A Model of Informed Intermediation in the Market for Going Public

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Abstract

We present a model in which informed experts intermediate in the market for going public by acquiring private firms and reselling their shares to public investors. Because information incorporated by the public market generates resale pricing risk for experts, the acquisition prices they pay act as credible signals of firm value. Accordingly, intermediated sales provide a superior alternative for firms that expect to be undervalued in traditional IPOs. We characterize how signaling via the acquisition price affects the sharing of the surplus between the experts and the selling firms. We also analyze the co-existence of intermediated sales and IPOs and the efficiency of the resulting market equilibrium. Our analysis of intermediated sales helps rationalize several design features of Special Purpose Acquisition Companies (SPACs).

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Recent years have witnessed an explosion in the number of private firms going public by merging with Special Purpose Acquisition Companies (SPACs).[1] Structured as a publicly-listed entity whose sole purpose is to explore and compete the acquisition of a private firm, a SPAC effectively intermediates the transfer of the target firm from its private owners to public market investors. The SPAC sponsor – often a former executive or investment professional with industry knowledge – plays a central role in this intermediation process by identifying a target firm and negotiating the acquisition price. The involvement of such expert individuals in SPACs suggests that part of the value created by a SPAC might lie in helping mitigate information frictions in the market for going public.

To explore the potential informational role of SPACs, we analyze a model in which an informed "expert" intermediates the sale of a private firm to public-market investors.[2] The key friction in the model, asymmetric information between the entrepreneur who owns the firm and public-market investors, causes a traditional IPO to be undervalued when the firm value is relatively high. We show that an intermediated transaction in which the expert simply acquires the firm from the entrepreneur at a negotiated price and resells it to the public at the market price completely overcomes the undervaluation problem, despite the expert having exactly the same information as the entrepreneur. In other words, the acquisition price in an intermediated transaction signals the firm type to the market. We also show that the presence of the expert exacerbates the adverse selection problem in the traditional IPO market, which in turn feeds back into the acquisition price of the intermediated sale. Finally, we analyze the market equilibrium that obtains with costly entry by experts and show that both over-entry and under-entry are possible.

[1] According to whitecase.com, the number of SPAC mergers increased from 26 in 2019 to 92 in 2020 and 209 in 2021. The pace of SPAC mergers has slowed in 2022, with 49 completed in the first half of the year, though the IPO market as a whole has contracted at an even faster rate.

[2] While our model abstracts from several features of real-world SPACs, some important aspects of the intermediation role played by the expert in the model resemble the activities of SPAC sponsors in practice. We discuss these parallels in more detail in Section 5 below.

The key feature that allows for signaling in an intermediated transaction is resale pricing risk, which stems from additional information that public market investors produce before purchasing shares. To illustrate the intuition, we consider a two-type example that we discuss in detail in Section 1. In an intermediated transaction, 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 close from below to 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.[3] Importantly, unlike many other proposed forms of signaling in the equity market, such as retention (e.g., Leland and Pyle, 1977), the signal sent by the expert's acquisition price 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 value is 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 matched with an expert but rejects the expert's offer or is not matched with an expert, then the entrepreneur chooses to either take the firm public in a traditional IPO or keep the firm private. After an acquisition by an expert or decision to undertake a traditional IPO but before the market establishes a price for the firm, public market investors receive a noisy signal about firm value.[4]

[3]Note that signaling through the acquisition price requires an arm's length transaction: This mechanism is not available to the entrepreneur in a traditional IPO because the entrepreneur already owns the firm.

[4]The paper's conclusions rely on public market investors receiving a signal after an acquisition by the

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, 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 creates a "cream-skimming" effect on the traditional IPO market. While the most valuable firms remain private when not matched with an expert, there is a subset of moderately high valued firms acquired by an expert that would have gone public in a traditional IPO if not matched. As a result, the expert's potential presence degrades the IPO pool and hence reduces the equilibrium IPO price. A lower IPO price results in a higher likelihood that an unmatched firm remains private. In addition, the lower IPO price worsens the entrepreneur's outside option when her firm is matched with an expert, increasing the likelihood that she sells to the expert, further degrading the IPO pool. 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. 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 price

expert. We assume that investors also receive a signal after a decision to undertake a traditional IPO to maintain a level playing field.

in a traditional IPO and the firm's value if it remains private. However, the entrepreneur's reservation value may not be a high enough offer price to allow for separation when public investors' signal is weak, for two reasons. First, a weak signal implies that the expected IPO price for the entrepreneur varies little with true firm value. Second, the expert faces relatively little risk of being exposed by the market, which increases his temptation to overbid in order to pretend that the firm value is higher than it actually is. For both of these reasons, the equilibrium acquisition price needs to increase more steeply in firm value than the entrepreneur's reservation value does to allow for separation. Thus, the equilibrium acquisition price can exhibit a premium over the entrepreneur's reservation value when information quality in the public market is low.

After characterizing the equilibrium of the model with a single entrepreneur and expert, we extend the model to the case with 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. An expert creates social value when he intermediates the sale of a firm that would otherwise remain private. 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 fully internalizes the social value created by intermediation if he pays the entrepreneur her reservation value (i.e., the value of the firm if it remains private). 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 that the expert pay higher prices to successfully separate from worse types.

The combination of an arm's length acquisition at a publicly-observed price by an informed party and a commitment to resell the firm at the market-determined price gives the expert in our model the flavor of a SPAC. We consider factors that might explain the rise of SPACs in recent years through the lens of the model. One possible factor is the number of former executives becoming investors through their involvement with private equity in the last decade. In the context of the model, this shift increases the probability that a firm is matched with an expert. Another possible factor is the increasing prevalence of startup firms going public. Because a startup has a short track record by definition, the arrival rate of information about its value is likely to be high. The rapid arrival of information increases the pricing risk that an expert faces in an intermediated transaction, which makes signaling through acquisition price more credible, resulting in more intermediated transactions.

In a final extension, we allow the expert to choose *ex ante* whether to commit to a resale or maintain the discretion to sell selectively after completing an acquisition. The latter alternative is similar to 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. To motivate this analysis, we assume that the expert observes additional information about firm value after acquiring the firm. 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 have a more valuable firm by offering a higher price to the entrepreneur since the signal is wasted when the expert retains the firm. Thus, the acquisition price that allows for separation increases less steeply with firm value than in the commitment case, reducing the expected premium paid to the entrepreneur.

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 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.

We also contribute to the small but growing literature on SPACs. Gahng, Ritter, and Zhang (2021) provide a detailed discussion of the contrast between SPACs and traditional IPOs as alternative ways of going public, and document investor and sponsor returns in recent SPAC transactions. A number of recent studies present theoretical analyses that emphasize the potential conflicts of interest between SPAC sponsors and investors (Chatterjee, Chidambaran, and Goswami, 2016; Bai, Ma, and Zheng, 2021; Luo and Sun, 2021; Gryglewicz, Hartman-Glazer, and Mayer, 2021).[5] Our model, which abstracts from frictions between experts and their investors, complements these studies by analyzing the signaling aspect of SPAC acquisitions and the resulting implications for the traditional IPO market.

