will actually compare the acquisition value of their firm not to its IPO valuation, but to the weighted average of the IPO value and its (potentially lower) long-term (say, three years after IPO) stock market value where the weight on the IPO value is the fraction of equity insiders liquidate in the IPO. Given that the weighted average of their firm's short-run IPO valuation and long-term stock market value may be lower than the value realized in an acquisition, entrepreneurs may choose an acquisition over an IPO even though their firm's valuation at its IPO price will be higher than its valuation at the acquisition price. Consistent with this, the empirical analysis of Bayar and Chemmanur (2009) finds that, when comparing a firm's acquisition value to the weighted average of its short-run IPO valuation and long-term stock market value (rather than its IPO value alone), the IPO valuation premium vanishes almost entirely.

5. *Welfare implications surrounding the choice between IPOs and acquisitions:* In our model, private benefits of control induce less viable (low quality) firms to opt for an IPO even though an acquisition is socially optimal for them, given that an acquisition creates greater real value due to the synergy benefits of an acquisition. Thus, our model predicts that as a result of the exit choice of private firms, social welfare will be distorted more in industries with higher private benefits of control.

6. *The feedback effect of the choice between IPOs and acquisitions on product market competition:* As we mentioned above, our model predicts that the likelihood of IPOs relative to acquisitions will be

[31] As shown by Leland and Pyle (1977), if insiders sell a larger fraction of equity in their IPO relative to that required to satisfy their liquidity demands, IPO market investors will infer that the firm is of type L and value the firm accordingly.

[32] For evidence that entrepreneurs and other insiders retain, on average, a lion's share (64%) of equity in the firm after an IPO, while liquidating almost all their equity holdings after an acquisition (they hold only 5% equity in the combined firm, post-acquisition) see Brau, Francis and Kohers (2003).

smaller in more concentrated industries where there is already a dominant firm so that the benefits of being acquired by a larger, established firm are greater. The extent of synergy with potential acquirers can also be expected to be larger in more concentrated industries where there is a dominant firm (provided that the bargaining power of the acquiring firm is not so large that the acquirer is able to extract the entire value of the synergy benefits obtained from the acquisition). The above predictions also have implications for post-exit product market competition in the firm's industry. Our model implies that IPOs increase the level of product market competition by increasing the number of independent, viable stand-alone firms in the product markets, while private firm acquisitions reduce the level of product market competition by consolidating the number of stand-alone firms. If acquisitions outnumber IPOs in an industry in a particular time period, this will increase the industry concentration, making acquisitions even more likely to be the exit choice for other private firms. Conversely, if IPOs outnumber private firm acquisitions under certain market conditions, then this will reduce industry concentration, increasing the likelihood of even more IPOs in the future. Empirical evidence consistent with this prediction in the context of IPO waves is provided by Chemmanur and He (2009): they find that the product market share of existing public firms in an industry is decreasing (on average) in the fraction of private firms going public in that industry. Further, Hsu, Reed, and Rocholl (2010) find that the operating performance of already public firms in an industry is decreasing in the number of firms going public in that industry.

7. *A potential rational explanation of the IPO overvaluation result of Purnanandam and Swaminathan (2004)*: Our model may provide a rational explanation of the empirical finding of Purnanandam and Swaminathan (2004) that IPOs are overvalued relative to their seasoned industry peers. This is because, in our setting, the pool of IPO firms will consist of a much higher fraction of high quality firms than the peer group of seasoned firms to which they are compared, which will have a combination of higher quality and lower quality divisions (since the low quality private firms that choose to be ac-

quired in equilibrium in our setting will become part of the seasoned public firms that acquire them). Since intrinsic firm quality (intrinsic value) is unobservable to the econometrician, a comparison of the valuation of IPO firms to size and industry matched seasoned firms would indicate that the IPO firms are "overvalued" relative to their industry peers, while, in reality, the relative valuations of the two groups of firms may merely reflect the difference in their true quality.[33, 34]

8. *Post-IPO acquisitions*: Our analysis predicts that acquisitions in the years immediately following an IPO are more likely to occur in industries where competing firms have established a more powerful product market position. Further, firms which are subject to post-IPO acquisitions will be those which are less successful in product market competition compared to those preferring to remain stand-alone firms.

9. *Strategic versus financial acquirers*: Given that a firm chooses to be acquired rather than go public, our analysis has three predictions for a firm's choice between strategic acquirers (e.g., a large corporation acquiring a private firm facilitating entry into a new product market segment) and financial acquirers (e.g., a private equity fund acquiring the firm). First, firms with greater potential synergies with other firms in their industry are more likely to be acquired by strategic acquirers. Second, firms in industries yielding greater benefits of control are more likely to be acquired by financial acquirers. Third, firm valuations in strategic acquisitions will be higher than those in financial acquisitions, but lower than those in IPOs, since strategic acquisitions yield greater synergy value than financial acquisitions.[35]

[33] We thank an anonymous referee for suggesting predictions five, six, and seven, and also for suggesting that prediction seven may provide a rational explanation of the Purnanandam and Swaminathan (2004) IPO overvaluation result.

[34] While Purnandam and Swaminathan (2004) also match on the prior year's EBITDA profit margin, matching on one year's profit margin may not completely control for differences in intrinsic firm quality between IPO firms and seasoned industry peer firms.

