A Model of Informed Intermediation in the Market for Going Public

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September 2023

Abstract

We present a model in which informed experts intermediate the going public process by acquiring private firms and reselling them to public investors. Because information incorporated by the public market generates resale pricing risk for experts, acquisition prices act as credible signals of firm value. Accordingly, intermediated sales provide a superior alternative for firms expecting undervaluation in traditional IPOs. We characterize how signaling via acquisition price affects surplus sharing between experts and sellers and analyze market equilibrium efficiency when intermediated sales and IPOs coexist. Our analysis sheds light on possible informational roles of transactions such as SPACs and PE investments.

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Private firms wishing to transition to public-firm status historically went through a traditional initial public offering (IPO) process, in which the firm and its underwriters directly sell the firm's shares to public market investors. More recently, however, several alternative mechanisms to IPOs have emerged. These mechanisms typically involve intermediation by an unaffiliated third party who acquires equity in the firm and then resells to public market investors, assuming some investment risk in the process. Examples include Special Purpose Acquisition Companies (SPACs), which are publicly-traded blank check companies seeking private acquisition targets, and various types of private equity (PE) investments in which the PE buyers aim to eventually sell their equity stakes to the public. The intermediaries in these transactions, often called "sponsors" or "general partners," are typically investment professionals or former executives with industry expertise. The involvement of such experts suggests that part of the value in these intermediated transactions might lie in helping mitigate information frictions in the market for going public.

To explore the potential informational role of intermediaries in the going public process, we analyze an otherwise standard asymmetric information model in which an informed "expert" can intermediate by acquiring a private firm and reselling it to public market investors. Asymmetric information between the entrepreneur who owns the private firm and public market investors causes a traditional IPO to be undervalued when firm value is relatively high. We show that the acquisition price in an intermediated transaction signals the firm's type to public market investors, resulting in resale at the firm's fair valuation. As such, an intermediated sale completely overcomes the undervaluation problem, despite the expert having exactly the same information as the entrepreneur. We also analyze the co-existence of intermediated sales with traditional IPOs and the consequences of intermediated sales for the efficiency of the market for going public.

The key feature that allows for signaling in an intermediated sale is resale pricing risk, which stems from additional information that public market investors produce before purchasing shares of the firm. To illustrate the intuition for the signaling result, we consider a two-type example that we discuss in detail in Section 1. In an intermediated sale, the expert's expected resale price is lower if firm type is low than if it is high, since the additional information public market investors observe is more likely to be negative with a low type. Thus, an acquisition price that is sufficiently high but below the true value of a high-type firm constitutes a credible signal of high type: The expert earns a positive expected profit when the firm type is indeed high, but would lose money in expectation if the type were in fact low. Importantly, unlike other proposed forms of signaling in the equity market, such as retention of an ownership stake (e.g., Leland and Pyle, 1977), the signal that the expert's acquisition price sends is non-dissipative, as the acquisition price is simply a transfer from the expert to the entrepreneur.

In our model, an entrepreneur is endowed with a firm that is more valuable if owned by public market investors than if it remains private. The firm's intrinsic value, drawn from a continuous distribution, is the entrepreneur's private information. With some probability, the firm is matched with an expert, who also observes the firm's value and can make a take-it-or-leave it offer to the entrepreneur. Public market investors do not directly observe whether a firm is matched with an expert. However, if the firm is matched and the entrepreneur accepts the expert's offer, the market observes the acquisition and its price. The expert then automatically resells the firm to public market investors. If the entrepreneur is not matched with an expert or is matched with an expert but rejects the expert's offer, then the entrepreneur chooses to either take the firm public in a traditional IPO or keep the firm private. In either kind of public sale (i.e., a resale by the expert or a traditional IPO by the entrepreneur), public market investors produce some additional, albeit noisy, information about firm value before establishing a price for the firm. The incorporation of this additional signal into the firm's public valuation is the source of the above-mentioned pricing risk for the seller.[1]

We first characterize the jointly-determined equilibrium in the intermediated and traditional IPO markets. If the firm is not matched with an expert, the standard adverse selection outcome obtains: The entrepreneur sells the firm in an IPO if firm value is relatively low and opts to remain private if firm value is high. In case of a match, the expert's willingness to make an offer that is acceptable to the entrepreneur depends on whether the entrepreneur expects a traditional IPO to be over or undervalued. If firm value is sufficiently low, the entrepreneur enjoys an overvalued IPO due to pooling of firm types in the IPO market, and thus rejects any offer that would be profitable for the expert. However, if firm value is high, the entrepreneur faces the prospect of an undervalued IPO. In this case, the expert makes an offer that is both profitable for himself and acceptable to the entrepreneur. Thus, an acquisition takes place only if firm value is sufficiently high.

The possibility that the firm may match with an expert leads to "cream-skimming" in the traditional IPO market. While a sufficiently high-valued firm would have remained private in the absence of a match, there is a range of moderately high values in which the firm would have gone public in a traditional IPO if not matched but sells to the expert instead when matched. As a result, the expert's potential presence degrades the IPO pool and hence reduces the equilibrium IPO price. A lower anticipated IPO price induces marginal types that would have gone public if unmatched to remain private. It also worsens the entrepreneur's outside option when her firm is matched with an expert, lowering the value threshold above which she sells to the expert. Both effects further degrade the IPO pool and lower the equilibrium IPO price. Thus, the potential presence of an expert creates a negative feedback loop in terms of the pricing and likelihood of traditional IPOs.

Next, we analyze the acquisition price that the expert offers to the entrepreneur. Specif-

[1]The paper's main conclusions rely on public market investors receiving an informative signal in intermediated sales. We assume that investors receive a similar signal in valuing traditional IPOs to maintain a level playing field.

ically, we characterize a separating equilibrium in which the acquisition price signals firm value to public market investors. Such an equilibrium requires the acquisition price to be sufficiently high for a given firm type to prevent the expert from mimicking when he is matched with lower types. Since the expert makes a take-it-or-leave-it offer, he can always acquire the firm by offering the entrepreneur's reservation value, which is the greater of the entrepreneur's expected payoff from a traditional IPO and the firm's value if it remains private. However, this reservation value may or may not be high enough to support a separating equilibrium.

We show that when the quality (i.e., informativeness) of the public signal is relatively low, the expert may pay the entrepreneur more than her reservation value in equilibrium. Low information quality exacerbates the mimicking incentives of the expert, since he faces low risk of being exposed by the market. As a result, separation requires the acquisition price to be relatively high, and possibly higher than the entrepreneur's reservation value. Note that the expert pays a premium in this case even though he has all of the bargaining power.

After characterizing the equilibrium of the model with a single entrepreneur and expert, we extend the model to the case of a fixed mass of entrepreneurs and an endogenous mass of experts determined in market equilibrium. Experts pay a fixed cost to enter (i.e., to be potentially matched with a firm). More entry by experts increases the probability that a given firm is matched to an expert. We show that, relative to the social optimum, there can be either too much or too little entry by experts. Two factors encourage excess entry. First, an expert earns rents when he intermediates the sale of a firm that would have gone public via a traditional IPO if not matched, for which intermediation creates no social value. Second, an increase in the probability that a firm is matched with an expert exacerbates adverse selection in the traditional IPO market, resulting in more unmatched firms remaining private.

The possibility of under-entry by experts is perhaps more surprising. An expert creates social value when he intermediates the sale of a firm that would otherwise remain private. The expert fully internalizes this social value if he pays the entrepreneur her reservation value. However, he only partly internalizes the value created when he must pay the entrepreneur a premium to achieve separation. The failure of the expert to fully internalize the value created by intermediation can result in under-entry. Under-entry is most likely to occur when information quality in the public market is low, as lower information quality requires the expert to pay a higher price to successfully separate from worse types.

In a final extension, we allow the expert to choose *ex ante* whether to commit to a resale or retain the discretion to sell selectively after completing an acquisition. Our base model assumes commitment, which gives the intermediated sale the flavor of a SPAC. Specifically, a firm acquired by a SPAC automatically becomes public since the SPAC shares are already publicly traded. Furthermore, the SPAC sponsor and institutional investors participating in any PIPE financing used to complete the acquisition face resale pricing risk, since their shares tend to be locked up for at least several months post-SPAC merger and large stakes tend to be relatively illiquid in general. The discretion case in contrast gives the transaction the flavor of a private equity (PE) buyout, where the acquirer sometimes takes the firm public again quickly – say, within one year – and sometimes retains ownership for years.[2]

To create scope for discretion, we extend the model by assuming that the expert observes additional information about firm value after acquiring the firm but before a potential resale. Due to this additional information, discretion creates adverse selection in the resale market, which directly hurts the expert. However, discretion also weakens the expert's incentive to pretend to be matched with a more valuable firm by offering a higher price to the entrepreneur, since the signal is wasted when the expert retains the firm. Thus, separation

[2]We discuss the parallels between variants of our model and intermediated firm sales observed in practice in more detail in Section 6.

can be achieved with a smaller premium than in the commitment case. This second effect benefits the expert. When information quality in the public market is low and hence the cost of separation is high, the second effect can dominate, and the expert may prefer discretion over commitment.

Our paper adds to the literature on signaling in the market for going public. Prominent theories posit signaling via retention of an ownership stake (Leland and Pyle, 1977), hiring a reputable underwriter or auditor (Baron, 1982; Titman and Trueman, 1986), or underpricing (Allen and Faulhaber, 1989; Welch, 1989). These signaling mechanisms are all dissipative, in the sense that the entrepreneur bears a deadweight cost of using them. In contrast, signaling via the expert's acquisition price in our model is non-dissipative, as the acquisition price is simply a transfer from the expert to the entrepreneur. We also note the crucial role of the arm's length transaction between the entrepreneur and expert in this signaling mechanism. An entrepreneur, despite having the same information as the expert in our model, cannot replicate the signaling that the expert can achieve through an arm's-length acquisition because she already owns the firm.[3]

Our analysis also adds to the literature on cream-skimming by informed investors. Both Fishman and Parker (2015) and Bolton, Santos, and Scheinkman (2016) present models in which informed investors exacerbate adverse selection in asset markets by selectively acquiring high quality assets. In their models, the presence of an informed investor unambiguously makes sellers of all types of assets worse off because the informed investor extracts informational rents without increasing social surplus. These models consequently always feature over-entry in equilibrium. In contrast, the presence of the expert in our model has positive as well as negative consequences for sellers since it results in some firms going public

[3]Another related study is Daley, Green, and Vanasco (2020), in which banks signal asset quality by engaging in costly retention. The availability of informative public ratings weakens banks' signaling incentives, similar to the quality of information produced by public markets affecting experts' signaling incentives in our model.

that would otherwise inefficiently remain private, and there can be under-entry of experts in equilibrium.

Finally, our paper is related to the recent literature on the decline of IPOs in the U.S. Gao, Ritter, and Zhu (2013) and Doidge, Karolyi, and Stulz (2017) document the phenomenon and evaluate some potential explanations, such as regulatory changes that affect the costs and benefits of going public or technological changes that affect optimal ownership structures. Ewens and Farre-Mensa (2020) and Davydiuk, Glover, and Szymanski (2020) highlight the increased supply of private capital sources for private firms as an explanation for the decline in IPOs. Our model, which focuses on private firms' ability to access public markets in different ways, provides a theoretical framework for exploring these explanations.

The remainder of the paper is organized as follows. Section 1 presents a simple example that illustrates how the price in an intermediate sale can signal firm value. Section 2 describes the baseline model. Section 3 presents the equilibrium analysis. Section 4 introduces expert entry and characterizes the resulting market equilibrium. Section 5 presents the analysis of an alternative form of intermediation in which the expert has discretion to sell an acquired firm. Section 6 discusses the parallels between our model and intermediated firm sales observed in practice. Section 7 concludes. The Appendix contains the proofs.

1. An Example

Before presenting our model, we begin with a simple example that illustrates how the price paid in an intermediated transaction can signal firm quality and allow for separation. Consider a firm with a future cash flow of either 0 or 1. The firm can either be a high type, in which case it realizes cash flow of 1 with probability 2/3, or a low type, in which case it realizes cash flow of 1 with probability 1/3. There is an expert who observes the firm's type and can buy the firm at a publicly-observed acquisition price, with commitment to resell the firm to a competitive group of public market investors at a market-determined price.

