Clustered IPOs as a Commitment Device*

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Abstract

I model the strategic interaction of two underwriters' decisions of accepting IPO mandates of firms with correlated values. Underwriters act as certifiers and increase the perceived value of issuing firms. Investors, however, take the agency conflict associated with the fee paying structure of IPOs into account and discount the offer price accordingly. By timely clustering of related IPOs across different underwriters, investment banks expose themselves to the outcome of other concurrent IPOs which results in a mutual disciplining effect. In this way, underwriters can credibly commit themselves to the marketing of high-value firms only. The model suggests that underpricing levels might be a function of underwriter syndicate composition and provides an agency based rational for the observed cyclicality in IPOs.

Keywords: Commitment Device, Underpricing, IPO waves, Underwriter Syndicate

JEL classification codes: G24, G32

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1 Introduction

Every Initial Public Offering (IPO) is associated with large information asymmetries between the involved parties: issuers, underwriters, and investors. In particular, the role of underwriters is subject to debate as conflicts of interests exist in multiple dimensions. For instance, underwriters play a key role in assessing a “fair” price of an issuing company, but at the same time are involved in distributing primary shares to investors. There is evidence that underwriters are paid by institutional investors for allocating highly profitable primary shares through higher commissions on other trades, which raises the suspicion of deliberate underpricing.[1] In addition, reputable investment banks want to be perceived as being associated with high quality firms’ offerings and are therefore expected to market the equity only of valuable firms. But at the same time, a large fraction of the income of underwriters is generated as a fixed fraction of IPO proceeds which naturally is only generated if an IPO takes place. Therefore, underwriters have an incentive to, at least to some extent, ignore their “gatekeeping” role and pass through each firm to the primary market.[2]

This multitude of uncertainty creates skepticism about underwriters’ incentives and could be detrimental for underwriters’ businesses and impede their capital allocation role in the economy. In this paper, I argue that investment banks can use in time clustering of *related* IPOs across *different* underwriters as a credible commitment device to overcome skepticism by primary market investors.

In the model, investment banks face reputational concerns when deciding upon acting as an underwriter in an IPO as markets expect the underwriter to screen out low-value firms or price them accordingly. However, given that underwriters earn a fraction of the issue volume, the underwriter is stuck in a “signal-jamming”-type of equilibrium: if reputation

[1] See for instance Loughran and Ritter (2004), Liu and Ritter (2010), Goldstein et al. (2011), Chang et al. (2017).

[2] Commenting on the IPO of LinkedIn, Steven Davidoff Solomon wrote “How can any banker pass up being underwriter to an IPO like LinkedIns, no matter the terms or quality?”, referring to questionable corporate governance structure in the form of a dual-class stock and a staggered board (Dealbook, June 14, 2011).

concerns are not too big, the strategic underwriter accepts IPO mandates for low-value firms with high-probability. In Equilibrium, primary market investors are not fooled and issue prices are relatively low. Ex-ante, that is, before learning the issuing firm type, underwriters would like to commit themselves to a strategy that alleviates the perceived agency conflict. In isolation, however, a commitment to decline the IPO mandate of low-value firms is not credible ex-post.

In time clustering of *related* IPOs across *different* underwriters may be such a commitment device. By exposing oneself to the information contained in other IPOs brought to the market by different investment banks, an underwriter offers market participants more information to judge upon its issue. Ex-ante, this has three effects on the expected profits for the underwriter: i) higher prices in the primary market if the investment bank accepts its underwriting mandate; ii) lower number of accepted IPO mandates, and iii) higher expected reputation. Whether the ex-ante clustering of related IPOs across different underwriters is credible, depends whether the effects of i) and iii) outweigh ii).

The strategic interaction of underwriters in the timing of IPOs generates new empirical predictions. First, the paper suggests that underpricing levels are a function of market-wide underwriter syndicate composition. In the model, the presence of other underwriters disciplines a given underwriter in accepting IPO mandates by low-quality firms. Such a disciplining effect is stronger, the more uncertainty there is about other underwriters' strategies which may depend on past relations of investment bankers or similarity of underwriter syndicates. Intuitively, the less a given investment bank can gauge the strategies of the other underwriters in the market, the more will it fear to be confronted while bringing a low-value firm to the primary market. Therefore, it will cut back in accepting low-quality IPO mandates. As underpricing levels are increasing in the remaining uncertainty about the issuing firm's value, the outlined disciplining effect translates into underpricing levels.

Second, the model predicts that issues are less underpriced if multiple *related* firms issue equity at roughly the same time and *different* investment banks act as underwriters.

Benveniste et al. (2002) present a model that outlines the first part of the prediction - less underpricing in a wave of *related* IPOs. In addition to this effect, in my model, the strategic interaction of underwriters results in a mutual discipling effect. By that, underpricing is reduced even further. Therefore, this paper suggests that within an industry IPO wave, the more different investment banks act as underwriters for different issuing firms, the less should the level of observed underpricing be.

Another contribution of the paper is to add an agency explanation to the literature on IPO waves. After observing a successful IPO, market participants are less worried about agency conflicts at the IPOs' underwriters. Therefore, investment banks acting as underwriters for other issues, might push their clients to also pursue their IPO and thus use the markets optimism. Alternatively, assuming different investment banks can coordinate on the timing of issues, IPO waves might occur as a strategy to reduce perceived agency conflicts by offering other information sources - contemporaneous offerings.

In the model, there are four kinds of agents: Entrepreneurs, investment banks, sophisticated and ordinary investors. Entrepreneurs approach an investment bank to underwrite their equity issues. Reputable investment banks are associated with high-value issues only, therefore the presence of a prestigious investment bank acting as an underwriter increases the perceived value of IPO firms from investors' perspectives. For low-value firms, the strategic underwriter faces a trade-off. By accepting the mandate, the investment bank earns a fee income that is a fraction of IPO proceeds. At the same time, however, the investment bank risks its reputation as the market may find out that the firm is, in fact, of low value. In equilibrium, investors anticipate the incentive problem of underwriters and discount the presence of an underwriter appropriately in the sense that the underwriter cannot increase the perceived firm values to a large extent. The more uncertain market participants perceive an issue, the higher information asymmetries between primary market investors will be. The resulting underpricing, which is a required discount for less informed investors to be shielded against the winner's curse problem in the bidding for the offering, remains considerably high.

If investment banks could commit to never accept the underwriting mandate of low-value firms, offer prices and therefore fees would be higher. In addition, underwriters would benefit in terms of lower expected reputation costs. However, such a commitment is not credible in isolation, as every underwriter has an incentive to push a low quality firm to the market whenever it is approached by one and therefore, in equilibrium, chooses to do so with positive probability.

Timely clustering of *related* IPOs *across different* underwriters can be such a commitment device. The outcome of other IPOs serves as an informative signal for investors about a given investment bank's incentives. Take the case of two firms, i and j, that approach two different investment banks to underwrite their issue. For simplicity of the argument, assume the types of the two firms are identical, both are either of high or low value. In such a case, the offer price of i, and therefore the fee income of its underwriter, depends on j's IPO outcome. If the underwriter of i accepts the mandate but at the same time j's underwriter declines the offer, markets immediately know that j must be of low value.[3] As the firms are perfectly correlated, investors realize that i is also of low-value and will be willing to pay only a low offer price. In this situation, i's underwriter faces large reputational damage, as it is bringing a low-value firm to the market. In addition, it will earn a low amount of fees as investors are willing to accept a low offer price only. Anticipating that its IPO marketing decision might get confronted with the outcome of j's IPO, disciplines the underwriter of firm i ex-ante. The higher the information content of contemporaneous IPOs, that is, the higher the correlation of firm types, the higher will this disciplining effect be. In addition, the better informed i is about j's probable equilibrium strategy, the lee will i fear a negative primary market outcome after accepting the mandate of low-value firms. By that logic, the model provides a channel through which underwriter composition of j might influence the strategy of underwriter i and therefore the underpricing observed in the IPO underwritten

[3] In the paper I model the strategies of underwriters as binary, that is, to accept or decline an IPO mandate. As I will argue later in section 3.5, the argument prevails also in situations where the underwriters' strategies are to set optimal offer prices.

by investment bank i.

2 Contribution and Literature Review

The strategic interaction of underwriters in clustered IPOs generates new empirical predictions. The central prediction is that issues are less underpriced if multiple *related* IPOs take place at roughly the same time and *different* investment banks act as underwriters. In the model, underpricing is a result of information asymmetries between primary market investors. Clustering of IPOs reduces this asymmetry in two dimensions, first with respect to the issuing firms' post-IPO values and second with respect to the underwriters' incentives. Benveniste et al. (2002) present a model which outlines the first effect. If underpricing reflects compensation to investors for costly information production, investment banks can spread the burden of producing information by smoothing underpricing across a wave of related or correlated IPOs. Therefore, investment banks can overcome the coordination problem of which firm should be leading the way in pursuing its IPO. Indeed, Benveniste et al. (2003) present empirical evidence that firms attempting IPOs condition offer terms on the experience of their primary market contemporaries. While Benveniste et al. (2002) assume that underpricing arises by the efforts of the investment bank to smooth information production costs of investors across related issues, underpricing in my paper arises due to information asymmetries between primary investors. If there is a monopolistic underwriter, like in Benveniste et al. (2002), clustering of IPOs in an industry reduces information asymmetry with respect to firm values, but not, with respect to the incentive problem of the underwriter itself. This is a novel insight of my paper. By clustering IPOs in an industry but *across* different underwriters, investment banks commit themselves to bringing fewer high risk firms to the market. Therefore, the level of underpricing in an IPO wave of a given industry is expected to be lower if several different investment banks act as underwriters. The reason behind the disciplining effect is that each investment bank faces uncertainty with respect to the competing investment bank's incentives. Therefore, the higher this uncertainty is, the higher the disciplining pressure - a looser connection between investment banks, could be a measure of such uncertainty.

My model also belongs to the literature on IPO waves across time and especially within industries. Several papers argue that hot and cold markets occur due to time-varying investors' optimism and therefore time-varying costs of equity capital (see e.g. Helwege and Liang (2004), Alti (2006), Pagano et al. (1998), Pastor et al. (2009)). Another stream of the literature identifies time-varying degrees of adverse selection (e.g. Khanna et al. (2008), Yung et al. (2008), Chemmanur and He (2011)). Other papers argue that the information content in current IPOs spills over to subsequent IPOs and therefore facilitate the going public decision of subsequent firms (e.g. Alti (2005), Benveniste et al. (2002), Hoffmann-Burchardi (2001)). This paper extends the IPO wave literature in adding another potential channel of IPO waves. By coordinating the timing of their respective IPOs, investment banks can credibly alleviate perceived agency conflicts.

My research is related to the literature of agency conflicts of underwriters in IPOs. Mostly, this paper is in line with models and evidence that highlights the agency conflicts inherent in the IPO process: by accepting IPO mandates by "bad" firms underwriters sell their reputation in exchange for fee income proportional to the amount raised in the IPO (Chemmanur and Fulghieri (1994)); by deliberately underpricing issues and allocating them to favored clients (Loughran and Ritter (2004),Liu and Ritter (2010), Goldstein et al. (2011), and Chang et al. (2017)); and by providing (almost always) positive post-IPO analyst coverage in exchange for higher underpricing (Krigman et al. (2001) and Bradley et al. (2003)). In addition, the findings of Lyandres et al. (2017) indicate that collusion is more likely to be in line with the observed patterns in the underwriter industry than oligopolistic competition. My model takes this anti-competitive view of the underwriter industry into account in assuming skeptical investors vis-à-vis the incentives of underwriters to screen out high risk firms. The skepticism results in large underpricing which reduces the fee income of underwriters. Actively clustering IPOs is feasible due to close ties between underwriters in the model, in line with the empirical evidence highlighting collussionary tendencies in the underwriting industry. Even though investors anticipate the incentives of clustering, it still increases the perceived quality of firms in the IPO pool, which results in lower underpricing and therefore is beneficial for underwriters.