[35] While we are not aware of any empirical evidence supporting a private firm's choice between financial and strategic acquirers (in the event it chooses to be acquired rather than go public), there is some anecdotal evidence supporting

VIII. Conclusion

In this paper, we have analyzed a private firm's choice of exit mechanism between IPOs and acquisitions, and provided a resolution to the "IPO valuation premium puzzle." The private firm is run by an entrepreneur and a venture capitalist (insiders) who desire to exit partially from the firm. A crucial factor driving their exit choice is competition in the product market: while a stand-alone firm has to fend for itself after going public, an acquirer is able to provide considerable support to the firm in product market competition. A second factor is the difference in information asymmetry characterizing the two exit mechanisms. Finally, the private benefits of control accruing post-exit to the entrepreneur and the bargaining power of outside investors versus firm insiders are also different across the two mechanisms. We have analyzed two different situations: the first, where the entrepreneur can make the exit choice alone (independent of the venture capitalist) and the second, where the entrepreneur can make the exit choice only with the concurrence of the venture capitalist. We have derived a number of testable implications regarding insiders' exit choice between IPOs and acquisitions and about the IPO valuation premium puzzle.

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these predictions of our model in the practitioner literature. To quote: "A strategic buyer might pay our client (seller) a higher multiple...However with private equity groups we find that there is more flexibility than with strategic buyers. They can tailor something a little more to the current owner's liking in terms of how much he will get to participate in the firm going forward, and what freedom he will have." (*Mergers and Acquisitions Magazine 2003 Roundtable*, August 4, 2003, pages 8 to 10).

References

Allen, F., and G. Faulhaber. "Signaling by Underpricing in the IPO Market." *Journal of Financial Economics*, 23 (1989), 303-323.

Bayar, O., and T. J. Chemmanur. "What Drives the Valuation Premium in IPOs versus Acquisitions? An Empirical Analysis." Working Paper, Boston College and University of Texas at San Antonio (2009).

Brau, J.; F. Francis; and N. Kohers. "The Choice of IPO versus Takeover: Empirical Evidence." *Journal of Business*, 76 (2003), 583-612.

Boot, A. W. A.; R. Gopalan; and A. Thakor. "The Entrepreneur's Choice between Private and Public Ownership." *Journal of Finance*, 61 (2006), 803-836.

Chemmanur, T. J. "The Pricing of Initial Public Offerings: A Dynamic Model with Information Production." *Journal of Finance*, 48 (1993), 285-304.

Chemmanur, T. J., and P. Fulghieri. "A Theory of the Going-Public Decision." *The Review of Financial Studies*, 12 (1999), 249-279.

Chemmanur, T. J., and J. He. "IPO Waves, Product Market Competition, and the Going Public Decision: Theory and Evidence." Working paper, Boston College (2009).

Chemmanur, T. J.; J. He; S. He; and D. Nandy. "The Exit Choices of Entrepreneurial Firms." Working paper, Boston College (2009).

Chemmanur, T. J.; S. He; and D. Nandy. "The Going Public Decision and the Product Market: Empirical Evidence." *Review of Financial Studies*, 23(2010), 1855-1908.

Chemmanur, T. J.; I. Paeglis; and K. Simonyan. "Management Quality and Anti-Takeover Provisions." *Journal of Law and Economics*, Forthcoming (2010).

Chemmanur, T. J., and A. Yan. 2009, "Product Market Advertising and New Equity Issues." *Journal of Financial Economics*, 92 (2009), 4065.

Cho, I., and D. M. Kreps. "Signaling Games and Stable Equilibria." *The Quarterly Journal of Economics*, 102 (1987), 179-221.

Cumming, D. J. "Contracts and Exits in Venture Capital Finance." *The Review of Financial Studies*, 21 (2008), 1947-1982.

Fudenberg, D., and J. Tirole. "Perfect Bayesian Equilibrium and Sequential Equilibrium." *Journal of Economic Theory*, 53 (1991), 236-260.

Fulghieri, P., and M. Sevilir. "Size and Focus of a Venture Capitalists Portfolio." *Review of Financial Studies*, 22 (2009), 4643-4680.

Fulghieri, P., and M. Sevilir. "Organization and Financing of Innovation, and the Choice between Corporate and Independent Venture Capital." *Journal of Financial and Quantitative Analysis*, 44 (2009), 1291-1321.

Hellmann, T. "IPOs, Acquisitions and the Use of Convertible Securities in Venture Capital." *Journal of Financial Economics*, 81 (2006), 649-679.

Hsu, H.; A. V. Reed; and J. Rocholl. "The New Game in Town: Competitive Effects of IPOs." *Journal of Finance*, 65 (2010), 495-528.

Leland, H. E., and D.H. Pyle. "Informational Asymmetries, Financial Structure, and Financial Intermediation." *Journal of Finance*, 32 (1977), 371-387.

Maksimovic, V., and P. Pichler. "Technological Innovation and Initial Public Offerings." *The Review of Financial Studies*, 14 (2001), 459-494.

Nahata, R. "The Determinants of Venture Capital Exits: An Empirical Analysis of Venture Backed Companies." Working Paper, Vanderbilt University (2003).

Pagano, M.; F. Panetta; and L. Zingales. "Why Do Companies Go Public?" *Journal of Finance*, 53 (1998), 27-64.

Poulsen, A., and M. Stegemoller. "Moving Firms from Private to Public Ownership: Selling Out to Public Firms vs. Initial Public Offerings." *Financial Management*, 37 (2008), 81-101.

Purnanandam, A. K., and B. Swaminathan. "Are IPOs Really Underpriced?" *Review of Financial Studies*, 17 (2004), 811-848.

Rajan, R. G., and J. Wulf. "Are Perks Purely Managerial Excess?" *Journal of Financial Economics*, 79 (2006), 1-33.

Ritter, J. R., and I. Welch. "A Review of IPO Activity, Pricing, and Allocations." *Journal of Finance*, 57 (2002), 1795-1828.

Sigg, K. "Cerent Corporation." Case Study E-83, Graduate School of Business, Stanford University (2000).

