Product Market Competition, IPOs versus Acquisitions, and the Valuation Premium Puzzle: A Theoretical Analysis

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Abstract

We develop a theoretical analysis of a private firm's choice of exit mechanism between IPOs and acquisitions. We consider an entrepreneur managing a private firm backed by a venture capitalist. The entrepreneur and venture capitalist desire to exit partially from the firm, motivated either by the desire to satisfy their liquidity demands or to raise external financing for the firm (or both). 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 tend for itself after going public, an acquirer is 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. Further, unlike atomistic investors in the IPO market who are at an informational disadvantage with respect to firm insiders, potential acquirers are able to value the firm correctly by virtue of their industry expertise. On the negative side, acquirers have considerable bargaining power with respect to the entrepreneur, which allows them to extract some of the firm's net present value from insiders, unlike investors in the competitive IPO market. Finally, while the entrepreneur is able to maintain his private benefits from control even after his firm goes public, he is likely to lose these after an acquisition. In this setting, we derive a number of testable implications regarding a firm's equilibrium choice between IPOs and acquisitions. Our theoretical analysis is able to explain the "IPO valuation premium puzzle": i.e., the empirical finding that many firms that are able to obtain higher valuations in the IPO market nevertheless choose to be acquired.

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1 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 (2005)), 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 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

[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 eight of the last ten years. The NVCA reports that acquisitions constituted 76% of the value of exits of venture backed firms in 2006: while acquisitions of venture backed firms accounted for $16.6 billion in value, IPOs of venture backed firms accounted for only $5.3 billion.

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.

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: why would an entrepreneur choose to do an acquisition if he could exit with a much higher payoff through

[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..."

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 the above two alternatives. We can think of three 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, the other extreme case, where the venture capitalist is so powerful that, while the entrepreneur manages the firm, the exit choice is made by the venture capitalist ("VC controlled firm"); third, a scenario midway between the above two extremes, 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 an exit choice made by the former.[6] Since most real world situations are close to either the entrepreneur

[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 if these agents do not sell more equity than is required to satisfy their liquidity demand. 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] 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, lie somewhere on a continuum between the entrepreneur controlled and VC controlled firms in our model: whether such firms are closer to being entrepreneur controlled or VC 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. 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 Automatic

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.[7]

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 tend 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 about the viability of alternative business models in the product market.[10] On

Conversion provision of the term sheet. The automatic conversion provision reads something like: "The Series [A] Preferred shall be automatically converted into Common Stock, at the then applicable conversion price, (i) in the event that the holders of at least two thirds of the outstanding Series A Preferred consent to such conversion or (ii) upon the closing of a firmly underwritten public offering of shares of Common Stock of the Company at a per share price not less than x times the Original Purchase Price per share and for a total offering with net proceeds to the Company of not less than $y million (a "Qualified IPO")." Note that 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," determine the stringency of this provision: the larger the numbers x and y, the greater the venture capitalist's power over the exit decision.

[7]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.

[8]Practitioner discussions of IPOs versus acquisitions often refer to such synergies. See, e.g., "The acquisition game" (Austin Business Journal, February 18, 2000): "Never has so much money been available to companies like ours in my 20 years of being an entrepreneur...From VCs, to IPOs, secondary offerings, private placements – there's so much money available out there that it's very tempting to focus on the money. But if you find the right partner, you get so much more than money. You get brand marketing, promotion, customer service architecture – you get an array of sources." Two examples of private firms which got "more than money" from an acquisition cited in this story was Schwab's acquisition of CyBerCorp and Lucent's acquisition of Agere: "In the case of CyBerCorp – an online brokerage business – partnering with Schwab gave the company 6.6 million retail brokerage accounts, access to the institutional market and international ties, almost overnight." 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 eventually decided to be acquired by Cisco Systems. To quote the Stanford Business School Case on Cerent (Sigg (2000)): "If there was one company in particular that Russo didn't want to have battle in the marketplace, it was Cisco. Cisco could be a formidable competitor and Russo much preferred to have them as an ally." 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."). A third example is Netscape, which went public but whose web browser could not subsequently succeed in product market competition against Microsoft's "Internet Explorer" web browser (and whose insiders might therefore have been better off being acquired by Microsoft instead of going public). Netscape underwent a post-IPO acquisition by America Online (AOL), but the acquisition came too late to benefit the firm in the product market much: Netscape is a classic example of the cost of waiting to be acquired post-IPO.

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

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, but can maintain to a substantial extent in the event of an IPO.[11]

An interesting aspect of one 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 shorter 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 shorter term investor, may be less affected by such concerns.

Our analysis generates a number of testable predictions 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 choose to be acquired. Second, the choice between IPOs and acquisitions will depend on the nature of the industry the firm is operating in: while the likelihood of IPOs relative

[11] 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."

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 than being acquired will depend on the extent of information asymmetry in the IPO 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 type), 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; further, a larger proportion of firms going public do so during periods of high market valuations. 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, 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.

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 equally or 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.[12] Seventh, we develop predictions about the characteristics of firms likely to undergo post-IPO acquisitions or post-acquisition IPOs: while, given the additional costs involved, such double exits are puzzling, they emerge as equilibrium behavior in our setting. Finally, we develop predictions for a firm's choice between strategic and financial acquirers (given that it has decided to be acquired).

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 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 6 present the equilibria of our extended models. Section 7 describes the testable predictions of our model. Section 8 concludes.

2 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 tradeoffs we analyze here, are however, completely different: our focus here is on firms that have decided that they want to have access to the public equity market, but are deciding on whether to obtain such access by going public or by being acquired by a publicly traded firm.

[12]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 equally or less likely to go public (i.e., equally or more likely to be acquired), since the venture capitalist makes his exit decisions purely on financial considerations, unlike an entrepreneur.

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 (2008), 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 (2008) 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 (Brau, Francis, and Kohers (2003), and Poulsen and Stegemoller (2008)). Another closely related empirical literature focuses on the exit decisions of only venture backed firms: e.g., Cumming (2008) and Nahata (2003).

3 The Model

The model consists of two dates. 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.[13] 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

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

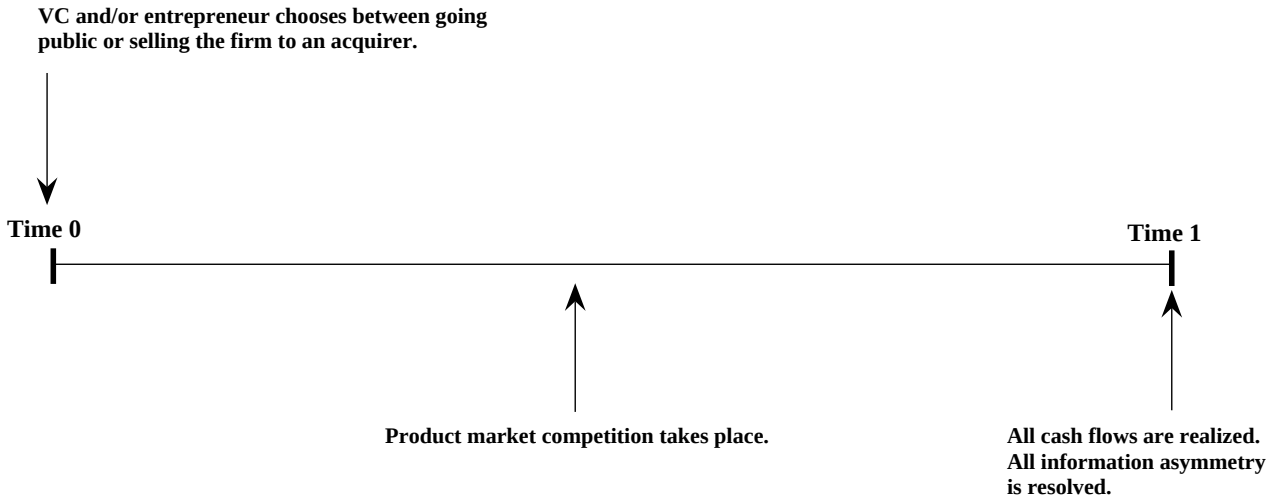

Figure 1: Sequence of Events in the Basic Model

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 incumbent firms in the product market.[14] 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 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 $0 < V_F < V_S$ and the risk-free rate of return is zero.