More broadly, this paper is related to the literature on strategic interactions of "certifiers" in the context of Finance. For instance, Gao and Zhang (2016) highlight strategic complementaries in the earnings manipulation of managers, which leads to a underprovision of internal control investments of firms. Bar-Isaac and Shapiro (2013) present in an extension of their main model that the form of strategic interaction of rating agencies mainly depends on the assumed punishment structure upon inflated ratings. In the setting of Perotti and Suarez (2002), banks lending decisions are strategic substitutes due to higher market concentration and higher rents if the competitor engages in "speculative lending" and gets bankrupt. Using a similar mechanism as in this paper, Piccolo (2018) models the effects of competition on credit rating agencies' rating standards. As issuers have the opportunity to not publish a preliminary rating, they can effectively conceal negative information. In such a situation, being trustworthy as a rating agency is not always appreciated by the market as it is not clear, whether the rating agency was not approached by the firm or whether it actually offered a preliminary bad rating and the firm concealed it. Effectively, this destroys the disciplining effect competitors have on each other and therefore duopolistic rating agencies engage in more rating inflation than in a monopoly market. The interaction of information provider, in my model underwriters and in Piccolo's (2018) model rating agencies, leads to strategic complementarities in both models. In contrast to Piccolo's (2018) model, the complementarities in my model *reduce* tendencies of "ratings inflation", that is, the marketing of high risk firms. The reason is that the issuing firm cannot conceal the negative information of an underwriter declining its IPO mandate. In section 3.5, I will further discuss why the assumption of revelation of negative news, that is, whether an underwriter has declined the

IPO mandate, is reasonable in the IPO setting. Even though the strategic interactions of information providers are widely studied in economics and finance, I do not know of any paper studying the impact of strategic interactions on agency conflicts in the IPO setting.

3 The Model

3.1 Overview

The economy consists of four types of agents, who are all risk neutral: entrepreneurs, investment banks, informed, and uninformed investors. The riskless interest rate is zero. The structure of the game is common knowledge.

There are four time periods. In the first period, firm and investment bank types are drawn. I will clarify the differences in types in the next subsections. In the second period, a firm decides whether to pursue its IPO individually or using the underwriting services by an investment bank. If approached by a firm, the investment bank decides whether to accept or decline the underwriting mandate. Subsequently, the firm (potentially with the advice of the underwriter) sets the offer price to maximize IPO proceeds.[4] The third period determines the primary market outcome. After observing the offer price and whether a prestigious investment bank acts as an underwriter in the IPO, informed and uninformed investors submit bids. In the last period, shares are allocated (I will be more specific about the allocation of shares below), secondary market trading takes place, and market participants perfectly learn the firm's type and update their belief of the underwriter's type accordingly.

[4] As will be clear later, the offer price will be determined by the rational conjecture about the behavior of primary market participants. As usual in rational expectations models, this conjecture is true in equilibrium. At this stage of the game, the firm's type is revealed to the underwriter, therefore, incentives are aligned in the sense that both want to maximize the issuance price.

3.2 Entrepreneurs

As the main purpose of this paper is to highlight the disciplining role of clustered IPOs for underwriters, I assume the need for going public arises exogenously for firms.[5] Each entrepreneur wishing to raise money in an IPO chooses to market equity either directly to investors or using the services of an investment bank. If there are several investment banks in the market, the entrepreneur chooses the one where his expected proceeds from the IPO are the highest.[6] For simplicity, I will assume that firms will choose to go public whenever the proceeds are non-negative.

Differences in issuing firms are characterized by differences in their post-IPO firm values. Let $\tilde{R}_\theta$ be the random firm value of firm type $\theta = \{H, L\}$, that is, the firm value can be either high or ow. Without loss of generality, I assume that the high and low firm values are $\tilde{R}_H = H > 0$ and $\tilde{R}_L = 0$, respectively. While the firm knows its own type θ, all other players assess the probability of the high type to be 1/2.

As the main goal of the paper is to understand the strategic interactions of underwriters' IPO marketing decisions and the implications for IPO outcomes, market participants have to be able to cross-learn from the different initial public offerings. Therefore, I assume that the firm types of firm i and j may be correlated, i.e. $Pr(\theta_i = H \mid \theta_j = H) = Pr(\theta_i = L \mid \theta_j = L) = \frac{1}{2}(1 + \rho)$, where $\rho \in [-1, 1]$.

3.3 Investment banks

If a firm applies for underwriting services at an investment bank, the investment bank conducts an evaluation of the approaching firm's type. I assume that investment banks are time-constrained in the sense that they can only evaluate the type of one firm per time

[5]Other theoretical IPO paper model the motives of entrepreneurs to take their firms public essentially in two ways: diversification (e.g. Rock (1986) and Pastor et al. (2009)) and financing (e.g. Chemmanur and Fulghieri (1994), Chemmanur and Fulghieri (1999), Benveniste et al. (2002), Alti (2005), Khanna et al. (2008), Chemmanur and He (2011), Bustamante (2012), and Banerjee et al. (2016)).

[6]If several investment banks generate the same issuance volume, the entrepreneur randomizes which investment bank to choose.

period and therefore, at most, accept one IPO mandate per time period. Otherwise, there is no cost of evaluation and abstracting away from an effort problem, I assume that the underwriter learns the firm type θ perfectly. After the investment bank has evaluated the project's quality, it decides whether it will market the firm's equity or not, which I denote as $m \in \{M, N\}$ respectively.

The service of the underwriter may be of value for the firm as the capital market is characterized by asymmetric information. Whereas entrepreneurs know the quality of their firm, outside investors cannot tell a high value firm from a low value one. By using the marketing service by investment banks, type-H firms can potentially separate themselves from low-value firms and obtain more favorable issuance terms. Denote γ as the updated belief of investors that the firm is of type-H, given the observed action of the underwriter.

Investor's valuation of a firm depends on the investment bank's marketing decision, as well as the credibility of the underwriter in doing so.[7] In this paper, I adopt the "adverse selection" approach to modeling reputation introduced by Kreps and Wilson (1982) and Milgrom and Roberts (1982). In particular, investment banks may be one of two types, indexed by τ. With probability μ, the investment bank is honest, $\tau = h$, and therefore committed to only market equity of type-H firms. If a low-value firm approaches an honest investment bank, it declines to serve as an underwriter. With probability $1 - \mu$, the investment bank is strategic, $\tau = s$, and makes its marketing decision based on maximizing its objective function, which I specify below. In all other aspects, the two types of investment banks are identical.

The investment bank's type is private information and independent across investment banks and uncorrelated with either firm's type. The probability that other agents in the economy attach to an investment bank being of the ethical type reflects the bank's reputation.

Investment banks obtain a fee only from firms whose equity they market. The fee is

[7] Extensive empirical evidence highlights the beneficial role of investment bank's reputation for issuing firms (e.g. less underpricing (Carter and Manaster (1990); Carter et al. (1998)), more and better analyst coverage post IPO (Loughran and Ritter (2004); Cliff and Denis (2004)), price support post IPO (Ellis et al. (2000); Lewellen (2006)).

assumed to be an exogenous fraction[8], $\phi \in (0,1)$, of the "surplus value" generated by the investment bank. The surplus value is the difference between the firms IPO proceeds when the offering is underwritten by the underwriter and its IPO proceeds when the firm brings its share to the market by itself. The fee payment structure creates an incentive for strategic investment banks to market both firm types.[9] The reason why the presence of an investment bank is of value for an issuing firm is that the honest investment bank type is "committed" to declining IPO mandates by L-type firms. Therefore, any strategic investment bank wants to be perceived as a honest-type investment bank when marketing the equity of the issuing firm as this increases the offer price and generates higher fee income for the investment bank. By that, a strategic investment bank faces a trade-off when being approached by a L-type firm. If it agrees to market its equity, the investment bank may loose its reputation as the markets eventually learn that the investment bank has brought a bad firm to the market. On the other hand, by accepting the IPO mandate of a low-value firm, the underwriter generates fee income. To capture the trade-off between fee income and reputation considerations in my model in a simple fashion, I assume that the objective of the investment bank is to maximize the sum of fee income and the expected posterior reputation, after the market has learned the firm type, which happens after the stock has traded in the secondary market. In a sense, this way of modeling reputation concerns is a shortcut for having a multi-period model, where the outcome of a given period impacts the reputation in subsequent rounds of play and therefore the future potential to generate fee income.[10]

[8]There is extensive empirical literature showing that investment banks do not compete with respect to fees. For instance, Chen and Ritter (2000); Hansen (2001) report that over 90% of IPOs in the US market have gross spreads of exactly 7%. Abrahamson et al. (2011) and Lyandres et al. (2017) find similar patterns in more recent data. Therefore, I follow Liu and Ritter (2011) in treating the gross spreads as exogenous and the level of underpricing as endogenous.

[9]The agency conflict in this stylized model is restricted to the incentive conflict of the underwriter "milking" its reputation to generate fee income, that is, the ex-post adverse selection problem. There are several other agency conflicts preeminent in the IPO process. In this model, clustering of IPOs alleviates the perceived agency conflict by investors expecting the underwriter to sometimes bring low-value firms to the market in order to generate fee income. As I will argue later in section 3.5, the disciplining effect outlined in this paper might be also be prevailing in other dimensions of agency conflicts.

[10]The literature often models reputation concerns in a multi-period model where future profits depend on the updated reputation of the information provider, see e.g. Chemmanur and Fulghieri (1994); Mathis et al. (2009); Fulghieri et al. (2014); Frenkel (2015); Piccolo (2018). In these models, future profits are a (mostly

I conjecture (and later verify) that a strategic investment bank will never decline the mandate of a type-H firm in equilibrium, as fee income can be generated without adversely affecting reputation. Therefore, let $p \in [0, 1]$ denote the probability of the strategic investment bank to market equity of a type-L firm.

Investment banks are only able to convince firms to request its underwriting services if they sufficiently reduce information asymmetries and therefore are able to increase IPO proceeds for firms net of fees. The issuance price, in turn, depends on the credibility of the investment bank in marketing low risk firms. In order to describe the role of underwriters to increase the IPO-proceeds for firms, let us now turn to the model's primary equity market.

3.4 Investors, Information, and Prices

Investors value firms taken public based on whether an investment bank is marketing the issue, the confidence they have that this evaluation is correct, and the other variables that are common knowledge.

The primary market microstructure used here is a variant of the models introduced by Rock (1986) and Carter and Manaster (1990). There is a single informed investor that knows θ, but has limited funds K_I to invest in the stock.

In addition to informed capital, the IPO attracts uninformed investors. K_U is the total capital contribution to an IPO by uninformed investors. The value of K_U is exogenously given and sufficient to fully subscribe the IPO. Therefore, every IPO is fully subscribed or even oversubscribed if uninformed investors bid in the IPO. The shares are allocated to investors according to their bids and distributed on a pro-rata basis if the shares are oversubscribed.