Spiegel, M., and H. Tookes. "Dynamic Competition, Innovation and Strategic Financing." Working Paper, Yale University (2007).

Stoughton, N. M.; K. P. Wong; and J. Zechner, "IPOs and Product Quality." *Journal of Business*, 74 (2001), 375-408.

Welch, I. 1989, "Seasoned Offerings, Imitation Costs, and the Underpricing of Initial Public Offerings." *Journal of Finance*, 44 (1989), 421-449.

Appendix: Proofs of Propositions

Proof of Proposition 1. First, we conjecture that the entrepreneurs of each type of firm choose the following strategies in equilibrium:

1) A type H firm goes public with probability 1, i.e., $\Pr(a = 1|q = H) = 1$.

2) A type L firm goes public with probability β_E and is acquired with probability $(1 - \beta_E)$, i.e., $\Pr(a = 1|q = L) = \beta_E$.

In this equilibrium, none of the exit choices (IPO or acquisition) is off the equilibrium path. In addition, the beliefs of outsiders in response to out-of-equilibrium moves by firms are as follows. Outside investors in the IPO market infer that any IPO firm setting a price other than P^E_{ipo} given in (13) or offering a fraction of new shares other than $\frac{I}{P^E_{ipo}}$, and any IPO firm in which the entrepreneur and the VC sell fractions of shares other than α_E and α_V, respectively, of their remaining equity holdings, is a type L firm with probability 1.

Given the equilibrium strategies of each type of entrepreneur, we next determine the best responses of the investors in the IPO market and the acquiring firm in the acquisition market. The acquisition price P_{acq} for a type L or type H firm is given by $I + \rho V_A$. From the posterior beliefs of IPO market investors updated by Bayes' rule as in (11) and (12) on the equilibrium path of the game, it follows that the IPO price P^E_{ipo} is given by (13).

Now, given the valuations P^E_{ipo} and P_{acq} in the IPO market and acquisition market respectively, and the investors' out-of-equilibrium beliefs specified, we will show that the entrepreneur's strategies conjectured above are indeed optimal in equilibrium. For the type L entrepreneur to optimally respond by playing a mixed strategy in equilibrium, he must be indifferent between his pure strategies (IPO or acquisition), which translates into the following indifference equation:

$$\delta_E(1-\gamma)[\alpha_E P^E_{ipo} + (1-\alpha_E)(I + V_L)] + B = \delta_E \rho V_A. \tag{A1}$$

By substituting $\gamma = \frac{I}{P^E_{ipo}}$, and after some algebra, we obtain the following expression for the type L firm's entrepreneur's objective function:

$$\text{(A2)} \qquad \max_{a\in\{0,1\}} a \cdot [\delta_E(\alpha_E(P^E_{ipo} - I) + (1-\alpha_E)(I+V_L)(1 - \frac{I}{P^E_{ipo}})) + B] + (1-a)\cdot\delta_E\rho V_A.$$

By rearranging (A2) and from the definition of Q in (4), we obtain the indifference condition (10), which we solve for the closed-form solution of the equilibrium IPO price P^E_{ipo} given by (A3) and we denote this particular value of P^E_{ipo} by $P^{E^*}_{ipo}$:

$$\text{(A3)} \qquad P^{E^*}_{ipo} = \frac{Q + \alpha_E V_L - (1-2\alpha_E)I + \sqrt{(Q+\alpha_E V_L - (1-2\alpha_E)I)^2 + 4\alpha_E(1-\alpha_E)I(I+V_L)}}{2\alpha_E}.$$

By substituting the equilibrium IPO price $P^{E^*}_{ipo}$ from (A3) in (13), we obtain the equilibrium value of β_E, which is given by

$$\text{(A4)} \qquad \beta_E = \frac{\theta(I + V_H - P^{E^*}_{ipo})}{(1-\theta)(P^{E^*}_{ipo} - (I+V_L))}.$$

Given the equilibrium beliefs and strategies of other players, $P^{E^*}_{ipo}$ is the IPO valuation which makes the type L firm's entrepreneur indifferent between his pure strategies of going public and choosing an acquisition. In a partially pooling equilibrium where the type L firm's entrepreneur plays a mixed strategy, β_E must lie in the open interval $(0,1)$. Therefore, the restriction that $P^{E^*}_{ipo}$ must lie in the open interval $(\theta V_H + (1-\theta)V_L, V_H)$ follows from the mixed strategy equilibrium condition $0 < \beta_E < 1$ and (A4). Note that the expression for P^E_{ipo} given in (13) is decreasing in the probability β_E of the type L firm going public. Therefore, the minimum feasible IPO price in this partially pooling equilibrium is given by setting $\beta_E = 1$, which is equal to $I + \theta V_H + (1-\theta)V_L$. Similarly, the maximum feasible IPO price is given by setting $\beta_E = 0$, which is equal to $I + V_H$. Hence, we have the parameter

restriction, $\theta V_H + (1-\theta)V_L < P_{ipo}^{E^*} - I < V_H$, such that $\beta_E \in (0,1)$, which translates into the parameter restriction on Q imposed in Proposition 1. Given the objective function of the entrepreneur in (A2) and his indifference condition (10), this restriction is equivalent to the following condition (which is stated at the beginning of the proposition) in terms of the exogenous parameters of our model:

$$K_L < Q = \rho V_A - V_L - \frac{B}{\delta_E} < K_H, \tag{A5}$$

where

$$K_L = \left[\alpha_E + (1-\alpha_E)\frac{I}{I + V_L + \theta(V_H - V_L)}\right]\theta(V_H - V_L), \tag{A6}$$

$$K_H = \left[\alpha_E + (1-\alpha_E)\frac{I}{I + V_H}\right](V_H - V_L). \tag{A7}$$