Finally, our analysis shares some theoretical ingredients and results with a number of studies whose focus is not the markets for going public. Both Fishman and Parker (2015) and Bolton, Santos, and Scheinkman (2016) present models in which informed investors exacerbate adverse selection in asset markets by cream-skimming high quality assets. In

[5] See also Banerjee and Szydlowski (2021), which provides a rationale for SPACs based on investor overconfidence.

Daley, Green, and Vanasco (2020), 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.

The remainder of the paper is organized as follows. Section 1 presents a simple example that illustrates the key intermediation mechanism in our model. 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 discusses the parallels between our model and real-world SPACs. Section 6 concludes. Appendix A presents the analysis of an alternative form of intermediation in which experts have discretion to sell the acquired firms. Appendix B 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 has cash flow of 1 with probability 2/3, or a low type, in which case it has cash flow of 1 with probability 1/3. Suppose that an expert who observes firm type can buy the firm at a publicly observed price with commitment to resell it to public market investors at the market price – that is, the price that allows investors to break even conditional on their information.

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 always high 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.[6] The probability of a high signal is $1 - \frac{q}{3}$ 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 market's belief that the firm is a high type and observing a high public signal, the market value of the firm is $\frac{2}{3-q}$. 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

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

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 a high type is its full-information value of 2/3. The expert's payoff if it pays 2/3 to acquire a low-type firm is

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

which is strictly negative if $q > 0$. That is, as long as the public signal is informative, the expert would suffer a negative expected profit by paying 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. This pricing risk is 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 buying a high-type firm.

It is easy to see by continuity that the expert can also signal a high firm type by paying

[6] 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.

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 even when the firm type is low but the market values the resale as a high type. This price is given by

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

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 not specified the outside option of the seller of the firm and assessed her willingness to sell to the expert, or 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 the investors in the public market. In Section 4, we extend the model to allow for a continuum of entrepreneurs and free entry of experts. 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 the liquidity needs of the entrepreneur, or the financing constraints a private firm faces.

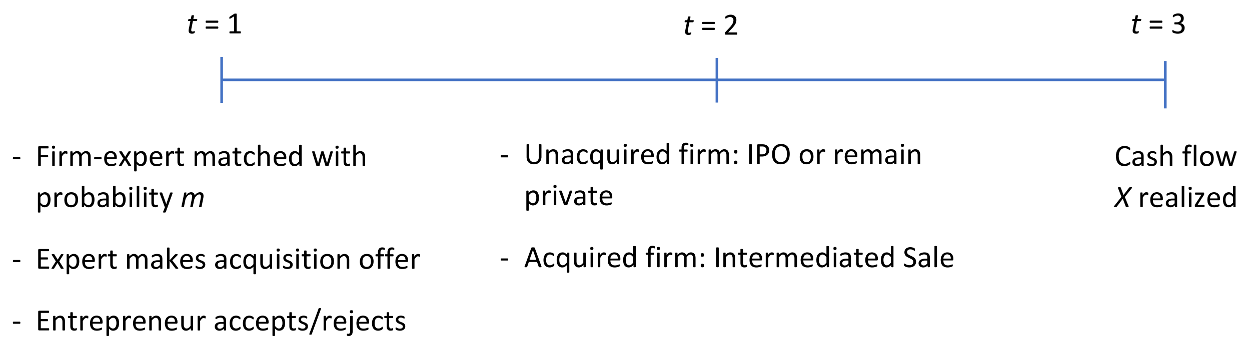
The entrepreneur can sell the firm directly to the public market in an IPO. Alternatively, she can sell the firm to an expert, who acts as an intermediary between the entrepreneur and the public market. For now, we assume that the expert is present with some exogenous likelihood m. We derive this likelihood as an equilibrium outcome in Section 4, where we formally analyze experts entering the market and contracting with investors to raise funds.

Specifically, the firm gets matched with an expert with probability m, or gets matched with no expert with probability $1 - m$. 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 the entrepreneur accepts or rejects.

An important assumption we make is that the expert has a *contractual commitment* to reselling the firm in the public market subsequent to the acquisition. Specifically, if the entrepreneur accepts the offer and thus the acquisition takes place at $t = 1$, the expert has to resell the firm in the public market at $t = 2$. We refer to this alternative, expert-led form of going public as an *intermediated sale*. The commitment aspect of the intermediated sale is similar to the de-SPAC phase of SPAC transactions observed in practice, whereby the SPAC shares reflect the value of the acquired firm immediately after the acquisition. We provide a more detailed discussion of the SPAC interpretation of the intermediated sales in our model in Section 5.

Investors who populate the public market act competitively. If the firm is not acquired by an expert at $t = 1$, public 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 firm is

Figure 1: Timeline



acquired by an expert at $t = 1$, the public investors observe the acquisition price paid by the expert 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 firm is acquired, the intermediated sale takes place. 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 the investors in the public market produce some valuation-relevant information in either kind of sale. Specifically, in a public sale at $t = 2$, investors observe a signal $s \in \{L, H\}$. If the firm cash flow is $X = 1$, then $s = H$ with probability one. If the 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 produced by the public market. After observing the 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.[7]

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 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 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 acquiring the firm and reselling it in 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, $\phi(p)V_{IPO}$; and (if matched) selling the firm

[7] 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 SPACs in Section 5.

to the expert, V_{Acq}.

ii. The expert chooses the 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. Prices in public sales equal the expected values of the firm's cash flow conditional on all publicly available information. The IPO price is zero if $s = L$ and $V_{IPO} = E(X \mid \mathbb{1}_{IPO} = 1, s = H)$ 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 intermediated sale price is zero if $s = L$ and $V_{Int} = E(X \mid V_{Acq}, s = H)$ 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 reveals the firm type to the public before an intermediated sale 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.[8]

3.2. The IPO Market

We start our analysis by characterizing the equilibrium in the IPO market. If the entrepreneur decides to sell her firm in an IPO, the sale takes place at a price conditional on the realization of the public signal s. As discussed above, a low signal $s = L$ reveals that the firm cash flow is zero, and thus results in an IPO price of zero. A high signal $s = H$, however, does not reveal the firm cash flow; therefore, $V_{IPO} > 0$. The entrepreneur with firm type p thus has an expected IPO payoff of $\phi(p)V_{IPO}$, where $\phi(p) = p + (1-p)(1-q)$ is the probability of the high signal $s = H$ conditional on type p.

The indifference thresholds p_δ and p_0 described in Property 1 in Section 3.1 satisfy the following equations:

$$p_\delta - \delta = \phi(p_\delta)V_{IPO} \tag{1}$$

$$p_0 = \phi(p_0)V_{IPO} \tag{2}$$

Equation (1) 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 (2) indicates that firm's IPO is fairly priced in expectation if $p = p_0$. Note

[8] 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.

