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Doctoral Thesis

Pricing and Interactions on IPO primary market

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SUMMARY

This dissertation consists of three related essays on Initial Public Offerings (IPOs) primary market pricing.

The aim of this study is to examine the impact of underwriters- institutional investors on IPO primary market pricing. While the first essay provides a review of existing literature, the second and the third essays provide two empirical studies on this topic.

In the first essay we point out that, although a large body of literature deals with secondary market pricing anomalies in Initial Public Offerings (IPOs) (underpricing, hot issue markets, and long run underperformance), relatively few works regard the IPO primary market pricing. Among the multitude of variables that might affect the way shares are priced and sold in new offerings, the role of previous relationships between key parties of an IPO - namely the issuing firm, investment banks, and institutional investors - are the object of analysis in the present paper. Existing mixed evidence suggests that the role of repeated interactions between the three major parties might play a crucial role in that they are likely to reduce the likelihood of asymmetric information problems. Nonetheless, opportunistic behaviors arising from such interactions might be taking place, as well. This work highlights the way in which these relationships shape the entire pricing process and the early market performance of the offering, revealing that IPO primary market has received relatively little attention because of the lack of transparency in bidding and allocation data, and, based on existing mixed evidence, suggests the importance of shifting attention to this market in order to better understand IPO pricing dynamics.

JEL Classification: G14, G23, G24.

Keywords: Initial public offerings; Primary markets pricing; Interactions; Due Diligence; Bookbuilding

The second study investigates the impact of ongoing relationships between lead managers and institutional investors on Initial Public Offerings (IPO) pricing. Differently from previous studies that are focused on allocations of underpriced shares, we propose a model of primary market pricing in which the incomplete adjustment of the offer price to its maximum achievable level depends on the intensity of interactions between players in the years before the IPO. Using a stochastic frontier approach on a sample of 1,677 US IPOs between 2000 and 2016, the paper shows that the more investment banks and investors regularly work together, the more the IPO offer price is set closer to the fair value of the issuing firm. This study helps to disentangle the ambiguous effects of underwriters' discretion on IPO primary market pricing when bookbuilding is used. It supports the idea that banks can maximize value to issuers by fostering a regular clientele of investors.

JEL Classification: G14, G23, G24.

Keywords: Initial public offerings; Stochastic frontier; Primary markets pricing; Interactions; Bookbuilding.

In the third essay we investigate the mechanisms that are behind the way IPO price ranges are set in the due diligence step. Differently from previous studies that are mainly focused on underwriters' networks (Cowrin and Schultz, 2005; Chuluun, 2015; Bajo et al., 2016; Lu and Liu, 2016; Rumokoy et al., 2017), we propose a model where the effects of underwriters-funds relationships on the IPO pricing are investigated. Using different network centrality measures on a sample of 1,246 U.S. IPOs issued between 2004 and 2016, we demonstrate that IPOs underwritten by book managers having more central investors' networks and a higher level of investor attention (proxied by the search volume in Google) are more likely to be set with a price range that follows SEC's indications. This study also provides an analysis of the determinants of the dimension of the IPO filing price ranges.

JEL Classification: G14, G23, G24

Keywords: Initial public offerings; Primary markets pricing; Interactions; IPO price range; Investor attention.

Chapter 1: Review of IPO primary market pricing literature

1.1 Introduction

An initial public offering (IPO) occurs when a firm goes public for the first time. Several reasons and theories have been advanced to address why firms should go public (Pagano et al., 1998; Boot et al., 2006; Chemmanur et al., 2009).[1] Some authors suggest that IPOs are natural events which occur at some stage of a firm's life (Zingales, 1995). Thus, at the beginning of its life cycle a firm will be private but then, as time goes on, it becomes suitable for it to go public (Chemmanur and Fulghieri, 1999). In most cases, raising public equity yields some benefits, the first being the possibility of selling stock to many diversified investors (Ritter and Welch, 2002). Public trading also increases the liquidity of the company and allows for the creation of public, open-market transactions in which shareholders can convert their participation into cash (Ibbotson and Ritter, 1995). In addition, the possibility of equity financing allows for some outside monitoring (Holmstrom and Tirole, 1997) and enables acquisitions (Brau and Fawcett, 2006). However, this process also entails costs, incurred by each public market investor, related to evaluating the firm (Chemmanur and Fulghieri, 1999) or to control problems (Jensen and Meckling, 1976; Boot, Gopalan and Thakor, 2006).

The main problem associated with the IPO is the determination of an appropriate offer price for the issuing firm's shares. IPOs are typically characterized by problems of adverse selection and moral hazard, as first described by Akerlof (1970) in his "lemons" problem. In the absence of any mechanism that helps in distinguishing between bad and good firms, the bad drive out the good and markets might collapse (Varshney and Robinson, 2004). Nonetheless, the quality of issuing firms

[1] The choice between private and public has been analyzed as a trade-off between a higher cost of capital involving private investors and the costs for the evaluation and the control incurred by public market investors (Loughran and Ritter, 2002; Benninga et al., 2005; Boot et al., 2006). A number of studies have attempted to conciliate this idea with the fluctuation in the number of IPOs (Ritter, 2011). In fact, over the past decade in the U.S. there has been a low volume of IPOs not only due to excessive regulation, but also to the structural shift in the profitability of small private companies compared to the larger public ones (Gao et al., 2013). Since the tech stock bubble burst in 2000, there has been, especially in the U.S. market, a reduction in the volume of new offerings, suggesting that the cost of being public may have increased. This "listing gap" has been particularly pronounced among young firms (Doidge et al. 2017). Some explanations for this drop may be found in the low demand for capital, changes in investor sentiment, and information asymmetry problems (Lowry, 2003).

cannot easily be predicted because listing firms are often young and new in the market and the information environment, from which investment decisions can be made, is limited; indeed, there are no secondary market performance records and the operating history data is short (Thornton et al., 2009). All these factors increase the valuation uncertainty of IPOs and might give rise to well-known secondary market pricing anomalies: underpricing[2], hot issue markets, and long run underperformance (Ibbotson et al., 1988; Jenkinson and Ljungqvist, 2001; Ritter and Welch, 2002). The former is empirical evidence of the fact that the first-day closing price is usually higher than the offer price (Ibbotson, 1975). First day returns can range from an average of 12.3% as in the case of US IPOs in 2002-2007 (Bradley et al., 2008) or they can be considerably higher at 20.4% as in the case of Chinese IPOs in 2010 (Ritter, 2011). Although the existence of a physiological discount is quite normal (due to the premium for risk and to the presence of transaction costs), observed levels are too high to be explained through this sole reason. The result of this anomaly is a dilution of capital: if no underpricing exists, firms can obtain the same money by offering a smaller number of shares. In other terms, underpricing for issuing firms represents an additional cost associated with the listing (also known as *money left on the table*). There is a growing body of literature attempting to understand this anomaly, also known as the IPO underpricing puzzle (Ljungqvist, 2007).