From (14), it follows that it is optimal for the type H firm's entrepreneur to take his firm public with probability 1 (given the equilibrium beliefs and strategies of other players), if and only if the following inequality is satisfied:

$$\delta_E(I + V_H - (I + \rho V_A - \frac{B}{\delta_E})) > \delta_E(\alpha_E + (1-\alpha_E)\frac{I}{P_{ipo}^{E^*}})(I + V_H - P_{ipo}^{E^*}). \tag{A8}$$

The type L firm's entrepreneur's indifference condition (10) implies that the following inequality must hold (see also Proposition 3):

$$P_{ipo}^{E^*} > I + \rho V_A - \frac{B}{\delta_E}. \tag{A9}$$

Moreover, in equilibrium, we have $I + V_H > P_{ipo}^{E^*}$ since $\beta_E > 0$. Thus, it follows that

$$I + V_H > P_{ipo}^{E^*} > I + \rho V_A - \frac{B}{\delta_E}. \tag{A10}$$

From (A10) and since $0 < \alpha_E + (1-\alpha_E)\frac{I}{P_{ipo}^{E*}} < 1$, it follows that (A8) holds in equilibrium.

The type L firm's entrepreneur's going public decision is privately optimal for the type L firm's VC iff the following inequality holds in equilibrium:

$$\rho V_A - V_L < (\alpha_V + (1-\alpha_V)\frac{I}{P_{ipo}^{E*}})(P_{ipo}^{E*} - V_L - I). \tag{A11}$$

It follows from (A11) that the VC of a type L firm finds it privately optimal to go public in equilibrium only if $P_{ipo}^{E*} > I + \rho V_A$, since $\alpha_V + (1-\alpha_V)\frac{I}{P_{ipo}^{E*}} < 1$. From the type L firm's entrepreneur's indifference equation (10), it follows that

$$\frac{\rho V_A - V_L}{P_{ipo}^{E*} - V_L - I} = \alpha_E + (1-\alpha_E)\frac{I}{P_{ipo}^{E*}} + \frac{B}{\delta_E(P_{ipo}^{E*} - V_L - I)}. \tag{A12}$$

Thus, substituting this into (A11), we obtain:

$$\alpha_E + (1-\alpha_E)\frac{I}{P_{ipo}^{E*}} + \frac{B}{\delta_E(P_{ipo}^{E*} - V_L - I)} < \alpha_V + (1-\alpha_V)\frac{I}{P_{ipo}^{E*}}. \tag{A13}$$

Then, (A13) implies that the type L firm's VC would find an IPO privately optimal iff $1 > \alpha_V > \hat{\alpha}_V$, where $\hat{\alpha}_V$ is given by

$$\alpha_V > \hat{\alpha}_V \equiv \alpha_E + \frac{B}{\delta_E(P_{ipo}^{E*} - I - V_L)(1 - \frac{I}{P_{ipo}^{E*}})}. \tag{A14}$$

Note that $\hat{\alpha}_V < 1$ iff $P_{ipo}^{E*} > P_{acq} = I + \rho V_A$. To show this, we derive another expression for $\hat{\alpha}_V$ from the indifference condition (set (A11) as an equality) of the type L firm's VC, when the firm is controlled by the entrepreneur:

$$\hat{\alpha}_V + (1-\hat{\alpha}_V)\frac{I}{P_{ipo}^{E*}} = \frac{I + \rho V_A - (I + V_L)}{P_{ipo}^{E*} - I + V_L}, \tag{A15}$$

where $\hat{\alpha}_V$ is finally given by:

$$\hat{\alpha}_V = \frac{1}{1 - \frac{I}{P_{ipo}^{E*}}}\left(\frac{\rho V_A - V_L}{P_{ipo}^{E*} - I - V_L} - \frac{I}{P_{ipo}^{E*}}\right). \tag{A16}$$

Thus, after some algebra, $\hat{\alpha}_V < 1$ iff $P_{ipo}^{E*} > I + \rho V_A$. The type H firm's entrepreneur's decision to take the firm public with probability 1 is privately optimal for the type H firm's VC, iff the following inequality holds:

$$V_H - \rho V_A > (\alpha_V + (1 - \alpha_V)\frac{I}{P_{ipo}^{E}})(I + V_H - P_{ipo}^{E}). \tag{A17}$$

This implies the following inequality:

$$\alpha_V + (1 - \alpha_V)\frac{I}{P_{ipo}^{E*}} < \frac{I + V_H - (I + \rho V_A)}{I + V_H - P_{ipo}^{E*}}. \tag{A18}$$

Thus, from (A18) we see that, if $P_{ipo}^{E*} > I + \rho V_A$, the type H firm's entrepreneur's exit choice to go public is privately optimal for the type H firm's VC since the LHS is always less than 1. If $P_{ipo}^{E*} < I + \rho V_A$, then (A18) is satisfied only if $\alpha_V < \hat{\alpha}_{vh}$ where $\hat{\alpha}_{vh}$ is given by

$$\hat{\alpha}_{vh} \equiv \frac{1}{1 - \frac{I}{P_{ipo}^{E*}}}\left(\frac{V_H - \rho V_A}{I + V_H - P_{ipo}^{E*}} - \frac{I}{P_{ipo}^{E*}}\right). \tag{A19}$$

The RHS of (A19) is positive only if $\rho V_A < V_H$ which is equivalent to $1 - p_H < \hat{p} \equiv \frac{V_S}{V_S - V_F}(1 - \rho) + \rho p_A$. The restriction $Q < K_H$ implies that this condition is satisfied. Note that $\hat{\alpha}_{vh} > 1$ iff $P_{ipo}^{E*} > I + \rho V_A$.