This microstructure of the primary equity market per definition contains asymmetric information between informed and uninformed investors and results in adverse selection.

linear) functions of the reputation in the upcoming periods, therefore in the current period, the strategic player takes the impact on expected reputation into account. Essentially, this resembles my specification of the objective function being the sum of current fee income and the expected posterior reputation.

Informed capital will flow to profitable IPOs only, that is, issues where the firm value is greater than the issue price P. In these situations, the issue will be oversubscribed and uninformed investors will receive only a fraction of their demand. In contrast, whenever the IPO is not profitable, uninformed investors will be allocated the entire IPO. Anticipating adverse selection in the primary market leads the uninformed investors to shy away from bidding if the offer price is not sufficiently low.

The issuer, with or without the underwriter, anticipates this adverse selection problem and in order to ensure participation of uninformed capital and therefore full subscription, underprices the issue accordingly. I assume that the proceeds from the IPO are maximized if the offer price is set as the highest price ensuring participation of uninformed investors. This assumption is crucial in the sense that entrepreneurs have a clear preference of the issue being fully subscribed. Endogenously, this will define the required level of underpricing to ensure participation of uninformed investors.

3.5 Discussion of Main Assumptions

Preference of Fully Subscribed Issues

The question remains, whether participation of uninformed investors is optimal for the entrepreneur. Rock (1986) discusses this issue intensively. It depends on the preferences of the entrepreneur, the form of the firm value distribution, and the assumed distribution of wealth and private information across different investor groups. In order for an entrepreneur to prefer an offer price that shies away uninformed investors over a price that ensures their participation, i) the informed investors have to be sufficiently wealthy, ii) the alternative offer price needs to be sufficiently higher than the full-subscription price that ensures participation of uninformed capital, iii) the expected amount of informed capital actually subscribing to the issue must be high enough, iv) and the entrepreneur must not be too risk-averse. Therefore, the preference of the entrepreneur of a full-subscribed issue can be justified by one of the outlined assumptions.

Primary Market and Pro-Rate Allocation

The assumed structure of information asymmetry between primary market investors, that is, informed investor perfectly knowing firm value and uninformed not, is stronger than generally necessary. To generate qualitatively the same results, I need some information asymmetry between investors and the anticipation of the resulting Winner's Curse effect in the allocation process of IPO shares.

In contrast to Rock (1986) and Carter and Manaster (1990), I keep the amount of informed capital K_I exogenously fixed. Endogenizing the information acquisition decision and therefore the amount of informed capital involved in the bidding of an IPO would only strengthen the results of the paper: In an information acquisition stage, information production is positively related to ex-ante uncertainty about firm values. Put differently, the riskier an issue is, the stronger are the incentives to produce private information about it. The role of the underwriter in the model is to increase the posterior of the firm being a high type, if it accepts the IPO mandate of that firm. As the firm values follow a Bernoulli distribution, an increase in that belief is associated with a reduction in the variance. This, in turn, reduces the incentives of investors to become informed and eventually moderates the Winner's Curse effect even further. Therefore, endogenizing the share of informed capital participating in the primary market setup, would increase the importance of underwriters and ultimately the disciplining role of clustered IPOs.[11]

For the same reason, it is not crucial that shares are allocated on a pro-rata basis in the model. By definition, a pro-rata allocation treats all bidders equally. If shares are allocated in a way that puts the more informed investors in a relative advantage over less informed ones, the expected winner's curse effect will be even larger and therefore the resulting underpricing more severe. Therefore, assuming other distribution mechanisms like book building might even strengthen the qualitative results of the model, if one thinks that a preferential

[11] In an earlier version of the model, I characterize the primary market outcome with endogenously determined levels of K_I. Except of making the model less tractable, no further insights could be generated, therefore I stick to treating K_I exogenously. This alternative model is available upon request.

treatment in the allocation of shares is positively associated with an information advantage.[12]

Other Dimensions of Agency Conflicts:

As already mentioned, the outlined agency conflict in this paper is only one of several dimensions of agency conflicts in the IPO process. In this paper, I argue how timely clustering of related IPOs across different underwriters can act as a credible commitment device in overcoming the agency conflict in the gate-keeping function, that is, ex-post misreporting of the firm type. When considering other dimensions of agency conflicts in equity offerings, one could argue that this commitment effect prevails. Take for instance the problem of *deliberate* underpricing of the issue in exchange for some kind of "kickbacks" for the entrepreneur or executive of the issuing company.[13] The underwriter itself might benefit from retaining a large, profitable, share of the issue on its own books. In such an example, the agency conflict arises as other initial investors expect the underwriter to price the company fairly. Anticipating that the underwriter might "collude" with the company's executive in setting too low an offering price, initial investors might shy away from the IPO and block the offering completely. In such a situation, in time clustering of related IPOs across different investment banks might act as a commitment device too. By offering skeptical initial shareholders a way to gauge the accuracy of the offer price trough other, related IPO outcomes, underwriters may commit themselves not to "misbehave" in paying some form of kickbacks to entrepreneurs in order to underprice the issue extensively. Therefore, the outlined disciplining effect of clustering related IPOs across different underwriters might arguably be working in other dimensions too.

Strategies of Underwriters:

I model the underwriters' strategies as accepting or declining the IPO mandate of their

[12]Given the empirical evidence of underwriters favoring certain groups of investors, a more realistic share allocation mechanism is likely to strengthen the required level of underpricing. Arguably, the favored investor groups might have closer ties to the underwriter which might also be associated with an information advantage. If this is the case, the resulting winner's curse effect will be even larger.

[13]Such a kickback could be "spinning", the allocation of shares of other profitable IPOs to company executives in order to influence the pricing of their own company's IPO (Liu and Ritter, 2011). Other examples can be found in Loughran and Ritter (2004); Goldstein et al. (2011); Chang et al. (2017).

clients. This might seem to be an unrealistic representation of the IPO process in reality, as it is uncommon for an underwriter to decline IPO mandates.[14] Clearly, instead of declining the issue straight away, an underwriter might charge a low enough offer price for low value firms to preserve its reputation. To make the model more realistic, I could for instance change the model such that the committed underwriter charges offer prices of P_0 and P_γ, which will be the equilibrium offer prices that ensure participation of uninformed investors conditional on the firm being of type-L or H, respectively. In that sense, the honest underwriter type sets a low offer price for the low value firm and a higher price for the high firm type. The profit-maximizing underwriter type has to follow suit in charging P_0 or P_γ, otherwise its type will be revealed immediately. Essentially, whether the underwriters' strategies are accepting vs. declining IPO mandates or to set high vs. low offer prices entails the same information about firm and underwriter types. Therefore, the key element of this paper of information spillover of concurrent IPOs is captured in either modeling way.

4 The Analysis

In this section, I analyze the model in two steps. To highlight the driving forces behind the information spillover contained in multiple IPOs pursued by different underwriters, I start with a benchmark with only one firm and a single underwriter. This model is equivalent to solving a multiple firm model in which the firm values are uncorrelated. After that, I show how the presence of a second IPO, that is underwritten by a different investment bank, changes the equilibrium outcome.

The solution concept is Perfect Bayesian Equilibrium (PBE):

Definition 1 *A PBE consists of:*

- *the firm's decision on whether to pursue an IPO with or without the underwriter's service,*

[14] There is a large literature focusing on how issuers and underwriters choose each other (see for instance Habib et al. (1997); Fernando et al. (2005); Corwin and Schultz (2005))

- *the strategic underwriter's marketing strategy of high and low value firms,*
- *the firm's (and potentially underwriter's) decision of the issue price P, and*
- *the decision of informed and uninformed investors to participate in bidding at the primary market.*

In addition, the PBE requires a system of rational beliefs such that: 1) the choices made by the firm, the underwriter, and the investors maximize their respective utility (given the equilibrium choices of the other players and the equilibrium beliefs), 2) beliefs are rational given the equilibrium choices of the agents and are formed using Bayes' rules whenever applicable.

4.1 Single-Firm Case

Let us start with the primary market outcome of the single-firm case. $\alpha = K_I/(K_U + K_I)$ represents the fraction of informed capital of the total capital in bidding for primary market shares if both informed and uninformed capital subscribe to the issue. By γ, I denote the posterior belief of market participants that the firm type is of type H, given the observation of whether the investment bank agreed to market the issue or not.

Uninformed investors anticipate that the informed investors may be participating in the bidding of IPO allocations. Therefore, uninformed investors will only invest if, in expectations, they will be earning the risk-free rate, which is normalized to zero in the model. In particular, the uninformed investor will only participate in the primary market if the following inequality holds:

$$(1-\alpha)\gamma(H-P) - (1-\gamma)P \geq 0 \tag{1}$$

The first term of of Equation 1 captures the expected gain if the actual firm value exceeds the subscription price. Only when the IPO is profitable, informed investors will participate and capture part of the IPO gains, which means only a fraction of $(1-\alpha)$ of the IPO proceeds are left for uninformed capital providers. The second part is the expected loss to uninformed investors from purchasing IPOs when the firm value is in fact zero, which represents the adverse selection costs.

Essentially, uninformed investors will only participate if the offer price, P, is sufficiently low to guarantee expected profits of zero. As uninformed capital is, by assumption, necessary to complete the IPO and therefore maximize IPO proceeds, underwriters as well as issuing firms have an incentive to underprice the issue sufficiently. The maximum offer price, P^*_γ that guarantees the full subscription of the issue is therefore[15]:

$$P^*_\gamma = \gamma H \frac{(1-\alpha)}{1-\alpha\gamma}. \tag{2}$$

Lemma 1 *The unique offer price P^*_γ is increasing in γ, the belief that the firm is of type-H and decreasing in the proportion of informed capital, α.*[16]

Clearly, whenever the firm is revealed to be of type L, investors are only willing to accept an offer price of $P^*_0 = 0$.

As the proportion of informed capital, α is increasing, so is the "winner's curse" problem of uninformed investors. More informed capital, leads to a smaller allocation of profitable IPO shares to uninformed investors. To ensure the participation of uninformed investors, the offer price P^*_γ has to be reduced sufficiently to undo the increase of adverse selection costs.

Now let us move to the underwriter subgame, meaning the investment bank's decision whether to accept the underwriting mandate by the firm. Clearly, marketing the issue of a given firm leads to earnings in terms of fees. I conjecture (and verify) that the strategic investment bank always accepts the underwriting mandate by a H-type firm. Thus, my

[15]Note that I use asterisks, *, to denote equilibrium outcomes and a tilde, $\tilde{}$, refers to conjectures about other agents' strategies.

[16]It is easy to see that the partial derivatives are $\partial P^*_\gamma/\partial\gamma = \frac{(1-\alpha)H}{(1-\alpha\gamma)^2} > 0$ and $\partial P^*_\gamma/\partial\alpha = -\frac{(1-\gamma)\gamma H}{(1-\alpha\gamma)^2} < 0$.

discussion below focuses on the case in which the strategic underwriter is approached by a low-value firm.