Public market investors do not observe firm type, but they do observe a noisy signal of the firm's cash flow between the time the expert acquires the firm and the time he resells it. The public signal is high with probability one if cash flow is 1. When cash flow is 0, the public signal is low with probability q and high with probability $1 - q$. The parameter q thus captures the informativeness of the public signal.[4] Given the cash flow distributions of the two types, the probability of a high signal is then $1 - \frac{q}{3}$ if the firm is a high type and $1 - \frac{2q}{3} < 1 - \frac{q}{3}$ if the firm is a low type.

Conditional on the public market investors' belief that the firm is a high type and observing a high public signal, the probability that the cash flow is 1 equals $\frac{2}{3-q}$, which is also the market value of the firm. Suppose that the expert can signal that he is buying a high-type firm by paying an acquisition price of 2/3, which is the full-information value of a high-type firm. The expert's expected payoff if the firm is indeed a high type is

$$\left(1 - \frac{q}{3}\right) \times \frac{2}{3-q} - \frac{2}{3} = 0. \tag{1}$$

The expert breaks even in expectation because the expected resale price conditional on the firm being a high type and the market believing that the firm is indeed a high type is the firm's full-information value of 2/3. If the firm is instead a low type but the expert pretends that it is a high type by acquiring it a price of 2/3, the expert's payoff is

$$\left(1 - \frac{2q}{3}\right) \times \frac{2}{3-q} - \frac{2}{3} = -\frac{2}{3} \times \left(\frac{q}{3-q}\right), \tag{2}$$

which is strictly negative if $q > 0$. That is, as long as the public signal is informative, the

[4]This signal structure is convenient since the market price of the firm conditional on a low public signal is 0, regardless of firm type, making it necessary to compute the market price only conditional on a high public signal. However, this particular structure is not essential – the key insight follows as long as the public signal is informative about the firm's cash flow.

expert would suffer an expected loss if he pays an acquisition price of 2/3 for a low type firm. Thus, an acquisition price of 2/3 allows for separation.

Intuitively, the expert faces resale price risk at the time of the acquisition due to the uncertainty about the realization of the public signal. The downside of this pricing risk is naturally greater if the firm type is low than if it is high because the market is less likely to observe a high signal if the firm type is low. Thus, the expert loses money in expectation by buying a low-type firm at a price at which he would break even when buying a high-type firm.

It is easy to see by continuity that the expert can also signal a high firm type by paying a price that is sufficiently high but less than 2/3. The lowest price that allows for separation is the price at which the expert breaks when the market values the resale as a high type but the firm is in fact a low type. This price is given by

$$\left(1 - \frac{2q}{3}\right) \times \frac{2}{3-q} = \frac{2}{3} \times \left(\frac{3-2q}{3-q}\right), \tag{3}$$

which is strictly less than 2/3 if $q > 0$. Thus, as long as the public signal is informative, the expert can successfully signal that he is acquiring a high-type firm by paying an acquisition price in the interval $\left[\frac{2}{3}\frac{3-2q}{3-q}, \frac{2}{3}\right]$.

Note that the example in this section abstracts from a number of important ingredients that are necessary to characterize an equilibrium. We have neither specified the outside option of the seller of the firm and assessed her willingness to sell to the expert nor described the process that determines the acquisition price. In the next section, we present our full model, which features a richer firm type space and includes these additional ingredients.

2. The Model

The baseline model has three dates, $t = 1, 2, 3$, and three types of agents - an entrepreneur, an expert, and investors in the public market. We assume universal risk-neutrality and zero discounting throughout.

2.1. Agents

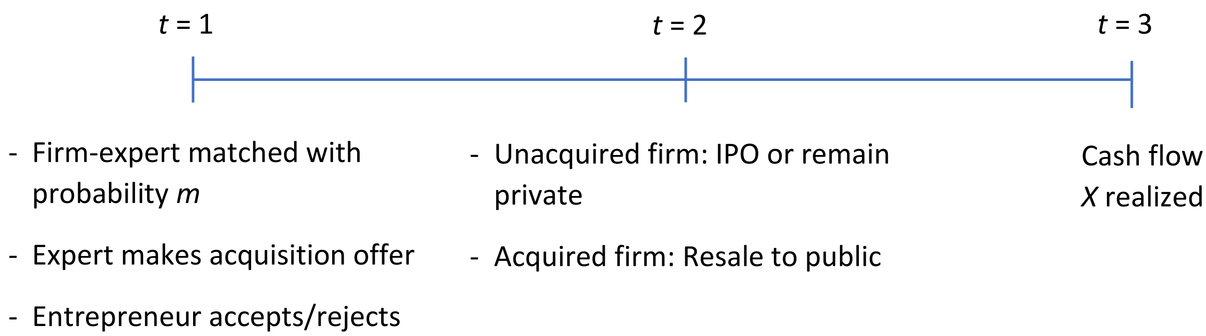
The entrepreneur is the sole owner of a private firm. The firm generates a single cash flow X at $t = 3$, which is either $X = 1$ (success) with probability p or $X = 0$ (failure) with probability $1 - p$. The success probability p is a random draw from the uniform distribution with support $(0, 1)$. The entrepreneur privately observes the realization of p; investors in the public market do not. We refer to p as the firm type hereafter.

Keeping the firm private is costly for the entrepreneur. Specifically, the entrepreneur receives $X - \delta$ if she still owns the firm at $t = 3$. The "private firm discount" $\delta > 0$, which is the source of the gain from going public in the model, can be interpreted as resulting from liquidity needs of the entrepreneur or financing constraints that private firms face.

The entrepreneur can sell the firm directly to the public market in an IPO. Alternatively, she may be able to sell the firm to an expert, who acts as an intermediary between the entrepreneur and the public market. For now, we assume that the entrepreneur is matched with an expert with exogenous likelihood $m \in (0, 1)$. We derive this likelihood as an equilibrium outcome in Section 4, where we analyze endogenous expert entry. In case of a match, the expert observes the firm type at no cost and makes an acquisition offer to the entrepreneur. We assume that the expert has full bargaining power in acquisition negotiations: He makes a take-it-or-leave-it offer to the entrepreneur, which she either accepts or rejects.

We assume for now that the expert is *committed* to reselling the firm in the public market subsequent to the acquisition. Specifically, if the entrepreneur accepts the offer and thus the

Figure 1: Timeline



acquisition takes place at $t = 1$, the expert must resell the firm to public market investors at the market price at $t = 2$. We refer to this expert-led form of going public as an *intermediated sale*. In Section 5 we consider an alternative form of intermediation in which the expert has discretion to resell the acquired firm to public market investors.

Investors who populate the public market act competitively. If the expert does not acquire the firm at $t = 1$, public market investors do not observe whether the firm was not matched with an expert or the entrepreneur rejected the offer from a matched expert. If the expert acquires the firm at $t = 1$, public market investors observe the acquisition and the price that the expert pays to the entrepreneur.

Figure 1 summarizes the timing of events. At $t = 1$, the firm and the expert match with probability m. In case of a match, the expert makes an acquisition offer and the entrepreneur accepts or rejects the offer. At $t = 2$, if the firm is unacquired, the entrepreneur decides between an IPO and keeping the firm private. If the expert acquires the firm, he then resells it to public market investors, completing the intermediated sale. At $t = 3$, firm cash flow X is realized.

2.2. Public Sales

As discussed above, the firm can be sold in the public market in two different ways – directly by the entrepreneur in an IPO or indirectly by the expert in an intermediated sale. We assume that investors in the public market produce some value-relevant information in either kind of sale. Specifically, before a public sale at $t = 2$, investors observe a signal $s \in \{L, H\}$. The signal structure is the same as in the example in Section 1: If firm cash flow is $X = 1$, then $s = H$ with probability one, and if firm cash flow is $X = 0$, then $s = L$ with probability q and $s = H$ with probability $1 - q$. Thus, $q \in [0, 1)$ parameterizes the quality of the information that the public market produces. After observing signal s, public investors buy the firm at a price that equals the expected value of the cash flow X conditional on s as well as any other publicly available information.[5]

2.3. Payoffs

We introduce the following notation to characterize the entrepreneur's and expert's payoffs. Let V_{Acq} denote the acquisition price the expert offers to the entrepreneur. Let V_{IPO} denote the price the entrepreneur receives in an IPO conditional on the high public signal $s = H$ being realized. Let V_{Int} denote the price the expert receives when reselling the firm in an intermediated sale conditional on the information public investors infer from the acquisition price and the high public signal $s = H$ being realized. Note that, since the low signal $s = L$ reveals the low cash flow $X = 0$, the price conditional on $s = L$ being realized is zero in either kind of public sale. Finally, let $\phi(p) = p + (1 - p)(1 - q)$ denote the probability of a high public signal $s = H$ given firm type p.

The entrepreneur's expected payoff from keeping the firm private is $p - \delta$, her expected

[5]The presence of the signal in the case of an IPO is not essential, but we include it to make the playing field between an IPO and an intermediated sale level. For IPOs, the public signal can be interpreted as the information produced during the bookbuilding process. We discuss the interpretation of the public signal in the context of intermediated sales in Section 6.

payoff from an IPO is $\phi(p)V_{IPO}$, and her payoff from selling the firm to the expert is V_{Acq}. The expert's expected payoff from an intermediated sale is $\phi(p)V_{Int} - V_{Acq}$. If the expert does not acquire the firm, his payoff is zero.

3. Equilibrium Analysis

3.1. Equilibrium Definition and Conjecture

A Perfect Bayesian Equilibrium (PBE) of the model consists of strategies and expectations that satisfy the following:

i. The entrepreneur chooses the alternative with the highest expected payoff - remaining private, $p - \delta$; selling the firm in an IPO, $\phi(p)V_{IPO}$; or (if matched) selling the firm to the expert, V_{Acq}.

ii. The expert chooses an acquisition offer price V_{Acq} to maximize his expected payoff, which equals $\phi(p)V_{Int} - V_{Acq}$ if the entrepreneur accepts the offer and zero otherwise.

iii. The price in a public sale (an IPO or a resale in the case of an intermediated sale) equals the expected value of the firm's cash flow conditional on all publicly available information. The price in an IPO is zero if $s = L$ and is $V_{IPO} = E(X \mid \mathbb{1}_{IPO} = 1, s = H)$ if $s = H$, where $\mathbb{1}_{IPO}$ is an indicator function that takes the value of one in states of the world in which the entrepreneur's optimal choice is an IPO. The price in an intermediated sale is zero if $s = L$ and is $V_{Int} = E(X \mid V_{Acq}, s = H)$ if $s = H$.

In the remainder of this section, we characterize an equilibrium in which the following conjectured properties hold:

Property 1 (Pooling in the IPO market)**.** *The entrepreneur's IPO decision is characterized by the type thresholds p_δ and p_0:*

a. When unmatched with an expert, the entrepreneur prefers an IPO to remaining private if and only if $p < p_\delta$.

b. When matched with an expert, the entrepreneur prefers an IPO to selling the firm to the expert if and only if $p < p_0$.

Property 2 (Signaling in intermediated sales)**.** *The acquisition offer price* V_{Acq} *is strictly increasing in firm type* p*. Therefore, an accepted offer price in an intermediated sale perfectly reveals the firm's type to the public before resale to public market investors takes place.*

To ensure the existence of the threshold p_δ introduced in Property 1, we make the following parametric assumption:

Assumption 1. *The parameter values satisfy* $\delta < (1-q)/(2-q)$.