The equilibrium in Proposition 1 survives the Intuitive Criterion of Cho and Kreps (1987). For an equilibrium to survive the Cho-Kreps Intuitive Criterion, the requirement (as applied to our model setting) is that there be no out-of-equilibrium move that can be made by the informed party (firm insiders in our case) that satisfies the following two conditions simultaneously (see Cho and Kreps

(1987)): (i) The out-of-equilibrium move is such that, regardless of the beliefs of investors in response to such an out-equilibrium move, the type L firm does not have an incentive to undertake such a move; and (ii) by making the above out of equilibrium move, the type H firm obtains a higher expected payoff than its equilibrium payoff, under outsider-beliefs revised such that they infer that the firm making the above out-of-equilibrium move is a type H firm. In our setting, there are no out-of-equilibrium moves that satisfy these two conditions for two reasons. First, the number of possible out-of-equilibrium moves is limited, since both going public and being acquired are equilibrium strategies. Second, for the out-of-equilibrium moves that do exist, either (i) or (ii), or both are not satisfied (in other words, both conditions are never simultaneously satisfied). Consider, for example, the out-of-equilibrium move where the type H firm underprices equity dramatically in its IPO, in order to distinguish itself from the type L firm. Clearly, even if the type L firm were not to mimic it, this does not satisfy condition (ii), since the type H firm would be worse off by making such a move compared to its payoff in equilibrium: revealing itself as a type H firm would not increase its payoff, since this will be done costlessly in any case (at time 1) if the type H sticks with its equilibrium move when the firm's final cash flows are revealed (in other words, underpricing equity in the IPO relative to its equilibrium value simply ensures that the type H firm's IPO (time 0) proceeds are lower, while its time 1 proceeds remain the same, compared to the cash flows it would have received in equilibrium). Consider another possible out-of-equilibrium move where the type H firm sells a lower fraction of equity than the equilibrium fraction γ. Under our current assumptions, neither type of firm would find it optimal to make such a move, since the fraction of equity sold by the firm in equilibrium is the minimum possible that yields the firm the funds required to satisfy its investment needs and the entrepreneur his liquidity needs (recall that we are assuming that the equity market is the only source of external financing, so that the cost of funds from alternative sources is prohibitively large). However, even if we were to relax this assumption and assume that each firm can raise additional funds from other sources at a finite

but significant cost, such an out-of-equilibrium move would still not satisfy the requirements of the Cho-Kreps Intuitive Criterion as long as the cost of such funds is the same for the type H and type L firms. This is because, if, by selling a smaller equity fraction than γ, the type H firm can convince outsiders that is of type H, the type L firm would also mimic its move, since it is better off making this out-of-equilibrium move as well, thus violating condition (i). It should be obvious that a combination of the above two moves (i.e., underpricing equity in the IPO to prevent the type L from mimicking, and selling a very low fraction of equity in the IPO) would also not satisfy condition (ii), for the same reason as that discussed under the first out-of-equilibrium move mentioned above. ■

Proof of Proposition 2. By partially differentiating β_E in (A4) and implicitly differentiating $P_{ipo}^{E^*}$ in (10), we obtain the following results. The probability of an entrepreneur controlled type L firm going public β_E is (a) increasing in the private benefits B of the entrepreneur:

$$\frac{\partial \beta_E}{\partial B} = \frac{\theta(V_H - V_L)}{(1-\theta)(P_{ipo}^{E^*} - (I+V_L))^2} \frac{1}{\alpha_E + (1-\alpha_E)\frac{I(I+V_L)}{(P_{ipo}^{E^*})^2}} \frac{1}{\delta_E} > 0. \tag{A20}$$

(b) Increasing in the bargaining power $(1-\rho)$ of the acquiring firm:

$$\frac{\partial \beta_E}{\partial \rho} = -\frac{\theta(V_H - V_L)}{(1-\theta)(P_{ipo}^{E^*} - (I+V_L))^2} \frac{1}{\alpha_E + (1-\alpha_E)\frac{I(I+V_L)}{(P_{ipo}^{E^*})^2}} V_A < 0. \tag{A21}$$

(c) Decreasing in the synergy benefit from an acquisition of a type L firm, $\Delta \equiv p_A - p_L$:

$$\frac{\partial \beta_E}{\partial \Delta} = -\frac{\theta(V_H - V_L)}{(1-\theta)(P_{ipo}^{E^*} - (I+V_L))^2} \frac{1}{\alpha_E + (1-\alpha_E)\frac{I(I+V_L)}{(P_{ipo}^{E^*})^2}} \rho(V_S - V_F) < 0. \tag{A22}$$

(d) Increasing in the prior probability θ that a firm is of type H:

$$\frac{\partial \beta_E}{\partial \theta} = \frac{1}{(1-\theta)^2} \frac{(I + V_H - P_{ipo}^{E^*})}{(P_{ipo}^{E^*} - (I+V_L))} > 0. \tag{A23}$$

(e) Increasing in the fraction of shares α_E sold by the entrepreneur in a potential IPO:

$$\frac{\partial \beta_E}{\partial \alpha_E} = -\frac{\theta(V_H - V_L)}{(1-\theta)(P_{ipo}^{E^*} - (I + V_L))^2} \frac{-(1 - \frac{I}{P_{ipo}^{E^*}})(P_{ipo}^{E^*} - V_L - I)}{\alpha_E + (1-\alpha_E)\frac{I(I+V_L)}{(P_{ipo}^{E^*})^2}} > 0. \tag{A24}$$