Facing a type-L firm, the underwriter maximizes the sum of it's expected fee income and its expected reputation, namely:

$$\max_{p\in[0,1]} p\phi\Delta P^*_\gamma + \mathbb{E}[\hat{\mu}], \tag{3}$$

where $\gamma(m)$ is the posterior belief of investors that the firm is of type-H given the action of the underwriter, m, and given investors' conjecture about the equilibrium strategy of the underwriter $\tilde{p}$. Clearly, only low-value firms will be declined by both both types of underwriters, hence $Pr(\theta = H \mid N) = \gamma(N) = 0$. If the underwriting mandate is accepted, $m = M$, the posterior of the firm being of type H is $Pr(\theta = H \mid M) = \gamma(M) = \frac{1}{1+(1-\mu)\tilde{p}}$. ΔP^*_γ represents the increase in the issue price generated by the underwriter's presence in the IPO, for which the underwriter is compensated by a percentage fee ϕ (remember, as the firm is issuing one perfectly divisible share, the issue volume and price coincide). The underwriter's expectation of its own reputation based on its action m and after the market has learned the true firm type through the revelation in the secondary market is captured by $\mathbb{E}[\hat{\mu}]$.

The underwriter's decision of whether to accompany the IPO of a given firm is informative for investors. The informational content arises because every type-H firm will be accepted by both types of underwriters. In contrast, only strategic investment bank's will potentially market the IPO of a low-value firms. In fact, the probability that a type-L firm will be accepted by an underwriter is equal to the probability that a strategic underwriter decides to accept such a mandate, $(1-\mu)p^*$. Markets take this into account as they conjecture the strategy of a profit-maximizing investment bank. In addition, as type-H firms know that the underwriter will agree on marketing their issue with certainty, they have no incentive to pursue an IPO individually. In equilibrium, only type-L firms that were declined by investment banks pursue an IPO individually raising $P^*_{\gamma(N)} = 0$.

In addition to contemporaneous fee income, underwriters care about their reputation in subsequent periods. From the underwriter's point of view, expected reputation is $\mathbb{E}[\hat{\mu}] = \frac{(1-p^*)\mu}{\mu+(1-\mu)(1-\tilde{p})}$. Clearly, if it agrees to market the equity of a type-L firm the reputation will be destroyed, $\hat{\mu} = 0$, as the investors will learn the firm type once it is traded in the secondary market. In contrast, if the underwriter declines to accept the mandate, which, in equilibrium, it does with probability $1 - p^*$, the reputation will increase to $\frac{\mu}{\mu+(1-\mu)(1-\tilde{p})}$.

Strategic underwriters take their impact on posteriors, and subsequently on the offer price into account when deciding upon accepting the mandate of a type-L firm. The equilibrium strategy, $p^* \in [0, 1]$ of the strategic underwriter is therefore the solution to the first-order condition:

$$\phi \Delta P^*_\gamma - \frac{\mu}{\mu + (1-\mu)(1-p^*)} = 0. \tag{4}$$

Proposition 1 *There exists a unique $p^* \in [0, 1]$, such that the following strategy-belief combination constitutes an equilibrium.*
Entrepreneurs: Both types of entrepreneurs apply for underwriting services by an underwriter. If declined, they pursue an IPO individually, raising a price of $P^*(\gamma(N)) = 0$.
Strategic underwriter: the strategic underwriter always accepts the mandate of type-H firms. With probability p^*, a strategic investment bank underwrites the issue of a type-H firm. $p^* \in [0, 1]$ is characterized by:

$$p^* = \begin{cases} 0, & \text{if } H \leq \underline{H} \\ \frac{(1-\alpha)(H\phi-\mu)}{(1-\mu)(H\phi(1-\alpha)+\mu)}, & \text{if } \underline{H}_1 < H < \overline{H} \\ 1, & \text{if } H \geq \overline{H}_1 \end{cases} \tag{5}$$

with $\underline{H} = \frac{\mu}{\phi}$ *and* $\overline{H} = \frac{2-\alpha-\mu}{\phi(1-\alpha)}$.

The equilibrium offer price, P^**, solves Equation 2.*

Investor beliefs: along the equilibrium path, investors set $\gamma(M) = Pr(\theta = H \mid M) = \frac{1}{1+(1-\mu)p^*}$ *and* $\gamma(N) = Pr(\theta = H \mid N) = 0$*; off the equilibrium path,* $\gamma = Pr(\theta = H) = 0$ *after a firm does not approach an investment bank and* $\gamma = 0$ *after the offer price deviates from Equation 2.*

The equilibrium marketing decision set by the strategic underwriter may be a corner solution ($p^* = \{0, 1\}$), or an interior ($p^* \in (0, 1)$), depending on the importance of concurrent fee income relative to reputation concerns. Clearly, when the fee to be earned in bringing a low-value firm to the market is sufficiently high (low) relative to the long-run reputation concerns, the strategic underwriter will always (never) accept the underwriting mandate.

As type-H firms will always be accepted by underwriters they are able to raise $(1 - \phi)\Delta P^*_{\gamma} + P^*_{\gamma=0}$. They have no incentive to deviate to attempting an IPO by themselves, as markets view this as evidence that this firm is of low-value, which would eventually result in less attractive IPO proceeds of $P^*_{\gamma=0} = 0$. Whenever $\mu > 0$ investor's posterior about the firm being a type-H is higher if the IPO is underwritten by an investment bank. In theses cases ΔP^*_{γ} is positive and both firm types have an incentive to try to the get the underwriting service of an investment bank. Therefore, the low-value firm type tries to secure underwriting services by an investment bank too. As conjectured, a strategic investment bank has no incentive to decline the mandate by a H-type firm. By doing so, it would not generate fee income in the current period. Additionally, there would be no benefit of reputation building either. Given the assumption that firms will pursue an IPO individually if they got declined by an investment bank, the market will eventually find out that the firm is in fact of high-value. Such a behavior is not consistent with the behavior of the honest type, therefore, the reputation of strategic type drops to zero.

In terms of firm type, the equilibrium is a partial pooling equilibrium. Since there is a positive probability that type-L firms' IPOs will be underwritten by an investment bank, it is not possible for investors to infer firm type with certainty by observing that an investment bank accepted a mandate. Only if they observe that an investment bank declined an IPO mandate, they can be sure that the firm is of low-value. Whenever $p^* < 1$, the equilibrium is also partially pooling in terms of underwriter type. As the firm type gets revealed through secondary market trading, markets can separate the underwriter types only whenever the strategic type's action was $m = M$ for a type-L firm.

The purpose of this paper is to show how underwriters can use timely clustering of related IPOs as a commitment device for not bringing low-value firms to the market. But before moving to the multiple-firm case, we need to establish that such a commitment device is beneficial for underwriters in the first place. The next lemma outlines the conditions under which a strategic underwriter would like to ex-ante commit itself to only bringing type-H firms to the market.

Lemma 2 *Ex ante, that is, before an underwriter learns the issuing firm type, a strategic underwriter benefits in the single-firm case from committing to* $p_c = 0$*, iff* $H > \underline{H}$.

Before a strategic underwriter learns the type of the issuing firm, it would like to commit to bring only type-L firms to the market, that is, $p_c = 0$, if the expected fee income from always behaving honestly and the associated expected reputation outweigh the expected exploitation benefit of reputation. By credibly committing, the presence of an underwriter at an IPO would increase the posterior $\gamma(M)$ to 1. Therefore, the underwriter would not have to under price the issue as the presence of an underwriter is evidence that the firm is of value H, which results in fee income of ϕH for the underwriter. Given that there is no reputation loss, the ex-ante value of the objective function would be $\frac{\phi H}{2} + \mu$. Note that, the strategic underwriter effectively behaves honestly and therefore is generating fees only in 1/2 of the cases, namely when the approaching firm is of type H.

In contrast, when the underwriter is not committed to $p_c = 0$, the equilibrium as outlined in Proposition 1 evolves. This means that, ex-ante, the expected fee income for the strategic underwriter is $1/2(1 + p^*)\phi P^*_\gamma$ and the expected posterior reputation is $1/2(\mu + \mathbb{E}[\hat{\mu}])$. As stated in Lemma 2, it can be shown, that the ex-ante benefit of a commitment of $p_c = 0$ is beneficial if $H > \frac{\mu}{\phi} = \underline{H}$, which is in fact, also the condition that $p^* > 0$. Therefore, whenever the the equilibrium is that the strategic bank is accepting the IPO mandate of low-value firms with some probability, the investment bank would from an ex-ante perspective benefit of a commitment not to do so. Clearly, such a commitment would not be credible, as a strategic underwriter has always an ex-post incentive of milking its reputation when facing a type-L firm. The next subsection outlines how the timely clustering of related IPOs across different underwriters can, in fact, act as a credible commitment device.

4.2 Two-Firm Case

In the present model, underwriters are tempted to also bring low-value firms to the market as they are paid only conditional on providing underwriter services. Fully rational investors take this conflict of interest into account and request a sufficiently large level of underpricing. Even if a strategic underwriter would like to commit to a strategy that only accepts mandates by H-type firms, investors anticipate the incentive problem associated with such a strategy and conjecture a positive probability of underwriting L firms. I argue that clustering IPOs, not only within an industry as proposed by Benveniste et al. (2002), but also across different underwriters, may serve as an effective disciplining device.

Let us consider two investment banks that are individually and simultaneously approached by two different entrepreneurs who want to take their firm public.[17] For the ease of exposition, let us call these two firms i and j and their respective investment banks likewise.[18]

I treat the primary market of the two IPOs separately. For both IPOs there is an

[17]The assumption of simultaneous IPOs is made for simplicity. In order to generate the desired information spillover result, it is necessary that the decisions of underwriters are subject to uncertainty about the competitor's behavior. This is the case if there is remaining uncertainty about the value of the competitor's issuing firm even after the issuance.

[18]I treat the matching of firms and underwriters as exogenous as later on, I will focus on the symmetric equilibrium outcome and therefore both underwriters are observationally equivalent for firms and investors. Fernando et al. (2005)

exogenous amount of uninformed capital K_U that is sufficient to fully subscribe each IPO. The informed investor of e.g. firm i has mechanically knowledge about the type of firm j, subject to the correlation coefficient ρ. However, I assume that the informed investors about firm i either submit bids in the IPO of firm i or does not participate at all. The same restriction applies to the informed investor about firm j. Alternatively assuming that informed investors i also is allowed to bid in firm j's IPO would worsen the winner's curse problem even further. Naturally, informed investors might use the information in two instead of one IPO. This means that they will choose to invest in the most profitable IPO of the two. This makes the winner's curse problem more severe, as effectively α, the share of informed capital, is increased and therefore uninformed rationed even more in profitable IPOs. Therefore, by shutting down this cross-learning channel by investors, the anticipated level of underpricing is effectively reduced. Other than that, however, this assumption has no impact on the analysis.

Investors now use both decisions m_i and m_j of the two underwriters to update their belief about firm types. Again, I conjecture, and later verify, that neither of the investment banks will decline an IPO mandate of a high-value firm. Denote $\gamma_i(m_i, m_j)$ as the posterior of investors about firm i being the high-value type after observing the marketing decisions of investment banks i and j. The posterior $\gamma_i(m_i, m_j)$ captures investors uncertainty about firm i's type and therefore is essential in determining its offer price. The posterior about firm i being of high value, conditional on both underwriters accepting their IPO mandate is:

$$\gamma_i(M_i, M_j) = \frac{\gamma_i(M_i)}{\gamma_i(M_i) + (1 - \gamma_i(M_i))\frac{Pr(M_j|L_i)}{Pr(M_j|H_i)}} \tag{6}$$

Firm types are assumed to be correlated, which means that m_j also reveals information about firm i. If both underwriters agree to market the equity of their respective clients, investors take this into account when forming their posterior about firm i. For instance, whenever $\rho > 0$, the belief about firm i being of type-H is increased (decreased) for $m_j = M$

$(m_j = N)$.[19] The next lemma describes the impact of underwriter j's action on the perceived quality of firm i.