Another anomaly that is frequently observed during IPOs is the "hot issue" market (Ibbotson and Jaffe, 1975; Ritter, 1984); in bullish markets, the concentration in terms of volume of offerings and industries tends to increase. This evidence also suggests that if a firm goes public during hot issue markets underpricing tends to be higher and the firm's performance is threatened by possible variations in the market conditions. Moreover, in a few years after the listing so-called long run underperformance (Ritter, 1991) may occur. At the beginning of negotiations, the initial returns on

[2] One of the most watched outcomes in an IPO is its initial first-day return (namely the percentage difference between the public offering price in the primary market and the closing price at the end of the first day of trading in the secondary market). On the one hand, a higher initial return is often taken as a measure of success of the IPO and the result of a successful marketing effort by underwriters (Krigman et al., 2001). Consequently, it can be seen as a sort of advertising (Demers and Lewellen, 2003; Chemmanur and Yan, 2009). On the other hand, from the perspective of the issuer, higher initial returns mean more money "left on the table", thus suggesting a negative outcome (Clooney et al, 2015).

new offerings are positive but, over time, markets conditions might change, stocks progressively become less attractive, the volume of trading decreases (Mikkelson et al., 1997), and performance worsens. In part, this is because there are more IPOs following periods of high market returns but, holding constant the characteristics that are associated with low returns in general, it seems that long run returns are abnormally low (Ritter, 2011). All of these puzzling phenomena raise questions concerning market efficiency, but they also suggest that "the solution to the underpricing puzzle has to lie in focusing on the setting of the offer price" (Ritter and Welch, 2002).

Two kinds of informational frictions affect the way IPO offer prices are set in the primary market. One arises because issuers have an incentive to misrepresent themselves to potential investors; the other arises because investors are likely to be unequally informed about factors outside the issuing firm (Benveniste and Spindt, 1989). Overcoming this type of asymmetry is difficult because neither the issuing firm nor its underwriter can know precisely what the market's valuation of the stock will be. On the contrary, the certification role of underwriters may help issuers to deal with the first type of informational asymmetry (Booth and Smith, 1986; Smith, 1986). Given that firms' information opacity creates high uncertainty with respect to share value, intermediaries have the potential to overcome some problems associated with underwriting. Companies seeking capital know more about their prospects than investors do, and investors know more about the terms on which they are willing to provide capital. Each party has an incentive to protect its informational advantage. The IPO market is a typical example of a mediated market in which the presence of 'structural holes', namely holes in the flow of information, requires the presence of a broker (Burt, 2009). These brokers, or third parties, help disparate actors to interact, to exchange information, and to conclude transactions. Investment bankers, through repeated dealings with large networks of issuers and investors, build trust necessary to filter out information that counterparties are unwilling to share with one another. In this sense, investment banks can be seen as coordinators of largescale, strategic information networks (Wilhelm, 2005). Although all players involved in the IPO (i.e., investment banks, firms, institutional investors, venture capitalists and analysts, lawyers, accountants, government regulators)

play an important role on pricing new securities, it is the firm, the lead underwriter (with the underwriting syndicate), and the investors who initially purchase shares in the offering that play the greatest role in shaping the pricing and early market performance of the offering (Pollock, 2004). Each of the three decision makers involved in an IPO might have different incentives that are not necessarily compatible. The incentive of the firm is to maximize wealth for the original shareholders, to raise capital, and to dilute capital; the investment banker's incentive is to maximize its expected profits; that of investors is to maximize the return on their investment. In this process, established relationships and repeated interaction between the key parties of this market play a crucial role in reducing uncertainty regarding the firm's value, but opportunistic behaviors could also be involved.

This paper contributes to the existing IPO literature by portraying a broader picture of the dynamics that influence the pricing decision in the primary market. It will highlight the way in which relationships between the key parties of an IPO transaction (namely the issuing firm, the bank that underwrites and markets the deal, and the investors) influence the entire price setting process.

It has been argued that reasons for the anomalies outlined above might lie with how underwriters set the price at which the company goes public and controls allocations in the primary market; However, research has provided little guidance, to date. As a matter of fact, empirical research in this field has been limited due to the lack of data on the bidding and share allocation practice, especially for the U.S.[3] This contribution is novel in that it not only delves into IPO primary market pricing but, in doing so, stresses the influence that relationships between issuing firms, underwriters, and investors have on the valuation and on the pricing process. The rest of this paper is structured as follows.

The chapter starts in Section 1.2 by reviewing the IPO pricing process. Section 1.3 provides an overview of the choice of the underwriter and the formation of the underwriting syndicate. Section

[3] Usually, to deal with banks-found relations, the first reported holding by investors at the end of the offering quarter is used as a proxy for the participation in the IPO (Reuter, 2006; Ritter and Zhang, 2007; Field and Lowry, 2009; Goyal and Tam, 2013).

1.4 provides a discussion of the key aspects of the due diligence process. Section 1.5 discusses the role of intermediaries and institutional investors throughout the bookbuilding, Section 1.6 concludes.

1.2 IPO pricing process

There are two primary ways in which IPOs may be underwritten: best effort and firm commitment. In the first case the underwriter does not pre-commit to purchase shares from the issuer, but it agrees, as an issuer's agent, to 'do its best' to place the issue (Hanley, 2017). On the contrary, in the firm commitment method the underwriter guarantees that it will purchase the shares of the offering from the issuer (net of an underwriting discount) even if the entire issue is not placed (Ibbotson and Ritter, 1995). In this case, offerings are most often conducted and priced by using a bookbuilding procedure which involves the submission of a non-binding indication of interest from a clientele of regular investors.[4] Along with bookbuilding, underwriters usually provide additional services like price support and analyst coverage. Price support, in particular, is used to stabilize the aftermarket price by purchasing shares or by means of short coverings (Aggarwal, 2000; Ellis, Michaely, and O'Hara, 2000). The immediate benefit of this temporary manipulation of the price is to avoid downward spirals (Welch, 1992) in the stock price, but it could also explain the long run underperformance of new securities (Lewellen, 2006). Analyst coverage consists in positive recommendations usually provided by analysists affiliated with the investment bank (Michaely and Womack, 1999; Bradley, Jordan, and James and Karceski, 2006; Ritter, 2008). The main advantage of bookbuilding, which represents the dominant and de facto only method adopted, is that underwriters can control both the price and the allocation schedule of newly issued shares. To date, three main theories describe the allocation strategy of investment bankers during bookbuilding (Nimalendran et al. 2007). In the academic view, investors who bid aggressively, thus revealing favorable information, are rewarded with disproportionately large allocations of shares (Ljungqvist, 2007). Hanley and Wilhelm (1995),

[4] An alternative price mechanism is the auction mechanism in which the offer price is set at the point where demand equals supply.