[14] We assume in the basic model that competition takes place with probability 1. In an extension to the basic model we will assume that the probability of entry by competition is $\omega < 1$ and allow for post-IPO acquisitions.

3.1 The Entrepreneur

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 as a stand-alone company against the competition in the product markets with probability p_H. A low type (L) firm has also 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 keeps a fraction of δ_E of the initial shares outstanding in the firm, derives private benefits of control which we denote by B. If the firm is acquired at time 0, the entrepreneur will be fired from the firm's management and will forfeit his private benefits. 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 equity to outsiders) and sum of the expected value of his time 1 cash flow and the value of the private benefits of control accruing to him.

3.2 The Venture Capitalist

The venture capitalist initially owns a fraction δ_V of the firm. He 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 out the firm to an acquirer at time 0 will be made by him rather than the venture capitalist.[15] Later, we also analyze the case where the firm is controlled by the venture capitalist ($\delta_V >> \delta_E$) and also the case where neither the VC nor the entrepreneur has the absolute control right as to who is going to make the exit decision, but one of the parties can make side payments to the other, thus convincing 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 is taken public and new equity is raised, we assume that the VC will sell a fraction of α_V of his remaining shares 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 equity to outsiders)

[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.

[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.

and the expected value of his time 1 cash flow.

3.3 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 private 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 high and low type firms, acquisition adds value in the sense that the acquirer helps the target firm in the product market and the probability of success in competition with incumbent firms is increased 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. Clearly, the expected time 1 cash flow of a type H or type L firm after an acquisition is given by $I + p_A V_S + (1 - p_A)V_F$.

3.4 The IPO Market

If firm insiders (the entrepreneur and/or the VC) decide to take the firm public, they issue new equity worth I and sell a certain fraction of their initial share holdings at the price V_{ipo} in a competitive IPO market which consists of numerous competitive outside investors. Upon issuing new equity, a fraction γ of shares is sold to new shareholders. Furthermore, the entrepreneur and the VC 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 to satisfy their respective liquidity demands. The number of outstanding shares in the firm is normalized to 1 and 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 V_{ipo} depends on the equilibrium strategies of the two types of firms and the outside investors' prior probability assessment about the firm type q. As discussed before, outside investors in the IPO market have less information than entrepreneurs and

[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 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 expertise of the acquiring firm's management in the industry common to it and the target firm.

venture capitalists about the true quality or type of the firm approaching them for capital. The prior probability assessment of outside investors in the IPO market about firm type is as follows:

$$\Pr(q = H) = \theta, \quad \Pr(q = L) = (1 - \theta). \tag{2}$$

The prior probability assessment of outside investors about firm type reflects the IPO market conditions prevailing at time 0. Intuitively, if the IPO market conditions are more favorable, the unconditional probability assessment θ of outsiders that a firm is of type H will be high. On the other hand, if the state of the new issues market is unfavorable, outsiders will assess a low value of θ.

4 Equilibrium

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 (the venture capitalist) at time 0 between going public and selling out to an acquiring firm; (ii) a decision by the investors about whether to bid in the IPO at the price V_{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 made by 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 choices 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 the equilibrium.

We can think of three kinds of equilibria depending on which party, the entrepreneur or the VC, is making the exit decision of the private firm: (1) equilibrium in an entrepreneur-controlled firm, (2) equilibrium in a VC-controlled firm, (3) equilibrium in a jointly controlled firm. 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, and the VC essentially goes along with the entrepreneur's decision. Conversely, we define a VC controlled firm as the other extreme, where the VC makes the

exit choice, and the entrepreneur essentially goes along with the VC's decision. Finally, 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, thus inducing him to converge with the exit decision made by him. Due to space limitations, we will focus only on entrepreneur controlled and jointly controlled firms; similar results on VC controlled firms are available to interested readers from the authors.[18]

Within each category of equilibrium above, we 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 (goes public with probability β); (ii) both firm types 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 proved that other categories of 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) are only special cases of equilibria of category (i). Therefore, we will focus here only on the equilibria of category (i), since it is the most interesting and economically relevant one that fleshes out the details of the trade-offs driving firms' exit choice between IPOs and acquisitions. We therefore characterize the conditions for the existence of such equilibria and obtain comparative statics results.[19]

4.1 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

[18] Real world examples of entrepreneur controlled firms are firms which are not venture backed. In practice, most venture backed firms may approximate jointly controlled firms in our model, though they may tend toward VC controlled as the fraction of equity held by the VC and his other control rights (e.g., representation on the firm's board, and other provisions in the venture capital contract) become significantly large compared to those of the entrepreneur.

[19] Proofs of nonexistence for 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.

to time the market and benefit from a high IPO price, denoted by V_{ipo}^E, by selling a fraction of shares α_E, out of his remaining equity holdings $\delta_E(1-\gamma)$ after the firm issues new shares in the IPO, in order to satisfy his liquidity demand at time 0.[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

$$V_q = V(p_q) = p_q V_S + (1-p_q)V_F, \tag{3}$$

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 both type H and type L firms 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, $a = 1$, the IPO valuation of the firm denoted by V_{ipo}^E will be determined according to the updated beliefs of outside investors in the equilibrium by using Bayes' rule:

$$V_{ipo}^E = I + \Pr(q = H \mid a = 1)V_H + \Pr(q = L \mid a = 1)V_L. \tag{4}$$

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 $V_{ipo}^E \gamma = I$. If the entrepreneur decides to sell out the firm to an acquiring firm, a = 0, the acquiring firm will invest I for the project and pay the private firm insiders only a fraction ρ of the net present value V_A of the firm. Thus, 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 $q \in \{H, L\}$:

$$\max_{a \in \{0,1\}} a \cdot [\delta_E(1-\gamma)(\alpha_E V_{ipo}^E + (1-\alpha_E)(I + V_q)) + B] + (1-a) \cdot \delta_E \rho V_A \ , \tag{5}$$

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

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:

$$V_A - V_q = (p_A - p_q)(V_S - V_F) \quad \text{for } q \in \{H, L\}. \tag{6}$$

However, since the acquirer has bargaining power, the entrepreneur and the venture capitalist of a type H or type L firm do not get the full share of the synergy gain from an acquisition. They are offered only a fraction ρ of the intrinsic net present value V_A and the long-run benefit of an acquisition accruing to the insiders of the private target firm is equal to D_q which is defined as:[21]

$$D_q \equiv \rho V_A - V_q \quad \text{for } q \in \{H, L\}. \tag{7}$$

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

$$Q \equiv D_L - \frac{B}{\delta_E}. \tag{8}$$

One can think of $\delta_E Q$ 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 D_L is the improvement in the long term fundamental value of the firm after an acquisition, 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 Q is positive. If we rewrite the type L entrepreneur's objective function as follows:

$$\max_{a \in \{0,1\}} a \cdot \delta_E(\alpha_E + (1 - \alpha_E)\frac{I}{V_{ipo}^E})(V_{ipo}^E - V_L - I) + (1 - a) \cdot (\delta_E(\rho V_A - V_L) - B), \tag{9}$$

then, it is obvious that the type L entrepreneur will make his choice by comparing the value premium

[21] The intrinsic value of a type q public firm is the expected value of time 1 project cash flows which is given by V_q in (3).

paid by the acquiring firm given by $\delta_E Q = \delta_E(\rho V_A - V_L) - B$ from (8) and the premium $\delta_E \breve{\alpha}_E(V_{ipo}^E - V_L - I)$ paid by the IPO investors at time 0 where $\breve{\alpha}_E \equiv \alpha_E + (1-\alpha_E)\frac{I}{V_{ipo}^E}$ is the effective fraction of shares sold by the entrepreneur. If the IPO market conditions are more favorable (θ is relatively high), an IPO may be a more advantageous exit route from the type L entrepreneur's perspective because due to the presence of asymmetric information between firm insiders and outside investors, type L firms will be temporarily overvalued in the IPO market at time 0 and the firm's equity will be priced in a competitive IPO market where outside investors have almost 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 control benefits after an acquisition.