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, an intermediated sale following an acquisition is always fairly priced in expectation since the offer price reveals the firm type in our conjectured equilibrium. Thus, an acquisition dominates an IPO 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

$$\begin{aligned} V_{IPO} =& E(X|\, \mathbb{1}_{IPO} = 1, s = H) \\ =& \frac{(1-m)\int_{p=0}^{p_\delta} p dp + m \int_{p=0}^{p_0} p dp}{(1-m)\int_{p=0}^{p_\delta} \phi(p) dp + m \int_{p=0}^{p_0} \phi(p) dp} \\ =& \frac{(1-m)p_\delta^2 + m p_0^2}{q((1-m)p_\delta^2 + m p_0^2) + 2(1-q)((1-m)p_\delta + m p_0)}. \end{aligned} \tag{3}$$

Solving (1), (2), and (3) simultaneously, we obtain the following closed-form solutions:

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

$$V_{IPO} = \frac{\delta\sqrt{1-m}}{1-q}, \tag{4}$$

$$p_\delta = \frac{\delta(1-q)\left(1+\sqrt{1-m}\right)}{1-q-\delta q\sqrt{1-m}} < 1, \tag{5}$$

$$p_0 = \frac{\delta(1-q)\sqrt{1-m}}{1-q-\delta q\sqrt{1-m}} < p_\delta, \tag{6}$$

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

All proofs are in Appendix B 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), and when the IPO market is informationally less efficient (low q). Importantly, the potential presence of the expert also exacerbates the adverse selection problem. The expert *cream-skims* by acquiring relatively high firm types and leaving the worse types for the IPO market. Thus, a greater likelihood of the expert being present (high m) results in a lower price V_{IPO} and lower IPO thresholds p_δ and p_0.

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, as conjectured in Property 2, the expert's acquisition offer V_{Acq} is a strictly increasing function of the firm type in equilibrium, which we denote as $V_{Acq}(p)$ hereafter. 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 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:

$$V_{Int}(p) = E(X|\, p, s = H) = \frac{p}{\phi(p)}. \tag{7}$$

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:

$$V'_{Int}(p) = \frac{1-q}{[\phi(p)]^2} > 0. \tag{8}$$

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

$$V_{Res}(p) = \max\left(\phi(p)V_{IPO}, p - \delta\right) \tag{9}$$

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

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

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

$$\max_{p'} \pi(p, p') \equiv -V_{Acq}(p') + \phi(p)V_{Int}(p'), \tag{10}$$

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

$$\pi(p) = -V_{Acq}(p) + \phi(p)V_{Int}(p) = -V_{Acq}(p) + p. \tag{11}$$

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':[9]

$$\frac{\partial \pi(p, p')}{\partial p'} = -V'_{Acq}(p') + \phi(p)\frac{1-q}{[\phi(p')]^2}. \tag{12}$$

Equation (12) 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 cannot 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 (12) is increasing in p:

$$\frac{\partial \pi(p, p')}{\partial p \partial p'} = \frac{q(1-q)}{[\phi(p')]^2} \geq 0. \tag{13}$$

Equation (13) is the Spence-Mirrlees single crossing property, which indicates that conveying a stronger signal is more valuable for higher types. 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*

[9] 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.

payoff $\pi(p,p) \geq \pi(p,p')$ *for any* p' *for which* $V_{Acq}(p') \geq V_{Res}(p)$ *if and only if*

$$V'_{Acq}(p) \geq \frac{1-q}{\phi(p)}, \tag{14}$$

with the inequality constraint in (14) *binding if* $V_{Acq}(p) > V_{Res}(p)$.

While the general intuition for Lemma 2 is fairly standard, the inequality constraint in (14) deserves some explanation. Equation (14) reflects the cost and the benefit of a local deviation; it simply follows from computing (12) at $p' = p$. In most models, incentive compatibility necessitates a condition akin to (14) 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 (14):

$$V'_{Res}(p) \geq \frac{1-q}{\phi(p)} \tag{15}$$

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

Because $\phi(p) = p + (1-p)(1-q) \geq (1-q)$, the inequality in (15) 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 if the inequality in (15) 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, $V_{Acq}(p) > V_{Res}(p)$ for some p, and thus by Lemma 2 the incentive compatibility constraint is binding. Integrate (14) to obtain

$$V_{IC}(p) \equiv V_{Acq}(p_0) + \int_{x=p_0}^{p} \frac{1-q}{\phi(x)} dx \tag{16}$$

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

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 $V_{IC}(p)$:

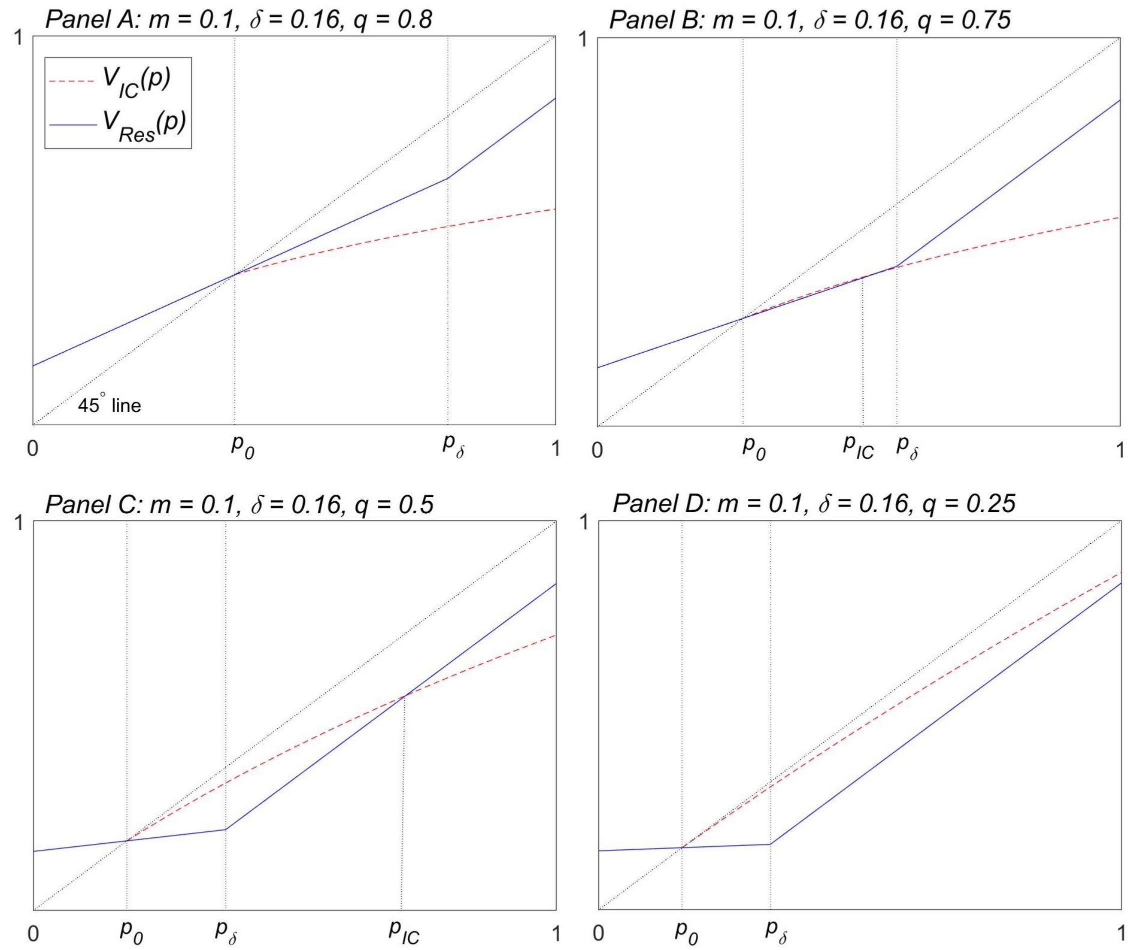
Lemma 3. *The offer price* $V_{Acq}(p) = \max(V_{Res}(p), V_{IC}(p))$ *satisfies the incentive compatibility condition in* (14). *Furthermore:*