(f) Increasing in the investment required I:

$$\frac{\partial \beta_E}{\partial I} = \frac{\theta(V_H - V_L)}{(1-\theta)(P_{ipo}^{E^*} - (I + V_L))^2}(1 - \frac{\partial P_{ipo}^{E^*}}{\partial I}). \tag{A25}$$

Since by Proposition 3 we have $\frac{\partial P_{ipo}^{E^*}}{\partial I} < 1$, it follows that $\frac{\partial \beta_E}{\partial I} > 0$. ■

Proof of Proposition 3. From the indifference condition (10) of the type L firm's entrepreneur, it follows that

$$P_{ipo}^{E^*} > I + \rho V_A - \frac{B}{\delta_E}. \tag{A26}$$

By comparing the equilibrium IPO price $P_{ipo}^{E^*}$ given by (A3) and the acquisition price $P_{acq} = I + \rho V_A$, it is easy to verify that the IPO price exceeds the acquisition price iff (15) holds. The comparative statics results for the IPO price follow from the implicit differentiation of $P_{ipo}^{E^*}$ in (10) with respect to α_E, I, B, $(1-\rho)$ and $(p_A - p_L)$. We obtain:

$$\frac{\partial P_{ipo}^{E^*}}{\partial \alpha_E} = \frac{-(1 - \frac{I}{P_{ipo}^{E^*}})(P_{ipo}^{E^*} - V_L - I)}{\alpha_E + (1-\alpha_E)\frac{I(I+V_L)}{(P_{ipo}^{E^*})^2}} < 0, \tag{A27}$$

$$\frac{\partial P_{ipo}^{E^*}}{\partial I} = \frac{\alpha_E + (1-\alpha_E)\frac{I-(P_{ipo}^{E^*} - V_L - I)}{P_{ipo}^{E^*}}}{\alpha_E + (1-\alpha_E)\frac{I(I+V_L)}{(P_{ipo}^{E^*})^2}} < 1, \tag{A28}$$

(A29)
$$\frac{\partial P_{ipo}^{E^*}}{\partial Q} = \frac{1}{\alpha_E + (1-\alpha_E)\frac{I(I+V_L)}{(P_{ipo}^{E^*})^2}} > 0.$$

Note that $\frac{\partial P_{ipo}^{E^*}}{\partial I} > 0$ if $I > (V_H - V_L)$. Since $Q = \rho V_A - V_L - \frac{B}{\delta_E}$, $\frac{\partial Q}{\partial \rho} = V_A > 0$, and $\frac{\partial Q}{\partial B} = -\frac{1}{\delta_E} < 0$, it follows by the chain rule that $P_{ipo}^{E^*}$ is increasing in ρ and decreasing in B. Let's define $\Delta \equiv p_A - p_L$. Since $\frac{\partial Q}{\partial \Delta} = \rho(V_S - V_F) > 0$, the chain rule also implies that $P_{ipo}^{E^*}$ is increasing in $(p_A - p_L)$. ■

Proof of Proposition 4. We first prove that it is optimal for the type L entrepreneur to play a mixed strategy as outlined in Proposition 4, given the equilibrium beliefs and strategies of other players. First, let $\alpha_V \geq \hat{\alpha}_V = \alpha_E + \frac{B}{\delta_E(P_{ipo}^{E^*} - I - V_L)(1 - \frac{I}{P_{ipo}^{E^*}})}$, where $P_{ipo}^{E^*}$ is the IPO price in the equilibrium of an entrepreneur controlled firm (Proposition 1). Let $P_{ipo}^{V^*}$ be the IPO valuation at which the VC of a type L firm is indifferent between an IPO and an acquisition, and β_V be the probability of going public of a type L firm if the VC were to be in charge of making the exit decision. These quantities can be obtained by setting $B = 0$ and substituting α_E with α_V in (A3) to obtain $P_{ipo}^{V^*}$, and then by substituting $P_{ipo}^{E^*}$ with $P_{ipo}^{V^*}$ in (A4) to obtain β_V respectively. It is easy to show that $\beta_V \geq \beta_E$ iff $\alpha_V \geq \hat{\alpha}_V$ since β_E is increasing in B and α_E as shown in Proposition 2. Since $P_{ipo}^{E^*}$ and $P_{ipo}^{V^*}$ are decreasing in β_E and β_V respectively (this follows from (13)), it follows that $P_{ipo}^{E^*} \geq P_{ipo}^{V^*}$ iff $\beta_V \geq \beta_E$ and therefore, $P_{ipo}^{E^*} \geq P_{ipo}^{V^*}$ iff $\alpha_V \geq \hat{\alpha}_V$. This implies that, if $\alpha_V \geq \hat{\alpha}_V$, the type VC of a type L firm prefers an IPO to an acquisition at the price $P_{ipo}^{E^*}$, and that he needs to be compensated by a positive transfer T_2 from the type L firm's entrepreneur in case the entrepreneur chooses an acquisition. Therefore, we have a new set of indifference equations (17) and (18) for the entrepreneur and the VC of a type L firm respectively, which together imply the joint indifference equation (19). Given (19), outside investors' IPO valuation (13), the acquisition price P_{acq} set by the acquiring firm, and the type L firm's VC's individual indifference condition (18), we solve for the equilibrium IPO price $P_{ipo}^{J^*}$, the equilibrium probability β_J of the type L firm going public, and the equilibrium transfer