If the firm goes public, the insiders' ownership of the firm is diluted because the firm issues new equity worth I to finance its investment project. However, new equity issued by type L firms is overvalued and the higher is the investment I at time 0, the greater will be the value of the firm.[22] From the expression for $\breve{\alpha}_E$ one should also note that the greater the fraction $\gamma = \frac{I}{V_{ipo}^E}$ of newly issued shares in an IPO, a larger portion of the total IPO overvaluation ($V_{ipo} - V_L - I$) of a type L firm accrues to the entrepreneur since he is effectively selling a larger fraction of shares in the secondary offering.[23]

Thus, the main ingredients of the trade-off facing an entrepreneur are as follows: the differential between the IPO price V_{ipo}^E and the intrinsic value of the stand-alone firm going public V_q, the investment capital I raised for the firm's project, the fraction α_E of shares sold by the entrepreneur in the IPO to satify his liquidity demand, the private benefits of control B the entrepreneur would enjoy after an IPO, the long term competitive advantage from acquisition $V_A - V_q$, and the fraction of the firm's project's NPV extracted by the acquiring firm, $1 - \rho$.

4.2 Analysis of the Venture Capitalist's Problem

The wedge between the objectives of the entrepreneur and the VC comes from two sources: 1) the VC does not enjoy private benefits of control after the IPO and 2) the liquidity demands α_E and α_V

[22] Note that because of the partial pooling of type H and type L firms we have $I + V_L < V_{ipo}^E < I + V_H$. See also Proposition 3.

[23] Later in proposition 3 we show that the endogenous variables γ and V_{ipo}^E both increase as a result of an exogenous increase in the investment level I.

of the entrepreneur and the VC could be different in an IPO. If the VC has the control of the private firm, he solves the following maximization problem for a given firm type $q \in \{H, L\}$:

$$\max_{a\in\{0,1\}} a \cdot \delta_V(\alpha_V(V_{ipo}^V - I) + (1-\alpha_V)(V_q + I)(1 - \frac{I}{V_{ipo}^V})) + (1-a) \cdot \delta_V \rho V_A, \tag{10}$$

where a denotes the exit choice; $a \in \{0, 1\}$ according as the firm goes public or accepts the acquisition offer respectively. We can rewrite the VC's objective function as follows:

$$\max_{a\in\{0,1\}} a \cdot \delta_V(\alpha_V + (1-\alpha_V)\frac{I}{V_{ipo}^V})(V_{ipo}^V - V_q - I) + (1-a) \cdot \delta_V(\rho V_A - V_q). \tag{11}$$

From (11), it is clear that the VC will make his decision by comparing the premium $D_q = \rho V_A - V_q$ paid by the acquiring firm at time 0 and the overvaluation premium $\breve{\alpha}_V(V_{ipo}^V - V_q - I)$ paid by the IPO investors where $\breve{\alpha}_V \equiv \alpha_V + (1-\alpha_V)\frac{I}{V_{ipo}^V}$ can be interpreted as the effective fraction of shares sold by the VC. Similar to the entrepreneur's problem, the trade-off the VC is facing depends on: the differential between the IPO price V_{ipo}^V and the intrinsic value of the stand-alone firm going public V_q, the investment capital I raised for the firm's project, the fraction of shares sold α_V in the IPO, the long term competitive advantage from the acquisition $V_A - V_q$ and the acquiring firm's discount ρ.

4.3 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.

Proposition 1 *(**Choice between IPO and Acquisition in an Entrepreneur Controlled Firm**) If $\theta V_H + (1-\theta)V_L < Z_E - I < V_H$, then:*

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

$$\beta_E = \frac{\theta(I + V_H - Z_E)}{(1-\theta)(Z_E - (I + V_L))}, \tag{12}$$

or chooses an acquisition with probability $(1 - \beta_E)$.

(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

$$\alpha_V > \hat{\alpha}_V \equiv \alpha_E + \frac{B}{\delta_E(Z_E - I - V_L)(1 - \frac{I}{Z_E})}. \tag{13}$$

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

The intuition behind the existence of the above equilibrium is clear from the preceding discussion. The type L firm's entrepreneur is indifferent between the pure strategy choices he can make. Because of partial pooling between the two types of firms, the IPO price V_{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 $V_{ipo}^E > I + V_L$. Thus, even though the type L firm is temporarily overvalued 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 because 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 indifference condition holds:[24]

$$Q = \breve{\alpha}_E(V_{ipo}^E - V_L - I), \tag{14}$$

where Q was defined in (8). The IPO price V_{ipo}^E which makes the type L entrepreneur indifferent between an IPO and an acquisition is denoted by Z_E and it is found by solving the indifference equation (14).[25] In equilibrium, outside investors' beliefs in the IPO market about the firm types are updated using Bayes' rule as follows:

$$\Pr(q = H \mid a = 1) = \frac{\theta}{(1-\theta)\beta_E + \theta}; \tag{15}$$

$$\Pr(q = L \mid a = 1) = \frac{(1-\theta)\beta_E}{(1-\theta)\beta_E + \theta}. \tag{16}$$

[24] 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.

[25] The indifference equation (14) is quadratic in the IPO price V_{ipo}^E and has therefore two roots. We choose the larger positive root because the higher the IPO price, the smaller will be the dilution of the old shareholders. See the Appendix for the closed-form solution of the IPO price, Z_E, which solves this indifference equation.

Then, from (4) it follows that in the IPO market a firm going public will be valued at the price

$$V_{ipo}^{E} = I + \frac{(1-\theta)\beta_E(1-p_L) + \theta(1-p_H)}{(1-\theta)\beta_E + \theta} V_F + \frac{\beta_E(1-\theta)p_L + \theta p_H}{(1-\theta)\beta_E + \theta} V_S. \tag{17}$$

Since the type L firm is temporarily overvalued in the IPO market, the IPO price V_{ipo}^{E} will be decreasing in the equilibrium 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. We substitute the closed-form solution for the IPO price, Z_E, into (17) to solve for the equilibrium probability β_E of the type L firm going public. The acquisition value P_{acq} of a type H or 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 an acquisition from the product market competition between time 0 and time 1 is relatively smaller for a type H 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:

$$\delta_E(V_H - \rho V_A) + B > \delta_E \breve{\alpha}_E(I + V_H - V_{ipo}^{E}). \tag{18}$$

In other words, even though the IPO price V_{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, since the acquiring firm can help the type H firm in the product market competition between time 0 and time 1 only to a lesser extent than it can help the type L firm so that the benefits of an IPO over an acquisition discussed before (namely, the fact that equity is priced competitively in the IPO market while the acquirer will extract a fraction $(1-\rho)$ of project NPV, and the fact that the entrepreneur will continue to enjoy control benefits after an IPO but will lose them after an acquisition) always dominate for a type H firm.

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 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 (10). By partially pooling with type H firms when going public, a type L firm's VC also gains from a temporary 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 VC would agree with this decision only if the IPO price V_{ipo}^E is higher than the acquisition price P_{acq} because unlike the entrepreneur, he 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 temporarily 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 ($D_L > 0$), the type L firm's VC would prefer an IPO over an acquisition only if he could sell enough of his shares α_V out of the fraction of shares $\delta_V(1-\gamma)$ he retains after the IPO, such that the profit from selling equity at time 0 exceeds the long term benefit D_L of the acquisition arising from product market competition between time 0 and time 1. By the same reasoning, the type L firm's VC would agree with the decision of a type L firm's entrepreneur to sell out the firm to an acquiring firm only if the fraction of shares sold in the IPO is less than $\hat{\alpha}_V$.[26] Since the long term benefit of an acquisition is relatively small for a type H firm, the VC of a type H firm always agrees with the entrepreneur's decision to take his firm public.