Cornelli and Goldreich (2001) and Jenkinson and Jones (2004) have empirically found support for this view. Next to this, the pitchbook view suggests that underwriters favor long-term investors (also known as “smart money investors” or “strong hands”) and discourage the activity of "flippers" who, by selling their shares in the immediate aftermarket, increase the cost of price support and intervention in the aftermarket to stabilize prices (Aggarwal, 2003; Jenkinson and Jones, 2004; Goyal and Tam, 2013). Consistent with the profit-sharing view, shares are assigned by investment banks on the basis of commissions paid by investors (Nimalendran et al., 2007); in other terms, banks use their monopsony power to give large allocations to investors who, through trading commissions, can transfer profits and benefits to the bank (Ritter, 1984; Chalk and Peavy, 1987; Reuter, 2006). Although these theories propose different motivations that might drive the allocation policy of underwriters, their commonality is that IPO allocation policies tend to favor institutional investors, while retail investors are excluded from the bidding process, thus receiving a smaller proportion of highly underpriced IPOs. Therefore, on the one hand, bookbuilding allows investment banks to form a clientele of regular investors that will not flip the allocated shares, thereby reducing the cost of price support and increasing the brokerage commissions, with the quid pro quo expectation that these institutions will also buy the cold IPOs. On the other hand, this method not only excludes retail investors but, quite often, does not allow an offer price that clears the market to be set because IPO shares are not allocated to the investors who value them the most (Whilem, 2005).

In order to fully investigate IPO pricing in the primary market and to highlight the role of bookbuilding in the pricing process, a better understanding of each step of the IPO is needed. In the U.S., the offering process typically consist of three important steps: the selection of the underwriter that will bring the issue to market, the registration statement with the Securities and Exchange Commission (SEC), and the final offer price decision on the day before the offer. As shown in Figure 1, the offering process usually begins with the engagement of an underwriter that will be the lead manager. The underwriter is designated to evaluate the firm, to form an underwriters’ syndicate, and to fill the preliminary prospectus or an amended statement filed with the Securities and Exchange

Commission (SEC). The same investment bank also conducts a due diligence investigation and assists the firm in pricing and marketing the new stocks (Ibbotson and Ritter, 1995). Given the multitude of activities that underwriters are requested to carry out in an IPO, it is possible that they share some of those activities with other figures such as a global coordinator, co-lead managers, and bookrunners but, in most of the cases, the tasks are carried out by a single underwriter. Therefore, at the beginning of the IPO, along with the choice of the underwriter, the underwriting syndicate is set up. After the issuer has chosen the underwriter, due diligence, which will become the basis for the disclosure in the registration statement (Form S-1) filed with the SEC, begins; the prospectus is also distributed at this time to potential investors. This is an important step because an adequate due diligence process on the part of the underwriter can mitigate exposure to future lawsuits (Hanley and Hoberg, 2012) and can aid the underwriter and issuing firm in setting an adequate initial offer price range. As a matter of the fact, in the preliminary prospectus the first pricing information is provided to the public in the form of an offer price range. It represents the maximum and the minimum achievable offer price that reflects the lowest acceptable price for the issuing firm and the highest price predicted by the underwriter to clear the market (Thompson, 2014). Indeed, during the waiting period, the lead underwriter may meet regular investors, namely those that are actively involved in purchasing shares of newly issued stocks, during road shows. Those meetings are important for both underwriters and issuing firms, because they acquire nonbinding indications of interest, helpful in estimating the demand and the offer curves and, consequently, to "build the book" (Ritter and Welch, 2002).

Up to this point, and through the registration period, the price may undergo an upward or a downward revision with respect to the midpoint of the range in response to investors' demand (Ibbotson et al., 1988). The midpoint of the initial price range represents the expected offer price (Hanley, 1993). Studies dating back to Logue (1973) suggest that, at this stage of the IPO, the revision in the offer price from the midpoint of the original range offers a powerful explanation for the underpricing that

follows (Ritter, 2011).[5] Thus, if the price experiences an upward revision, in response to investors' demand, a more drastic underpricing is expected due to a partial adjustment phenomenon (Hanley, 1993). More specifically, when a high demand is displayed during the bookbuilding phase, the offering price is then adjusted upward, but such an adjustment might be incomplete (Ibbotson et al., 1988); in order to induce investors to truthfully reveal good information, a large number of underpriced shares must be allocated to them (Hanley, 1993; Cornelli and Goldreich, 2001).[6]

An additional key point of primary market pricing regards the time when the above mentioned information is produced and/or revealed (Lowry et al. 2017). Consistent with Hanley and Hoberg (2010), information production occurs prior to the IPO, during the due diligence phase in talks with management, suppliers, venture capitalists etc. In keeping with this view, the initial price range already contains valuable information regarding the firm's intrinsic value (Aussenegg, Pichler, Stomper, 2006; Derrien and Kecskes, 2007; Chang, Chiang, Qian and Ritter, 2016). By contrast, another stream of literature sustains that underwriters may get valuable information about demand from the repeated nature of interactions with institutional investors, during the bookbuilding process (Benveniste and Spindt, 1989; Sherman and Titman, 2002; Chiang, Qian, and Sherman, 2009). In this case, the revision of the offer price during the registration period is useful for forecasting the investor demand.[7] In line with Crain et al. (2017), due diligence activities and bookbuilding are not independent but complementary; information production begins with the due diligence, continues through the bookbuilding, and characterizes the entire primary market.

[5] Lowry and Schwert (2004) demonstrate that the filing range midpoint is not an unbiased predictor of the offer price.

[6] The expression 'walk up' is usually used to deal with this situation in which the initial price range is set deliberately low (Thornton et al., 2009). The fact that the price is set just below the maximum point of the range creates a "feel good factor" for investors believing they have bought discounted new shares.

[7] Consistent with this idea that information production can occur prior to the IPO, a number of countries have variations in issuing strategies, which offer potential benefits. For example, some firms in the United Kingdom use a two-stage issuing strategy, whereby they list without issuing equity and then subsequently issue (Derrien, 2005). Jenkinson et al (2006) suggest that the extent of information collection prior to the IPO filing is even more extensive in Europe, since regulations governing pre-IPO (and prior to the intent to file an IPO) interactions between investors and underwriters are less stringent than in the U.S.

1.3 Underwriters' choice and syndicate formation

The extant literature recognizes that the choice of the underwriter is driven by more than one factor: the investment bank's reputation and certification role (Corwin and Schultz, 2005), the underwriter's distribution channel and the networking function accumulated through repeat dealings in securities offerings, brokerage services, and analyst research coverage (Dunbar, 2000; Huang et al., 2008; Michaely and Womack, 1999; Krigman, Shaw and Womack, 2001). In addition, other services provided after the IPO, such as price support and market making activities, might impact on the underwriter selection. However, it is worthy of note that pre-existing bank relationships appear to be the main factor influencing the choice of underwriter (Bharath et al., 2007; Klein and Zoeller, 2001). The benefits generated by lending relationships for a firm have been pointed out by different studies (Petersen and Rajan, 1994; 1995; James, 1987; Diamond, 1984; 1991; Stiglitz and Weiss, 1983). These authors suggest that firms with close ties to financial institutions are less credit-constrained because, through lending and monitoring activities, the bank obtains information regarding the firm's value that is unavailable to other institutions and that cannot be easily and credibly conveyed (Petersen and Rajan, 1994; 1995). When firms go public, the market and the firm are asymmetrically informed on the true value of the firm. Hence, the issuing firm must provide information regarding its performance and prospects, and in return, it receives feedback from investors (Benveniste et al., 2002). Nevertheless, by revealing information about the firm's business the issuer is exposed to the potential the potential risk and, consequently, cost of revealing proprietary information to rivals. In this context, having an established relationship with the bank that manages the IPO can contribute to the certification of the firm's value and facilitate the underwriting. An inside bank has an informational advantage that can mitigate asymmetric information problems when underwriting its client's equity and might help to price the firm's new issue more accurately. However, a lending bank's informational advantage presents a conflict of interest, because banks that have a stake in a firm might have incentives to promote overpriced issuance of a junior claim. The conflict-of-interest