Intuitively, the private firm discount δ needs to be sufficiently small for relatively high firm types $p > p_\delta$ to prefer remaining private; otherwise, even the highest possible type $p = 1$ would strictly prefer an IPO to remaining private.[6]

3.2. The IPO Market

We start our analysis by characterizing the equilibrium in the IPO market. The indifference thresholds p_δ and p_0 described in Property 1 in Section 3.1 satisfy the following equations:

$$p_\delta - \delta = \phi(p_\delta)V_{IPO} \tag{4}$$

$$p_0 = \phi(p_0)V_{IPO} \tag{5}$$

[6]Our focus on an equilibrium with $p_\delta < 1$ is due to its interesting welfare implications. However, much of our analysis concerning the competition between IPOs and intermediated sales remains intact even when Assumption 1 is not satisfied. We also note that, given m, the weaker condition $\delta(1 - q + \sqrt{1-m}) < 1 - q$ is sufficient for $p_\delta < 1$. Assumption 1 guarantees that $p_\delta < 1$ for all feasible values of m.

Equation (4) indicates that the entrepreneur is indifferent between an IPO and remaining private if $p = p_\delta$. Note that the function $(p - \delta)/\phi(p)$ is strictly increasing in p. Therefore, $p - \delta < \phi(p)V_{IPO}$ if and only if $p < p_\delta$. That is, types $p < p_\delta$ strictly prefer an IPO over remaining private, while types $p > p_\delta$ strictly prefer remaining private to an IPO, as conjectured in Property 1.a.

Equation (5) indicates that firm's IPO is fairly priced in expectation if $p = p_0$. Note that the function $p/\phi(p)$ is strictly increasing in p. Therefore, $p < \phi(p)V_{IPO}$ if and only if $p < p_0$. That is, an IPO is overvalued in expectation if $p < p_0$ and undervalued in expectation if $p > p_0$. As we show formally in Section 3.3, the expected resale price in an intermediated sell is the firm's fair value, p, since the acquisition price reveals the firm type in our conjectured equilibrium. Thus, an intermediated sale dominates an IPO in the sense it increases the joint surplus of the entrepreneur and expert if and only if $p > p_0$, as conjectured in Property 1.b.

Given the indifference thresholds p_δ and p_0, the IPO price conditional on the high public signal $s = H$ is given by

$$\begin{aligned} V_{IPO} =& E(X|\ \mathbb{1}_{IPO} = 1, s = H) \qquad (6) \\ =& \frac{(1-m)\int_{p=0}^{p_\delta} p dp + m \int_{p=0}^{p_0} p dp}{(1-m)\int_{p=0}^{p_\delta} \phi(p) dp + m \int_{p=0}^{p_0} \phi(p) dp} \\ =& \frac{(1-m)p_\delta^2 + m p_0^2}{q((1-m)p_\delta^2 + m p_0^2) + 2(1-q)((1-m)p_\delta + m p_0)}. \end{aligned}$$

Solving (4), (5), and (6) simultaneously, we obtain the following closed-form solutions:

Lemma 1. *The equilibrium in the IPO market is described by*

$$V_{IPO} = \frac{\delta\sqrt{1-m}}{1-q}, \tag{7}$$

$$p_\delta = \frac{\delta(1-q)\left(1+\sqrt{1-m}\right)}{1-q-\delta q\sqrt{1-m}} < 1, \tag{8}$$

$$p_0 = \frac{\delta(1-q)\sqrt{1-m}}{1-q-\delta q\sqrt{1-m}} < p_\delta, \tag{9}$$

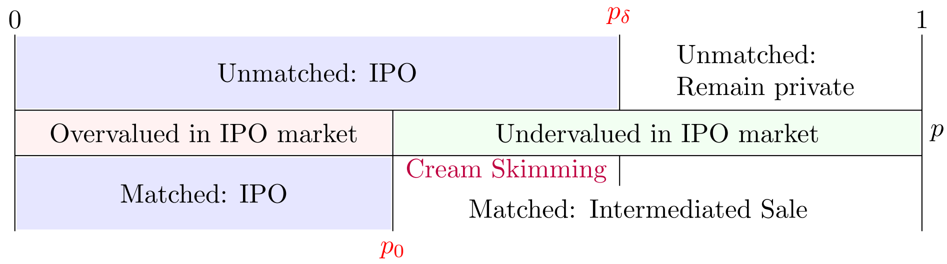
which are all strictly increasing in δ and q, and strictly decreasing in m.

All proofs are in the Appendix unless they are presented in the text. Lemma 1 illustrates how the degree of adverse selection in the IPO market depends on various model parameters. Only relatively low firm types ($p < p_\delta$ when unmatched and $p < p_0$ when matched) go public via IPOs, depressing the selling price V_{IPO}. The depressed price, in turn, discourages IPOs further. The adverse selection problem is more severe (that is, V_{IPO}, p_δ, and p_0 are relatively low) when the benefit of being public is small (low δ), which results in more high-valued firms opting to remain private, and when public markets generate less information (low q), which makes the expected proceeds from an IPO less sensitive to firm type. Importantly, the potential presence of the expert also exacerbates the adverse selection problem. The expert *cream-skims* by acquiring relatively high-type firms and leaving worse types for the IPO market. Thus, a greater likelihood of the expert being present (higher m) results in a lower price V_{IPO} and lower IPO thresholds p_δ and p_0. Figure 2 illustrates the equilibrium in the IPO market.

3.3. Acquisition Offers and Intermediated Sales

We now turn to the expert's offer decision and his payoff from an ensuing intermediated sale. Suppose that the expert's acquisition offer V_{Acq}, which we denote as $V_{Acq}(p)$ hereafter,

Figure 2: Equilibrium in IPO market



is a strictly increasing function of firm type in equilibrium, as conjectured in Property 2. Under this conjecture, investors in the public market can infer the firm type from the publicly observed acquisition price whenever the entrepreneur accepts the offer. Public investors use this information, along with the realization of the public signal s, in pricing the firm in the resale portion of the intermediated sale.

Specifically, consider the valuation of the firm in an intermediated sale following an acquisition at some price $V_{Acq}(p)$ from which the public investors infer firm type p. If the public signal realization is $s = L$, the firm is valued at zero since $s = L$ reveals the low cash flow $X = 0$. If the public signal realization is $s = H$, the firm value is calculated using Bayes' rule as the expected value of X conditional on $s = H$ being realized for the inferred type p:

$$V_{Int}(p) = E(X|\, p, s = H) = \frac{p}{\phi(p)}. \tag{10}$$

Note that, because $s = H$ is unconditionally more likely for a higher type, the firm value conditional on $s = H$ is increasing in the inferred type p:

$$V'_{Int}(p) = \frac{1-q}{[\phi(p)]^2} > 0. \tag{11}$$

Next, consider the expert's offer decision. To start with, we restrict attention to offers that the entrepreneur is expected to accept. Specifically, the expert knows the actual firm type p, and takes as given the public market's inference p' from an observed offer price $V_{Acq}(p')$. The entrepreneur will accept an offer $V_{Acq}(p')$ if and only if $V_{Acq}(p') \geq V_{Res}(p)$, where

$$V_{Res}(p) = \max\left(\phi(p)V_{IPO}, p - \delta\right) \tag{12}$$

$$= \begin{cases} \phi(p)V_{IPO} & \text{if } p \leq p_\delta \\ p - \delta & \text{if } p > p_\delta \end{cases}$$

is the entrepreneur's reservation value, which is the greater of her payoffs from an IPO and remaining private.

Subject to the restriction that $V_{Acq}(p') \geq V_{Res}(p)$, the expert's problem can be stated as

$$\max_{p'} \pi(p, p') \equiv -V_{Acq}(p') + \phi(p)V_{Int}(p'), \tag{13}$$

where $\pi(p, p')$ denotes the expert's expected payoff from the intermediated sale. With a slight abuse of notation, let $\pi(p) \equiv \pi(p, p)$ denote the expert's expected payoff in equilibrium when his offer correctly reveals firm type p:

$$\pi(p) = -V_{Acq}(p) + \phi(p)V_{Int}(p) = -V_{Acq}(p) + p. \tag{14}$$

To see the trade-off the expert faces in choosing the offer price, differentiate the expected payoff function $\pi(p,p')$ with respect to p':[7]

$$\frac{\partial \pi(p,p')}{\partial p'} = -V'_{Acq}(p') + \phi(p)\frac{1-q}{[\phi(p')]^2}. \tag{15}$$

Equation (15) illustrates the marginal cost and benefit to the expert of signaling a higher firm type. The cost is that the expert has to pay more for the acquisition in order to convey a higher firm type. The benefit is that the expert resells the firm at a higher price if $s = H$ is realized, which happens with probability $\phi(p)$ given the actual firm type p.

Incentive compatibility requires that the expert be unable to increase his expected payoff by deviating to any offer price $V_{Acq}(p') \geq V_{Res}(p)$ that is acceptable to the entrepreneur. To characterize incentive-compatible offer prices, first note that the marginal payoff in (15) is increasing in p:

$$\frac{\partial \pi(p,p')}{\partial p \partial p'} = \frac{q(1-q)}{[\phi(p')]^2} \geq 0. \tag{16}$$

Equation (16) is the Spence-Mirrlees single crossing property, which indicates that conveying a stronger signal is more valuable for higher types. Intuitively, the benefit to the expert of being perceived to be matched to a higher type firm increases with the firm's actual type since the probability that the expert receives the higher resale price increases with actual type. When this property holds, incentive compatibility can be fully characterized by the expert's payoff from a local deviation. Formally, we have the following result:

Lemma 2 (Incentive Compatibility)**.** *Suppose that $V_{Acq}(p) \geq V_{Res}(p)$. The expert's expected payoff $\pi(p,p) \geq \pi(p,p')$ for any p' for which $V_{Acq}(p') \geq V_{Res}(p)$ if and only if*

$$V'_{Acq}(p) \geq \frac{1-q}{\phi(p)}, \tag{17}$$

[7] As we show below, the equilibrium offer price function $V_{Acq}(p)$ may exhibit kinks where its left and right hand derivatives differ. When this is the case, we compute $V'_{Acq}(p)$ as the right hand derivative.

with the inequality constraint in (17) *binding if* $V_{Acq}(p) > V_{Res}(p)$.

While the general intuition for Lemma 2 is fairly standard, the inequality constraint in (17) deserves some explanation. Equation (17) reflects the cost and the benefit of a local deviation; it simply follows from computing (15) at $p' = p$. In most models, incentive compatibility necessitates a condition akin to (17) to hold as an equality, so as to prevent deviations to both higher and lower types. This is also the case in our model whenever $V_{Acq}(p) > V_{Res}(p)$. However, if $V_{Acq}(p) = V_{Res}(p)$, the incentive compatibility condition is one-sided and requires only preventing deviations to higher types. Deviations to lower types are not feasible in this case, as the entrepreneur would not accept any offer $V_{Acq}(p') < V_{Acq}(p) = V_{Res}(p)$.

Equipped with Lemma 2, we now construct the equilibrium offer price $V_{Acq}(p)$ for $p \geq p_0$. Since the expert makes a take-it-or-leave-it offer to the entrepreneur, a natural candidate for the equilibrium offer price is the entrepreneur's reservation value $V_{Res}(p)$. Note also that $V_{Res}(p_0) = \phi(p_0)V_{IPO} = p_0$, which satisfies the indifference threshold conjecture in Property 1.b. However, for $V_{Acq}(p) = V_{Res}(p)$ to be an equilibrium, $V_{Res}(p)$ needs to satisfy the incentive compatibility condition in (17):

$$V'_{Res}(p) \geq \frac{1-q}{\phi(p)} \tag{18}$$

$$\Leftrightarrow \begin{cases} q\phi(p)V_{IPO} \geq 1-q & \text{if } p \in [p_0, p_\delta], \\ \phi(p) \geq 1-q & \text{if } p > p_\delta. \end{cases}$$

Because $\phi(p) = p + (1-p)(1-q) \geq (1-q)$, the inequality in (18) is satisfied for $p > p_\delta$. However, it may or may not be satisfied for $p \in [p_0, p_\delta]$. Since $\phi(p)$ is increasing in p, the inequality is most constrained at $p = p_0$. Therefore, $V_{Acq}(p) = V_{Res}(p)$ is incentive compatible for all $p \geq p_0$ if the inequality in (18) holds at $p = p_0$. We provide the parametric condition for this to be the case in Lemma 3 below.