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 difference $p_A - p_L$; (d) increasing in the 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

[26] 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 $V_{ipo}^E > P_{acq}$.

in various parameter values. Result (a) follows from the fact that the entrepreneur does not get any control benefits after an acquisition. 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 difference $p_A - p_L$ increases, the gain from an acquisition in the target firm's product market competition between time 0 and time 1 increases, which yields us the result (c). If the prior probability assessment θ of outside investors that the firm is of type H is higher, than the type L 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 would sold by the entrepreneur 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 entrepreneur's incentive to issue overvalued equity in the IPO market increases 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:

$$\delta_E(1-\alpha_E)(\rho V_A - V_L) > B(1 + \frac{I}{\rho V_A}). \tag{19}$$

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

(ii) The equilibrium IPO price V_{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 difference $p_A - p_L$.

The intuition behind part (i) is as follows. First, an acquisition adds value to a type L firm, thereby increasing its intrinsic value if it is acquired compared to 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 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 (19) 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. 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. The total market value of the firm will increase with the investment requirement I, which 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 pool with type H firms in the IPO market to a lesser extent, which yields the result (e).

4.4 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 his 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* $\theta V_H + (1-\theta)V_L < Z_E - I < V_H$ *and* $\theta V_H + (1-\theta)V_L < Z_V - I < V_H$*. Then:*

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

(ii) ***The type L firm:*** *The entrepreneur takes the firm public with probability* $\hat{\beta}_E$ *given by*

$$\hat{\beta}_E = \frac{\theta(I + V_H - Z_J)}{(1-\theta)(Z_J - (I + V_L))}, \tag{20}$$

or chooses an acquisition with probability $(1-\hat{\beta}_E)$*. If the fraction of shares* α_V *sold by the VC is less than* $\hat{\alpha}_V$*, he makes a transfer* T_1 *given by* (22) *to the VC before going public. If* $\alpha_V > \hat{\alpha}_V$*, he makes a transfer* T_2 *given by* (25) *to the VC before an acquisition.*[27] *In each case, the VC chooses not to veto the entrepreneur's decision in return for the wealth transfer provided to him.*

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. In the entrepreneur controlled firm's equilibrium characterized in Proposition 1, if α_V is less than the threshold $\hat{\alpha}_V$, the VC of the type L firm agrees with the type L entrepreneur, if he chooses an acquisition, but disagrees with him if he decides to go public. In a jointly controlled firm, the VC has the contractual right to veto the entrepreneur's decision, so that the entrepreneur needs to compensate the VC, in case he decides to go public, by making some side payments. Given the need to make such payments to the VC, an entrepreneur running a jointly controlled firm will go public less often in equilibrium compared to the case of an entrepreneur running a firm where he is totally in control (i.e., where the VC has no veto rights on the entrepreneur's exit decision (Proposition 1)).

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. Expecting that he has to make a transfer $T_1 > 0$ to the VC in case the firm goes public, the type L entrepreneur has now the following indifference condition:

$$\delta_E \rho V_A = \delta_E(\alpha_E + (1-\alpha_E)\frac{I}{\hat{V}^E_{ipo}})(\hat{V}^E_{ipo} - V_L - I) + \delta_E V_L + B - T_1. \tag{21}$$

Since the VC prefers an acquisition by another firm in the absence of any transfer from the entrepreneur, the transfer T_1 will compensate him to be just indifferent between the two possible exit choices:

$$\delta_V \rho V_A = \delta_V(\alpha_V + (1-\alpha_V)\frac{I}{\hat{V}^E_{ipo}})(\hat{V}^E_{ipo} - V_L - I) + \delta_V V_L + T_1. \tag{22}$$

[27] In practice, such transfers from the entrepreneur to the VC may be made by adjusting the conversion provisions of the VC's privately held shares to the post-IPO (publicly traded) shares of the firm (in the case of an IPO) such that the VC's equity fraction increases at the expense of that of the entrepreneur. Similarly, in the case the firm is acquired, such transfers may be made by assuming that a large fraction of the acquisition price paid by the acquirer is allocated to the VC at the expense of the entrepreneur.

Substituting T_1 from (22) in (21) we obtain the following relationship that must hold in the equilibrium of a jointly controlled firm:

$$(\delta_E\alpha_E + \delta_V\alpha_V + (\delta_E(1-\alpha_E) + \delta_V(1-\alpha_V))\frac{I}{\hat{V}^E_{ipo}})(\hat{V}^E_{ipo} - V_L - I) + B = (\delta_E + \delta_V)(\rho V_A - V_L). \quad (23)$$

This relationship indicates, that in equilibrium, the sum of the total premium paid at time 0 by the IPO investors to the insiders of the firm and the private benefits B of the entrepreneur is equal to the time 0 expected value added by the acquiring firm in the product market competition between time 0 and time 1. Solving equations (23), (17) and (22) we obtain the equilibrium IPO price $\hat{V}^E_{ipo}(Z_J)$, the equilibrium probability $\hat{\beta}_E$ of the type L firm going public, and the equilibrium transfer T_1.

On the other hand, suppose that the fraction of shares α_V sold by the VC is higher than the threshold value of $\hat{\alpha}_V$. In this case, in the equilibrium of an entrepreneur controlled firm (Proposition 1), the VC of the type L firm disagrees with the decision of the type L entrepreneur to choose an acquisition as the exit choice (which he makes with probability $(1-\beta_E)$) and agrees with his choice to take the firm public (which he makes with probability β_E). Similar to the case above, if the VC disagrees with the entrepreneur's choice of acquisition and has the right to veto an exit decision, the entrepreneur has to compensate the VC with a side payment T_2 in the case of an acquisition. Then, by analogy to the previous case, the entrepreneur is indifferent between going public and being acquired if the following condition holds:

$$\delta_E\rho V_A - T_2 = \delta_E(\alpha_E + (1-\alpha_E)\frac{I}{\hat{V}^E_{ipo}})(\hat{V}^E_{ipo} - V_L - I) + \delta_E V_L + B. \quad (24)$$

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:

$$\delta_V\rho V_A + T_2 = \delta_V(\alpha_V + (1-\alpha_V)\frac{I}{\hat{V}^E_{ipo}})(\hat{V}^E_{ipo} - V_L - I) + \delta_V V_L. \quad (25)$$

Substituting T_2 from (25) in (24) gives the same equilibrium condition as in (23). Therefore, the equilibrium IPO price $\hat{V}^E_{ipo}$, the equilibrium probability $\hat{\beta}_E$ of the type L firm going public will be the same as in the case where α_V is less than the threshold $\hat{\alpha}_V$. The equilibrium transfer T_2 can then be

solved from (25).

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 that of a VC controlled firm. Thus, in the equilibrium characterized in Proposition 1, we show that if the fraction of shares α_V is greater than the threshold $\hat{\alpha}_V$, the VC of a type L firm will disagree with the entrepreneur if he chooses an acquisition over an IPO. In this situation, the above proposition shows that because the disagreement will be resolved by compensating the VC with a side payment when the VC has veto rights, the type L 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 $\hat{V}^E_{ipo}$ of a jointly controlled firm will be lower than that (V^E_{ipo}) 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.[28]

[28]We can also assume that the VC is initially in control of the firm and that the entrepreneur could veto the exit decision of the VC in case it is not in the entrepreneur's best interest (i.e., the VC controlled firm). In this case, the VC will need to compensate the entrepreneur in case of a disagreement by making side payments in order to make him indifferent between an IPO and an acquisition. For brevity, we omit the analysis and the proofs of this case because the results obtained are a mirror image of the results of the case where the entrepreneur is initially in control and makes side payments to the VC in order to prevent him from vetoing the firm's exit choice. In this situation, $\hat{\beta}_V$ and $\hat{V}^V_{ipo}$ denote the probability of a type L firm going public and the IPO value of the firm respectively. A comparison of the equilibrium in the VC controlled firm with the equilibria in the entrepreneur controlled firm (proposition 1) and the jointly controlled firm (proposition 4) shows that once we allow the VC or the entrepreneur to veto the decision of the other party, the resulting equilibrium via bargaining is independent of which party has initially the control right to choose the exit route at time 0 and at the end the total surplus of the entrepreneur and the VC is maximized. In fact, it turns out that the IPO valuation of the firm and the probability of a type L firm going public are the same in both cases regardless of who is initially in control of the firm. If the fraction α_V of shares sold by the VC is less than $\hat{\alpha}_V$, or equivalently $\alpha_E > \hat{\alpha}_E$, then

Similarly, we showed in Proposition 1 that if the fraction of shares α_V sold by the VC is lower than the threshold $\hat{\alpha}_V$, the VC of a type L firm will disagree with the entrepreneur's exit choice to go public.[29] In this situation, the above proposition shows that, since the disagreement will be resolved by compensating the VC with a side payment when the VC has veto rights, the type L entrepreneur will go public with a lower probability in a jointly controlled firm than he does in an entrepreneur controlled firm. Therefore, in this case, the IPO price $\hat{V}^E_{ipo}$ of a jointly controlled firm will be higher than that of an entrepreneur controlled firm (V^E_{ipo}) since type L firms will pool with type H firms to a lesser extent in the IPO market.