Lemma 3 *The impact of underwriter j's action $m_j \in \{M_j, N_j\}$ on investors' beliefs of i's firm type is:*
$\gamma_i(M_i, M_j) > \gamma_i(M_i) > \gamma_i(M_i, N_j)\ \forall \rho \in (0, 1]$ *and*
$\gamma_i(M_i, M_j) < \gamma_i(M_i) < \gamma_i(M_i, N_j)\ \forall \rho \in [-1, 0)$.

The information spillover from j's IPO to firm i arises due to two forces: for instance with $m_i = m_j = M$ and $\rho > 0$, as two investment banks decided to market the equity of their respective clients, two independent intermediaries "certify" that the issues are individually of high-value. Basically, this is the effect shown by Benveniste et al. (2002). The second effect, which is at the heart of this paper, arises due to the strategic interaction of the two underwriters which results in a mutual disciplining effect and therefore in a lower p_i^* and p_j^*, relative to a situation where there is no other, related IPO. Before moving to the equilibrium of this two-firm case and the reason for the underwriters effectively disciping each other, consider the underwriters' maximization problem.

In the two-firm case, underwriter i's maximization problem facing a L-type firm is

$$\max_{p_i \in [0,1]} p_i \phi \mathbb{E}_{m_j}(\Delta P^*_{\gamma_i}) + \mathbb{E}(\hat{\mu}_i) \tag{7}$$

Equation 7 is similar to equation 3 in the single firm case, except that ΔP^*_{γ} is replaced by $\mathbb{E}_{m_j}(\Delta P^*_{\gamma_i})$. Again, underwriter i only earns fees if it is able to generate a positive surplus value for its client. In the situation of two IPOs and only one is underwritter by i, underwriter j's equity marketing decision m_j has an impact on the perceived quality of firm i whenever $\rho \neq 0$, as outlined in Lemma 3. Therefore, at the time of deciding whether to accept or decline the underwriting mandate of its firm, investment bank i faces uncertainty with respect to the subsequent offer price it will be able to charge $P^*_{\gamma_i}$ in the primary market.

[19]Slightly abusing notation, I sometimes denote $m_i = M$ as M_i and similarly for $m_i = N = N_i$.

In contrast, there is no impact of j's actions on the expected posterior reputation for i. After the issuing firms' stocks get traded at the secondary market, their type gets revealed independent of firm and underwriter j. Therefore, the information of investment bank j's action or even the type of firm j are redundant to judge upon underwriter i's type after firm type i has been revealed.

In sum, at the time investment bank i chooses its equity marketing decision, it does not observe j's actual acceptance choice, m_j. Instead, it conjectures that underwriter j will choose $\tilde{p}_j$ and takes this into consideration. The next proposition highlights the best-response of i with respect to its conjecture $\tilde{p}_j$.

Proposition 2 *For every interior of $\tilde{p}_j$, the best-response of underwriter i's equity marketing decision, $p_i^*(\tilde{p}_j)$, is increasing in $\tilde{p}_j$, the conjecture about j's intensity of bringing type-L firms to the market.*

In order to discuss the intuition behind this result, note that j's impact on i's marketing decision is solely driven by impact it has on i's expectation over the fee it can earn. The expectation, from i's perspective, about the offer price it can charge when accepting the mandate of its type-L firm is therefore

$$\mathbb{E}_{m_j}[P^*_{\gamma_i} \mid L_i] = Pr(M_j \mid L_i)P^*_{\gamma_i(M_i,M_j)} + Pr(N_j \mid L_i)P^*_{\gamma_i(M_i,N_j)}.$$

Investors' expectation about j's decision, however, is not based on the true firm type of i, but rather the mere observation of $m_i = M$. Thus, investors expect the influence of m_j on i's offer price to be:

$$\mathbb{E}_{m_j}[P^*_{\gamma_i} \mid M_i] = Pr(M_j \mid M_i)P^*_{\gamma_i(M_i,M_j)} + Pr(N_j \mid M_i)P^*_{\gamma_i(M_i,N_j)} = P^*_{\gamma_i(M_i)}.$$

The last equality is an immediate consequence of the law of iterated expectations, which intuitively states that the arrival of j's equity marketing decision m_j does not affect investor's belief of firm i *on average*. That is, the effect of $\tilde{p}_j$ on the distribution of m_j and investor's posterior belief about θ_i upon observing m_j cancel out for the two outcomes of m_j, i.e. M_j and N_j.

The strategic investment bank i knows that its firm is of type L, wheres investors observe only $m_i = M$ and the action of underwriter j, m_j. An increase in $\tilde{p}_j$, therefore, increases the "noise" in the signal m_j for investors to judge upon i's firm value. The information asymmetry between investors and underwriter i effectively increases. This, in turn, encourages underwriter i to use this information asymmetry in bringing more L-type firms to the market. In sum, i's best-response is increasing in the conjecture about j's probability of bringing L-type firms to the market.

The strategic complementarity feature of marketing decisions of underwriters is the central element of the paper. When there are multiple (or in the case of the model two) IPOs, investors are better informed about firm values than in an isolated IPO for two reasons-more independent signals of investment banks accepting underwriting mandates and less of an incentive problem associated with each investment bank's underwriting decision. The first effect is obvious. All else equal, the marketing decision of two independent underwriters strengthens the "gate-keeping" function as the two firms individually passed the tests of their investment banks. The second reason is more subtle. As outlined, the marketing decisions of underwriters are strategic complements. If for instance underwriter i expects his competitor j to bring more poor quality firms to the market, the best-response of i is to also increase his marketing efforts for type-L firms. The next proposition, in turn, shows that this complementarity feature in such a two-firm IPO case will lead to lower equilibrium levels of p.

In order to describe the equilibrium, I focus on symmetric underwriters, i.e. $\mu_i = \mu_j = \mu$. Denote p_1^* and p_2^* as the equilibrium strategy of strategic underwriters in the single-IPO case and in the two-firm IPO case, respectively. In addition, denote $\mathcal{P}_2^*$ as the set of equilibria in the two-firm case.

Proposition 3 *The symmetric underwriter marketing equilibrium in the two-firm case can be described as follows:*

$$p_2^* = \begin{cases} 0, & \text{if } \rho = \{-1, 1\} \\ 0, & \text{if } \rho \in (-1, 1) \text{ and } H \leq \underline{H}_2 \\ \in (0,1), & \text{if } \underline{H}_2 < H < \overline{H}_2 \\ 1, & \text{if } H \geq \overline{H}_2 \end{cases} \tag{8}$$

with $\underline{H}_2$ *and* $\overline{H}_2$ *being characterized in the appendix, an interior* p_2^* *is defined by the argument that maximizes equation 7 and an equivalent equation for underwriter* j*, and all other equilibrium properties are as in Proposition 1.*

Multiple symmetric underwriter marketing equilibria can arise. Each equilibrium that can arise in the two-firm case is weakly smaller than the equilibrium in the one-firm case, that is, $p_1^* \geq p_2^*$ *for all* $p_2^* \in \mathcal{P}_2^*$ *and* $\rho \in [-1, 1]$.

In the two-firm IPO setting, investors are able to use both underwriters' marketing decisions to gauge the value of a given firm. Investors are better able to assess the type of a firm, as j's IPO can be seen as an additional informative signal about i's type. More importantly, underwriter j's equilibrium strategy disciplines underwriter i in his choice of marketing low-value firms. At first sight, it might be unclear why every equilibrium in the two-firm case is weakly smaller than in the single-firm case. Let us consider a situation where underwriter i expects his strategic competitor j to always accept the IPO mandate of a low-value firm, that is, $\tilde{p}_j = 1$. In this situation, one might expect that investment bank i's best-response would be to also always bring type-H firm to the market. This, however, is not the case. Even if underwriter i expects his strategic counterpart to always choose $m_j = M$ for low-value firms, i faces uncertainty with respect to underwriter j's type. With probability μ, underwriter j is of the honest type and declines all mandates of type-L firms. Therefore, if investment bank i accepts to underwrite the issue of its low-value firm, with probability μ,

i will be confronted by j's decision of $m_j = N$. Essentially, the uncertainty with respect to its competitor's type, that is, $\mu \in (0,1)$, leads to the disciplining effect of clustered IPOs for underwriter i. Conversely, if there were no honest-type underwriters, the complementarity structure in the two-firm case might lead to equilibria where $p_2^* > p_1^*$.

For perfectly correlated firm types, that is $\rho = \{-1, 1\}$, the disciplining effect is so strong, that $p_2^* = 0$ is always an equilibrium. For instance with perctly positively correlated firm types, if i expects it's competitor never to bring type-L firms to the market, that is $\tilde{p}_j = 0$, i's marketing decision of M_i will always be confronted by N_j. Consequently, market participants will believe that firm i must be of the low-quality type, too. Therefore, underwriter i will not be able to raise a price higher than 0 in the primary market which completely destroys the incentive for M_i. In contrast, every non-zero best-response of i puts its reputation at danger. Therefore, i's best-response will always be $p_i^*(\tilde{p}_j = 0) = 0$, which means $p_2^* = 0$ is always an equilibrium for $\rho = 1$. By the same logic, this holds true for $\rho = -1$.

The title of this paper suggests that the timely clustering of related IPOs across different underwriters may serve as a credible commitment device in overcoming the ex-post agency conflict by underwriters of accepting low-value firms. Therefore, let us examine under which conditions, such a clustering is beneficial for underwriters. Ex-ante, that is, before learning the firm's type, underwriter i's expected profits in the single-firm case, Π_1, and in the two-firm case, Π_2, are:

$$\Pi_1 = 1/2\phi(1 + p_1^*)P_1^* + 1/2\left[(1 - p_1^*)\hat{\mu}_1 + \mu\right]$$

$$\Pi_2 = 1/2\phi\left[p_2^*\mathbb{E}_{m_j}(P_2^* \mid L_i) + \mathbb{E}_{m_j}(P_2^* \mid H_i)\right] + 1/2\left[(1 - p_2^*)\hat{\mu}_2 + \mu\right],$$

with $\hat{\mu}_k = \frac{\mu}{\mu + (1-\mu)(1-p_k^*}$ being the posterior reputation in either the one or two-firm case, $k = 1, 2$, after the market has observed N_i and L_i.

Clustering IPOs across different underwriters has two effects on the ex-ante expected profits for underwriter i. First, as an immediate consequence of Lemma 3, conditional on the same equilibrium p^*, the price difference between the one-firm and two-firm case that i will be able to raise in the primary market, is proportional to the correlation coefficient ρ, that is, $P_2^* - P_1^* > 0$ for $\rho > 0$. Essentially, for $\rho > 0$, two positively related firm passed the screening of their respective underwriters which results in more confidence of investors that either one firm is of high-value.

Second, the severity of the ex-post agency conflict of underwriters pushing low-value firms to the market is lower in the two-firm case. As outlined in Proposition 3, the marketing decisions of the two underwriters are strategic complements leading to a mutual disciplining effect, that is, $p_1^* \geq p_2^*$.

The effect of being in the two-firm case relative to one-firm scenario on i's ex-ante profits can be described by the sum of the impact on expected fee income and on expected posterior reputation. The next proposition states in which situations the underwriters are ex-ante willing to cluster their underwriting activities.