When $V_{Acq}(p) = V_{Res}(p)$ is not incentive compatible for all $p \geq p_0$, $V_{Acq}(p) > V_{Res}(p)$ for some p, and thus by Lemma 2 the incentive compatibility constraint is binding. Integrate (17) to obtain

$$V_{IC}(p) \equiv V_{Acq}(p_0) + \int_{x=p_0}^{p} \frac{1-q}{\phi(x)} dx \tag{19}$$

$$= p_0 + \frac{1-q}{q} \ln\left(\frac{\phi(p)}{\phi(p_0)}\right).$$

The offer price $V_{IC}(p)$ satisfies the incentive compatibility condition by construction. Note also that $V_{IC}(p_0) = V_{Res}(p_0) = p_0$.

The following Lemma characterizes $V_{Acq}(p)$ for $p > p_0$ in terms of $V_{Res}(p)$ and $V_{IC}(p)$:

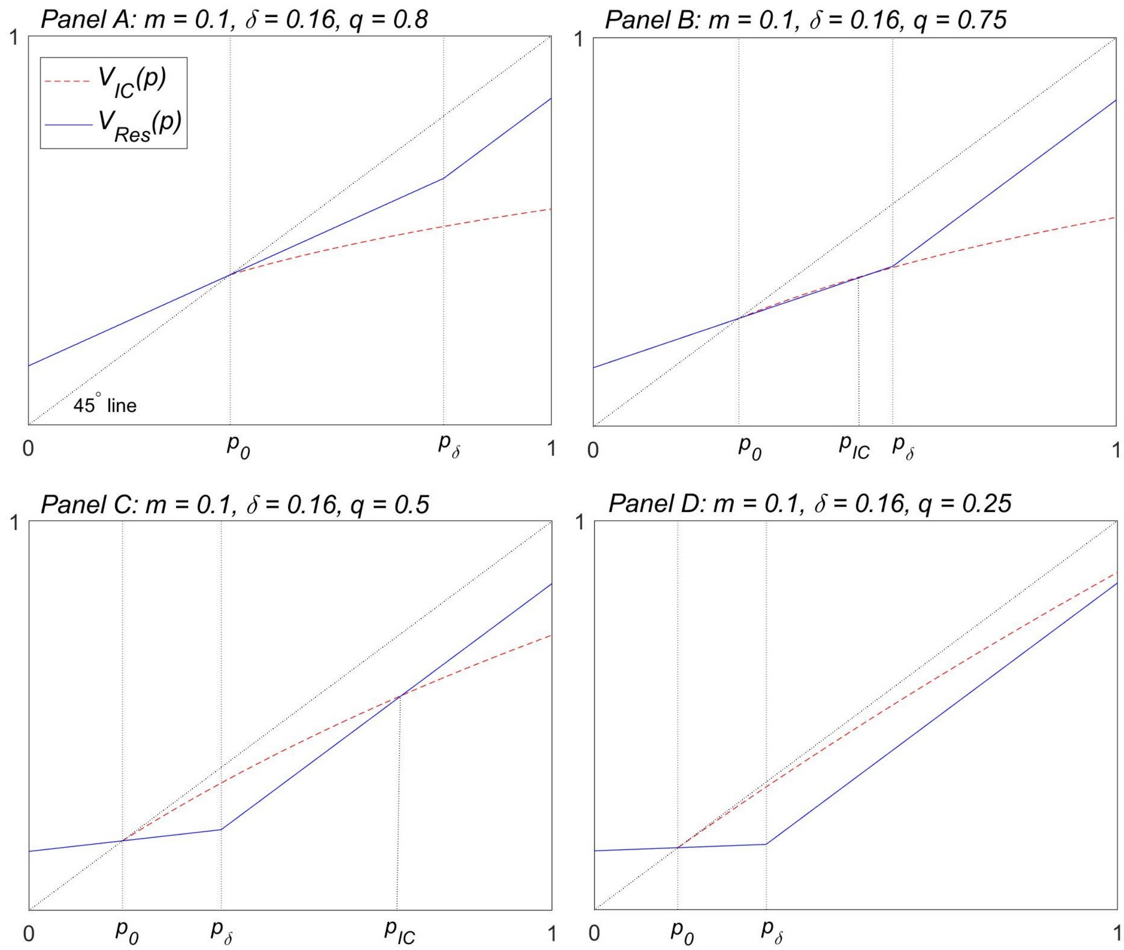
Lemma 3. *The offer price* $V_{Acq}(p) = \max(V_{Res}(p), V_{IC}(p))$ *satisfies the incentive compatibility condition in* (17). *Furthermore:*

i. If $2\delta q\sqrt{1-m} \geq 1-q$, $V_{Acq}(p) = V_{Res}(p) > V_{IC}(p)$ *for all* $p > p_0$.

ii. If $2\delta q\sqrt{1-m} < 1-q$, *there exists* $p_{IC} \in (p_0, 1]$ *such that* $V_{Acq}(p) = V_{IC}(p) > V_{Res}(p)$ *for* $p < p_{IC}$ *and* $V_{Acq}(p) = V_{Res}(p) > V_{IC}(p)$ *for* $p > p_{IC}$.

The parametric condition in part (i) of Lemma 3 is more likely to hold when q and δ are high and m is low. Such parameter values imply a strong IPO market with relatively little adverse selection, which increases the entrepreneur's reservation value. In addition, a high value of q implies greater resale price risk for the expert, curbing his incentive to mimic higher firm types. For both reasons, paying the entrepreneur her reservation value constitutes a credible signal of firm value in this case. When the parametric condition is not satisfied, however, paying the entrepreneur her reservation value is not a sufficiently strong

Figure 3: A numerical example of incentive compatible offer prices



signal. Ensuring incentive compatibility in this case requires an offer price that exceeds the entrepreneur's reservation value, despite the expert having all the bargaining power.

Figure 3 illustrates the incentive compatibility of offer prices with a numerical example. In this example, the information quality parameter q varies in Panels A through D, while m and δ are kept constant. In Panel A, the public market is highly efficient in producing information; as a result, the incentive compatibility constraint is not binding for any firm type $p \geq p_0$. As q declines in Panels B and C, the incentive compatibility constraint becomes more binding, resulting in offer prices that exceed the entrepreneur's reservation value for a growing range of firm types. In Panel D, the very low information quality necessitates offer prices that are much higher than the entrepreneur's reservation value. As a result, the incentive compatibility constraint binds for all types $p \geq p_0$.

To complete the equilibrium description, let $V_{Acq}(p) = p$ for $p < p_0$. As with $p \geq p_0$, the public market infers the firm type p if an acquisition at price $V_{Acq}(p) = p < p_0$ takes place. However, in equilibrium, the entrepreneur does not accept the offer $V_{Acq}(p) = p$ since the firm is overvalued in the IPO market. Thus, the expert's equilibrium payoff is zero if $p < p_0$.[8] Finally, note that there exists no profitable deviation $V_{Acq}(p') \geq V_{Res}(p)$ if $p < p_0$: Resale generates an expected payoff of $\phi(p)V_{Int}(p') < \phi(p')V_{Int}(p') = p' = V_{Acq}(p')$ if $p' \in (p, p_0]$, and $\phi(p)V_{Int}(p') < \phi(p_0)V_{Int}(p') < V_{Acq}(p')$ if $p' > p_0$.

The following Proposition summarizes the equilibrium characterized in this section:

Proposition 1. *The following constitute an equilibrium:*

i. The expert makes offer $V_{Acq}(p) = p$ if $p \leq p_0$ and $V_{Acq}(p) = \max(V_{Res}(p), V_{IC}(p))$ if $p > p_0$, where $V_{Res}(p)$ is given by (12) and $V_{IC}(p)$ is given by (19).

ii. When not matched with an expert, the entrepreneur chooses an IPO if $p \leq p_\delta$ and remaining private otherwise, where p_δ is given by (8). When matched with an expert, the entrepreneur chooses an IPO if $p \leq p_0$ and accepts the expert's offer otherwise, where p_0 is given by (9).

iii. The IPO price is zero if $s = L$ and V_{IPO} as given by (7) if $s = H$.

iv. Following an acquisition at price $V_{Acq}(p)$ for $p \in (0, 1)$, the resale price in intermediated sale is zero if $s = L$ and $V_{Int}(p)$ as given by (10) if $s = H$.

[8] There are several different offer price functions $V_{Acq}(p)$ that can sustain this equilibrium outcome for $p < p_0$ when coupled with appropriate off-equilibrium beliefs. We set $V_{Acq}(p) = p$ because it makes the offer price $V_{Acq}(p)$ continuous and strictly increasing over the whole type space $p \in (0, 1)$.

We conclude this section with a brief discussion of other potential equilibria in which intermediated sales take place.[9] The firm type space being a continuum renders an exhaustive analysis of all equilibria of the model difficult. However, we are able to characterize a set of partial pooling equilibria in which the expert makes the same offer to a pool of firm types. Specifically, for any $V_{Acq} \in [1-\delta, 1)$, there exists an equilibrium in which the expert successfully acquires firm types $[p^*, 1)$ by offering V_{Acq}, where $p^* > 0$ is a strictly increasing function of V_{Acq}. These partial pooling equilibria are similar to the separating equilibrium that we characterized in this section in two important respects. First, because the expert acquires only higher firm types $p > p^*$, these equilibria also feature a cream-skimming effect.[10] Second, similar to the case in the separating equilibrium in which the incentive compatibility constraint binds, the expert shares the surplus with the entrepreneur by making an offer that exceeds the latter's reservation value.

Importantly, we find that the partial pooling equilibria require off-equilibrium beliefs that may not necessarily survive standard refinements. First, depending on parameter values, some of these partial pooling equilibria fail the Intuitive Criterion (Cho and Kreps, 1987). In particular, when the information quality parameter q is relatively high, the expert can credibly signal higher firm types by increasing his offer and thus breaking the pool. Second, all of the partial pooing equilibria fail the D1 criterion (Banks and Sobel, 1987), as the expert's expected payoff from a deviation under any belief is strictly increasing in firm type. We conclude that, while qualitatively similar in certain respects to the separating equilibrium, these partial pooling equilibria are not as robust.

[9] We present a non-technical discussion for brevity; formal derivations are available upon request.

[10] It is easy to show, using Assumption 1, that a full pooling equilibrium in which the expert acquires all firm types $p \in (0, 1)$ with the same offer does not exist.

4. Market Equilibrium with Expert Entry

We now turn to the market equilibrium that obtains with free entry of experts. To do so, we extend the model and the timeline as follows. At date $t = 0$, there is a unit mass continuum of firms. There is also a large number of potential experts, who can each enter the market at personal cost c. Let ω denote the number of experts who enter.

At $t = 1$, experts and firms get randomly matched according to a linear matching technology. Specifically, the number of matches between the mass ω of experts and the mass one of firms equals $m \equiv \omega/(1+\omega)$. Therefore, the probability that a firm is matched with an expert is $m/1 = m$, and the probability that an expert is matched with a firm is $m/\omega = 1-m$. Note that this matching formulation implies a *congestion externality* for experts: Each expert is less likely to find a match when more experts are operating in the market. An expert matched with a firm learns the firm type p. Unmatched experts leave the game. The rest of the model timeline and events are the same as in Figure 1.

4.1. Entry Equilibrium

We characterize the equilibrium in terms of a firm's match probability m rather than the number of experts ω, since the former is easier to interpret and monotonically increasing in the latter. Recall from (14) that an expert's payoff from a match with firm type p is $\pi(p)$. Let $g(m)$ denote an expert's expected payoff conditional on a random match, where the expectation is taken with respect to the uniformly-distributed firm type p:

$$g(m) = E\left(\pi(p)\right) = E\left(p - V_{Acq}(p)\right). \tag{20}$$

The payoff in (20) is a function of m because the equilibrium offer price $V_{Acq}(p)$ depends on m. Finally, let $\Pi(m)$ denote an expert's ex-ante (i.e., upon entry at $t = 0$) expected payoff:

$$\Pi(m) = (1 - m)g(m). \tag{21}$$

The following Lemma characterizes an expert's expected payoff upon entry:

Lemma 4. *An expert's expected payoff conditional on a match, $g(m)$, is strictly increasing in m. Furthermore, his ex-ante expected payoff, $\Pi(m)$, is strictly concave in m.*

An expert's ex-ante expected payoff in (21) is the product of two terms, namely, the likelihood that the expert gets matched to a firm and his expected payoff conditional on a match. The former is decreasing in m due to the congestion externality discussed above. The latter in increasing in m, because more experts operating in the market exacerbates adverse selection in the IPO market and thus depresses entrepreneurs' reservation values. As $m \to 1$, the congestion externality dominates, so (21) is always decreasing in m for large m. However, depending on parameter values, (21) can be increasing in m for relatively small values of m. That is, despite the congestion externality, an expert may benefit from entry of more other experts, due to the adverse impact of entry on entrepreneurs' reservation values.