and the certification debate of relationship banking has received much attention after the 1999 Gramm-Leach-Bliley Act, which repealed the Glass-Steagall Act in the United States and introduced a universal banking system. The Gramm-Leach-Bliley Act allows commercial banks, namely those with a prior financial claim in the firm (that can be debt, equity, or some combination of the two) to underwrite the firm's securities. Empirical evidence supports the certification role of banks underwriting their clients' IPOs. In other terms, existing studies find that private information obtained from prior financial claims are used to better certify the firm's value during the IPO. In particular, the model developed by Puri (1999) shows that commercial banks certify better than investment houses, thus obtaining better prices for underwritten securities. Bharath et al. (2007) and Schedone (2004) suggest that relationship banking reduces the cost of going public because of the lower asymmetric information problems. Schedone (2004) reports that firms with a lending relationship with a prospective IPO underwriter face a cost of equity capital that is 16 percent lower than that of firms with no banking relationships with potential underwriters. Ang and Richardson (1994), Kroszner and Rajan (1994), Puri (1994) and Benzoni and Schedone (2010) show that IPOs underwritten by relationship banks exhibit better long run performance compared to equity issues underwritten by investment houses. In sum, previous findings reveal that universal banks might use their superior information regarding client firms to float the stock of the "cherries", not the "lemons" (Ber et al., 2001). Consequently, the selection process is a two-way affair, with the reputable investment banker choosing its clients at least as carefully as the company chooses its underwriter (Lowry et al., 2017). Another stream of literature suggests that having past relationships with other banks and institutional investors is crucial for being included in the underwriting syndicate. As suggested in James (1992), banks are likely to increase their reputation and their network of relationships, through repeated dealings. Cooney et al. (2015) examine the role of social ties in IPO underwriting syndicate formation and find that an investment bank is more likely to be included in the underwriting syndicate when interpersonal social ties with the IPO firm exist. These social relationships generate better outcomes for both issuers and investment banks; the former obtains wealth gains for its pre-IPO shareholders

and greater information production while the latter is likely to receive a higher compensation, a more senior role in the IPO, and greater share allocations. Investment banks are also included in the IPO underwriting syndicate because of their participation in recent syndicates led by the same book manager (Corwin and Schultz, 2005). Underwriters' relationships are vital - to alleviate moral hazard problems and foster cohesiveness in the syndicate - but may also be used as a channel for familiarity or to reduce the search costs. Thus, underwriters might relay information directly from co-managers and indirectly through conversations with the issuer; this double channel of information might affect the likelihood and magnitude of offer price revisions. The effect is more evident in the case of multiple bookrunners (multiple lead underwriters or MLUs); in fact, between 2001 and 2010, nearly half of the IPOs were managed by underwriting syndicates with more than one lead underwriter (Corwin and Schultz, 2005). A key advantage of MLU syndicates is that they can produce additional information beyond the capacity of an individual underwriter (Barzel, Habib, and Johnsen, 2000; Corwin and Schultz, 2005; Pichler and Wilhelm, 2001). Jeon et al. (2015) find the issuers have greater pre- and post- IPO visibility, greater offer price revision, and a larger investor base in the case of multiple lead underwriters. Some recent studies suggest that MLU syndicates provide more bargaining power to the issuers (Hu and Ritter, 2007) and price the IPOs near the firm's intrinsic value because they prefer to safeguard their reputation capital (Vithanage et al. 2016). The structure of investment bank peer networks has also been studied in terms of implications in the quantity and quality of information and resources that flow through the networks (Chuluun, 2015, Bajo et al. 2016, Rumokoy et al. 2017). Making use of social network analysis, these studies suggest that peer relationships represent important channels of information and resources: an underwriter can tap other underwriters' client and investor networks indirectly, thus reaching out to additional information and distribution channels. In particular, Chuluun (2015) shows that IPOs underwritten by book managers with more central and cohesive networks are associated with a higher likelihood of an offer price revision and larger price revisions. Bajo et al. (2016) sustain that investment banking networks allow lead IPO underwriters to induce institutions to pay attention and to extract information useful in pricing the

firms' IPOs from various institutional investors. The positive effect of network centrality in terms of IPO outcomes has also been examined in the Chinese market by Rumokoy et al. (2017). As a matter of the fact, investment banking is more of a relationship-based rather than a transaction-based sector. Although peer relationships between banks and institutional investors help investment banks to win trust from investors and to induce investors to produce and truthfully reveal price-relevant information, the investor network has not been explicitly examined. One main limitation to the empirical examination of underwriters-institutional investor networks is that investment banks are not required to disclose their order book and allocation schedule.

1.4 Due diligence process

Once the underwriter has been identified, a letter of intent is drafted. It typically includes a clause requiring the company to reimburse the underwriter for any uncovered expenses or in case the offering is withdrawn;[8] an agreement by the company to collaborate during the due diligence process, by providing all the relevant information; and a commitment to establish the compensation for the underwriter (Lowry et al., 2017). This compensation comes from the gross spread, namely the difference between the price at which the shares are bought from the firm and that at which they are sold to the public, which is almost always 7% of the proceeds[9] (Chen and Ritter, 2000; Hansen, 2001). The gross spread includes the underwriting fee, which covers syndicate costs and compensates risk-bearing by the underwriting syndicate (typically 20% of the gross spread), the selling concession that represents the amount per share received by investment banks in the selling group (60% of the gross spread), and the management fee which compensates the lead investment bank and any co-managers for their managerial and organizational activities in the offering (the remaining 20% of the gross spread) (Butler, 2005). Moreover, in the underwriting agreement an over-allotment option is often

[8] The existence of the option to walk away in bookbuilding leads to better offer pricing (Busaba, 1999) and reduces underpricing by strengthening the issuers' bargaining power with respect to investors (Busaba et al., 2001) because underwriters can price-up weakly demanded IPOs to prevent issuers from withdrawing their offering (Busaba et al. 2018).
[9] For larger IPOs, the gross spread is lower, and it is much lower in Europe and elsewhere, as documented by Torstila (2003) and Abrahamson, Jenkinson and Jones (2011).

included, which allows the underwriter to sell an additional 15% of the issue if the price goes up in the aftermarket. This put-like payoff represents an additional source of compensation which has become a standard clause in the IPO industry (Ellis et al., 2000 and Bajo et al., 2017). Some studies have examined the question of whether investment banks' compensation affects IPO performance, but the evidence is mixed. Using data on UK IPOs, Ljungqvist (2003) concludes that higher commissions lead to less underpricing. In the US context, Butler (2005) shows that higher selling concessions lead to higher offer prices, but do not reduce underpricing once price revision is taken into account.