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 δ and q are high and m is low. Such parameter values imply a strong IPO market with relatively less adverse selection, which increases the entrepreneur's reservation value. The expert's willingness to meet this high reservation value makes the acquisition price a credible signal of

Figure 2: A numerical example of incentive compatible offer prices



firm type. When the parametric condition is not satisfied, however, paying the entrepreneur her relatively low reservation value is not a sufficiently strong 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 2 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 $p < p_0$.[10] Finally, note that there exists no profitable deviation $V_{Acq}(p') \geq V_{Res}(p)$: the intermediated sale 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 the 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 (9) and $V_{IC}(p)$ is given by (16).

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 (5). 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 (6).

iii. The IPO price is zero if $s = L$ and V_{IPO} in (4) if $s = H$.

[10] 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 $p \in (0, 1)$.

iv. Following an acquisition at price $V_{Acq}(p)$ for $p \in (0,1)$, the intermediated sale price is zero if $s = L$ and $V_{Int}(p)$ in (7) if $s = H$.

We conclude this section with a brief discussion of other potential equilibria in which intermediated sales take place.[11] 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 relatively higher firm types $p > p^*$, these equilibria also feature a cream-skimming effect.[12] 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 reservation value of the latter.

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.

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

[12] 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 enter the market at personal cost c. Let ω denote the number of experts who enter. Upon entry, each expert contracts with outside investors to invest in acquisitions on their behalf. We abstract away from agency frictions between an expert and his investors; thus, the expert is compensated for his services with a fixed fee.[13]

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 is 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 (11) that the expert's payoff from a match with firm type p is $\pi(p)$. Let $g(m)$ denote the expert's expected payoff conditional on a random match, where the expectation is taken with respect to the uniformly-distributed firm type p:

$$g(m) = E(\pi(p)) = E(p - V_{Acq}(p)) . \tag{17}$$

[13] Alternatively and without loss of generality, the expert can be compensated with a stake in the firm he may acquire.

The payoff in (17) is a function of m because the equilibrium offer price $V_{Acq}(p)$ depends on m. Finally, let $\Pi(m)$ denote the expert's ex-ante (i.e., upon entry at $t = 0$) expected payoff:

$$\Pi(m) = (1 - m)g(m). \tag{18}$$

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

Lemma 4. *The 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.*

The expert's ex-ante expected payoff in (18) 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 (18) is always decreasing in m for large m. However, depending on parameter values, (18) can be increasing in m for relatively small values of m. That is, despite the congestion externality, experts may benefit from entry of more 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 entrant expert charges his investors a fee of c and breaks even. Likewise, his investors break even by paying the expert c and receiving the expected payoff $\Pi(m_e) = c$.

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:

$$\begin{aligned}\Psi(m) &\equiv \left[1 - p_\delta(0) - (1-m)(1 - p_\delta(m))\right]\delta - \frac{mc}{1-m} \qquad (19)\\ &= \frac{\delta(1-m)\left[\delta\sqrt{1-m} - (1-\delta)(1-q)\right]}{1 - q - \delta q\sqrt{1-m}} - \frac{mc}{1-m}.\end{aligned}$$

The first line of (19) expresses p_δ as a function of m, and the second line follows from substituting the closed-form formula for p_δ in (5). Equation (19) formulates the welfare criterion in terms of $m = \omega/(1+\omega)$, which corresponds to $\omega = m/(1-m)$. The last term in (19) is thus the deadweight cost of entry incurred by the experts. The bracketed term in (19) 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 (19) is difficult since Ψ is not globally concave or convex. However, identifying the reasons why the competitive equilibrium m_e does not maximize (19) 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. But these matches do not directly affect the welfare criterion (19), 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.

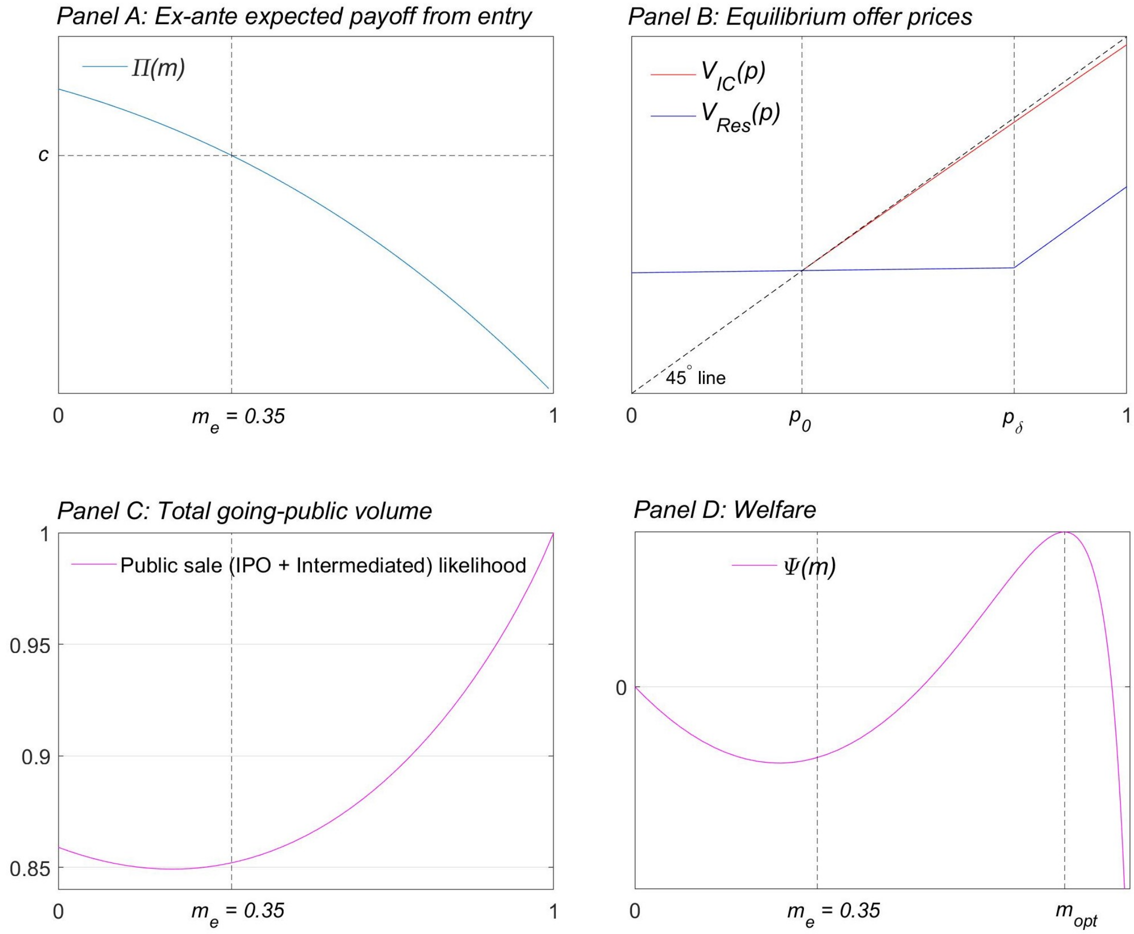
2. Adverse selection: Entry exacerbates adverse selection in the IPO market, lowering p_δ and thus increasing the likelihood that unmatched firms remain private. Since experts do not internalize the resulting welfare loss, this channel also incentivizes over-entry.