The next result characterizing the equilibrium follows directly from the above discussion and Lemma 4:

Proposition 2. *Assume $c < g(0)$. Then there exists a unique entry equilibrium m_e given by $\Pi(m_e) = c$.*

The assumption stated in the Proposition ensures that entry is profitable at $m = 0$. Given this assumption, the concavity of $\Pi(m)$ and the fact that $\Pi(1) = 0$ result in a unique equilibrium level of entry. In equilibrium, an expert who enters pays the entry cost c and breaks even.

4.2. Welfare Properties of the Equilibrium

To assess the welfare properties of the competitive equilibrium, we consider a utilitarian social welfare function Ψ that measures the net surplus created by experts' entry:

$$\Psi(m) \equiv [1 - p_\delta(0) - (1-m)(1-p_\delta(m))]\,\delta - \frac{mc}{1-m} \tag{22}$$

$$= \frac{\delta(1-m)\left[\delta\sqrt{1-m} - (1-\delta)(1-q)\right]}{1-q-\delta q\sqrt{1-m}} - \frac{mc}{1-m}.$$

The first line of (22) expresses p_δ as a function of m, and the second line follows from substituting the closed-form formula for p_δ in (8). Equation (22) formulates the welfare criterion in terms of $m = \omega/(1+\omega)$, which corresponds to $\omega = m/(1-m)$. The last term in (22) is thus the deadweight cost of entry incurred by experts. The bracketed term in (22) is the welfare gain or loss associated with expert entry relative to the base case $m = 0$. Specifically, firm types $p > p_\delta(0)$ remain private and thus forgo δ when $m = 0$. With $m > 0$, firm types $p > p_\delta(m)$ remain private and forgo δ only if they are not matched with experts, which happens with probability $1 - m$. Note that the welfare criterion $\Psi(m)$ is normalized to attain the value of zero at $m = 0$.

An analytical characterization of the social-optimum m_{opt} that maximizes (22) is difficult since Ψ is not globally concave or convex. However, identifying the reasons why the competitive equilibrium m_e does not maximize (22) is relatively straightforward. Specifically, experts' entry incentives deviate from social welfare considerations due to three distinct channels in our model:

1. Cream skimming: Entry increases the likelihood that firms with types $p \in (p_0, p_\delta)$ are

matched with and taken public by experts. However, these matches do not directly affect the welfare criterion (22), since the entrepreneurs would take these firms public via IPOs anyway. The fact that experts nevertheless profit from such matches generates an incentive for over-entry relative to the social optimum.

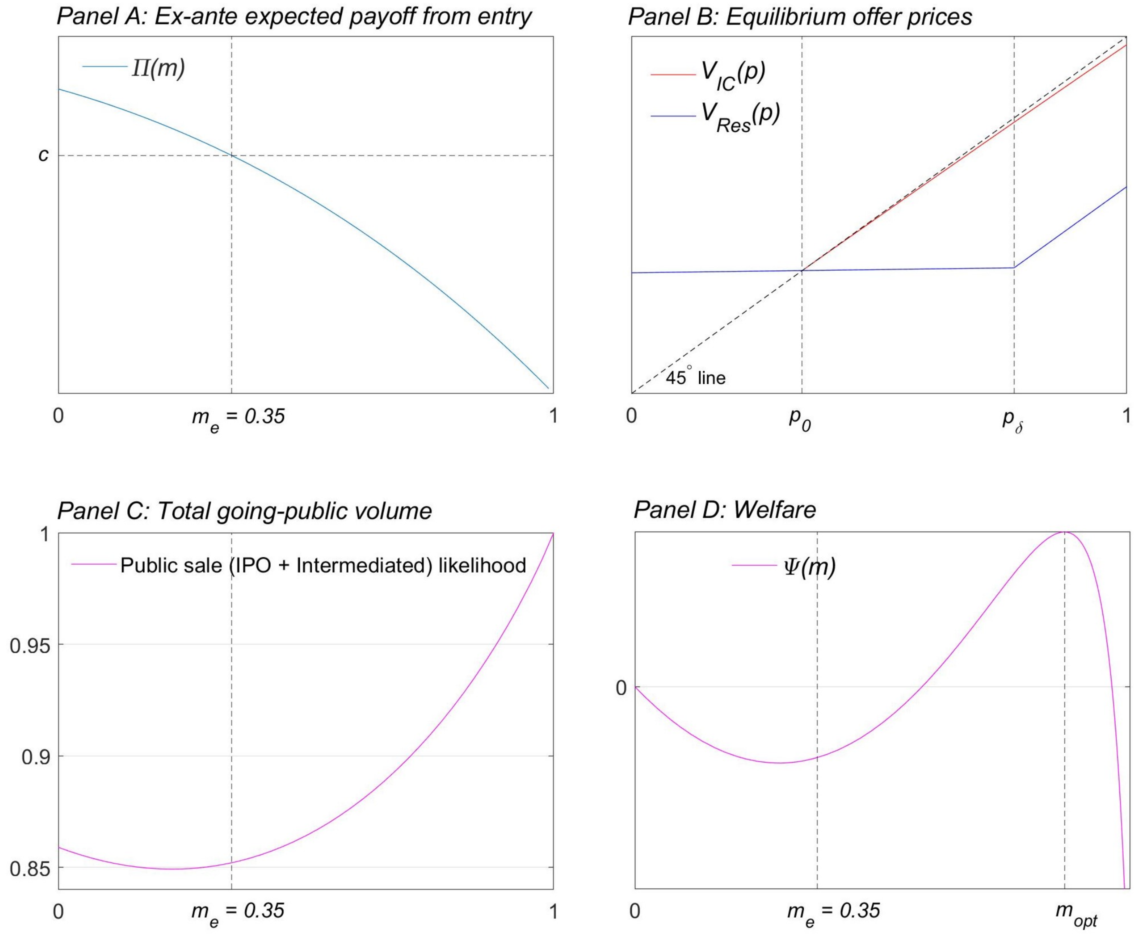
2. Adverse selection: Entry exacerbates adverse selection in the IPO market, lowering p_δ and thus increasing the likelihood that unmatched firms remain private. Since experts do not internalize the resulting welfare loss, this channel also incentivizes over-entry.

3. Surplus sharing: Entry improves welfare by increasing the likelihood that firms with types $p > p_\delta$, which would otherwise remain private, are matched with and taken public by experts. When the equilibrium acquisition price $V_{Acq}(p)$ equals the entrepreneurs' reservation values $V_{Res}(p)$, experts fully internalize this positive welfare effect of entry. However, when the incentive compatibility constraint binds, experts share part of the surplus with entrepreneurs by making offers $V_{Acq}(p) = V_{IC}(p) > V_{Res}(p)$. Thus, when the incentive compatibility constraint binds for firm types $p > p_\delta$, experts do not fully internalize their positive effect on welfare. Unlike the first two channels above, this third channel causes under-entry by experts.

While over-entry is a common equilibrium outcome in many models, under-entry is more interesting and novel. We conclude this section with a numerical example that shows that the third channel that favors under-entry can dominate the other two channels, resulting in an equilibrium with too few entrants relative to the social optimum. Figure 4 summarizes the example.

Panel A shows that, with parameter values $q = 0.05$, $\delta = 0.42$, and $c = 0.004$, entry results in an equilibrium with $m_e = 0.35$. Panel B shows the determination of equilibrium offer prices. Since information quality q is very low, the incentive compatibility constraint is binding for all types $p > p_0$. The resulting equilibrium offer prices well exceed entrepreneurs'

Figure 4: A numerical example of equilibrium entry and welfare



reservation values, leaving only a small share of the surplus for the experts.

The bottom two panels plot as functions of m two metrics that are relevant for welfare comparisons. Panel C shows the likelihood that a firm goes public via either an IPO or an intermediated sale, which can be interpreted as the total volume in the markets for going public. Note that for small values of m, total volume declines with entry, as increased adverse selection depresses the IPO market volume. In fact, fewer firms become public with $m = m_e$ than with $m = 0$, indicating that the equilibrium is inefficient even ignoring the deadweight cost of entry. Panel D, which plots the welfare criterion $\Psi(m)$ that does account for the deadweight cost, also shows that no entry is better than equilibrium entry. Interestingly, however, the social optimum m_{opt} is higher, not lower, than m_e. Further presence of experts beyond m_e has relatively little impact on the already depressed IPO market, and improves welfare by increasing the number of intermediated sales.

5. Commitment versus Discretion in Intermediated Sales

In our baseline model, we assume that an acquisition by the expert is always followed by resale to public market investors. While this assumption can be interpreted as the expert having made a pre-commitment to resell, such commitment is not really necessary in the model, since the timeline has no informational events between the acquisition and the resale.[11] The expert would choose to resell even without commitment, since the expected payoff of the resale, p, exceeds the expected payoff from keeping the acquired firm private, $p - \delta$.

Some cases of intermediation in practice may involve an intermediary that has discretion to either retain or resell the firm after acquiring it. In this section, we analyze an extension of the model presented in Section 2, in which the expert receives additional private information between the time of the acquisition and possible resale and can choose to either retain or resell the firm after observing this information. The revised timeline and payoffs are depicted in Figure 5. Specifically, we assume the following:

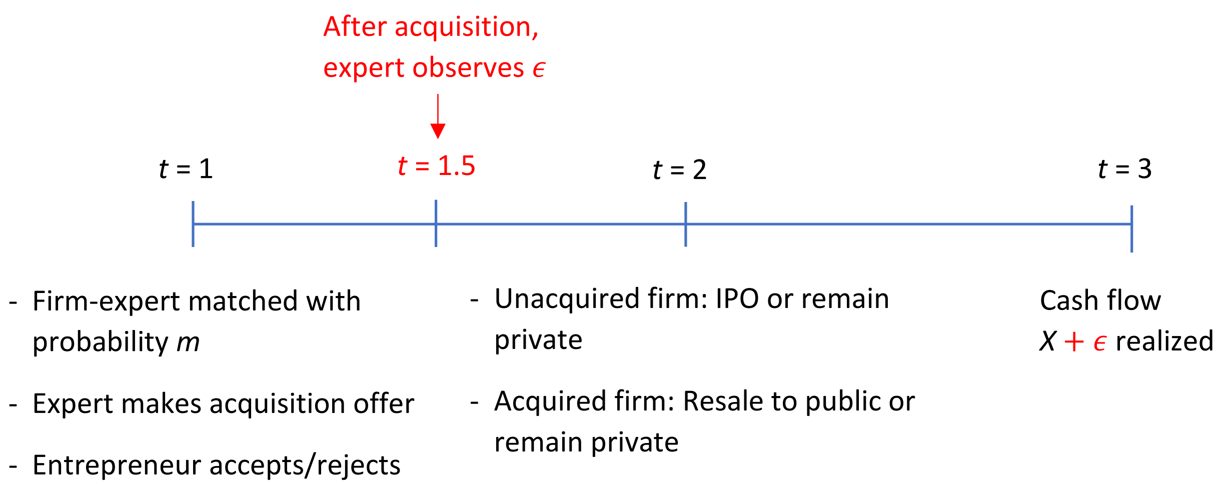
- The firm's cash flow at $t = 3$ is $X + \epsilon$, where ϵ is normally distributed with mean zero and standard deviation σ and is independent of p. Let $f(\epsilon)$ and $F(\epsilon)$ denote the probability density and cumulative distribution functions of ϵ, respectively.