5 Post-IPO Acquisitions

As an extension to the basic model, in this section we model the possibility of an acquisition after the 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.[30] 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

the entrepreneur controlled type L firm's probability of going public β_E is greater than the probability of going public of the jointly controlled type L firm, which is in turn greater than the IPO probability β_V of a purely VC controlled firm. The opposite relationship holds if α_V is greater than $\hat{\alpha}_V$. One can also verify that the common equilibrium IPO value $\hat{V}_{ipo}$ of the firm will be greater than the acquisition price P_{acq} unless the private benefits B of the entrepreneur are too large.

[29] 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 V^E_{ipo} and a lower overvaluation premium ($V^E_{ipo} - I - V_L$) 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. If B is very large, $\hat{\alpha}_V = \alpha_E + \frac{B}{\delta_E(Z_E - I - V_L)(1 - \frac{I}{Z_E})}$ can be even greater than 1, in which case the VC would favor an acquisition over an IPO for any $\alpha_V < 1$.

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

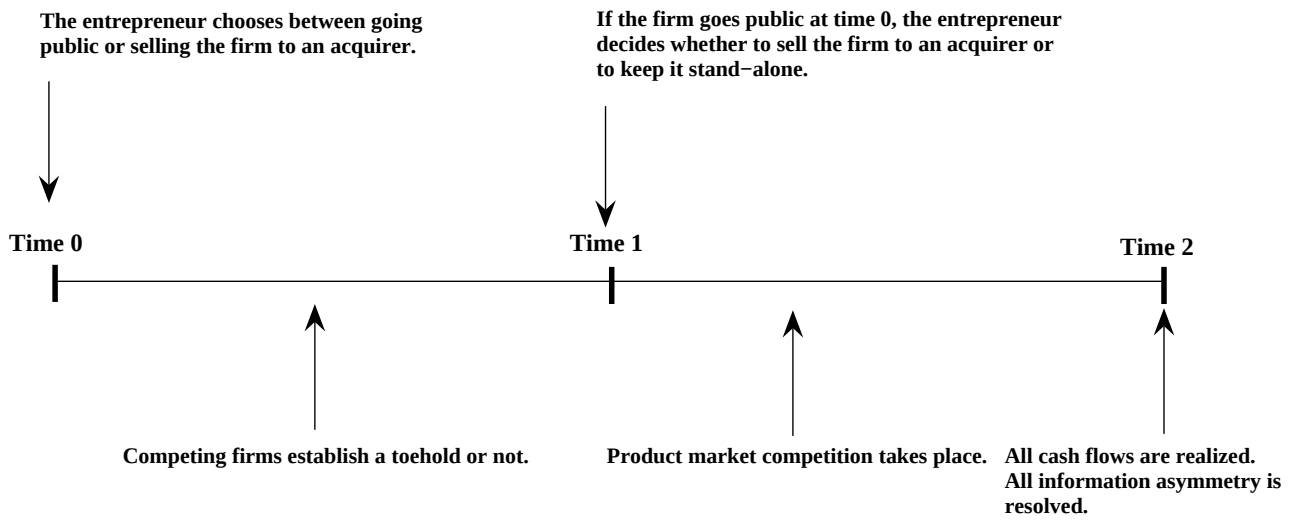

Figure 2: Sequence of Events in the Extended Model

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 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.[31] We denote the event that

[31]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 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 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

the product market, so that Netscape's probability of success in the product market competition was not significantly enhanced by the AOL acquisition.

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* $\alpha_2\theta\psi_H + (1 - \alpha_2\theta)\psi_L < \bar{\psi}$*, 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* (A41) *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* (A35) *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:

$$\hat{\theta} \equiv \Pr(q = H \mid a = 1) = \frac{\theta}{(1 - \theta)\beta_p + \theta}. \tag{26}$$

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:

$$V_n^1 = I + (1 - \hat{\theta})V(\psi_L) + \hat{\theta}V(\psi_H). \tag{27}$$

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 :

$$V_e^1 = I + V(\phi_L) + \frac{\rho V(p_E) - V(\phi_L) - \frac{(1-k)B}{\delta_E(1-\gamma)(1-\alpha_E)}}{\alpha_E^{'}}. \tag{28}$$

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:

$$\delta_E(\rho V_A - V_p^L) = \delta_E(\alpha_E + (1 - \alpha_E)\frac{I}{V_p^E})(V_p^E - V_p^L - I) + B(k + ((1 - \omega) + \omega\eta)(1 - k)). \tag{29}$$

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

$$Q_p \equiv (\rho V_A - V_L^p) - B(k + ((1-\omega) + \omega\eta)(1-k))/\delta_E, \tag{30}$$

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.

6 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.

7 Implications and Testable Hypotheses

Our model has several testable 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 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.[32] Propositions 1 and 4 of our model predict that, on average, more established firms with business models already viable against product market competition are more likely to go public through an IPO rather than be acquired. Note that in our model, higher quality (type H) firms go public with probability 1, whereas less viable (type L) firms play a mixed strategy.

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.

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. Those control benefits will be retained after an IPO, but they will be lost after an acquisition.

Fourth, in our model, potential acquirers have industry and product market expertise and can value the private firm better than IPO market investors. Thus, an acquisition is costly in the sense that private firm insiders have no information advantage against acquiring firms. Hence, type L firms will be correctly valued in an acquisition. In contrast, given that IPO market investors have less information than firm insiders, type L firms can get potentially higher valuations in the IPO market by pooling with type H firms in equilibrium (Propositions 1 and 4). Due to this difference in adverse selection across the two exit mechanisms, our model predicts that firms facing a greater extent of

[32]Evidence consistent with this prediction is also provided by Poulsen and Stegemoller (2008), who find that firms characterized by higher pre-exit sales growth are more likely to go public rather than be acquired. Using size as a proxy for the firm's viability in the product market, one can also interpret the evidence of Brau, Francis, and Kohers (2003) documenting that IPO firms tend to be larger as being consistent with the above prediction of our model.

information asymmetry are more likely to choose an IPO over an acquisition.

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 hypothesis that firms operating in more capital intensive industries are more likely to choose an IPO over an acquisition.

Evidence supporting these predictions is provided by Bayar and Chemmanur (2009).

2. *Exit choices in venture backed versus non-venture backed firms:* First, our model predicts that, controlling for viability in the product market, firms which are venture backed (and therefore more likely to be jointly controlled firms) are more likely to choose to go public (rather than be acquired) relative to those which 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 seems likely to be 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. 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.[33] These testable implications lead to the prediction 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. Evidence supporting these prediction is provided by Bayar and Chemmanur (2009). [34]

[33] Cumming (2008) provides evidence consistent with this based on the exit decisions of firms in a number of European countries. He finds that financial contracts which give the venture capitalist or other private investor greater control over the governance of the firm increase the likelihood of the firm being acquired rather than going public. Thus, when the venture capitalist uses common equity (which is associated with weak contractual governance terms, as opposed to convertible debt or convertible preferred equity, which is associated with more investor veto and control rights) to finance the entrepreneurial firm, the likelihood of an IPO increases by approximately 30%. Takeovers are 25% more likely for entrepreneurial firms backed by private equity investors with strong control rights (particularly, the right to replace the founding entrepreneur as CEO).