3. Surplus sharing: Entry improves welfare by increasing the likelihood that firms with types $p > p_\delta$ 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. The example is summarized in Figure 3.

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 3: 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 a function 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. Discussion

While our model is not a model of a SPAC *per se*, it captures several important features of a SPAC transaction. These features include observation by public market investors of the price the expert pays to acquire a firm, the expert's commitment to resell the firm to public market investors, and the arrival of public information after an acquisition but before the resale price to public investors is established. In this section, we discuss the connection between these features and the features of SPAC transactions.

The observable acquisition price in the model allows the expert to signal the quality of a firm through the price that he pays for it, which has implications for the equilibrium in both the intermediated and non-intermediated markets for going public. This feature maps directly into the SPAC structure, where the price of the SPAC acquisition is a matter of public record. Note that this structure differs from that of a PE buyout of an entrepreneurial company, where the acquisition price is often undisclosed.

The expert's commitment to sell a firm that he acquires mirrors the de-SPAC portion of a SPAC transaction. Like the expert in the model, a SPAC sponsor does not have the discretion to retain a firm after acquiring it. As we note in our analysis of commitment versus discretion in Appendix A, discretion makes the expert more similar to a PE buyer. Our analysis in that Appendix shows that commitment is likely to be optimal when the market receives relatively precise signals about firm value before pricing the firm when it goes public.

In the model, the arrival of public information before the pricing of a going-public transaction limits the expert's return to pretending to be matched to a more valuable firm by paying a higher price, and thus allows for separation through pricing. In practice, two factors potentially amplify the investment risk that the expert faces. First, SPACs typically fund part of an acquisition through a Private Placement of Public Equity (PIPE). PIPE investors are often hedge funds and other sophisticated investors who are likely to be more informed than the average public market investor. Thus, the expert faces investment risk through the pricing of PIPEs. Second, experts typically face lock-up periods of one year or longer after the deSPAC, which leaves them exposed to information arrival for a long period after the acquired firm has already gone public.

Our model does not capture all features of SPAC transactions. For example, we do not model SPAC investors' option to redeem their shares rather than participate in the deSPAC. This feature of the SPAC structure ostensibly helps to address potential agency conflicts between SPAC sponsors and SPAC investors. We abstract away from agency conflicts in order to focus specifically on the role of experts as intermediaries between entrepreneurs and public market investors.

Interpreting intermediated sales as SPAC transactions, our analysis yields several empirical implications regarding the SPAC and traditional IPO markets. Cross-sectionally, Lemma 1 suggests that both traditional IPO and SPAC merger activity will be greater in industries and other market segments characterized by better public information and greater costs of remaining private. The presence of greater numbers of informed potential SPAC sponsors should result in fewer traditional IPOs. In the short run, holding the number of potential SPAC sponsors in a market segment fixed, factors such as regulation that increase (decrease) the net benefit of being publicly-traded or increase (decrease) public information should result in more (fewer) traditional IPOs and SPAC mergers. In the longer run, our analysis in Section 4 suggests that once potential SPAC sponsors have time to respond to changes in the benefits to being public or the degree of public information, increases in either result in more entry. Since more entry increases adverse selection in the traditional IPO market, such changes should have a dampening effect on traditional IPO activity.

6. Conclusion

We analyze a model in which informed experts can intermediate going public transactions between informed entrepreneurs and uninformed public market investors. Intermediated sales in the model share many features of SPACs, with experts playing the role of SPAC sponsors. Experts naturally use their informational advantage to engage in cream-skimming. This cream-skimming results in feedback between the intermediated and traditional (i.e., non-intermediated) markets for going public. Cream-skimming exacerbates adverse selection in the traditional IPO market, which weakens the entrepreneurs' outside option relative to intermediated sales, which further increases the likelihood that firms go public via intermediated transactions.

Our analysis emphasizes the signaling role of the publicly observed acquisition price in intermediated sales. Because the expert is exposed to investment 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 value – that is, the expert may share the gains from intermediation with the entrepreneur – when informational frictions are more severe. This 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.

Appendix A. Commitment versus Discretion in Intermediated Sales

The intermediated sale in our model is intended to capture an important aspect of real-world SPACs, namely, that a firm acquired by a SPAC immediately becomes a publicly-traded entity. In our baseline model, this outcome results from the assumption that an acquisition is always followed by an intermediated sale. While this assumption can be interpreted as the expert having made a pre-commitment to an intermediated sale, such commitment is not really necessary in the model, since the timeline has no informational even between the acquisition and the intermediated sale. The expert would choose to sell even without commitment, since the expected payoff of an intermediated sale, p, exceeds the expected payoff from keeping the acquired firm private and thus missing the benefit of being a public firm, $p - \delta$.

To illustrate the value of commitment more clearly, we briefly analyze a model extension with the revised timeline and payoffs depicted in Figure A.1. Specifically, we assume the following:

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

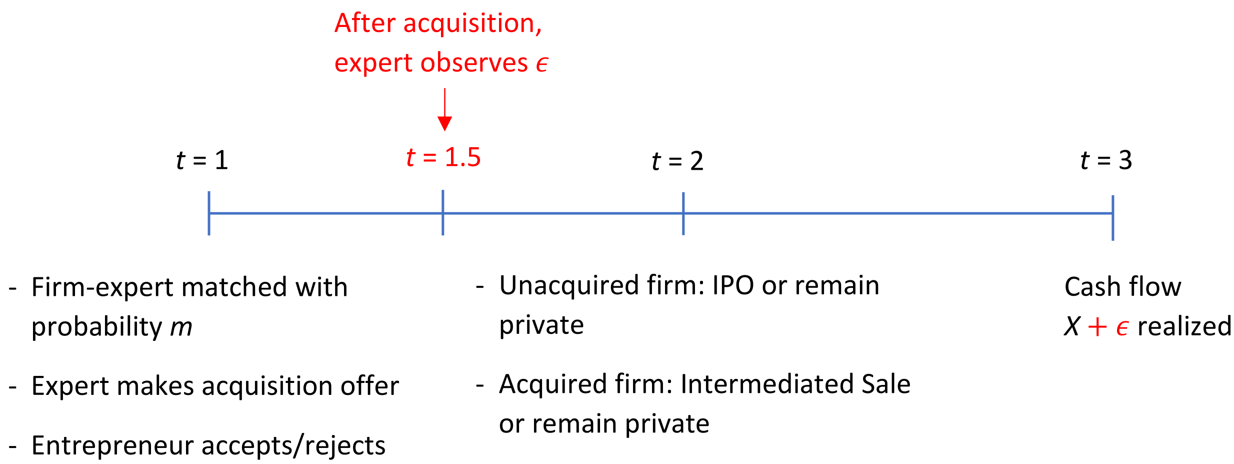
- The events at $t = 1$ are the same as in the baseline model, except that the expert acquires the firm without any commitment to resell in the public market at $t = 2$.

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

- 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 ϵ.

Figure A.1: Revised Timeline



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

The arrival of additional private information ϵ at date $t = 1.5$ can result from both short-term and medium-term events following the acquisition at $t = 1$. The short-term interpretation is relevant for illustrating the public market's concern about adverse selection. For instance, if the expert acquires the firm and, contrary to market's expectations, attempts at a quick resale, investors in the public market may interpret this as a sign that the expert may have stumbled on some negative information about firm value. Alternatively, date $t = 1.5$ can be viewed as the medium term (several months or years) following the acquisition, during which the expert can produce additional information about the firm under his management.[14]

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.

[14] 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.

First, note that the analysis of Section 3 continues to apply without any modifications with the revised timeline in Figure A.1. With commitment to resell, the only decision the expert makes 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 $V_{Acq}^D(p)$ 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 A.1. *Suppose that the expert acquires the firm with the equilibrium offer $V_{Acq}^D(p)$. At $t = 2$:*

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

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

The intuition for Lemma A.1 is straightforward. With discretion, the expert re-sells the firm 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 intermediated sale price includes an additional adverse selection discount Δ_ϵ relative to the commitment case.

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

$$\pi^D(p) = -V_{Acq}^D(p) + \int_{\epsilon=-\infty}^{\epsilon^*} (p - \Delta_\epsilon) f(\epsilon) d\epsilon + \int_{\epsilon=\epsilon^*}^{\infty} (p + \epsilon - \delta) f(\epsilon) d\epsilon \tag{A.1}$$

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

Compared with the commitment case in (11), the equilibrium payoff in (A.1) 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_0^D that is indifferent between an IPO and the expert's offer. Since the expert breaks even with type p_0^D, (A.1) implies the indifference condition

$$p_0^D - [1 - F(\epsilon^*)]\,\delta = \phi(p_0^D) V_{IPO}^D. \tag{A.2}$$

Equation (A.2) 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 (2).

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

Lemma A.2. *The equilibrium in the IPO market with expert discretion to resell is described by*

$$V_{IPO}^D = \frac{\delta\sqrt{1 - m + m\,[1 - F(\epsilon^*)]^2}}{1 - q} > V_{IPO}^C, \tag{A.3}$$

$$p_\delta^D = \frac{\delta(1-q)\left[1 + \sqrt{1 - m + m\,[1 - F(\epsilon^*)]^2}\right]}{1 - q - \delta q\sqrt{1 - m + m\,[1 - F(\epsilon^*)]^2}} > p_\delta^C, \tag{A.4}$$

$$p_0^D = \frac{\delta(1-q)\left[1 - F(\epsilon^*) + \sqrt{1 - m + m\,[1 - F(\epsilon^*)]^2}\right]}{1 - q - \delta q\sqrt{1 - m + m\,[1 - F(\epsilon^*)]^2}} > p_0^C. \tag{A.5}$$

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, $V^D_{Acq}(p) = p$ and the entrepreneur rejects the offer if $p \leq p^D_0$. Next consider $p > p^D_0$. The entrepreneur's reservation value is given by

$$V^D_{Res}(p) = \max\left(\phi(p)V^D_{IPO}, p-\delta\right) \tag{A.6}$$

$$= \begin{cases} \phi(p)V^D_{IPO} & \text{if } p \leq p^D_\delta, \\ p-\delta & \text{if } p > p^D_\delta, \end{cases}$$

While (A.6) has the same functional form as (9), the reservation value in (A.6) increases more steeply with firm type, since $V^D_{IPO} > V^C_{IPO}$.

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

$$\pi^D(p,p') = -V^D_{Acq}(p') + \int_{\epsilon=-\infty}^{\overline{\epsilon}(p,p')} \left(\phi(p)\frac{p'}{\phi(p')} - \Delta_\epsilon\right) f(\epsilon)\,d\epsilon + \int_{\epsilon=\overline{\epsilon}(p,p')}^{\infty} (p+\epsilon-\delta)\, f(\epsilon)\,d\epsilon, \tag{A.7}$$

where $\overline{\epsilon}(p,p')$ denotes the value of ϵ at which the expert is indifferent between an intermediated sale and remaining private at date $t=2$. Differentiating (A.7) with respect to p', we have

$$\frac{\partial \pi^D(p,p')}{\partial p'} = -V^{D'}_{Acq}(p') + \int_{\epsilon=-\infty}^{\overline{\epsilon}(p,p')} \left(\phi(p)\frac{1-q}{\left(\phi(p')\right)^2}\right) f(\epsilon)\,d\epsilon \tag{A.8}$$

$$= -V^{D'}_{Acq}(p') + F\left(\overline{\epsilon}(p,p')\right)\frac{(1-q)\,\phi(p)}{\left(\phi(p')\right)^2}.$$

Note that in obtaining (A.8), the term that corresponds to the derivative of $\overline{\epsilon}(p,p')$ with respect to p' drop out, since the two integrands in (A.7) evaluated at $\overline{\epsilon}(p,p')$ coincide with each other. Evaluating (A.8) at $p' = p$ and using the result from Lemma A.1 that $\overline{\epsilon}(p,p) = \epsilon^*$

for all p, we obtain the incentive compatibility condition

$$V_{Acq}^{D'}(p) \geq \frac{F(\epsilon^*)(1-q)}{\phi(p)}, \tag{A.9}$$

with the inequality binding if $V_{Acq}^{D}(p) > V_{Res}^{D}(p)$. Note that the term $F(\epsilon^*)$ on the right-hand side of (A.9) is less than one. Therefore, the incentive compatibility constraint is more relaxed with discretion relative to the commitment case in (14).