- The events at $t = 1$ are the same as in the baseline model, except that the expert acquires the firm without any commitment to resell in the public market at $t = 2$.

- If the acquisition takes place at $t = 1$, the expert observes ϵ at an interim date $t = 1.5$.

[11] Note that the public signal is realized only after the expert takes the firm to the market for resale.

Figure 5: Revised Timeline



- After observing ϵ, the expert decides at $t = 2$ whether to conduct an intermediated sale or keep the firm private.

- As before, the public market values an IPO or an intermediated sale at $t = 2$ conditional on the public signal s, which is informative about X but not about ϵ.

- If the firm is not sold in the public market, its owner (the entrepreneur or the expert) receives $X + \epsilon - \delta$ at $t = 3$.

The arrival of additional private information ϵ at date $t = 1.5$ can result from both short-term and long-term events following the acquisition at $t = 1$. The expert may observe private information shortly after completing the acquisition, possibly before even taking full control of the firm. If the expert acquires the firm and, contrary to market's expectations, attempts a quick resale, investors in the public market may naturally interpret this as a sign that the expert has stumbled on some negative information about firm value. Over the longer run, the expert is likely to acquire considerable private information about firm value through ownership and operation of the firm. The private status of the firm while under expert ownership may magnify the information asymmetry, since public market investors have limited opportunities to acquire information about a non-listed firm.[12]

In the remainder of this section, we characterize the equilibrium with the expert having discretion to resell, and compare his expected payoff in this case to the commitment case analyzed in Section 3. To facilitate comparisons, we use the superscripts D and C to indicate the equilibrium outcomes with discretion and commitment, respectively.

First, note that the analysis of Section 3 continues to apply without any modifications with the revised timeline in Figure 5 if the expert is committed to resell the firm. The only decision the expert makes in this case is the acquisition offer at $t = 1$; whether he observes additional information ϵ at a later date $t = 1.5$ is irrelevant.

Consider now the case where the expert has discretion to resell after an acquisition. As in the commitment case, we characterize a separating equilibrium in which the expert's acquisition offer $V^D_{Acq}(p)$ is strictly increasing in p. Thus, an accepted offer reveals the firm type to the public market. The following Lemma describes the equilibrium at $t = 2$ conditional on an acquisition taking place at $t = 1$:

Lemma 5. *Suppose that the expert acquires the firm with the equilibrium offer $V^D_{Acq}(p)$. At $t = 2$:*

i The expert's expected payoff from a resale equals $p - \Delta_\epsilon$, where $\Delta_\epsilon > 0$ is a constant independent of p.

ii The expert chooses a resale over remaining private if and only if $\epsilon < \epsilon^* \equiv \delta - \Delta_\epsilon$.

The intuition for Lemma 5 is straightforward. With discretion, the expert resells the firm

[12]To simplify the exposition and focus our attention on the expert, we assume that ϵ is observable only to the acquiring expert, not to the entrepreneur.

only if he observes relatively low values of the cash flow shock ϵ and keeps the firm private otherwise. Since the public market anticipates the expert's strategic choice, the resale price includes an additional adverse selection discount Δ_ϵ relative to the commitment case.

At $t = 1$, the expert's expected equilibrium payoff equals

$$\pi^D(p) = -V^D_{Acq}(p) + \int_{\epsilon=-\infty}^{\epsilon^*} (p - \Delta_\epsilon) f(\epsilon) d\epsilon + \int_{\epsilon=\epsilon^*}^{\infty} (p + \epsilon - \delta) f(\epsilon) d\epsilon \tag{23}$$

$$= -V^D_{Acq}(p) + p - [1 - F(\epsilon^*)] \delta.$$

Compared with the commitment case in (14), the equilibrium payoff in (23) is lower by $[1 - F(\epsilon^*)] \delta$, which is the expected value of the private firm discount that the expert incurs. Because of this reduction, the expert's ability to cream-skim the IPO market by making an attractive acquisition offer is curtailed when he has discretion to resell. Specifically, consider the firm type p^D_0 that is indifferent between an IPO and the expert's offer. Since the expert breaks even with type p^D_0, (23) implies the indifference condition

$$p^D_0 - [1 - F(\epsilon^*)] \delta = \phi(p^D_0) V^D_{IPO}. \tag{24}$$

Equation (24) shows that the lowest firm type that the expert can attract with discretion is in fact undervalued in the IPO market, rather than being fairly valued as in (5).

The following Lemma characterizes the IPO market equilibrium with discretion and shows that the equilibrium exhibits less adverse selection on p relative to the commitment case:

Lemma 6. *The equilibrium in the IPO market with expert discretion to resell is described* *by*

$$V_{IPO}^{D} = \frac{\delta\sqrt{1-m+m\left[1-F\left(\epsilon^{*}\right)\right]^{2}}}{1-q} > V_{IPO}^{C}, \tag{25}$$

$$p_{\delta}^{D} = \frac{\delta(1-q)\left[1+\sqrt{1-m+m\left[1-F\left(\epsilon^{*}\right)\right]^{2}}\right]}{1-q-\delta q\sqrt{1-m+m\left[1-F\left(\epsilon^{*}\right)\right]^{2}}} > p_{\delta}^{C}, \tag{26}$$

$$p_{0}^{D} = \frac{\delta(1-q)\left[1-F\left(\epsilon^{*}\right)+\sqrt{1-m+m\left[1-F\left(\epsilon^{*}\right)\right]^{2}}\right]}{1-q-\delta q\sqrt{1-m+m\left[1-F\left(\epsilon^{*}\right)\right]^{2}}} > p_{0}^{C}. \tag{27}$$

We now construct the equilibrium offer price function $V_{Acq}^{D}(p)$. Since the steps involved are the same as in the commitment case in Section 3, our presentation of the analysis is brief.

First, if $p \leq p_{0}^{D}$, then $V_{Acq}^{D}(p) = p$ and the entrepreneur rejects the offer. Next consider $p > p_{0}^{D}$. The entrepreneur's reservation value is given by

$$V_{Res}^{D}(p) = \max\left(\phi(p)V_{IPO}^{D}, p-\delta\right) \tag{28}$$

$$= \begin{cases} \phi(p)V_{IPO}^{D} & \text{if } p \leq p_{\delta}^{D}, \\ p-\delta & \text{if } p > p_{\delta}^{D}. \end{cases}$$

While (28) has the same functional form as (12), the reservation value in (28) increases more steeply with firm type, since $V_{IPO}^{D} > V_{IPO}^{C}$.

The expert's expected payoff from making the offer $V^D_{Acq}(p')$ when the firm type is p is

$$\pi^D(p,p') = -V^D_{Acq}(p') + \int\limits_{\epsilon=-\infty}^{\bar{\epsilon}(p,p')} \left(\phi(p)\frac{p'}{\phi(p')} - \Delta_\epsilon\right) f(\epsilon)\, d\epsilon + \int\limits_{\epsilon=\bar{\epsilon}(p,p')}^{\infty} (p+\epsilon-\delta)\, f(\epsilon)\, d\epsilon, \quad (29)$$

where $\bar{\epsilon}(p,p')$ denotes the value of ϵ at which the expert is indifferent between an intermediated sale and remaining private at date $t=2$. Differentiating (29) with respect to p', we have

$$\begin{aligned} \frac{\partial \pi^D(p,p')}{\partial p'} &= -V^{D'}_{Acq}(p') + \int\limits_{\epsilon=-\infty}^{\bar{\epsilon}(p,p')} \left(\phi(p)\frac{1-q}{(\phi(p'))^2}\right) f(\epsilon)\, d\epsilon \quad (30) \\ &= -V^{D'}_{Acq}(p') + F(\bar{\epsilon}(p,p'))\frac{(1-q)\,\phi(p)}{(\phi(p'))^2}. \end{aligned}$$

Note that in obtaining (30), the terms that correspond to the derivative of $\bar{\epsilon}(p,p')$ with respect to p' drop out, since the two integrands in (29) evaluated at $\bar{\epsilon}(p,p')$ coincide with each other. Evaluating (30) at $p'=p$ and using the result from Lemma 5 that $\bar{\epsilon}(p,p)=\epsilon^*$ for all p, we obtain the incentive compatibility condition

$$V^{D'}_{Acq}(p) \geq \frac{F(\epsilon^*)(1-q)}{\phi(p)}, \quad (31)$$

with the inequality binding if $V^D_{Acq}(p) > V^D_{Res}(p)$. Note that the term $F(\epsilon^*)$ on the right-hand side of (31) is less than one. Therefore, the incentive compatibility constraint is more relaxed with discretion relative to the commitment case in (17).

Integrating (31) and using the fact that the expert's expected payoff is zero when $p = p^D_0$, we obtain

$$V^D_{IC}(p) = p^D_0 - [1-F(\epsilon^*)]\,\delta + F(\epsilon^*)\frac{1-q}{q}\ln\left(\frac{\phi(p)}{\phi(p^D_0)}\right). \quad (32)$$

Similar to the commitment case, the equilibrium offer price for $p > p_0^D$ is given by

$$V_{Acq}^D(p) = \max\left(V_{Res}^D(p), V_{IC}^D(p)\right). \tag{33}$$

To analyze whether the expert is better off with commitment or discretion, we compute the expert's expected payoff given a match with a randomly drawn firm type. Specifically, let $E(\pi^i(p))$ denote the expectation of $\pi^i(p)$ over the uniformly-distributed firm type $p \in (0,1)$, where $i \in \{C, D\}$. The following results provide a partial comparison of $E(\pi^C(p))$ and $E(\pi^D(p))$:

Proposition 3. *Assume $2\delta q\sqrt{1-m} \geq 1-q$, so that the incentive compatibility constraint is not binding in the commitment case (see Lemma 3). Then the expert strictly prefers commitment to discretion: $E(\pi^C(p)) > E(\pi^D(p))$.*

Proposition 4. *For sufficiently small q, the expert strictly prefers discretion to commitment: $E(\pi^D(p)) > E(\pi^C(p))$.*

Propositions 3 and 4 illustrate the trade-off the expert faces in choosing between commitment and discretion. The cost of discretion is that the expert keeps the firm private with positive probability and thus incurs the private firm discount. The benefit of discretion is that it relaxes the incentive compatibility constraint. Precisely because resale is less likely with discretion, the expert's incentive to signal a higher firm type is reduced, which results in lower equilibrium offer prices than in the commitment case. If the incentive compatibility constraint is not binding with commitment, which is the case when information quality q is sufficiently high, then it is not binding with discretion either, and therefore commitment dominates discretion. If q is sufficiently low, however, the incentive compatibility constraint binds tightly, resulting in high equilibrium offer prices with commitment. In this case, the benefit of relaxing the incentive compatibility constraint is large enough to offset the cost of inefficient ownership, making discretion preferable for the expert.

6. Discussion

While our model is intended to provide a general analysis of intermediation in going-public transactions, a number of institutional arrangements and vehicles observed in practice have elements in common with the model. In this section, we discuss these similarities as well as some differences between the model and real-world intermediaries.

The intermediation mechanism that we consider in our base model is one in which the intermediary quickly resells the firm after acquiring it. This mechanism is broadly similar to the role investment banks play in firm-commitment underwriting of security offerings. However, underwriters often resort to the so-called book-building procedure to price the issue before purchasing the shares from the issuer, thus mitigating much of the resale pricing risk that is central to the signaling equilibrium in our model. Similarly, while lead arrangers in loan syndicates or securitization vehicles face some pipeline risk (i.e., the risk of a negative price shock before distribution to ultimate investors), communication and ongoing relationships with investors tend to alleviate this risk.