T_2 to the type L firm's VC in the case of an acquisition:

$$\beta_J = \frac{\theta(I + V_H - P_{ipo}^{J^*})}{(1-\theta)(P_{ipo}^{J^*} - (I + V_L))}, \tag{A30}$$

$$P_{ipo}^{J^*} = \frac{G + \sqrt{G^2 + 4(\delta_E\alpha_E + \delta_V\alpha_V)(\delta_E(1-\alpha_E) + \delta_V(1-\alpha_V))I(I+V_L)}}{2(\delta_E\alpha_E + \delta_V\alpha_V)}, \tag{A31}$$

$$T_2 = \delta_V(\alpha_V + (1-\alpha_V)\frac{I}{P_{ipo}^J})(P_{ipo}^J - V_L - I) - \delta_V(\rho V_A - V_L). \tag{A32}$$

The quantity G is defined by

$$G \equiv (\delta_E + \delta_V)(\rho V_A - V_L) - B + (\delta_E\alpha_E + \delta_V\alpha_V)V_L - (\delta_E(1-2\alpha_E) + \delta_V(1-2\alpha_V))I. \tag{A33}$$

If $\alpha_V \leq \hat{\alpha}_V$, the proof of the equilibrium is very similar. Without loss of generality, it is easy to show in this case that the equilibrium IPO price $P_{ipo}^{J^*}$ and the equilibrium probability β_J of the type L firm going public are also given by (A31) and (A30) respectively. The equilibrium transfer T_1 from the type L firm's entrepreneur to the type L firm's VC in the case of an IPO is given by $T_1 = -T_2$.

The restrictions $\theta V_H + (1-\theta)V_L < P_{ipo}^{E^*} - I < V_H$ and $\theta V_H + (1-\theta)V_L < P_{ipo}^{V^*} - I < V_H$ are necessary and sufficient conditions for the existence of a partially pooling equilibrium so that $\beta_J \in (0,1)$. These restrictions translate into the parameter restrictions on Q and $(\rho V_A - V_L)$ imposed in Proposition 4. If $\alpha_V \geq \hat{\alpha}_V$, then $P_{ipo}^{J^*} > P_{acq} = I + \rho V_A$ since $T_2 > 0$ in (18). In that case, both the entrepreneur and the VC of a type H firm prefer an IPO over an acquisition. If $\alpha_V \leq \hat{\alpha}_V$, Proposition 5 shows that $P_{ipo}^{J^*} > P_{ipo}^{E^*}$. Then, Proposition 1 implies that the type H firm's entrepreneur chooses to go public with probability 1. The parameter restrictions $\alpha_V < \hat{\alpha}_{vh}$ and $p_H > 1 - \hat{p}$ also imply that the type H firm's VC always finds an IPO privately optimal, since $P_{ipo}^{J^*} > P_{ipo}^{E^*}$ in this case (see Proposition 1). ■

Proof of Proposition 5. (i) If $\alpha_V > \hat{\alpha}_V$, the RHS of (17) and the indifference equation (10) of the entrepreneur controlled firm implies that $T_2 > 0$ iff $P_{ipo}^{J^*} < P_{ipo}^{E^*}$, since $\frac{\partial(\alpha+(1-\alpha)\frac{I}{P})(P-V_L-I)}{\partial P} > 0$. From outside investors' IPO valuation in (13), we have $\frac{\partial P_{ipo}}{\partial \beta} < 0$. Therefore, $P_{ipo}^{J^*} < P_{ipo}^{E^*}$ iff $\beta_J > \beta_E$. Since we have $P_{ipo}^{J^*} < P_{ipo}^{E^*}$ in this case, it follows that $\beta_J > \beta_E$, if $\alpha_V > \hat{\alpha}_V$. (ii) If $\alpha_V < \hat{\alpha}_V$, by symmetric arguments, $T_1 > 0$ implies that $P_{ipo}^{J^*} > P_{ipo}^{E^*}$, and therefore $\beta_J < \beta_E$ holds if $\alpha_V < \hat{\alpha}_V$. ■

Proof of Proposition 6. We solve for the equilibrium of this game by backward induction. Suppose the entrepreneur chooses to go public at time 0. Thus, the fraction of new shares issued at time 0 is equal to $\gamma = \frac{I}{V_p^E}$, where V_p^E denotes the IPO valuation of the firm. The entrepreneur enjoys a fraction k of his control benefits B between time 0 and time 1. Thus, if $e = N$, the type L entrepreneur will prefer to remain stand-alone at time 1 if the following condition holds:

$$\begin{aligned} &\delta_E(1-\gamma)(1-\alpha_E)[\alpha_E^{'}(I+(1-\hat{\theta})V(\psi_L)+\hat{\theta}V(\psi_H))+(1-\alpha_E^{'})(I+V(\psi_L))] \\ &+(1-k)B > \delta_E(1-\gamma)(1-\alpha_E)(I+\rho V(p_N)), \end{aligned} \tag{A34}$$

which further translates into

$$\alpha_E^{'}V_n^1+(1-\alpha_E^{'})(I+V(\psi_L))+\frac{(1-k)B}{\delta_E(1-\gamma)(1-\alpha_E)} > I+\rho V(p_N). \tag{A35}$$

Given this condition, we can solve for an upper bound $\bar{\psi}$ for $\alpha_E^{'}\theta(1-\psi_H)+(1-\alpha_E^{'}\theta)(1-\psi_L)$, for which (A34) is satisfied:

$$\bar{\psi} \equiv \frac{V_S(1-\rho)+\frac{B(1-k)}{\delta_E(1-\alpha_E)}}{V_S-V_F}+\rho p_N. \tag{A36}$$