Proposition 4 *Given $p_1^* \geq p_2^*$, the expected posterior reputation is higher in the two-firm case. The difference in expected fee income is, in general, ambiguous. A sufficient condition for the ex-ante clustering of IPOs to be profitable for underwriters is $H < \frac{(2-\mu)(2-\alpha)}{\phi(1-\alpha)} \equiv \overline{H}^c$ and $\rho \in \{-1, 1\}$.*

A higher p^* means that investment banks are, in equilibrium, willing to risk their reputation more often in order to generate fee income for type-L. Therefore, it is easy to show and intuitive that the ex-ante expected reputation is (weakly) higher in the two-firm case as $p_2^* \leq p_1^*$.

Whereas clustering of IPOs always (weakly) increases the expected posterior reputation from an ex-ante point of view for underwriters, this is not generally true for the expected fee income. Clearly, the clustering of IPOs is credible for investment banks if either both expected fee income and expected reputation benefits are positive; or if the increase in expected reputation gains outweighs losses in expected fee income.

A sufficient condition that makes such a commitment ex-ante credible is $H < \overline{H}^c$ combined with perfect correlation. As $\overline{H}^c > \overline{H}_1$ proposition 3 implies that $p_1^* = 1$, that is, absent any disciplining effect of a second IPO, the potential fee income is so large, that a strategic underwriter would always want to generate fee income from type-L firms. In addition, for $\rho \in \{-1, 1\}$, the threat of a second, potentially conflicting, IPO in the two-firm case is sufficient to result in a truth-telling equilibrium, $p_2^* = 0$.

Clearly, in this situation, the differences reputation loss is highest. The posterior reputation will stay at μ in the two-firm setting, as the strategic investment bank will always behave honestly and cannot be differentiated from an honest type. In contrast, in the single-firm case, the equilibrium is $p_1^* = 1$, which means the strategic investment bank will be revealing its type with certainty and therefore lose its reputation completely.

In term of revenues, the relative benefits of clustered versus non-clustered are reversed for the strategic investment bank type. Given that the strategic investment bank is never bringing a type-L firm to the market, M_i is evidence of the firm being of value H. From an ex-ante perspective, the expected revenue of such a two-firm equilibrium is $\frac{\phi H}{2}$.

In contrast, in the single-firm case the outlined equilibrium features p_1^* which results in a lower offer price that can be reached, $P^* = \frac{H(1-\alpha)}{2-\mu-\alpha}$. At the same time, however, the strategic investment bank will be earning the associated with for all firm types. Despite the lower fees per issue, the possibility of generating fees for low-value firms makes the equilibrium in the single-firm case more valuable in terms of expected revenues from an ex-ante perspective.

Combining the trade-off of lower expected revenues with higher expected posterior reputation, yields a cut-off of firm value $\overline{H}^c$ that determines whether the ex-ante clustering of IPOs is credible, which is the case if the expected benefit in posterior reputation outweighs the reduced expected fees.

In order to understand the reason behind the loss in expected earnings, let us decompose the right-hand side even further. Both $\Delta P_{\gamma 1}^*$ and $\Delta P_{\gamma 2}^*$ represent the increase of the issue price due to the presence of one and two underwriters, respectively. In the single-firm case, that is $\Delta P^*_{\gamma 1} = P^*_{\gamma 1} - P^*_0$. Before observing the decision of an underwriter, investors expect, on average, that the offer price stays at $P^*_{1/2}$ which would be the offer price given the ex-ante belief of 1/2. Put differently, this is an application of the law of iterated expectations, $\mathbb{E}_{m_i}[P^*_{\gamma(m_i)}] = Pr(m_i = M)P^*_{\gamma 1} + Pr(m_i = N)P^*_0 = P^*_{1/2}$. Similarly, the offer price $P^*_{\gamma 2}$ can be rearranged. Now, the right-hand side of Equation **??** can be written as:

$$\phi(P^*_{1/2} - P^*_0)\left(\frac{1 + p^*_1}{1 + (1-\mu)p^*_1} - \frac{1 + (1-\mu)(p^*_2)^2}{1 + (1-\mu)^2(p^*_2)^2}\right).$$

The term in brackets indicates, why the commitment of clustering is not credible in terms of *revenues* but can be net of costs, that is, in terms of *profits*. The first (second) fraction is a representation of the potential of a strategic underwriter to misguide investors in the one (two)-firm case. In a single-firm case, a strategic underwriter knows that it will be able to earn underwriting fees if the issuing firm is of low-risk and if the firm is a high-risk one and it decides to underwrite the issue anyway, that is with probability $1/2(1 + p^*_1)$. The market, however, faces uncertainty about the underwriter's type. Therefore, it expects *less* underwriting activity, that is $1/2(1 + (1-\mu)p^*_1)$, as the probability of the underwriter being strategic, μ, is less than one. The differences in this belief-fraction is smaller in the two-firm case. The reason is that underwriter i faces uncertainty about its competitor's type and therefore its own potential of generating fee income if it is approached by a high-risk firm. Therefore, the information advantage over the market with respect to its type is lower than in the single-firm case and which reduces the potential of misguiding investor and earning fees for type-H firms. Thus expected revenues are lower in the two-firm case. In a sense, by agreeing to cluster IPOs, strategic investment banks give up some of their information rent, which is due to the informational advantage about their own type.[20]

Nevertheless, if the expected cost reduction is sufficient to compensate for the loss in

[20] Based on this argument, clustering of IPOs should intuitively also reduce the expected fee revenue for $\rho \neq 1$. In the current model framework, however, the proof of this statement is incomplete. As the model does not feature explicit expressions of p^*_1 and p^*_2, I fail to proof this statement for imperfectly correlated firm types. Nevertheless, if the expected revenue were to be greater in the two-firm case than in the single-firm case for some ρ, this would even strengthen the argument that clustering is credible ex-ante.

expected revenues, the timely clustering of related IPOs is a credible commitment device.

5 Conclusion

In this paper, I argue that investment banks can use clustering of IPOs as a credible commitment device to overcome the agency problem in the underwriting process. In the model, investment banks act as gatekeepers, highlighting the certification role of underwriters. By increasing the perceived quality of an issuing firm, investors have a smaller incentive to acquire valuable information about the issuing firm. As only a subset of investors acquire information, the winner's curse effect arises, which leads to equilibrium underpricing as a means to ensure participation of less informed investors.

Therefore, underwriters are able to reduce the resulting amount of underpricing and are of value for the issuing firm. However, investors anticipate the agency conflict that arises from the fee paying structure. The positive signal of a prestigious investment bank acting as an underwriter in an IPO is harmed by the skepticism arising from this agency conflict. The result is that underpricing still arises to a large degree. Underwriters would like to commit themselves to a strategy that alleviates the agency conflict. In this paper, I argue that clustering *related* IPOs across *different* underwriters is such a commitment device. By exposing oneself to the presence of another IPO brought to the market by a different investment bank, an underwriter can credibly alleviate the perceived agency conflict by investors and thus increase the issuing price of its client, which results in higher expected profits in markets where clustering of related IPOs across different underwriters occurs. By that, IPO waves might occur as a means of underwriters to reduce the perceived agency conflict by investors. In addition to providing a new agency based rational of the occurrence of IPO waves, the paper highlight differences in underpricing levels as a function of underwriter presence and connection.

In general, the model could be applied to all information producing industries where there are agency conflicts and the action of one strategic party reveals information about the other. In these settings, the introduction of competition in terms of information provision might lead to higher profits for the information providers. Potential examples include credit ratings, syndicated loans, balance sheet misreporting and the like. It would be interesting to explore more of the strategic interaction of information providers in theses areas.

A Proofs

Proof of Proposition 1. Each entrepreneur type will try to get underwriting services. Type-H firms know that they will be accepted and know that they will be able to collect $(1-\phi)P^*_\gamma$ in the IPO. By deviating, the firm would be able to raise an amount of $P^*_{\gamma=0}=0$ as investors cannot tell a firm which was declined by an underwriter from a firm that did not approach an investment bank. Clearly, deviating is not profitable.

A similar reasoning applies to type-L firms. By not approaching an underwriter, they are able to raise $P^*_{\gamma=0}=0$. In contrast, by approaching an investment bank, the proceeds are $P^*(\gamma=0)+(1-\phi)P^*(\gamma)$ if accepted. If the underwriter declines the mandate, type-L firms will be able to pursue the IPO on their own, again raising $P^*_{\gamma=0}=0$. Therefore, every type-L firm will try to get the underwriting service.

A strategic investment bank will always bring type-H firms to the market, as the underwriter is able to raise fees, ϕP^*_γ, while the expected reputation stays at μ. Deviating to declining a high-value firm will result in no fee income and a loss of reputation, as the market will eventually find out, that the declined firm is, in fact, a high type. Therefore, the expected reputation after declining a mandate of type-H firms is 0. Clearly, the strategic investment bank will always accepts the mandate of type-H firms.

For type-L firms, the underwriter's strategy is described by p^* in equation 5. The first-order condition (FOC) in equation 4 is decreasing in p, as the derivative with respect to p is $-(1-\mu)\left(\frac{\mu}{(1-(1-\mu)p)^2}+\frac{(1-\alpha)H\phi}{(1-\alpha+(1-\mu)p)^2}\right)$. For values of $p^*=0$, the FOC is negative whenever $H\leq\underline{H}$ and for $p^*=1$, the FOC is positive whenever $H\geq\overline{H}$. For $\underline{H}<H<\overline{H}$ the equilibrium p^* boils down to be the unique interior solution of the FOC, as depicted in equation 5.

Investment banks have no incentive to deviate from the pricing rule outlined by equation 2. If they do so, the firm will be perceived as low-value firms, given the specified out-off-equilibrium belief. ■

Proof of Lemma 2. As outlined in the text, the ex-ante expected profit function is equal to $\frac{H\phi}{2} + \mu$ for $p_c = 0$. In contrast, given the interior equilibrium acceptance probability in equation 5, the ex-ante objective function is equal to $\frac{2H(1-\alpha)\phi+(4-\alpha)\mu}{2(2-\alpha)}$. By that, the underwriter would benefit from an commitment of the form $p_c = 0$, whenever $\frac{\alpha(H\phi-\mu)}{2(2-\alpha)} > 0$, which is the case for $H\phi - \mu > 0$. ■

Proof of Lemma 3. Let us start with proofing $\gamma_i(M_i, M_j) > \gamma_i(M_i)\ \forall \rho \in (0, 1]$:

$$\gamma_i(M_i) \equiv Pr(H_i \mid M_i) = \underbrace{(H_i \mid M_i, M_j)}_{\equiv \gamma_i(M_i,M_j)} Pr(M_j \mid M_i) + Pr(H_i \mid M_i, N_j)Pr(N_j \mid M_i)$$

$$= (H_i \mid M_i, M_j)Pr(M_j \mid M_i) + Pr(H_i, N_j \mid M_i)$$

$$\Leftrightarrow \gamma_i(M_i, M_j) = \frac{\gamma_i(M_i)Pr(M_j \mid H_i)}{Pr(M_j \mid M_i)} = \frac{\gamma_i(M_i)}{\gamma_i(M_i) + (1-\gamma_i(M_i))\frac{Pr(M_j|L_i)}{Pr(M_j|H_i)}}$$

The first line follows from the law of total expectations, the second from the application of Bayes' rule, and the third term from rearranging.

$$\gamma_i(M_i, M_j) - \gamma_i(M_i) = \frac{\gamma_i(M_i)}{\gamma_i(M_i) + (1-\gamma_i(M_i))\frac{Pr(M_j|L_i)}{Pr(M_j|H_i)}} - \gamma_i(M_i)$$

$$= \frac{\gamma_i(M_i)(1-\gamma_i(M_i))(1-\frac{Pr(M_j|L_i)}{Pr(M_j|H_i)})}{\gamma_i(M_i) + (1-\gamma_i(M_i))\frac{Pr(M_j|L_i)}{Pr(M_j|H_i)}}$$

In order for $\gamma_i(M_i, M_j) - \gamma_i(M_i) > 0$, $(1 - \frac{Pr(M_j|L_i)}{Pr(M_j|H_i)}) > 0$ or equivalently:

$$Pr(M_j \mid H_i) > Pr(M_j \mid L_i)$$

$$Pr(H_j \mid H_i) + Pr(L_j \mid H_i)Pr(M_j \mid L_j) > Pr(H_j \mid L_i) + Pr(L_j \mid L_i)Pr(M_j \mid L_j)$$

$$\underbrace{Pr(L_j \mid L_i) - Pr(L_j \mid H_i)}_{=\rho} > Pr(M_j \mid L_j)\underbrace{(Pr(H_j \mid H_i) - Pr(H_j \mid L_i))}_{=\rho}$$

$$\rho > \rho(1-\mu)\tilde{p}_j.$$

This inequality holds for $\rho \in (0, 1]$ as $\mu \in (0, 1)$ and $\tilde{p}_j \in [0, 1]$. For $\rho \in [-1, 0)$, this results in a contradiction. This completes the proof of $\gamma_i(M_i, M_j) > \gamma_i(M_i)$ for positive ρ and $\gamma_i(M_i, M_j) < \gamma_i(M_i)$ for negative ρ.