SPACs, which have recently become an increasingly popular alternative to traditional IPOs, exhibit closer parallels with the intermediation mechanism in our base model. A SPAC is organized by sponsors as a publicly-traded blank-check company seeking to acquire a private firm. The intermediated sale in our model resembles the design features of a SPAC in three important ways. First, the expert's commitment to resell the firm in the public market mirrors the de-SPAC (i.e., the acquisition) portion of a SPAC transaction: The acquired firm automatically becomes public, since the SPAC is already publicly traded but has no other operating assets.[13] Second, the observable acquisition price required for signaling in the model maps directly into the SPAC structure, where the price of the SPAC acquisition is a matter of public record. Third, the expert's exposure to resale pricing risk due to the arrival of public information is consistent with standard lock-up periods for SPAC sponsor shares of one year or longer, which leaves the sponsor exposed to the valuation risk of the acquired firm. Similarly, institutional investors (such as hedge funds or private equity firms) that often provide PIPE financing to the SPAC at the de-SPAC stage bear substantial price risk due to lock-up periods.[14] Resale pricing risk for the sponsor and PIPE investors likely extends beyond lock-up periods as well due to the relatively large size and illiquidity of their holdings.

Our model does not capture all important aspects of SPACs. For example, misalignment of interests between SPAC sponsors and SPAC shareholders may distort decision-making (Chatterjee, Chidambaran, and Goswami, 2016; Luo and Sun, 2022; Gryglewicz, Hartman-Glazer, and Mayer, 2022; Bai, Ma, and Zheng, 2023). The large presence of retail investors in SPACs generates concern that SPAC sponsors may exploit overconfident investors' appetite for speculative firms (Banerjee and Szydlowski, 2022). The poor stock-price performance of SPACs conducted during the SPAC boom of 2020-2022 (Gahng, Ritter, and Zhang, 2023) may suggest that conflicts of interest in the structure of recent SPACs were paramount. As it pertains to SPACs then, our model might be best interpreted as describing possible long-run outcomes for a viable SPAC market that has sorted out its current problems.[15]

[13]Note that the SPAC having registered as a public entity in advance is crucial to facilitate the commitment to resell to public market investors. An alternative, non-public vehicle, in which the sponsor has made an ex-ante promise to start the going-public process (i.e., register with the S.E.C.) *after* the acquisition, would not facilitate the same level of commitment, as the sponsor could plausibly deny responsibility for ex-post delays or the cancellation of that process.

[14]PIPE investors face a lock-up period of six months under SEC Rule 144. While these investors are not directly involved in identifying and negotiating with targets, they have expertise in pricing PIPEs, and SPAC sponsors are likely to account for the anticipated pricing of PIPEs when acquiring a firm.

[15]Changes in regulatory and market practices that are already under way may help address these problems. The SEC has proposed more detailed disclosure requirements for SPACs, including more information about SPAC sponsor compensation and conflicts of interest. Redemption rates in SPACs have increased

In contrast to the commitment case, intermediation with discretion to resell in our model extension resembles a PE investment in a private company that might otherwise have considered going public. Such PE investments may be structured as buyouts, growth equity injections, or late-stage venture capital investments, with an eventual IPO being a natural exit. Our analysis highlights the main trade-off these transactions involve relative to the firm becoming public without delay. On the one hand, delaying the floating of the firms' shares publicly implies that the PE investor is less concerned about signaling firm value to public market investors, which allows the PE investor to acquire the firm or an equity stake in it at a lower premium. On the other hand, discretion to resell at a later date generates an adverse selection discount at the time of resale, since the PE investor is likely to accumulate private information over the course of its ownership. Our results suggest that a PE investment that postpones the going-public transaction may be preferable when informational frictions render becoming public immediately – either directly or via an intermediary – particularly costly.[16]

7. Conclusion

We analyze a model in which an informed expert can intermediate the going public process between informed entrepreneurs and uninformed public market investors. Our analysis emphasizes the signaling role of the publicly observed acquisition price in intermediated sales. Because the expert is exposed to resale pricing risk, the acquisition price he is willing to pay to the entrepreneur constitutes a signal of firm value and allows for a separating equilibrium. We show that the equilibrium acquisition price can exceed the entrepreneur's reservation

substantially, exceeding 80% in 2022, reducing the role of retail investors in financing SPAC acquisitions. Shareholder SPAC litigation has also bloomed in response to poorly-performing SPAC IPOs.

[16] Another potential application that has the flavor of our model extension with discretion is venture debt. Intended to satisfy capital needs of VC-backed firms in between equity financing rounds, venture debt is typically provided by lenders that specialize in the venture capital industry. A common feature of venture debt is the inclusion of warrants on future equity issuances by the borrower, which can be exercised at the lender's discretion.

value – that is, the expert may share the gains from intermediation with the entrepreneur – when informational frictions are more severe, even though the expert has all of the bargaining power in the model. This result has two important implications. First, when entry is costly, there can be under-entry because the expert may not fully internalize the value his entry generates by facilitating more firms becoming public. Second, when we consider alternative intermediation structures, we find that the expert may prefer discretion to keep the acquired firm public, despite increased adverse selection at the resale stage, in order to reduce the signaling costs at the acquisition stage. Overall, our results highlight the relevance of informational frictions for the structure and the efficiency of the markets for going public.

Intermediated sales in our model share many features of transactions observed in practice. These include SPACs, which resemble our baseline model with commitment to resell, and PE buyouts, which resemble the extension of the model to the case with discretion to resell. Given the growing importance of such transactions as alternatives to the traditional IPO process, our analysis of the interactions and spillover effects between different forms of going public can provide useful insights for practitioners and regulators. It can also shed light on intermediation practices observed in other contexts and guide future research into these practices.

Appendix A. Proofs

Proof of Lemma 1. Solving for p_δ in (4) and p_0 in (5) in terms of V_{IPO} and substituting them into (6) results in a quadratic equation with no linear term, whose positive root is (7). Equations (8) and (9) follow from substituting (7) into (4) and (5), respectively, and rearranging terms. The expression in the denominators in (8) and (9), $1 - q - \delta q\sqrt{1-m}$, is positive by Assumption 1. The inequality $p_\delta < 1$ in (8) also follows from Assumption 1. The comparative statics stated in the Lemma follow directly from differentiating (7) through (9) with respect to δ, q, and m. □

Proof of Lemma 2. To establish necessity, suppose that the inequality constraint in (17) does not hold. If $V'_{Acq}(p) < (1-q)/\phi(p)$, a deviation to $V_{Acq}(p')$, where p' is sufficiently close to p from above, is profitable for the expert and accepted by the entrepreneur. Similarly, if $V_{Acq}(p) > V_{Res}(p)$ and $V'_{Acq}(p) > (1-q)/\phi(p)$, a deviation to $V_{Acq}(p')$, where p' is sufficiently close to p from below, is profitable for the expert and accepted by the entrepreneur. Both deviations thus contradict the incentive compatibility requirement stated in the Lemma. To establish sufficiency, write

$$\begin{aligned}\pi(p,p') - \pi(p,p) &= \int_{x=p}^{p'} \left(-V'_{Acq}(x) + \phi(p)\frac{1-q}{[\phi(x)]^2}\right) dx \\ &\le \int_{x=p}^{p'} \left(-V'_{Acq}(x) + \phi(x)\frac{1-q}{[\phi(x)]^2}\right) dx \\ &= \int_{x=p}^{p'} \left(-V'_{Acq}(x) + \frac{1-q}{\phi(x)}\right) dx \le 0.\end{aligned} \tag{A.1}$$

The first inequality in (A.1) follows from (16). For $p' > p$, the second inequality follows directly from (17). For $p' < p$, note that

$$V_{Acq}(x) > V_{Acq}(p') \geq V_{Res}(p) > V_{Res}(x) \tag{A.2}$$

for all $x \in (p', p)$. Therefore, the inequality constraint in (17) is binding for $x \in (p', p)$, and thus the integral in the last line of (A.1) equals zero. □

Proof of Lemma 3. The parametric condition

$$2\delta q\sqrt{1-m} \geq 1-q \tag{A.3}$$

follows from evaluating inequality (18) at p_0 using the closed-form expressions for V_{IPO} and p_0 from (7) and (9).[17]

i. If (A.3) is satisfied, $V'_{Res}(p) > (1-q)/\phi(p) = V'_{IC}(p)$ and thus $V_{Res}(p) > V_{IC}(p)$ for $p > p_0$. The incentive compatibility of $V_{Acq}(p) = V_{Res}(p)$ also follows from (A.3).

ii. If (A.3) is not satisfied, $V'_{Res}(p) < (1-q)/\phi(p) = V'_{IC}(p)$ at $p = p_0$, and thus $V_{IC}(p) > V_{Res}(p)$ for p sufficiently close to p_0 from above. Note that $V'_{IC}(p) \searrow 0$, while $V_{Res}(p)$ is piece-wise linear with an increased slope at p_δ. Therefore, there exists a unique $p^* > p_0$ such that $V_{IC}(p) > V_{Res}(p)$ if and only if $p < p^*$. It follows that $p_{IC} = \min\{p^*, 1\}$. The incentive compatibility of $V_{Acq}(p) = \max(V_{Res}(p), V_{IC}(p))$ follows from the fact that the inequality constraint (17) is binding for all $p \in [p_0, p_{IC}]$ by construction of the function $V_{IC}(p)$.

□

[17] There exist parameter values that satisfy both Assumption 1 and (A.3). Specifically, when $q > 2/3$, the set of feasible δ and m values that satisfy both conditions is non-empty.

Proof of Lemma 4. Let $p^* = p_0$ if $2\delta q\sqrt{1-m} \geq 1-q$ and $p^* = p_{IC}$ defined in Lemma 3 if $2\delta q\sqrt{1-m} < 1-q$. We now can write

$$g(m) = E(\pi(p)) = \int_{p=p_0}^{p^*} (p - V_{IC}(p))\, dp + \int_{p=p^*}^{1} (p - V_{Res}(p))\, dp. \tag{A.4}$$

Using $V_{IC}(p_0) = p_0$ and $V_{IC}(p^*) = V_{Res}(p^*)$, we have

$$g'(m) = -\int_{p=p_0}^{p^*} \frac{dV_{IC}(p)}{dm} dp - \int_{p=p^*}^{1} \frac{dV_{Res}(p)}{dm} dp. \tag{A.5}$$

Therefore,

$$\Pi'(m) = -g(m) + (1-m)g'(m) \tag{A.6}$$

exists and is continuous. To prove the Lemma, it is thus sufficient to show that $g'(m) > 0$ and that

$$\frac{d}{dm}\left[(1-m)g'(m)\right] < 0. \tag{A.7}$$

In (A.7) and other expressions below, the terms $d/dm\,[\cdot]$ denote right-hand derivatives.[18]

There are four cases to be considered:

Case 1: The incentive compatibility constraint is binding for all $p \geq p_0$, i.e., $p^* = 1$.

$$g(m) = \int_{p=p_0}^{1} (p - V_{IC}(p))\, dp \tag{A.8}$$

$$= \int_{p=p_0}^{1} \left[p - p_0 - \frac{1-q}{q} \ln\left(\frac{\phi(p)}{\phi(p_0)}\right)\right] dp.$$

[18] The second derivative $g''(m)$ exists except at a finite set of m values. Specifically, when $p_{IC} \in \{p_0, p_\delta, 1\}$, $g''(m)$ does not exist, because the left- and right-hand derivatives of $g'(m)$ differ from each other. These m values correspond to the boundaries of the four cases described below in the proof. The intervals of p^* that describe these four cases are chosen so that the right-hand derivative always exists.

Differentiating with respect to m,

$$g'(m) = -\int_{p=p_0}^{1} \frac{qp_0}{\phi(p_0)} \frac{dp_0}{dm} dp = -\frac{(1-p_0)(\delta q\sqrt{1-m})}{(1-q)} \frac{dp_0}{dm}. \tag{A.9}$$

Differentiating p_0 with respect to m, we obtain

$$\frac{dp_0}{dm} = -\frac{p_0^2}{2\delta(1-m)^{3/2}} < 0. \tag{A.10}$$

Substituting into (A.9), we have

$$g'(m) = \frac{q\,(1-p_0)\,p_0^2}{2(1-q)(1-m)} > 0. \tag{A.11}$$

Multiplying (A.11) by $1-m$ and differentiating with respect to m, we have

$$\frac{d}{dm}\left[(1-m)g'(m)\right] = \frac{qp_0(2-3p_0)}{2(1-q)} \frac{dp_0}{dm} < 0. \tag{A.12}$$

The inequality in (A.12) follows from (A.10) and the fact that $p_0 < 1/2$ and thus $2-3p_0 > 0$.