The underwriter performs an initial due diligence investigation of the firm in order to file the S-1 registration form with the SEC, in which preliminary price information is provided in the form of a price range. In the U.S., the Securities and Exchange Commission regulations provide general principles guiding the price range that must be included in the preliminary prospectus, as well as the total number or an aggregate value of shares that are being registered. As stated in Item 501(b)(3) of SEC Regulation S-K, the price range must reflect a "bona fide estimate" of the final offering price. This leaves open to interpretation the required precision of a bona fide estimate of the price range. The SEC guideline provides a "safe harbor" for issuers who limit their price range to a designated percentage that has changed across time. Until September 2001 the SEC suggested a bona fide estimate for a price range greater than $2 or 10% of the lower price; this indication was then relaxed in the volatile post-September 2001 period to greater than $2 or 20% of the lower price (Jenkinson et al., 2006). However, the SEC has also asserted that a bona fide estimate for the price range used in an IPO should be no more than $2 or 20% of the high end of the range (Bloomberg Corporate Law Journal, 2007). Despite these general guidelines, the SEC has retained discretion in reviewing and accepting a price range as a bona fide estimate. Generally speaking, the greater the uncertainty about the value of IPO shares to be issued, the greater the filing range set by underwriters (Bajo et al., 2016). This uncertainty could reflect difficulties in estimating the firm value, given that there is no observable market price prior to the offering and many of the issuing firms have little or no operating

history; however, it could also arise because the lead manager will choose the initial IPO offer price range based on the expected value of institutional investor demand. Nevertheless, when the initial price range is set, the precise value of the regular investors' demand it is not officially available, as it is realized only subsequently (during the book-building process) (Hanley, 1993; Ljungqvist and Wilhelm, 2002; Wang and Yung, 2011; Chuluun, 2015). In this restricted information environment, underwriters may rely on other sources of information to initially value an IPO, such as retail investor attention (Colaco et al., 2017), for example. Incorporating several variables to assess market conditions and investor demand for an issue (McCarthy, 1999) could lead to more appropriate valuations for newly-public firms and reduce the need for underwriters to engage in costly price stabilization activities when trading begins (Chowdhry and Nanda, 1996). Understanding and predicting how the broader market will receive the issue helps to reduce the uncertainty that remains even after the investigation of the issuer (in the due diligence phase) and after the underwriters' surveys of the regular investors (during the waiting period). Examining US IPOs in the period 2004–2011, Colaco et al. (2017) found that an increase in retail attention, proxied by Google's search volume index (SVI) in the month before the IPO, was associated with higher initial valuations. Moreover, Da et al. (2011) showed that SVI contributed to the large first-day return and long-run underperformance for a sample of IPO stocks from 2004 to 2008. However, no formal theoretical model has been presented in the existing literature regarding the process by which underwriters choose the initial offer price range (Chemmanur et al., 2016). It is reasonable to think that the existence of repeated interactions between the lead manager and the underwriter syndicate or regular investor could influence the IPO price range setting. The lead underwriter might make use of its investment banking network, indirectly, and its networks' clientele of regular investors, directly, to extract information from institutions about their demand for the IPO firm's shares. Put differently, underwriters, might be able to gather more precise information even before the roadshow begins, during the due diligence process, through previous interactions with regular investors. Such advantages would cause their initial price ranges to be more precise because the lead manager would

face lower uncertainty regarding the regular investors' demand. Although peer relationships between banks and institutional investors help investment banks to win trust from investors, making the market more optimistic, the impact of investors' networks on IPO price range has not been explicitly examined.

1.5 Bookbuilding

Once the company has addressed the registration and disclosure requirement of the SEC, the marketing begins: the company and the investment bank promote the IPO through the road show, when the underwriter receives non-binding bids, the majority of which tend to be from institutional investors. These indications of interest are used to proxy the demand curve and to establish the offer price. With an amended filing, underwriters can increase (or decrease) the price range, if there is excess (or too low) pre-offering demand. The harder the underwriter works at marketing the shares, the more can be learned about the market demand and the more it can be increased. Setting the final offer price represents a challenge for the bank that has to preserve its professional reputation, but, at the same time, has to balance contrasting interests; therefore, the final offer price should neither be set too high for issuers nor too low for investors-buyers. Choosing an inadequate offer price entails more than one consequence. On the one hand, if the price is set too high securities might be undersubscribed, leaving the underwriter with a stock of unsold shares and the issuing firm with a lower capital raised. On the other hand, if the offer price is set too low, the amount of money left on the table increases, resulting in a possible future loss of business for the underwriter. Accordingly, the best strategy for underwriters, if there is a high demand during the bookbuilding, is to partially adjust the offer price. Underwriters have more than one incentive to keep the offer price low (Loughran and Ritter, 2002); although the percentage gross spread is established before the final offer price decision, underwrites can benefit from omitting some information because it can reduce their marketing costs (Benveniste et al. (1996); Chowdhry and Nanda (1996)), protect their reputation (Beatty and Ritter (1986); Carter and Manaster (1990)), reduce the risk of lawsuits (Lowry and Shu,

2002), augment their brokerage commissions, allow them to allocate shares to corporate executives (Loughran and Ritter, 2002), and facilitate finding buyers (Baron, 1982). This means that, quite often, instead of raising the final offer price up to fair market value, investment banks adjust the price upwards incompletely. Studies dating back to Logue (1973) suggest that during the bookbuilding phase a variable of plausible explanatory power for underpricing is the revision in the offer price from the midpoint of the original range (Ritter, 2011). Thus, if the price is withstanding an upward revision, in response to investors' demand, there is, on average, a sharper underpricing than in IPOs where the revision is downward (Hanley, 1993). The empirical evidence of this partial adjustment phenomenon was first documented by Hanley (1993). In other terms, if there is a high demand during the bookbuilding, the offering price is adjusted upward, but the adjustment might be incomplete (Ibbotson et al., 1988) meaning that the information obtained during the waiting period is only partially reflected in the offer price revision to create underpricing that compensates investors for truthfully revealing their private information (Cornelli and Goldreich, 2001). There is a body of literature that has analyzed which kind of information is usually incorporated into offer prices; in order for private information to be revealed there needs to be an incentive (Hanley, 1993; Cornelli and Goldreich, 2001; Benveniste and Spindt, 1989), while public information should be available and completely incorporated into the final offer price in order to allow price efficiency. As pointed out in Lowry and Schwert (2004), Bradley and Jordan (2002), Loughran and Ritter (2002), and Derrien (2005), IPO offer prices tend to under-adjust to public information because the underpricing can be predicted using information known before the IPO date. However, Lowry and Schwert (2004) conclude that underwriters' treatment of public information appears to be almost consistent with an efficient IPO pricing process. From a theoretical point of view, much of the research on the partial adjustment has revolved around three mainstreams: the Dynamic Information Acquisition Hypothesis, the Bargaining Hypothesis and the Trade-off Hypothesis (İnce, 2014). In the first case, a partial adjustment of the offer price - resulting in greater underpricing - is used by underwriters to induce investors to reveal their private information and to satisfy their incentive compatibility constraint

(Benveniste and Spindt, 1989). The Bargaining Hypothesis states that the partial adjustment is the result of a negotiation between the underwriter and the issuing firm, each of which has different incentives. If positive information is revealed, during the waiting period, a surplus associated with a higher evaluation is likely to emerge, and this will be shared between the two parties according to their bargaining power (Loughran and Ritter, 2002). Lastly, the Trade-off Hypothesis (Edelen and Kadlec, 2005) sustains that the issuing firm responds with a revision of the offer price, observing valuations of comparable firms during the registration period. In other terms, if a positive valuation of the issuers' competitors is observed, a partial revision of the offer price will increase the probability of success of the IPO.