By a similar derivation, one can easily show the remaining inequalities stated in Lemma 3.

■

Proof of Proposition 2. Let λ_i be the first-order condition of underwriter i's maximization problem that follows from the objective function in equation 7:

$$\lambda_i(p_i, \tilde{p}_j) = \phi\left[Pr(M_j \mid L_i)P_{\gamma_i(M_i,M_j)} + Pr(N_j \mid L_i)P_{\gamma_i(M_i,N_j)}\right] - \frac{\mu}{\mu + (1-\mu)(1-p_i)}, \quad (9)$$

where $p_i^*(\tilde{p}_j)$, i's best-response to the conjecture about $\tilde{p}_j$, sets $\lambda_i(p_i, \tilde{p}_j) = 0$. For interior values of $\tilde{p}_j$, I utilize the implicit function theorem for studying the impact of $\tilde{p}_j$ on $p_i^*(\tilde{p}_j)$.

$$\frac{d\lambda_i(p_i, \tilde{p}_j)}{dp_i} = \phi\left[Pr(M_j \mid L_i)\frac{dP_{\gamma_i(M_i,M_j)}}{dp_i} + Pr(N_j \mid L_i)\frac{dP_{\gamma_i(M_i,N_j)}}{dp_i}\right] - \frac{(1-\mu)\mu}{(\mu + (1-\mu)(1-p_i))^2}. \quad (10)$$

Clearly, γ_i is decreasing in p_i and so is P^*_γ. Thus, $\frac{d\lambda_i(p_i,\tilde{p}_j)}{dp_i} < 0$, too.

As outlined in the main text, we can rewrite i's first order condition as:

$$\lambda_i(p_i, \tilde{p}_j) = \phi\left[P^*_{\gamma_i(M_i,N_j)} + Pr(M_j \mid L_i)(P^*_{\gamma_i(M_i,N_j)} - P^*_{\gamma_i(M_i,N_j)})\right] - \frac{\mu}{\mu + (1-\mu)(1-p_i)}$$

Before we turn to $\frac{\partial \lambda_i}{\partial \tilde{p}_j}$, note that the market's expectation about the offer price of firm i can be written as:

$$\mathbb{E}_{m_j}\left[P^*_{\gamma_i} \mid M_i\right] = Pr(M_j \mid M_i)P^*_{\gamma_i(M_i,M_j)} + Pr(N_j \mid M_i)P^*_{\gamma_i(M_i,N_j)} = P^*_{\gamma_i(M_i)}$$
$$\Leftrightarrow P^*_{\gamma_i(M_i,M_j)} - P^*_{\gamma_i(M_i,N_j)} = \frac{P^*_{\gamma_i(M_i)} - P^*_{\gamma_i(M_i,N_j)}}{Pr(M_j \mid M_i)}$$

where the second equality follows from the law of iterated expectations and the second line from rearranging. We can now plug this relationship between $P^*_{\gamma_i(M_i,M_j)} - P^*_{\gamma_i(M_i,N_j)}$ into underwriter i' foc:

$$\lambda_i(p_i, \tilde{p}_j) = \phi\left[P^*_{\gamma_i(M_i,N_j)} + \frac{Pr(M_j \mid L_i)}{Pr(M_j \mid M_i)}(P^*_{\gamma_i(M_i)} - P^*_{\gamma_i(M_i,N_j)})\right] - \frac{\mu}{\mu + (1-\mu)(1-p_i)}.$$

In order to calculate $\frac{\partial \lambda_i}{\partial \tilde{p}_j}$, it will be sufficient to calculate the partial derivative only of $\frac{Pr(M_j|L_i)}{Pr(M_j|M_i)}$, as the remaining parts of λ_i are independent of $\tilde{p}_j$.
The next lines show that P_{M_i,N_j} is indeed independent of $\tilde{p}_j$. As the offer prices are solely driven by the investors' beliefs of the firm being of type-H, let's check the belief induced by the joint underwriters' actions $\{M_i, N_j\}$:

$$\gamma_{M_i,N_j} = \frac{\gamma_{M_i}}{\gamma_{M_i} + (1-\gamma_{M_i})\frac{Pr(N_j|L_i)}{Pr(N_j|H_i)}}$$
$$\frac{Pr(N_j \mid L_i)}{Pr(N_j \mid H_i)} = \frac{Pr(L_j \mid L_i)Pr(M_j \mid L_j)}{Pr(L_j \mid H_i)Pr(M_j \mid L_j)} = \frac{Pr(L_j \mid L_i)}{Pr(L_j \mid H_i)},$$

therefore $\gamma_i(M_i, N_j)$ and $P^*_{\gamma_i(M_i,N_j)}$ are independent of $\tilde{p}_j$.
Now, $\frac{\partial \lambda_i}{\partial \tilde{p}_j} = \phi\frac{Pr(M_j|L_i)}{Pr(M_j|M_i)}(P^*_{\gamma_i(M_i)} - P^*_{\gamma_i(M_i,N_j)})$. From Lemma 3, we know that the sign of

$(\gamma_{M_i} - \gamma_{M_i,N_j})$ and thus the sign of $(P^*_{\gamma_i(M_i)} - P^*_{\gamma_i(M_i,N_j)})$ is proportional to ρ. Therefore:

$$\frac{\partial \lambda_i}{\partial \tilde{p}_j} \propto \frac{\partial \frac{Pr(M_j|L_i)}{Pr(M_j|M_i)}}{\partial \tilde{p}_j}\rho$$
$$\frac{Pr(M_j \mid L_i)}{Pr(M_j \mid M_i)} = \frac{1}{(1-\gamma_{M_i}) + \gamma_{M_i}\frac{Pr(M_j|H_i)}{Pr(M_j|L_i)}}$$
$$\frac{Pr(M_j \mid H_i)}{Pr(M_j \mid L_i)} = \frac{Pr(H_j \mid H_i) + Pr(L_j \mid H_i)Pr(M_j \mid L_j)}{Pr(H_j \mid L_i) + Pr(L_j \mid L_i)Pr(M_j \mid L_j)}$$

$$\begin{aligned}\frac{\partial \frac{Pr(M_j|H_i)}{Pr(M_j|L_i)}}{\partial \tilde{p}_j} =& \frac{Pr(L_j \mid H_i)(1-\mu)\left[Pr(H_j \mid L_i) + Pr(L_j \mid L_i)Pr(M_j \mid L_j)\right]}{(Pr(H_j \mid L_i) + Pr(L_j \mid L_i)Pr(M_j \mid L_j))^2} \\ &- \frac{Pr(L_j \mid L_i)(1-\mu)\left[Pr(H_j \mid H_i) + Pr(L_j \mid H_i)Pr(M_j \mid L_j)\right]}{(Pr(H_j \mid L_i) + Pr(L_j \mid L_i)Pr(M_j \mid L_j))^2} \\ =& \frac{-(1-\mu)\rho}{(Pr(H_j \mid L_i) + Pr(L_j \mid L_i)Pr(M_j \mid L_j))^2}\end{aligned}$$

Hence, $\frac{\partial \frac{Pr(M_j|H_i)}{Pr(M_j|L_i)}}{\partial \tilde{p}_j} \propto -\rho \Rightarrow \frac{\partial \frac{Pr(M_j|L_i)}{Pr(M_j|M_i)}}{\partial \tilde{p}_j} \propto \rho \Rightarrow \frac{\partial \lambda_i}{\partial \tilde{p}_j} \propto \rho^2 > 0$. By the implicit function theorem, we therefore know that $\frac{dp_i^*}{d\tilde{p}_j} > 0\ \forall \rho \neq 0$ which completes the proof. ■

Proof of Proposition 3. First, let us examine the conditions under which $p_2^* = 0$ is an equilibrium. In order for $p_2^* = 0$ to be an equilibrium, i's best-response to $\tilde{p}_j = 0$ has to be zero as well, that is,

$$\begin{aligned}\lambda_i(p_i, 0) &= \phi\left[P^*_{\gamma_i(M_i,N_j)} + \frac{Pr(M_j \mid L_i)}{Pr(M_j \mid M_i)}(P^*_{\gamma_i(M_i)} - P^*_{\gamma_i(M_i,N_j)})\right] - \frac{\mu}{\mu + (1-\mu)(1-p_i)} \\ &= \phi\left[P^*_{\gamma_i(M_i,N_j)} + \frac{Pr(H_j \mid L_i)}{Pr(H_j \mid M_i)}(P^*_{\gamma_i(M_i)} - P^*_{\gamma_i(M_i,N_j)})\right] - \frac{\mu}{\mu + (1-\mu)(1-p_i)}.\end{aligned}$$

Given that $\lambda_i(p_i, \tilde{p}_j)$ is decreasing in p_i for all $\tilde{p}_j$, for $p_2^* = 0$ to be an equilibrium, $\lambda_i(0,0) \leq 0$. That is, $\lambda_i(0,0) = H\phi - \mu$ for $\rho \in (-1,1)$. Therefore, $p_2^* = 0$ for $H \leq \mu/\phi \equiv \underline{H}_2$ whenever $\rho \in (-1,1)$. For $\rho = 1$ or $\rho = -1$, $\lambda_i(0,0) = -\mu$ and therefore $p_2^* = 0$ is always an equilibrium for perfectly correlated firm types.

By a similar reasoning, $\lambda_i(1,1) \geq 0$ for $p_2^* = 1$ to be an equilibrium. It is easy, but tedious, to show that this is the case for

$$\frac{(\mu\rho(\alpha-\mu)-(\mu-2)(\alpha+\mu-2))(\alpha(\rho-1)-\mu(\rho+1)+2)}{(\alpha-1)\phi(\alpha(\rho-1)(\mu(\rho-1)+2)+\mu(\rho+1)((\mu-2)\rho+\mu)-4\mu+4)} \equiv \overline{H}_2.$$

By a similar proof as in Proposition 2, one can show that for all interiors of p_2^*, $\frac{d\lambda(p_2^*,p_2^*)}{dp_2^*} < 0$. In addition, for all $\underline{H}_2 < H < \overline{H}_2$, $\lambda_i(0,0) > 0$ and $\lambda_i(1,1) < 0$. Therefore there always exists (at least one) symmetric interior equilibrium $p_2^* \in (0,1)$ for all $\underline{H}_2 < H < \overline{H}_2$. These symmetric interior equilibria are the solution to the first-order condition $\lambda(p_2^*,p_2^*) = 0$ in equation 9.