Integrating (A.9) and using the fact that the expert's expected payoff is zero when $p = p_0^D$, we obtain

$$V_{IC}^{D}(p) = p_0^D - [1 - F(\epsilon^*)]\,\delta + F(\epsilon^*)\,\frac{1-q}{q}\ln\left(\frac{\phi(p)}{\phi(p_0^D)}\right). \tag{A.10}$$

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

$$V_{Acq}^{D}(p) = \max\left(V_{Res}^{D}(p), V_{IC}^{D}(p)\right). \tag{A.11}$$

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

Proposition A.2. *For sufficiently small q, the expert strictly prefers discretion to commitment: $E(\pi^D(p)) > E(\pi^C(p))$.*

Propositions A.1 and A.2 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 the intermediated sale is relatively less likely with discretion, the expert's incentive to signal a higher firm type is reduced, which results in relatively lower equilibrium offer prices. If the incentive compatibility constraint is not binding with commitment, it is not binding with discretion either, therefore commitment dominates discretion. If information quality q is very low, however, the incentive compatibility constraint is severely binding, resulting in very 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 more preferable for the expert.

Appendix B. Proofs

Proof of Lemma 1. Solving for p_δ in (1) and p_0 in (2) in terms of V_{IPO} and substituting them into (3) results in a quadratic equation with no linear term, whose positive root is (4). Equations (5) and (6) follow from substituting (4) into (1) and (2), respectively, and rearranging terms. The expression in the denominators in (5) and (6), $1 - q - \delta q\sqrt{1-m}$, is positive by Assumption 1. The inequality $p_\delta < 1$ in (5) also follows from Assumption 1. The comparative statics stated in the Lemma follow directly from differentiating (4) through (6) with respect to δ, q, and m. □

Proof of Lemma 2. To establish necessity, suppose that the inequality constraint in (14) 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

$$\begin{aligned}\pi(p,p') - \pi(p,p) &= \int_{x=p}^{p'} \left(-V'_{Acq}(x) + \phi(p)\frac{1-q}{[\phi(x)]^2}\right) dx \\ &\leq \int_{x=p}^{p'} \left(-V'_{Acq}(x) + \phi(x)\frac{1-q}{[\phi(x)]^2}\right) dx \\ &= \int_{x=p}^{p'} \left(-V'_{Acq}(x) + \frac{1-q}{\phi(x)}\right) dx \leq 0.\end{aligned} \tag{A.12}$$

The first inequality in (A.12) follows from (13). For $p' > p$, the second inequality follows directly from (14). For $p' < p$, note that

$$V_{Acq}(x) > V_{Acq}(p') \geq V_{Res}(p) > V_{Res}(x) \tag{A.13}$$

for all $x \in (p', p)$. Therefore, the inequality constraint in (14) is binding for $x \in (p', p)$, and thus the integral in the last line of (A.12) equals zero. □

Proof of Lemma 3. The parametric condition

$$2\delta q\sqrt{1-m} \geq 1 - q \tag{A.14}$$

follows from evaluating inequality (15) at p_0 using the closed-form expressions for V_{IPO} and p_0 from (4) and (6).[15]

i. If (A.14) 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.14).

ii. If (A.14) 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 (14) is binding for all $p \in [p_0, p_{IC}]$ by construction of the function $V_{IC}(p)$.

□

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

$$g(m) = E(\pi(p)) = \int_{p=p_0}^{p^*} (p - V_{IC}(p))\, dp + \int_{p=p^*}^{1} (p - V_{Res}(p))\, dp. \tag{A.15}$$

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

$$g'(m) = \int_{p=p_0}^{p^*} \left(1 - \frac{dV_{IC}(p)}{dm}\right) dp + \int_{p=p^*}^{1} \left(1 - \frac{dV_{Res}(p)}{dm}\right) dp. \tag{A.16}$$

Therefore,

$$\Pi'(m) = -g(m) + (1-m)g'(m) \tag{A.17}$$

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

$$\frac{d}{dm}\left[(1-m)g'(m)\right] < 0. \tag{A.18}$$

In (A.18) and other similar expressions below, the terms $d/dm\,[\cdot]$ denote right-hand derivatives.[16]

There are four cases to be considered:

[15] There exist parameter values that satisfy both Assumption 1 and (A.14). Specifically, when $q > 2/3$, the set of feasible δ and m values that satisfy both conditions is non-empty.

[16] 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.

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

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

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

Differentiating with respect to m,

$$g'(m) = -\int_{p=p_0}^{1} \frac{qp_0}{\phi(p_0)} \frac{dp_0}{dm} dp = -\frac{(1-p_0)(\delta q\sqrt{1-m})}{(1-q)} \frac{dp_0}{dm}. \tag{A.20}$$

Differentiating p_0 with respect to m, we obtain

$$\frac{dp_0}{dm} = -\frac{p_0^2}{2\delta(1-m)^{3/2}} < 0. \tag{A.21}$$

Substituting into (A.20), we have

$$g'(m) = \frac{q\,(1-p_0)\,p_0^2}{2(1-q)(1-m)} > 0. \tag{A.22}$$

Multiplying (A.22) by $1-m$ and differentiating with respect to m, we have

$$\frac{d}{dm}\left[(1-m)g'(m)\right] = \frac{qp_0(2-3p_0)}{2(1-q)} \frac{dp_0}{dm} < 0. \tag{A.23}$$

The inequality in (A.23) follows from (A.21) 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., $p^* \in [p_\delta, 1)$.

$$g(m) = \int_{p=p_0}^{p^*} (p - V_{IC}(p))dp + \int_{p=p^*}^{1} (p - V_{Res}(p))dp \tag{A.24}$$

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

Differentiating with respect to m,

$$g'(m) = -\int_{p=p_0}^{p^*} \frac{qp_0}{\phi(p_0)} \frac{dp_0}{dm} dp \tag{A.25}$$

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

The inequality follows because $p^* > p_\delta > p_0$. Multiplying (A.25) by $1-m$ and differentiating with respect to m, we have

$$\frac{d}{dm}\left[(1-m)g'(m)\right] = \frac{qp_0}{2(1-q)}\left[2\left(p^* - p_0\right)\frac{dp_0}{dm} + p_0\left(\frac{dp^*}{dm} - \frac{dp_0}{dm}\right)\right]. \tag{A.26}$$

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

$$p_0 + \frac{1-q}{q}\ln\left(\frac{\phi(p^*)}{\phi(p_0)}\right) = p^* - \delta. \tag{A.27}$$

Differentiating both sides of (A.27) with respect to m gives

$$\frac{dp^*}{dm} = \frac{\phi(p^*)p_0}{\phi(p_0)p^*}\frac{dp_0}{dm}. \tag{A.28}$$

Substituting (A.28) into (A.26), we have

$$\frac{d}{dm}\left[(1-m)g'(m)\right] = \frac{qp_0}{2(1-q)}\left[2p^* - 3p_0 + \frac{\phi(p^*)p_0^2}{\phi(p_0)p^*}\right]\frac{dp_0}{dm} < 0. \tag{A.29}$$

The inequality in (A.29) follows from (A.21) 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., $p^* \in [p_0, p_\delta)$.

$$g(m) = \int_{p=p_0}^{p^*} (p - V_{IC}(p))dp + \int_{p=p^*}^{1} (p - V_{Res}(p))dp \tag{A.30}$$