[34] Poulsen and Stegemoller (2008) also find that venture backed firms are more likely to go public.

3. *Average firm valuation in IPOs versus acquisitions:* 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.[35] Our analysis suggests that this is because of two reasons. First, the average quality of the firms going public is higher than that of firms that are acquired. Second, given the greater information asymmetry characterizing the IPO market, the valuation of firms fluctuates in the IPO market, and firms tend to go public more often when IPO valuations are higher. The combination of the above two reasons gives a greater average valuation for firms going public compared to those that are acquired.

Therefore, 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 mentioned above. Our arguments above lead to the following hypothesis: Controlling for industry, time of transaction, and other characteristics affecting the choice of a firm between IPOs and acquisitions, there exists no IPO valuation premium, i.e., the valuation at which an acquired firm could have gone public is not higher than its acquisition value.

4. *A resolution to the "IPO valuation premium puzzle":* The valuation at which an acquired firm could have gone public in an IPO could be higher than its acquisition value even after controlling for its propensity to go public and matching it with a similar IPO firm. However, firm insiders may have private information that their firm's business model is not viable in the face of aggressive competition in the product market, so that the firm's IPO valuation 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, insiders can benefit from higher IPO valuations only if this valuation is sustained in the long run.[36] 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.[37] Given that the weighted average of their firm's short-run IPO valuation and

[35] For evidence on the valuation premium in IPOs, see Brau, Francis, and Kohers (2003), who document that sellers in acquisitions receive payoffs equal to only 78% of those in IPOs. See also Poulsen and Stegemoller (2008), who document that IPO firms have higher valuation multiples relative to those that are acquired.

[36] 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.

[37] 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).

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 is higher than its valuation at the acquisition price.

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 run stock market value where the weight on the IPO value is the fraction of equity insiders liquidate in the IPO. Thus, our explanation of the IPO valuation premium puzzle leads to the following hypothesis: Even if a firm's IPO valuation is truly higher, the acquisition value of a private firm will be higher than the weighted average of its current IPO value and long run (three years post-IPO) value, where the weight on the long run value is the fraction of equity retained by firm insiders subsequent to the IPO.[38] 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, consistent with prediction 3. Second, when they compare 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), they find that the IPO valuation premium vanishes almost entirely, consistent with prediction 4.

5. *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 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.

6. *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 in more competitive industries and thus with greater potential synergies with acquirers 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, our model predicts that firm valuations in strategic acquisitions will be

[38] Bayar and Chemmanur (2009) assume that the fraction of equity retained is assumed to be 1 minus the sum of the fraction of equity sold by insiders in the secondary offering (to satisfy their liquidity demands) and the fraction of equity issued to outsiders in order to raise external financing for the firm.

higher than those in financial acquisitions , but lower than those in IPOs.[39]

8 Conclusion

We developed a theoretical analysis of a private firm's choice of exit mechanism between IPOs and acquisitions. We consider an entrepreneur managing a private firm backed by a venture capitalist. The entrepreneur and venture capitalist desire to exit partially from the firm, motivated either by the desire to satisfy their liquidity demands or to raise external financing for the firm (or both). 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 tend for itself after going public, an acquirer is 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. Further, unlike atomistic investors in the IPO market who are at an informational disadvantage with respect to firm insiders, potential acquirers are able to value the firm correctly by virtue of their industry expertise. On the negative side, acquirers have considerable bargaining power with respect to the entrepreneur, which allows them to extract some of the firm's net present value from insiders, unlike investors in the competitive IPO market. Finally, while the entrepreneur is able to maintain his private benefits from control even after his firm goes public, he is likely to lose these after an acquisition. In this setting, we derived a number of testable implications regarding a firm's equilibrium choice between IPOs and acquisitions. Our theoretical analysis is able to explain the "IPO valuation premium puzzle": i.e., the empirical finding that many firms that are able to obtain higher valuations in the IPO market nevertheless choose to be acquired.

[39] 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 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)

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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., $\Pr(a = 1|q = L) = \beta_E$.

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 (15) and (16) on the equilibrium path of the game, it follows that the IPO price V_{ipo}^E is given by (17).

Now, given the valuations V_{ipo}^E and P_{acq} in the IPO market and acquisition market respectively, and the investors' out-of-equilibrium beliefs specified (see footnote 24), 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:

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

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

$$\max_{a\in\{0,1\}} a \cdot [\delta_E(\alpha_E(V_{ipo}^E - I) + (1-\alpha_E)(I+V_q)(1-\frac{I}{V_{ipo}^E})) + B] + (1-a)\cdot\delta_E\rho V_A. \tag{A2}$$

By rearranging (A2) and from the definitions of Q in (8), we obtain the indifference condition (14), which we solve for the closed-form solution of the equilibrium IPO price V_{ipo}^E given by (A3) and we denote this particular value of V_{ipo}^E by Z_E:

$$Z_E = \frac{Q + \alpha_E V_L - (1-2\alpha_E)I + \sqrt{(Q+\alpha_E V_L - (1-2\alpha_E)I)^2 + 4\alpha_E(1-\alpha_E)I(I+V_L)}}{2\alpha_E}. \tag{A3}$$

By substituting the equilibrium IPO price $V_{ipo}^E = Z_E$ from (A3) in (17), we obtain the equilibrium value of β_E, which is given by

$$\beta_E = \frac{\theta(I + V_H - Z_E)}{(1-\theta)(Z_E - (I+V_L))}. \tag{A4}$$

Given the equilibrium beliefs and strategies of other players, Z_E 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 Z_E 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).[40]

From (18), it follows that it is optimal for the type H firm's entrepreneur to take his firm public

[40] Note that the expression for V_{ipo}^E given in (17) 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, $\theta V_H + (1-\theta)V_L < Z_E - I < V_H$, such that $\beta_E \in (0, 1)$.

with probability 1 (given the equilibrium beliefs and strategies of other players), iff the following inequality is satisfied:

$$\delta_E(I + V_H - (I + \rho V_A - \frac{B}{\delta_E})) > \delta_E(\alpha_E + (1 - \alpha_E)\frac{I}{V_{ipo}^E})(I + V_H - V_{ipo}^E). \tag{A5}$$

Substituting V_{ipo}^E with Z_E as given by (A3), the type L entrepreneur's indifference condition (14) implies that the following inequality must hold (see also Proposition 3):

$$Z_E > I + \rho V_A - \frac{B}{\delta_E}. \tag{A6}$$

Moreover, in equilibrium, we have $I + V_H > Z_E$ (since $\beta_E > 0$ and $V_{ipo}^E = Z_E$). Thus, it follows that

$$I + V_H > Z_E > I + \rho V_A - \frac{B}{\delta_E}. \tag{A7}$$

From (A7) and since $0 < \alpha_E + (1 - \alpha_E)\frac{I}{Z_E} < 1$, it follows that (A5) holds in equilibrium.