The last part of the proposition that has to be shown is that every symmetric equilibrium in the two-firm case is strictly smaller than in the single-firm case, that is, $p_2^* < p_1^*$. The proof is by contradiction. Suppose, $p_2^* > p_1^*$. This implies that

$$\begin{aligned}
&\lambda_2(p_1^*,p_1^*) > \lambda_1(p_1^*) = 0 \\
&\phi\left[Pr(M_j \mid L_i)P^*_{\gamma_i(M_i,M_j)} + Pr(N_j \mid L_i)P^*_{\gamma_i(M_i,N_j)}\right] > \phi\left[P^*_{\gamma_i(M_i)}\right] \\
&Pr(M_j \mid L_i)P^*_{\gamma_i(M_i,M_j)} + Pr(N_j \mid L_i)P^*_{\gamma_i(M_i,N_j)} > P^*_{\gamma_i(M_i)} \\
&P^*_{\gamma_i(M_i,M_j)} - P^*_{\gamma_i(M_i,N_j)} > \frac{P^*_{\gamma_i(M_i)} - P^*_{\gamma_i(M_i,N_j)}}{Pr(M_j \mid L_i)}
\end{aligned}$$

Again applying the law of iterated expectations to boil down investors expectation of the price differential:

$$\frac{P^*_{\gamma_i(M_i)} - P^*_{\gamma_i(M_i,N_j)}}{Pr(M_j \mid M_i)} > \frac{P^*_{\gamma_i(M_i)} - P^*_{\gamma_i(M_i,N_j)}}{Pr(M_j \mid L_i)}$$

$\underline{\text{for } \rho > 0}$

$$Pr(M_j \mid L_i) > Pr(M_j \mid M_i)$$
$$1 > (1 - \gamma_{M_i}) + \gamma_{M_i}\left(\frac{Pr(M_j \mid H_i)}{Pr(M_j \mid L_i)}\right)$$
$$Pr(M_j \mid L_i) > Pr(M_j \mid H_i)$$
$$-\rho > -\rho(1-\mu)p_1^*$$
$$1 < (1-\mu)p_1^*$$

$\underline{\text{for } \rho < 0}$

$$Pr(M_j \mid L_i) < Pr(M_j \mid M_i)$$
$$1 < (1 - \gamma_{M_i}) + \gamma_{M_i}\left(\frac{Pr(M_j \mid H_i)}{Pr(M_j \mid L_i}\right)$$
$$Pr(M_j \mid L_i) > Pr(M_j \mid H_i)$$
$$-\rho < -\rho(1-\mu)p_1^*$$
$$1 < (1-\mu)p_1^*$$

which is a contradiction for all non-zero ρ. Therefore $p_2^* \leq p_1^*$ ■

Lemma 4 *The ex-ante expected revenue differences between the one firm case, $R^{\mathbb{O}}$, and in the two firm case, $R^{\mathbb{O}}$, can be both positive and negative for a strategic underwriter, depending on the equilibrium price function $P^*(\cdot)$.*

Proof. In order to indicate whether an expression refers to the two or one firm case, I will use $\mathbb{T}$ and $\mathbb{O}$, respectively. Let us rewrite the expected revenues for a strategic underwriter

$$R^{\mathbb{T}} = Pr^{\mathbb{T}}(M_i \mid S_i)(Pr(M_j \mid M_i, S_i)P^*_{M_i,M_j} + Pr(N_j \mid M_i, S_i)P^*_{M_i,N_j}) + Pr^{\mathbb{T}}(N_i \mid S_i)P^*_0 - P^*_0$$

$$= Pr^{\mathbb{T}}(M_i \mid S_i)(Pr(N_j \mid M_i, S_i)(P^*_{M_i,N_j} - P^*_{M_i,M_j}) + P_{M_i,M_j} - P^*_0)$$

application of law of iterated expectations on $P^*_{M_i,N_j} - P^*_{M_i,M_j}$

$$= Pr^{\mathbb{T}}(M_i \mid S_i)\frac{Pr(N_j \mid M_i, S_i)}{Pr(N_j \mid M_i)}(P^{*,\mathbb{T}}_{M_i} - P^*_{M_i,M_j}) + P^*_{M_i,M_j} - P^*_0)$$

application of law of iterated expectations on $P^{*,\mathbb{T}}_{M_i}$

$$= \frac{Pr(N_j, M_i \mid S_i)}{Pr(N_j, M_i)}\left(P^*_{1/2} - P^*_0\right) + \left(Pr^{\mathbb{T}}(M_i \mid S_i) - \frac{Pr(N_j, M_i \mid S_i)}{Pr(N_j \mid M_i)}\right)\left(P^*_{M_i,M_j} - P^*_0\right)$$

$$
\begin{aligned}
R^{\mathbb{O}} &= \frac{Pr^{\mathbb{O}}(M_i \mid S_i)}{Pr^{\mathbb{O}}(M_i)} \left(P^*_{1/2} - P^*_0\right) \\
R^{\mathbb{T}} - R^{\mathbb{O}} &= \left(P^*_{1/2} - P^*_0\right) \underbrace{\left(\frac{Pr(N_j, M_i \mid S_i)}{Pr(N_j, M_i)} - \frac{Pr^{\mathbb{O}}(M_i \mid S_i)}{Pr^{\mathbb{O}}(M_i)}\right)}_{\Xi} \\
&\quad + \left(P^*_{M_i,M_j} - P^*_0\right) \underbrace{\left(Pr^{\mathbb{T}}(M_i \mid S_i) - \frac{Pr(N_j, M_i \mid S_i)}{Pr(N_j \mid M_i)}\right)}_{\Psi}
\end{aligned}
$$

As the equilibrium prices are an increasing function of $\gamma(\cdot)$, it is easy to show that $\left(P^*_{1/2} - P^*_0\right) \leq \left(P^*_{M_i,M_j} - P^*_0\right)$.[21]. Let us further examine Ξ and Ψ:

$$
\begin{aligned}
\Psi &= Pr^{\mathbb{T}}(M_i \mid S_i) - \frac{Pr(N_j, M_i \mid S_i)}{Pr(N_j \mid M_i)} \\
&= \frac{Pr^{\mathbb{T}}(M_i \mid S_i)}{Pr(N_j \mid M_i)} \left(Pr(N_j \mid M_i) - Pr(N_j \mid M_i, S_i)\right) \\
&= \frac{Pr^{\mathbb{T}}(M_i \mid S_i)}{Pr(N_j \mid M_i)} \left(Pr(N_j \mid H_i) - Pr(N_j \mid L_i)\right) \left(Pr(H_i \mid M_i) - Pr(H_i \mid M_i, S_i)\right) \\
&= \frac{Pr^{\mathbb{T}}(M_i \mid S_i)}{Pr(N_j \mid M_i)} Pr(N_j \mid L_j)\rho \underbrace{\left(Pr(H_i \mid M_i) - Pr(H_i \mid M_i, S_i)\right)}_{<0} \propto -\rho
\end{aligned}
$$

$$
\begin{aligned}
\Xi &= \frac{Pr(N_j, M_i \mid S_i)}{Pr(N_j, M_i)} - \frac{Pr^{\mathbb{O}}(M_i \mid S_i)}{Pr^{\mathbb{O}}(M_i)} \\
&= \frac{Pr(N_j \mid S_i, M_i) Pr^{\mathbb{T}}(M_i \mid S_i)}{Pr^{\mathbb{T}}(M_i) Pr(N_j \mid M_i)} - \frac{Pr^{\mathbb{O}}(M_i \mid S_i)}{Pr^{\mathbb{O}}(M_i)} \\
&= \frac{Pr^{\mathbb{T}}(M_i \mid S_i) \left[Pr(H_i \mid M_i, S_i)(Pr(N_j \mid H_i) - Pr(N_j \mid L_i)) + Pr(N_j \mid L_i)\right]}{Pr^{\mathbb{T}}(M_i) \left[Pr(H_i \mid M_i)(Pr(N_j \mid H_i) - Pr(N_j \mid L_i)) + Pr(N_j \mid L_i)\right]} - \frac{Pr^{\mathbb{O}}(M_i \mid S_i)}{Pr^{\mathbb{O}}(M_i)} \\
&= \frac{p^*_2\rho + (1 + p^*_2)(1 - 1/2(1+\rho))}{(1-\mu)p^*_2\rho + (1 + (1-\mu)p^*_2)(1 - 1/2(1+\rho))} - \frac{1 + p^*_1}{1 + (1-\mu)p_1*} \\
&= \frac{\mu\left[(p^*_2 - p^*_1)(1 - 1/2(1+\rho)) + \rho p^*_2\right]}{(1-\mu)p^*_2\rho(1 + (1-\mu)p^*_1) + (1 + (1-\mu)p^*_1)(1 + (1-\mu)p^*_2)(1 - 1/2(1+\rho))}
\end{aligned}
$$

Ξ can be both positive and negative, depending on the equilibrium outcomes p^*_1, p^*_2 and the

[21]In fact, one has to show that $\gamma_{M_i,M_j} \geq 1/2$. Intuitively, γ_{M_i,M_j} is the lowest when $\rho = -1$. Then investors know that one of the underwriters has to been marketing the equity of a high-risk firm and the other of a low-risk firm. As both underwriters and firms are observationally equivalent, the posterior of both firms being of type-L drops to 1/2. For all other correlation values, $\gamma_{M_i,M_j} > 1/2$

correlation ρ. $\Xi > 0$ whenever $(1+\rho)/(1-\rho) > p_1^*/p_2^* \geq 1$. Therefore, $\rho < 0$ implies that $\Xi < 0$, too. For $\rho > 0$ the sign of Ξ can only be determined when knowing p_1^* and p_2^*.
With respect to the revenue differences, we can summarize:

1) for $\rho < 0$:	2) for $\rho > 0$:
$\Xi < 0, \Psi > 0$	$\Xi <> 0, \Psi > 0$

As $R^{\mathbb{T}} - R^{\mathbb{O}} = \left(P^*_{1/2} - P^*_0\right)\Xi + \left(P^*_{M_i,M_j} - P^*_0\right)\Psi$ and $\left(P^*_{M_i,M_j} - P^*_0\right) > \left(P^*_{1/2} - P^*_0\right)$, the only way of determining the sign of the revenue difference without having to determine the prices, is for 1), that is $\rho < 0$, $\Xi < 0$, $\Psi > 0$, and $\Xi + \Psi > 0$. The last inequality, however, does never hold given the model's parameter space.
For $\rho > 0$, there are parameter values for which $\Xi + \Psi > 0, whichisanecessaryconditionforapositiverevenu$
But whether $R^{\mathbb{T}} - R^{\mathbb{O}} > 0$, depends on the difference between $P^*_{M_i,M_j}$ and $P^*_{1/2}$ which cannot be answered without solving explicitly for the equilibrium prices. As stated in the main text, this can only be achieved by putting more structural assumption in to the model. In contrast, it is easy to show that $R^{\mathbb{T}} - R^{\mathbb{O}} < 0$. ■

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