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

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

Differentiating with respect to m,

$$g'(m) = \int_{p=p_0}^{p^*} \frac{qp_0^2}{2(1-q)(1-m)} dp + \int_{p=p^*}^{p_\delta} \frac{\delta\phi(p)}{2(1-q)\sqrt{1-m}} dp > 0. \tag{A.31}$$

Multiplying (A.31) by $1-m$ and differentiating with respect to m, we have

$$\begin{aligned}\frac{d}{dm}\left[(1-m)g'(m)\right] = &-\int_{p=p_0}^{p^*} \frac{qp_0^3}{2\delta(1-q)(1-m)^{3/2}} dp - \int_{p=p^*}^{p_\delta} \frac{\delta\phi(p)}{4(1-q)\sqrt{1-m}} dp \\ &+ \frac{\delta\phi(p_\delta)\sqrt{1-m}}{2(1-q)} \frac{dp_\delta}{dm} - \frac{qp_0^2}{2(1-q)} \frac{dp_0}{dm} \\ &+ \left[\frac{qp_0^2}{2(1-q)} - \frac{\delta\phi(p^*)\sqrt{1-m}}{2(1-q)}\right] \frac{dp^*}{dm}.\end{aligned} \tag{A.32}$$

The sum of the two integrals in the first line of (A.32) is negative. To evaluate the sign of the second line, note that

$$p_\delta = p_0 + \frac{\delta(1-q)}{1-q-\delta q\sqrt{1-m}} \Rightarrow \frac{dp_\delta}{dm} < \frac{dp_0}{dm} < 0, \tag{A.33}$$

and that

$$\delta\phi(p_\delta)\sqrt{1-m} = \frac{(1-q)p_0\phi(p_\delta)}{\phi(p_0)} > (1-q)p_0 > qp_0^2. \tag{A.34}$$

The second inequality in (A.34) 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.32) is negative as well. To evaluate the sign of the third line in (A.32), note that the outside option of firm type p^* is to conduct an IPO since $p^* < p_\delta$. Therefore,

$$p_0 + \frac{1-q}{q} \ln\left(\frac{\phi(p^*)}{\phi(p_0)}\right) = \phi(p^*)\frac{\delta\sqrt{1-m}}{1-q}. \tag{A.35}$$

Differentiate both sides of (A.35) with respect to m to obtain

$$\left(\frac{1-q}{\phi(p^*)} - \frac{\delta q\sqrt{1-m}}{1-q}\right)\frac{dp^*}{dm} = \frac{qp_0^2}{2(1-q)(1-m)} - \frac{\delta\phi(p^*)}{2(1-q)\sqrt{1-m}}. \tag{A.36}$$

Using (A.36), we can write the third line of (A.32) as

$$(1-m)\left(\frac{1-q}{\phi(p^*)} - \frac{\delta q\sqrt{1-m}}{1-q}\right)\left(\frac{dp^*}{dm}\right)^2 < 0. \tag{A.37}$$

The inequality in (A.37) 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.32) is negative.

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

$$g(m) = \int_{p=p_0}^{1} (p - V_{Res}(p))dp \tag{A.38}$$

$$= \int_{p=p_0}^{p_\delta} \left[p - \phi(p)\frac{\delta\sqrt{1-m}}{1-q}\right] dp + \int_{p=p_\delta}^{1} \delta dp.$$

Differentiating with respect to m,

$$g'(m) = \int_{p=p_0}^{p_\delta} \frac{\delta\phi(p)}{2(1-q)\sqrt{1-m}} dp > 0. \tag{A.39}$$

Multiplying (A.39) by $1-m$ and differentiating with respect to m, we have

$$\frac{d}{dm}\left[(1-m)g'(m)\right] = \frac{-1}{4\sqrt{1-m}} \int_{p=p_0}^{p_\delta} \frac{\delta\phi(p)}{1-q} dp \tag{A.40}$$

$$+ \frac{\delta\sqrt{1-m}}{2(1-q)} \left[\phi(p_\delta)\frac{dp_\delta}{dm} - \phi(p_0)\frac{dp_0}{dm}\right] < 0.$$

The inequality in (A.40) obtains because $dp_\delta/dm < dp_0/dm < 0$ from (A.33) 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 A.1. i. Given the expert's equilibrium strategy described in part (ii) of the Lemma, the intermediated sale price equals $E(X + \epsilon \mid p, s, \epsilon < \delta - \Delta_\epsilon)$. Since X and ϵ are independent, the expert's expected payoff from an intermediated sale is thus $p + E(\epsilon \mid \epsilon < \delta - \Delta_\epsilon)$. Define

$$\Delta_\epsilon = -E\left(\epsilon \mid \epsilon < \delta - \Delta_\epsilon\right) \tag{A.41}$$

$$= \frac{\sigma\phi\left(\frac{\delta-\Delta_\epsilon}{\sigma}\right)}{\Phi\left(\frac{\delta-\Delta_\epsilon}{\sigma}\right)},$$

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.41) as

$$\frac{\phi(t)}{\Phi(t)} = -t + \frac{\delta}{\sigma}. \tag{A.42}$$

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.42). 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 an intermediated sale equals

$$\phi(p)\frac{p}{\phi(p)} - \Delta_\epsilon = p - \Delta_\epsilon, \tag{A.43}$$

whereas his expected payoff from remaining private equals $p + \epsilon - \delta$. Therefore, the expert choose an intermediated sale if and only if

$$\epsilon < \epsilon^* = \delta - \Delta_\epsilon. \tag{A.44}$$

□

Proof of Lemma A.2. The equations characterizing p_δ^D and V_{IPO}^D are the same as (1) and (3), respectively, except for the superscript D. Solving for p_δ^D in (1) and p_0^D in (A.2) in terms of V_{IPO}^D and substituting them into (3) results in a quadratic equation with no linear term, whose positive root is (A.3). Equations (A.4) and (A.5) follow from substituting (A.3) into (1) and (A.2), respectively, and rearranging terms. The expression in the denominators in (A.4) and (A.5), $1 - q - \delta q\sqrt{1 - m + m\left[1 - F\left(\epsilon^*\right)\right]^2}$, 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 (A.3), (A.4), and (A.5) to (4), (5), and (6), respectively. □

Proof of Proposition A.1. From Lemma 3, (14) 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 $V_{Res}^{D'}(p_0^D) > V_{Res}^{C'}(p_0^D)$, (A.9) 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 A.2. Commitment: With q sufficiently small, (14) is binding for all $p > p_0^C$ and thus $V_{Acq}^C(p) = V_{IC}^C(p)$. From (16), $V_{IC}^C(p)$ converges to p and $E(\pi^C(p))$ converges to zero as $q \to 0$. Discretion: With q sufficiently small, (A.9) is binding at $p = p_0^D$. Differentiate (A.1) to obtain

$$\pi^{D'}(p_0^D) = 1 - V_{IC}^{D'}(p_0^D) = 1 - \frac{F(\epsilon^*)(1-q)}{\phi(p_0^D)} > 0, \tag{A.45}$$

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 $q \to 0$. □

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