Notwithstanding the fact that the lead underwriter is free to set the final offer price anywhere within the initial offer price range, setting it too distant from the midpoint of the range (that represents the expected offer price) is costly (Bajo et al., 2016). Costs could arise from the requirement to update the offer price and also from the waste of resources spent by regular investors to reveal their private information concerning their interest in the issuing firm. Given that underwriters have long-term relationships with regular investors, it is likely that these costs are transmitted to IPO underwriters in the long run, thus compromising future collaborations.

The increased use of bookbuilding from the 90s onward, has given rise to a debate regarding the advantages associated with this mechanism for selling IPOs. Unlike auctions, bookbuilding enhances underwriters' ability to elicit information from investors, increasing the price discovery (Benveniste and Busaba, 1997) and allowing control over both price and allocations (Lowry et al. 2017), reducing the risk of undersubscription (Sherman, 2005) and, consequently, increasing the expected proceeds. Sherman (2005) argues that the possibility of forming an underwriter's network of regular investors largely contributes to the growing popularity of bookbuilding as an IPO allocation mechanism. In other terms, bookbuilding is the most dominant method, despite its higher costs, because banks have ample opportunity to develop a reputation for fair dealing by interacting repeatedly with the network of regular investors. Although a distinguishing feature of bookbuilding is that an underwriter both

sets the price at which the company goes public and controls allocation, these advantages must be weighed against the possible conflicts of interest that might come with allowing underwriters to make preferential allocations (Lowry et al. 2017). In particular, excessive commissions, laddering, analyst conflicts of interest, and spinning practices during bookbuilding give rise to the well-known CLAS controversies (Ritter, 2011). 'C' represents the payment of excessive *commissions* by investors as a way of currying favor for IPO allocations (Nimalendran, Ritter and Zhang, 2007; Goldstein, Irvine and Puckett, 2011), 'L' stands for *laddering*, namely, the practice of allocating shares with the condition that the investor buy additional shares in the immediate aftermarket (Edwards and Hanley, 2010), 'A' is biased *analyst* recommendations, deriving from the fact that sell-side analysts are paid partly out of revenue generated by investment banking and therefore have an incentive to give favorable "buy" recommendations to underwriting clients (Bradley, Jordan and Ritter, 2008; Gao, Ritter and Zhu, 2011), 'S' represents *spinning*, i.e., the practice of allocating underpriced IPOs to the personal brokerage accounts of corporate executives as a way of influencing the executives in their choice of corporate investment banking decisions (Liu and Ritter, 2010). In sum, there are two streams of literature that concern the role played by underwriter-institutional investor relationships during bookbuilding. Some studies suggest that the allocation discretion of the underwriters significantly improves the efficiency of IPO prices by inducing optimal information production. Others sustain that the combination of underwriters' allocation discretion of shares and the relationship between underwriters and institutional investors involve opportunistic behavior that allows underwriters to obtain private benefits. More specifically, the open question is whether the 'discretionary' share allocation policy of the lead managers and their repeated interactions with regular investors or a 'discriminatory' practice that serves the bankers' interests at the expense of other parties to the transaction (Ljungqvist and Wilhelm, 2002) is beneficial for the issuer. Consistent with the bookbuilding theories, when investment banks sell repeatedly to the same investors, they collect valuable and reliable information in the premarket, which is used to more accurately price the IPO; accordingly, underpricing is reduced in exchange for priority in future IPO allocations

(Benveniste and Spindt, 1989; Benveniste and Wilhelm, 1990; Spatt and Srivastava, 1991; Sherman and Titman, 2002). Several papers provide support for the prediction that investors who provide the greatest amount of information bid aggressively, thus obtaining the largest allocations[10] (Cornelli and Goldreich, 2001, 2003; Jenkinson and Jones, 2004, 2009; Aggarwal et al., 2002; Chemmanur et al., 2010). Empirical studies such as those by Bubna and Prabhala (2011) for Indian IPOs or Ljungqvist and Wilhelm (2002) in France and the UK, find that allocation constraints, such as clawback provisions[11], result in smaller price revisions, smaller institutional allocations, and greater underpricing. On the contrary, the study by Mazouz et al., (2017) find on a sample of firms listed on the Hong Kong Stock Exchange, that the mandatory clawback provision has enhanced the fairness in IPO share allocations among different investor groups and has reduced the 'winner's curse' in the IPO market. The other steam of literature maintains that favoritism in the allocation is not automatically used in the best interest of the issuing firm, thus resulting in a higher amount of money left on the table (Ritter and Welch, 2002). The agency-based explanation (Baron, 1982) argues that the underwriter's discretion will aggravate the agency problem between investment bank and issuing firm (Ljungqvist and Wilhelm, 2002). In this case, underpriced shares are allocated to institutional investors that can provide some form of kickback. Reuter (2006), Nimalendran, Ritter and Zhang (2007), Goldstein, Irvine and Puckett (2011) and Ritter and Zangh (2007) document that underwriters give preference in allocations to rent-seeking investors who repay part of their trading profits by paying commissions in excess of direct execution costs, known as soft dollars, on other trades. Moreover, other studies such as Hao (2007), Edwards and Hanley (2010), Griffin et al. (2007) report the use of laddering, where shares are allocated under the condition that the investor buy additional quantities in the immediate aftermarket.

[10] In most cases these studies use samples of European offerings because data on both allocation and underwriter's order books is difficult to obtain, especially for the U.S. market. (Lowry et al. 2017)

[11] The claw back provision provides that, given the retail offering quota decided upon at the underwriters' discretion, the syndicate can allocate more shares ex post to retail investors when there is low demand from institutions.