Hence, if $\alpha_E^{'}\theta(1-\psi_H)+(1-\alpha_E^{'}\theta)(1-\psi_L) < \bar{\psi}$, the type L entrepreneur prefers to remain stand-alone when $e = N$. Since $\psi_H > \psi_L$, it follows that the type H entrepreneur also decides to remain

stand-alone. If $e = E$, the type L firm is indifferent between remaining stand-alone and choosing an acquisition as shown in the equation (22) for the time 1 valuation V_e^1. The probability η of a type L firm remaining stand-alone is given by:

$$\eta = \frac{\hat{\theta}}{(1-\hat{\theta})} \frac{(I + V(\phi_H) - V_e^1)}{(V_e^1 - I - V(\phi_L))}. \tag{A37}$$

The characterization of the overall equilibrium at time 0 is similar to the equilibrium of an entrepreneur controlled firm without a post-IPO acquisition as characterized in Proposition 1. The only difference is that we have to account for the post-IPO acquisition equilibrium at time 1 by backward induction. Since the agents have rational expectations, the intrinsic time 0 value of a firm conditional on going public is equal to V_p^q given by:

$$\begin{aligned} V_p^L =& \omega[(1-\eta)\rho V(p_E) + \eta(\alpha_E^{'}(V_e^1 - I) \\ &+ (1-\alpha_E^{'})V(\phi_L))] + (1-\omega)[\alpha_E^{'}(V_n^1 - I) + (1-\alpha_E^{'})V(\psi_L)], \end{aligned} \tag{A38}$$

$$\begin{aligned} V_p^H =& \omega[\alpha_E^{'}(V_e^1 - I) + (1-\alpha_E^{'})V(\phi_H)] \\ &+ (1-\omega)[\alpha_E^{'}(V_n^1 - I) + (1-\alpha_E^{'})V(\psi_H)]. \end{aligned} \tag{A39}$$

Thus, the objective function of the type L entrepreneur at time 0 becomes:

$$\begin{aligned} \max_{a\in\{0,1\}} a \cdot [&\delta_E(\alpha_E(V_p^E - I) + (1-\alpha_E)(I + V_p^L)(1 - \frac{I}{V_p^E})) \\ &+ B(k + ((1-\omega) + \omega\eta)(1-k))] + (1-a)\cdot\delta_E\rho V_A, \end{aligned} \tag{A40}$$

since, in equilibrium, with probability $\omega(1-\eta)$ the firm will be acquired at time 1 if it goes public at

time 0. Outside investors update their beliefs by Bayes' rule and their IPO valuation V_p^E of the firm is given by:

$$V_p^E = I + \frac{(1-\theta)\beta_p}{(1-\theta)\beta_p + \theta} V_p^L + \frac{\theta}{(1-\theta)\beta_p + \theta} V_p^H. \tag{A41}$$

From the type L entrepreneur's indifference condition (23), the equilibrium IPO valuation is now given by:

$$\begin{aligned} Z_p = [&Q_p + \alpha_E V_p^L - (1-2\alpha_E)I \\ &+ [(Q_p + \alpha_E V_p^L - (1-2\alpha_E)I)^2 + 4\alpha_E(1-\alpha_E)I(I+V_p^L)]^{1/2}]/(2\alpha_E). \end{aligned} \tag{A42}$$

The probability of going public at time 0 for the type L firm is then given by:

$$\beta_p = \frac{\theta(I + V_p^H - Z_p)}{(1-\theta)(Z_p - (I + V_p^L))}. \tag{A43}$$

■

Proof of Proposition 7. We first prove part (ii). A strategic acquirer will acquire the private firm at time $t = 0$ for $I + \rho V(p_s) = I + \rho(p_s V_S + (1-p_s)V_F)$. Thus, the entrepreneur's payoff will be $\delta_E \rho V(p_s)$, whereas his expected payoff with a financial acquirer will be equal to $\delta_E \rho V(p_f) + b = \delta_E \rho(p_f V_S + (1-p_f)V_F) + b$. A type H or type L firm's entrepreneur will therefore sell the firm to a financial acquirer iff the following condition holds:

$$\delta_E \rho V(p_f) + b > \delta_E \rho V(p_s), \tag{A44}$$

which is equivalent to the restriction

$$(p_s - p_f) < \frac{b}{\rho\delta_E(V_S - V_F)}. \tag{A45}$$

Part (i) of the proposition is proved by focusing on the choice between the type of acquisition chosen above and an IPO. If the entrepreneur prefers a strategic acquisition, the expected payoff from an acquisition at time 0 is equal to $\delta_E\rho V(p_s)$. Then, under a strategic acquirer, the IPO value of the firm is equal to Z_s from (A3) and the probability of the type L firm going public is given by β_s from (A4). If, however, a financial acquirer is preferred, the following indifference condition holds for the entrepreneur of a type L firm, in equilibrium, at time 0:

$$\delta_E(\rho V(p_f) - V_L) + b = \delta_E(\alpha_E + (1-\alpha_E)\frac{I}{Z_f})(Z_f - V_L - I) + B. \tag{A46}$$

The probability β_f of a type L firm's entrepreneur going public is then given by:

$$\beta_f = \frac{\theta(I + V_H - Z_f)}{(1-\theta)(Z_f - (I + V_L))}, \tag{A47}$$

where, from (A46), the equilibrium IPO value Z_f of the firm is given by:

$$Z_f = \frac{Q_f + \alpha_E V_L - (1-2\alpha_E)I + \sqrt{(Q_f + \alpha_E V_L - (1-2\alpha_E)I)^2 + 4\alpha_E(1-\alpha_E)I(I+V_L)}}{2\alpha_E}, \tag{A48}$$

where $Q_f \equiv \rho V(p_f) - V_L - \frac{B-b}{\delta_E}$. This completes the proof of part (i). Since $p_s > p_f$, we have $I + \rho V(p_s) > I + \rho V(p_f)$, so that part (iii) is proved. ■