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

$$\rho V_A - V_L < (\alpha_V + (1 - \alpha_V)\frac{I}{Z_E})(Z_E - V_L - I). \tag{A8}$$

It follows from (A8) that the VC of a type L firm finds it privately optimal to go public in equilibrium only if $Z_E > I + \rho V_A$, since $\alpha_V + (1 - \alpha_V)\frac{I}{Z_E} < 1$. From the type L entrepreneur's indifference equation (14), it follows that

$$\frac{\rho V_A - V_L}{Z_E - V_L - I} = \alpha_E + (1 - \alpha_E)\frac{I}{Z_E} + \frac{B}{\delta_E(Z_E - V_L - I)}. \tag{A9}$$

Thus, substituting this into (A8), we obtain:

$$\alpha_E + (1 - \alpha_E)\frac{I}{Z_E} + \frac{B}{\delta_E(Z_E - V_L - I)} < \alpha_V + (1 - \alpha_V)\frac{I}{Z_E}. \tag{A10}$$

Then, (A10) implies that the type L VC would find an IPO privately optimal iff $1 > \alpha_V > \hat{\alpha}_V$, where $\hat{\alpha}_V$ is given by

$$\alpha_V > \hat{\alpha}_V \equiv \alpha_E + \frac{B}{\delta_E(Z_E - I - V_L)(1 - \frac{I}{Z_E})}. \tag{A11}$$

Note that $\hat{\alpha}_V < 1$ iff $Z_E > P_{acq} = I + \rho V_A$.[41] To show this, we derive another expression for $\hat{\alpha}_V$ from the indifference condition (set (A8) as an equality) of the type L VC, when the firm is controlled by the entrepreneur:

$$\hat{\alpha}_V + (1 - \hat{\alpha}_V)\frac{I}{Z_E} = \frac{I + \rho V_A - (I + V_L)}{Z_E - I + V_L}, \tag{A12}$$

[41] The threshold value $\hat{\alpha}_V$ is the fraction of shares sold by the VC out of his remaining equity holdings, such that the VC is indifferent between an IPO and an acquisition at the IPO value Z_E of the firm (set (A8) as an equality). (A8) can hold as an equality only if $Z_E > I + \rho V_A$ since $\alpha_V + (1 - \alpha_V)\frac{I}{Z_E} < 1$.

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

$$\hat{\alpha}_V = \frac{1}{1-\frac{I}{Z_E}}(\frac{\rho V_A - V_L}{Z_E - I - V_L} - \frac{I}{Z_E}). \tag{A13}$$

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

$$V_H - \rho V_A > (\alpha_V + (1-\alpha_V)\frac{I}{V^E_{ipo}})(I + V_H - V^E_{ipo}). \tag{A14}$$

This implies the following inequality:

$$\alpha_V + (1-\alpha_V)\frac{I}{Z_E} < \frac{I + V_H - (I + \rho V_A)}{I + V_H - Z_E}. \tag{A15}$$

Thus, from (A15) we see that, if $Z_E > I + \rho V_A$, the type H entrepreneur's exit choice to go public is privately optimal for the type H VC since the LHS is always less than 1. If $Z_E < I + \rho V_A$, then (A15) is satisfied only if $\alpha_V < \hat{\alpha}_{vh}$ where $\hat{\alpha}_{vh}$ is given by

$$\hat{\alpha}_{vh} \equiv \frac{1}{1-\frac{I}{Z_E}}(\frac{V_H - \rho V_A}{I + V_H - Z_E} - \frac{I}{Z_E}). \tag{A16}$$

The RHS of (A16) is positive only if $\rho V_A < V_H$ which is equivalent to $1 - p_H < \hat{p} \equiv \frac{V_S}{V_S - V_F}(1-\rho) + \rho p_S$. Note that $\hat{\alpha}_{vh} > 1$ iff $Z_E > I + \rho V_A$.

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 V^E_{ipo} given in (17) or offering a fraction of new shares other than $\frac{I}{V^E_{ipo}}$, 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.[42] ■

Proof of Proposition 2. By partially differentiating β_E in (A4) and implicitly differentiating Z_E in (14), 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

$$\frac{\partial \beta_E}{\partial B} = \frac{\theta(V_H - V_L)}{(1-\theta)(Z_E - (I + V_L))^2}\frac{1}{\alpha_E + (1-\alpha_E)\frac{I(I+V_L)}{Z_E^2}}\frac{1}{\delta_E} > 0. \tag{A17}$$

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

$$\frac{\partial \beta_E}{\partial \rho} = -\frac{\theta(V_H - V_L)}{(1-\theta)(Z_E - (I + V_L))^2}\frac{1}{\alpha_E + (1-\alpha_E)\frac{I(I+V_L)}{Z_E^2}}V_A < 0. \tag{A18}$$

[42] The out-of-equilibrium beliefs supporting other equilibria throughout the remainder of the paper 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.

(c) Decreasing in the difference $\Delta \equiv p_A - p_L$

$$\frac{\partial \beta_E}{\partial \Delta} = -\frac{\theta(V_H - V_L)}{(1-\theta)(Z_E - (I+V_L))^2} \frac{1}{\alpha_E + (1-\alpha_E)\frac{I(I+V_L)}{Z_E^2}} \rho(V_S - V_F) < 0. \tag{A19}$$

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

$$\frac{\partial \beta_E}{\partial \theta} = \frac{1}{(1-\theta)^2} \frac{(I + V_H - Z_E)}{(Z_E - (I+V_L))} > 0. \tag{A20}$$

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

$$\frac{\partial \beta_E}{\partial \alpha_E} = -\frac{\theta(V_H - V_L)}{(1-\theta)(Z_E - (I+V_L))^2} \frac{-(1-\frac{I}{Z_E})(Z_E - V_L - I)}{\alpha_E + (1-\alpha_E)\frac{I(I+V_L)}{Z_E^2}} > 0. \tag{A21}$$

(f) Increasing in the investment required I

$$\frac{\partial \beta_E}{\partial I} = \frac{\theta(V_H - V_L)}{(1-\theta)(Z_E - (I+V_L))^2}(1 - \frac{\partial Z_E}{\partial I}). \tag{A22}$$

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

Proof of Proposition 3. From the indifference condition (14) of the type L firm's entrepreneur, it follows that

$$V_{ipo}^E > I + \rho V_A - \frac{B}{\delta_E}. \tag{A23}$$

By comparing the equilibrium IPO price V_{ipo}^E given by Z_E in (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 (19) holds. The comparative statics results for the IPO price follow from the implicit differentiation of Z_E in (14) with respect to α_E, I, B, $(1-\rho)$ and $p_A - p_L$. We have

$$\frac{\partial Z_E}{\partial \alpha_E} = \frac{-(1-\frac{I}{Z_E})(Z_E - V_L - I)}{\alpha_E + (1-\alpha_E)\frac{I(I+V_L)}{Z_E^2}} < 0, \tag{A24}$$

$$\frac{\partial Z_E}{\partial I} = \frac{\alpha_E + (1-\alpha_E)\frac{I-(Z_E - V_L - I)}{Z_E}}{\alpha_E + (1-\alpha_E)\frac{I(I+V_L)}{Z_E^2}} < 1, \tag{A25}$$

$$\frac{\partial Z_E}{\partial Q} = \frac{1}{\alpha_E + (1-\alpha_E)\frac{I(I+V_L)}{Z_E^2}} > 0. \tag{A26}$$

Note that $\frac{\partial Z_E}{\partial I} > 0$ 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 Z_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 Z_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 $\alpha_V < \hat{\alpha}_V = \alpha_E + \frac{B}{\delta_E(Z_E - I - V_L)(1-\frac{I}{Z_E})}$, where Z_E is the IPO price in the equilibrium of an entrepreneur controlled firm (Proposition 1). Let Z_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 VC-controlled type L firm. These quantities can be obtained by setting $B = 0$ and substituting α_E with α_V in (A3) and by substituting Z_E with Z_V in (A4) respectively. It is easy to show that $\beta_V < \beta_E$ iff $\alpha_V < \hat{\alpha}_V$. Since V^E_{ipo} and V^V_{ipo} are decreasing in β_E and β_V respectively, it follows that $Z_E < Z_V$ iff $\beta_E > \beta_V$ and therefore, $Z_E < Z_V$ iff $\alpha_V < \hat{\alpha}_V$. This implies that, if $\alpha_V < \hat{\alpha}_V$, the type L VC prefers an acquisition over an IPO at the price Z_E, and that he needs to be compensated by a positive transfer T_1 from the type L entrepreneur in the case of an IPO. Therefore, we have a new set of indifference equations (21) and (22) for the type L entrepreneur and the type L VC respectively, which together imply the joint indifference equation (23). Given (23), outside investors' IPO valuation (17), the acquisition price P_{acq} set by the acquiring firm, and the type L VC's individual indifference condition (22), we solve for the equilibrium IPO price $\hat{V}^E_{ipo} = Z_J$, the equilibrium probability $\hat{\beta}_E$ of the type L firm going public, and the equilibrium transfer T_1 to the type L VC in the case of an IPO:

$$\hat{\beta}_E = \frac{\theta(I + V_H - Z_J)}{(1-\theta)(Z_J - (I + V_L))}, \tag{A27}$$

$$\hat{V}^E_{ipo} = Z_J = \frac{G + \sqrt{G^2 + 4(\delta_E\alpha_E + \delta_V\alpha_V)(\delta_E(1-\alpha_E) + \delta_V(1-\alpha_V))I(I+V_L)}}{2(\delta_E\alpha_E + \delta_V\alpha_V)}, \tag{A28}$$

$$T_1 = \delta_V(\rho V_A - V_L) - \delta_V(\alpha_V + (1-\alpha_V)\frac{I}{Z_J})(Z_J - V_L - I). \tag{A29}$$