1.6 Conclusion

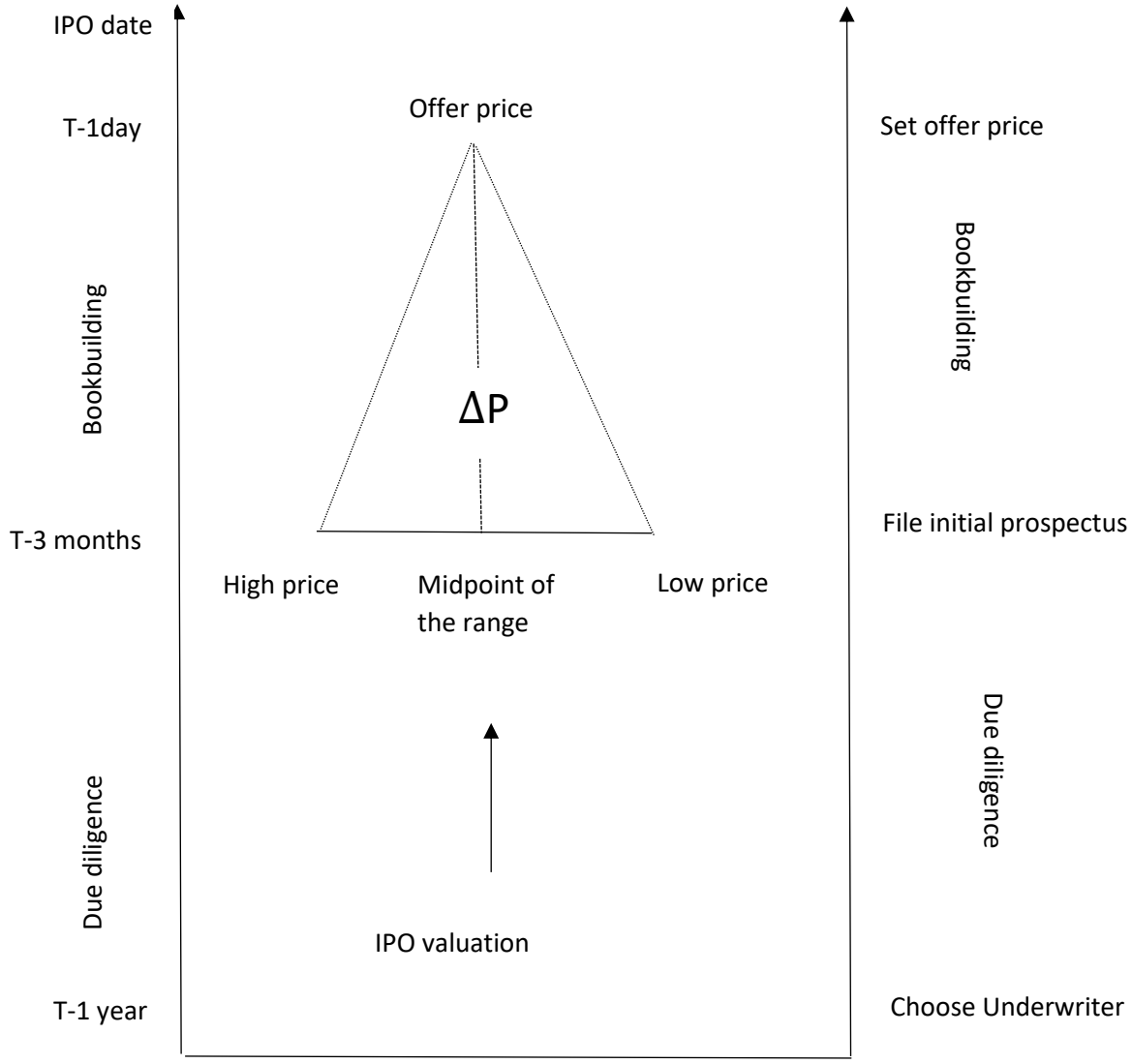
The IPO literature is rich and vast and, for most of the part, focused on secondary market pricing anomalies (underpricing, hot issue markets, and long-run underperformance). The empirical evidence on the pricing of IPOs remains puzzling to those who otherwise believe in efficient financial markets. The main difficulty associated with an initial public offering is to evaluate the issuing firm and to establish an adequate offer price at which new shares will be sold. The price decision and the valuation of the firm's potentialities typically occur in the primary market. Despite the relevance of the IPO primary market, (where new securities are created and priced, and where secondary market pricing anomalies originate), it has received relatively little attention. Setting the price of an initial public offering is crucial to a successful offering but it is also difficult, because the firm is informatively opaque to potential investors. Moreover, the IPO market is a mediated market characterized by a high incidence of asymmetric information. In this context, a situation of potential conflict of interest arises from different market operators, because at least one of the agents is connected to a different principal (Arthurs et al., 2008). Each of the three major parties involved in an IPO - issuers, investment banks, and investors - has different incentives that are not necessarily compatible. In this regard, companies going public offer an excellent opportunity to examine how the market deals with some of the problems created by information asymmetries between closely-held firms, underwriters, and external investors (Ibbotson and Ritter, 1995). An underwriter's activity in primary markets is expected to mitigate the moral hazard problem in the production of information; intermediaries, being repeated actors in the IPO market with relationship-intensive business (Chuluun, 2015), act as credible information producers (Carter and Manaster, 1990). In this context, the lead underwriter fills a critical role in an IPO deal network by recruiting investors and other underwriters to participate in the offering and by helping disconnected actors - namely investors and issuing firms - to interact, exchange information, and conclude transactions. The role played by relationships and repeated interaction between the key parties of this market is crucial to reducing the

uncertainty surrounding the firm's value, but by the same token, opportunistic behavior that allows underwriters to obtain private benefits from omitting relevant information could also be involved.

This paper provides an overview of the dynamics that influence the pricing decision and highlights the way in which relationships between three major parties involved in an IPO transaction (issuer, investment banker, and investors) shape the pricing and early market performance of the offering. More specifically, this study approaches these issues by providing a broader picture of how existing studies have addressed the importance of relationships and their impact on pricing, in each phase of the primary market. To date, research has shown that the choice of an underwriter, as well as the formation of the IPO syndicate, is driven by the existence of past relationships between banks and issuing firms. Relationship banking might decrease the asymmetric information problems, reducing the cost of going public (Bharath et al., (2007); Schedone (2004) and Puri (1999)). Moreover, IPOs underwritten by book managers with more central and cohesive underwriting networks are associated with an increase of the price discovery and information production (Bajo et al., 2016 and Chuluun, 2015). More recent empirical IPO literature has also increasingly recognized the importance and power of the institutional framework within which IPOs are conducted using bookbuilding (Ljunqvist, 2007). However, it is unclear whether or how the relationship between underwriters and institutional investors affects the bookbuilding process. Repeated interactions between underwriters and institutional investors might favor the issuing firm through increased information production (Benveniste and Spindt (1989); Benveniste and Wilhelm(1990); Spatt and Srivastava(1991) and Sherman and Titman (2002)) or they might determine a conflict of interest with the issuing firm and a higher amount of money left on the table (Reuter (2006), Nimalendran, Ritter and Zhang (2007), Goldstein, Irvine and Puckett (2011) and Ritter and Zangh (2007)). All in all, this mixed evidence draws attention to when the information is produced and/or revealed: during the due diligence process, during the bookbuilding procedure, and/or in the secondary market. As a matter of the fact, even after the underwriter's investigation of the issuer and surveys of the market, considerable uncertainty remains concerning how the broader market will receive the issue.

Although it is reasonable to think that the existence of repeated interactions between the lead manager and regular investor underwriters could also influence the IPO price range setting, no formal theoretical model has been presented in the existing literature regarding the process by which an underwriter chooses this initial offer price range (Chemmanur et al., 2016) and the impact of investor networks on IPO pricing has not been explicitly examined. The IPO primary market, in general, has received relatively little attention. Because of the lack of transparency in bidding and allocation data, market participants and regulators insist on the disclosure of material information (Ibbotson and Ritter, 1995) to help mitigate these potential problems. This and existing mixed evidence would point to the importance of shifting attention to the primary market in order to better understand pricing dynamics. The share allocation policy of underwriter represents one of the most active and prominent areas of IPO research (Hanley, 2017) and could help academics and regulators gain a better understanding of several other topics, including underpricing, post-issue ownership structure, underwriter compensation, and the impact of repeated interaction between institutional investors and investment banks on IPO price setting.