Case 2: The incentive compatibility constraint is binding at p_δ but not everywhere, i.e., $p^* \in [p_\delta, 1)$.

$$\begin{aligned} g(m) &= \int_{p=p_0}^{p^*} (p - V_{IC}(p))dp + \int_{p=p^*}^{1} (p - V_{Res}(p))dp \qquad \text{(A.13)} \\ &= \int_{p=p_0}^{p^*} \left[p - p_0 - \frac{1-q}{q} \ln\left(\frac{\phi(p)}{\phi(p_0)}\right)\right] dp + \int_{p=p^*}^{1} \delta dp. \end{aligned}$$

Differentiating with respect to m,

$$g'(m) = -\int_{p=p_0}^{p^*} \frac{qp_0}{\phi(p_0)} \frac{dp_0}{dm} dp \tag{A.14}$$

$$= \frac{q(p^* - p_0)p_0^2}{2(1-q)(1-m)} > 0.$$

The inequality follows because $p^* > p_\delta > p_0$. Multiplying (A.14) by $1-m$ and differentiating with respect to m, we have

$$\frac{d}{dm}\left[(1-m)g'(m)\right] = \frac{qp_0}{2(1-q)}\left[2\left(p^* - p_0\right)\frac{dp_0}{dm} + p_0\left(\frac{dp^*}{dm} - \frac{dp_0}{dm}\right)\right]. \tag{A.15}$$

Since $p^* > p_\delta$, the outside option of firm type p^* is to remain private. Therefore,

$$p_0 + \frac{1-q}{q}\ln\left(\frac{\phi(p^*)}{\phi(p_0)}\right) = p^* - \delta. \tag{A.16}$$

Differentiating both sides of (A.16) with respect to m gives

$$\frac{dp^*}{dm} = \frac{\phi(p^*)p_0}{\phi(p_0)p^*}\frac{dp_0}{dm}. \tag{A.17}$$

Substituting (A.17) into (A.15), we have

$$\frac{d}{dm}\left[(1-m)g'(m)\right] = \frac{qp_0}{2(1-q)}\left[2p^* - 3p_0 + \frac{\phi(p^*)p_0^2}{\phi(p_0)p^*}\right]\frac{dp_0}{dm} < 0. \tag{A.18}$$

The inequality in (A.18) follows from (A.10) and the fact that $2p^* - 3p_0 > 0$, which in turn obtains because $p^* > p_\delta > 2p_0$.

Case 3: The incentive compatibility constraint is binding at p_0 but not p_δ, i.e., $p^* \in [p_0, p_\delta)$.

$$g(m) = \int_{p=p_0}^{p^*} (p - V_{IC}(p))dp + \int_{p=p^*}^{1} (p - V_{Res}(p))dp \tag{A.19}$$

$$= \int_{p=p_0}^{p^*} \left[p - p_0 - \frac{1-q}{q} \ln\left(\frac{\phi(p)}{\phi(p_0)}\right)\right] dp$$

$$+ \int_{p=p^*}^{p_\delta} \left[p - \phi(p)\frac{\delta\sqrt{1-m}}{1-q}\right] dp + \int_{p=p_\delta}^{1} \delta dp.$$

Differentiating with respect to m,

$$g'(m) = \int_{p=p_0}^{p^*} \frac{qp_0^2}{2(1-q)(1-m)} dp + \int_{p=p^*}^{p_\delta} \frac{\delta\phi(p)}{2(1-q)\sqrt{1-m}} dp > 0. \tag{A.20}$$

Multiplying (A.20) by $1-m$ and differentiating with respect to m, we have

$$\frac{d}{dm}\left[(1-m)g'(m)\right] = -\int_{p=p_0}^{p^*} \frac{qp_0^3}{2\delta(1-q)(1-m)^{3/2}} dp - \int_{p=p^*}^{p_\delta} \frac{\delta\phi(p)}{4(1-q)\sqrt{1-m}} dp \tag{A.21}$$

$$+ \frac{\delta\phi(p_\delta)\sqrt{1-m}}{2(1-q)} \frac{dp_\delta}{dm} - \frac{qp_0^2}{2(1-q)} \frac{dp_0}{dm}$$

$$+ \left[\frac{qp_0^2}{2(1-q)} - \frac{\delta\phi(p^*)\sqrt{1-m}}{2(1-q)}\right] \frac{dp^*}{dm}.$$

The sum of the two integrals in the first line of (A.21) is negative. To evaluate the sign of the second line, note that

$$p_\delta = p_0 + \frac{\delta(1-q)}{1-q-\delta q\sqrt{1-m}} \Rightarrow \frac{dp_\delta}{dm} < \frac{dp_0}{dm} < 0, \tag{A.22}$$

and that

$$\delta\phi(p_\delta)\sqrt{1-m} = \frac{(1-q)p_0\phi(p_\delta)}{\phi(p_0)} > (1-q)p_0 > qp_0^2. \tag{A.23}$$

The second inequality in (A.23) holds because the incentive compatibility constraint is binding at p_0, and thus $1 - q > qp_0$. It follows that the sum of the terms in the second line of (A.21) is negative as well. To evaluate the sign of the third line in (A.21), note that the outside option of firm type p^* is to conduct an IPO since $p^* < p_\delta$. Therefore,

$$p_0 + \frac{1-q}{q} \ln \left(\frac{\phi(p^*)}{\phi(p_0)} \right) = \phi(p^*) \frac{\delta\sqrt{1-m}}{1-q}. \tag{A.24}$$

Differentiate both sides of (A.24) with respect to m to obtain

$$\left(\frac{1-q}{\phi(p^*)} - \frac{\delta q \sqrt{1-m}}{1-q} \right) \frac{dp^*}{dm} = \frac{qp_0^2}{2(1-q)(1-m)} - \frac{\delta \phi(p^*)}{2(1-q)\sqrt{1-m}}. \tag{A.25}$$

Using (A.25), we can write the third line of (A.21) as

$$(1-m) \left(\frac{1-q}{\phi(p^*)} - \frac{\delta q \sqrt{1-m}}{1-q} \right) \left(\frac{dp^*}{dm} \right)^2 < 0. \tag{A.26}$$

The inequality in (A.26) follows from the fact that $V'_{IC}(p^*) < V'_{Res}(p^*)$; that is, $V_{IC}(p)$ approaches $V_{Res}(p)$ from above as $p \nearrow p^*$. We have thus proved that the right-hand side of (A.21) is negative.

Case 4: The incentive compatibility constraint is not binding for any $p \geq p_0$.

$$\begin{aligned} g(m) &= \int_{p=p_0}^{1} (p - V_{Res}(p))dp \\ &= \int_{p=p_0}^{p_\delta} \left[p - \phi(p) \frac{\delta\sqrt{1-m}}{1-q} \right] dp + \int_{p=p_\delta}^{1} \delta dp. \end{aligned} \tag{A.27}$$

Differentiating with respect to m,

$$g'(m) = \int_{p=p_0}^{p_\delta} \frac{\delta \phi(p)}{2(1-q)\sqrt{1-m}} dp > 0. \tag{A.28}$$

Multiplying (A.28) by $1-m$ and differentiating with respect to m, we have

$$\frac{d}{dm}\left[(1-m)g'(m)\right] = \frac{-1}{4\sqrt{1-m}}\int_{p=p_0}^{p_\delta}\frac{\delta\phi(p)}{1-q}dp + \frac{\delta\sqrt{1-m}}{2(1-q)}\left[\phi(p_\delta)\frac{dp_\delta}{dm} - \phi(p_0)\frac{dp_0}{dm}\right] < 0. \tag{A.29}$$

The inequality in (A.29) obtains because $dp_\delta/dm < dp_0/dm < 0$ from (A.22) and $\phi(p_\delta) > \phi(p_0) > 0$. □

Proof of Proposition 2. The proof follows from the concavity of $\Pi(m)$ and the fact that $\Pi(1) = 0$. □

Proof of Lemma 5. i. Given the expert's equilibrium strategy described in part (ii) of the Lemma, the expected resale price equals $E(X+\epsilon \mid p, s, \epsilon < \delta - \Delta_\epsilon)$. Since X and ϵ are independent, the expert's expected payoff from a resale is thus $p + E(\epsilon \mid \epsilon < \delta - \Delta_\epsilon)$. Define

$$\Delta_\epsilon = -E\left(\epsilon \mid \epsilon < \delta - \Delta_\epsilon\right) = \frac{\sigma\phi\left(\frac{\delta-\Delta_\epsilon}{\sigma}\right)}{\Phi\left(\frac{\delta-\Delta_\epsilon}{\sigma}\right)}, \tag{A.30}$$

where ϕ and Φ are the probability density and cumulative distribution functions of the standard normal distribution, respectively, and their ratio is the inverse Mills ratio. Denoting $t = \frac{\delta-\Delta_\epsilon}{\sigma}$, we can write the equilibrium condition (A.30) as

$$\frac{\phi(t)}{\Phi(t)} = -t + \frac{\delta}{\sigma}. \tag{A.31}$$

Using the properties of the inverse Mills ratio that $\phi(t)/\Phi(t)+t$ is positive for all t and that it approaches zero as $t \to -\infty$, there exists a unique $t^* < \delta/\sigma$ that satisfies (A.31). Thus, given δ and σ, there exists a unique Δ_ϵ.

ii. Given the equilibrium prices described in part (i) of the Lemma, the expert's expected payoff from a resale equals

$$\phi(p)\frac{p}{\phi(p)} - \Delta_\epsilon = p - \Delta_\epsilon, \tag{A.32}$$

whereas his expected payoff from remaining private equals $p + \epsilon - \delta$. Therefore, the expert chooses a resale if and only if

$$\epsilon < \epsilon^* = \delta - \Delta_\epsilon. \tag{A.33}$$

□

Proof of Lemma 6. The equations characterizing p_δ^D and V_{IPO}^D are the same as (4) and (6), respectively, except for the superscript D. Solving for p_δ^D in (4) and p_0^D in (24) in terms of V_{IPO}^D and substituting them into (6) results in a quadratic equation with no linear term, whose positive root is (25). Equations (26) and (27) follow from substituting (25) into (4) and (24), respectively, and rearranging terms. The expression in the denominators in (26) and (27), $1 - q - \delta q\sqrt{1 - m + m\left[1 - F\left(\epsilon^*\right)\right]^2}$, is positive by Assumption 1. That $p_\delta^D < 1$ also follows from Assumption 1. The inequalities stated in the Lemma are obvious from comparisons of (25), (26), and (27) to (7), (8), and (9), respectively. □

Proof of Proposition 3. From Lemma 3, (17) is not binding at $p = p_0^C$ when $2\delta q\sqrt{1-m} \geq 1 - q$. Since $p_0^D > p_0^C$ and $V_{Res}^{D'}(p_0^D) > V_{Res}^{C'}(p_0^D)$, (31) is then not binding at $p = p_0^D$, and thus $V_{Acq}^D(p) = V_{Res}^D(p)$. The result $E(\pi^C(p)) > E(\pi^D(p))$ follows from the fact that $V_{Res}^D(p) \geq V_{Res}^C(p)$, with the inequality being strict for $p \in (p_0^D, p_\delta^D)$. □

Proof of Proposition 4. Commitment: With q sufficiently small, (17) is binding for all $p > p_0^C$ and thus $V_{Acq}^C(p) = V_{IC}^C(p)$. From (19), $V_{IC}^C(p)$ converges to p and $E(\pi^C(p))$ converges to zero as $q \to 0$. Discretion: With q sufficiently small, (31) is binding at $p = p_0^D$. Differentiate (23) to obtain

$$\pi^{D'}(p_0^D) = 1 - V_{IC}^{D'}(p_0^D) = 1 - \frac{F(\epsilon^*)(1-q)}{\phi(p_0^D)} > 0, \tag{A.34}$$

which converges to $1 - F(\epsilon^*) > 0$ as $q \to 0$. It follows that $E(\pi^D(p))$ is positive and bounded away from zero as $q \to 0$. $\square$

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