The quantity G is defined by

$$G \equiv (\delta_E + \delta_V)(\rho V_A - V_L) - B + (\delta_E\alpha_E + \delta_V\alpha_V)V_L - (\delta_E(1-2\alpha_E) + \delta_V(1-2\alpha_V))I. \tag{A30}$$

If $1 > \alpha_V > \hat{\alpha}_V$, Proposition 5 implies that $Z_V < Z_E$ as discussed above. This implies that the type L VC prefers an IPO over an acquisition at the price Z_E, and that he needs to be compensated by a positive transfer T_2 from the type L entrepreneur in the case of an acquisition. The indifference equations (24) and (25) of the type L entrepreneur and the type L VC , however, imply the same joint equilibrium indifference condition (23). Together with outside investors' IPO valuation (17) and the acquisition price P_{acq} set by the acquiring firm, this implies that the equilibrium IPO price $\hat{V}^E_{ipo}$, the equilibrium probability $\hat{\beta}_E$ of the type L firm going public are also given by (A28) and (A27) respectively. Then, we obtain the equilibrium transfer T_2 from the type L entrepreneur to the type L VC in the case of an acquisition from (25):

$$T_2 = \delta_V(\alpha_V + (1-\alpha_V)\frac{I}{\hat{V}^E_{ipo}})(\hat{V}^E_{ipo} - V_L - I) - \delta_V(\rho V_A - V_L). \tag{A31}$$

It is easy to verify that T_2 is positive iff $1 > \alpha_V > \hat{\alpha}_V$. From (A29) and (A31), it follows that $T_2 = -T_1$.

The restrictions $\theta V_H + (1-\theta)V_L < Z_E - I < V_H$, $\theta V_H + (1-\theta)V_L < Z_V - I < V_H$ are necessary and sufficient conditions for the existence of a partially pooling equilibrium so that $\hat{\beta}_E \in (0,1)$. If $1 > \alpha_V > \hat{\alpha}_V$, then $\hat{V}^E_{ipo} > P_{acq} = I + \rho V_A$ since $T_2 > 0$. In that case, both the entrepreneur and the VC of a type H firm prefer an IPO over an acquisition. If $\alpha_V < \hat{\alpha}_V$, Proposition 8 shows that $\hat{V}^E_{ipo} > Z_E$. Then, Proposition 1 implies that the type H 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 VC always finds an IPO privately optimal, since $\hat{V}^E_{ipo} > Z_E$ (see Proposition 1). ■

Proof of Proposition 5. (i) If $\alpha_V < \hat{\alpha}_V$, the RHS of (21) and the indifference equation (14) of the entrepreneur controlled firm implies that $T_1 > 0$ iff $\hat{V}^E_{ipo} > Z_E$, since $\frac{\partial(\alpha + (1-\alpha)\frac{I}{V})(V - V_L - I)}{\partial V} > 0$.

From outside investors' IPO valuation in (17), we have $\frac{\partial \hat{V}_{ipo}^E}{\partial \beta} < 0$. Therefore, $\hat{V}_{ipo}^E > Z_E$ iff $\hat{\beta}_E < \beta_E$. (ii) If $1 > \alpha_V > \hat{\alpha}_V$, however, then the RHS of (24) and (14) imply that $T_2 > 0$ iff $\hat{V}_{ipo}^E < Z_E$ and therefore $\hat{\beta}_E > \beta_E$ holds. ■

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:

$$\begin{aligned}\delta_E(1-\gamma)(1-\alpha_E)[\alpha_2(I+(1-\hat{\theta})V(\psi_L)+\hat{\theta}V(\psi_H))+(1-\alpha_E^{'})(I+V(\psi_L))] \\ +(1-k)B > \delta_E(1-\gamma)(1-\alpha_E)(I+\rho V(p_N)),\end{aligned} \tag{A32}$$

which further translates into

$$\alpha_E^{'}V_n^1+(1-\alpha_E^{'})(I+V(\psi_L))+\frac{(1-k)B}{\delta_E(1-\gamma)(1-\alpha_E)} > I+\rho V(p_N). \tag{A33}$$

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 (A32) is satisfied:

$$\bar{\psi} \equiv \frac{V_S(1-\rho)+\frac{B(1-k)}{\delta_E(1-\alpha_E)}}{V_S-V_F}+\rho p_N. \tag{A34}$$

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 (28) for the time 1 valuation V_e^1. The probability η of a type L firm remaining stand-alone is given by:

$$\eta = \frac{\hat{\theta}}{(1-\hat{\theta})}\frac{(I+V(\phi_H)-V_e^1)}{(V_e^1-I-V(\phi_L))}. \tag{A35}$$

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:

$$\begin{aligned}V_p^L =&\omega[(1-\eta)\rho V(p_E)+\eta(\alpha_E^{'}(V_e^1-I) \\ &+(1-\alpha_E^{'})V(\phi_L))]+(1-\omega)[\alpha_E^{'}(V_n^1-I)+(1-\alpha_E^{'})V(\psi_L)],\end{aligned} \tag{A36}$$

$$\begin{aligned}V_p^H =&\omega[\alpha_E^{'}(V_e^1-I)+(1-\alpha_E^{'})V(\phi_H)] \\ &+(1-\omega)[\alpha_E^{'}(V_n^1-I)+(1-\alpha_E^{'})V(\psi_H)].\end{aligned} \tag{A37}$$

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

$$\max_{a\in\{0,1\}} a \cdot [\delta_E(\alpha_E(V_p^E - I) + (1-\alpha_E)(I + V_p^L)(1 - \frac{I}{V_p^E})) \\ + B(k + ((1-\omega) + \omega\eta)(1-k))] + (1-a)\cdot \delta_E \rho V_A, \tag{A38}$$

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:

$$V_p^E = I + \frac{(1-\theta)\beta_p}{(1-\theta)\beta_p + \theta} V_p^L + \frac{\theta}{(1-\theta)\beta_p + \theta} V_p^H. \tag{A39}$$

From the type L entrepreneur's indifference condition (29), the equilibrium IPO valuation is now given by:

$$Z_p = [Q_p + \alpha_E V_p^L - (1-2\alpha_E)I \\ + [(Q_p + \alpha_E V_p^L - (1-2\alpha_E)I)^2 + 4\alpha_E(1-\alpha_E)I(I + V_p^L)]^{1/2}]/(2\alpha_E). \tag{A40}$$

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

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

■

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:

$$\delta_E \rho V(p_f) + b > \delta_E \rho V(p_s), \tag{A42}$$

which is equivalent to the restriction

$$(p_s - p_f) < \frac{b}{\rho \delta_E (V_S - V_F)}. \tag{A43}$$

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:

$$\delta_E(\rho V(p_f) - V_L) + b = \delta_E(\alpha_E + (1-\alpha_E)\frac{I}{Z_f})(Z_f - V_L - I) + B. \tag{A44}$$

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

$$\beta_f = \frac{\theta(I + V_H - Z_f)}{(1-\theta)(Z_f - (I + V_L))}, \tag{A45}$$

where, from (A44), the equilibrium IPO value Z_f of the firm is given by:

$$Z_f = \frac{Q_f + \alpha_E V_L - (1-2\alpha_E)I + \sqrt{(Q_f + \alpha_E V_L - (1-2\alpha_E)I)^2 + 4\alpha_E(1-\alpha_E)I(I+V_L)}}{2\alpha_E}, \tag{A46}$$

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. ■