Figure 1: **IPO primary market pricing process**
This figure shows the IPO primary market process. After the issuing firm chooses an underwriter, usually one year before the IPO, the due diligence valuation starts, and the initial prospectus is filed. The preliminary price information is provided to the public in the form of an initial price range and, quite often the midpoint of this range represents the expected offer price. During the bookbuilding phase the price can be revised following the indications of institutional investors. The offer final offer price is set the day before the offer.



Chapter 2: IPO pricing and dealers' interaction: a stochastic frontier approach

2.1 Introduction

An initial public offering (IPO) is launched when a firm goes public for the first time. One of the main problems associated with the IPO is pricing the shares issued by the listing company. Setting the price of an IPO is difficult because the firm is new in the market and, accordingly, no trading history exists, nor does the firm have any remarkable analyst coverage (See and Rashid, 2011).

Existing literature on IPO pricing in primary markets (Ibbotston and Ritter, 1995; Ritter and Welch, 2002; Roosenboom, 2012) suggests that the price is set deliberately low by the investment bank, thus allowing a large amount of money to be left on the table for the issuing firm. Underwriters might not raise the price to full market value for several reasons: adverse selection and moral hazard problems (Baron, 1982, Rock, 1986), the burden of market making (Benveniste, Busaba, and Wilhelm, 1996; Chowdhry and Nanda, 1996), the risk of lawsuits (Lowry and Shu, 2002), reputation concerns (Beatty and Ritter, 1986; Carter and Manaster, 1990), institutional and country-specific issues (Engelen and van Essen, 2010) or the efforts required for limiting aftermarket stabilization of transactions (Beatty and Ritter, 1986, Ibbotston et al., 1988; Aggarwal, 2003). Moreover, at this stage, underwriters and institutional investors who repeatedly work together during different IPOs might easily collude, thus deliberately tuning the offer price according to their prevailing interests (Ljungqvist and Wilhelm, 2002).

Several studies offer different views on the role played by repeated interactions on initial returns. Consistent with bookbuilding theories (Benveniste and Spindt, 1989; Benveniste and Wilhelm, 1990; Spatt and Srivastava, 1991; Sherman and Titman, 2002), underwriters that sell repeatedly to the same investors can take advantage of their position vis-à-vis information production, thus tuning the offer price upward with the promise of priority allocations in future underpriced IPOs. Similarly, the transparency of the IPO mechanism in some countries provides information benefits to investors who generate a larger demand that, in turn, positively affects IPO price (Neupane and Poshakwale, 2012).

By contrast, according to agency-based explanations, repeated interactions bring about a potential conflict of interest because large underpriced allocations might be given to regular investors in exchange for future brokerage commissions (Reuter, 2006). Consistent with this profit-sharing view, banks can use their monopsony power to allocate underpriced shares to investors that can pass on profits and benefits to banks[12] (Ritter, 1984; Chalk and Peavy, 1987; Reuter, 2006), thus supporting a conflict of interest motivation.[13]

The extant literature does not solve the puzzle of whether the practice of bookbuilding increases the price accuracy or the conflict of interest. Moreover, events occurred since the dot-com period showed that quid pro quo arrangements - where valuable share allocations were given in return for trading commissions (Liu and Ritter, 2010) - might have taken place. Therefore, doubts remain as to how well the market for new equity issues (the primary market) operates for issuers, so that regulators now require investment banks to implement specific policies to address conflicts of interest (Jenkinson et al., 2018).

To overcome the limitations of the existing literature and contribute to the analysis of the effects of the market interactions on the IPO results, we propose a model of primary market pricing that exploits the incomplete adjustment of the offer price with respect to the fair offer price. Following the extant literature on deliberate premarket underpricing, we extend Reber and Vencappa (2016) by explicitly considering the interactions between dealers as a source of variability in the definition and the revision of the offer price in primary markets. Contrary to previous studies that are mainly focused on how

[12] Investment banks receive revenues from the commissions paid by the issuers (the gross spreads) as a percentage of the capital raised. In addition, they can benefit from underpriced offerings, if they have discretion in allocating shares, to rent-seeking investors, who repay part of their trading profits with commissions in excess of direct execution costs. Investment banks and mutual fund families can also use underpriced IPOs to boost the performance of particular funds under their management (Ritter (2011); Ritter and Zhang (2007); Yan and Hao (2012)).

[13] On the empirical side, no conclusive findings regarding the role of repeated interactions on IPO primary market pricing have been provided. Existing research is mostly focused on the amount of underpriced shares that are allocated to institutional investors. However, data on actual IPO allocations are rarely disclosed by banks (Binay et al., 2007 and Hanley, 2017) and proxies of actual data have been used (Reuter, 2006; Ritter and Zhang, 2007; Goyal and Tam, 2013 and Field and Lowry, 2009). Moreover, the literature on the effect of the underwriters- investors' relationships on IPO primary market pricing hardly informs about the effect that repeated interactions produce along the preparation of an IPO in the primary market (Geranio, Mazzoli and Palmucci, 2017).

underwriters favour institutions they have previously worked with, in terms of greater participation (Binay et al., 2007) and allocation of underpriced shares (Reuter, 2006; Ritter and Zhang, 2007; Goyal and Tam, 2013), our study analyses the use of information, collected through repeated dealings, on pricing the IPO. More specifically, we analyse if and to what extent the IPO offer price is set deliberately low in the primary market when coalitions exist between investment banks and regular investors. Following Reber and Vencappa (2016), we first estimate the firm's intrinsic value, i.e. the maximum price achievable given the firm characteristics and fundamentals, using a Stochastic Frontier Approach (SFA). Then, we model the variance of the inefficient error component by including different measures of interaction between investment banks and institutional investors occurred in the years before the IPO. The relationship measure we introduce captures the frequency of repeated interactions between these agents. Generally, the higher are the interactions, the greater is the information collected by underwriters. We exploit if this information, extracted from institutional investors with which it had repeated interactions, is efficiently used in pricing the IPO firm's shares or to favour institutions giving a large amount of underpriced shares. Based on bookbuilding theories (Benveniste and Spindt, 1989; Benveniste and Wilhelm, 1990; Spatt and Srivastava, 1991 and Sherman and Titman, 2002), we expect that the adjustment process of the offer price to the firm's intrinsic value is shaped by the intensity of the underwriters-investors relationships. Our argument is that information gathered during bookbuilding is used by underwriters to set prices close to the fair market value, rather than to favour institutional investors who collaborate in IPOs. In other terms, we support the idea that banks dealing repeatedly with the same investors are likely to develop a reputation for fair dealing. When it is impossible to specify exactly all possible contingencies in an asset sale, reputation can help the bank to bridge the gaps in "incomplete" contracts (Wilhelm, 2005). Moreover, the apparently unfavourable outcome for institutional investors that comes out from this mechanism might be compensated by a quid pro quo expected arrangement to participate in future issues. Thus, the bank can raise the offer price on the IPO to the point at which

the benefits of lemon-dodging just equal the expected benefits of remaining in the bank's coalition (Gondat-Larralde and James, 2008).

Based on a sample of 1,677 US IPOs between 2000 and 2016, we find that the intensity of interaction between underwriters and investors in the years before the IPO explains the level of price accuracy. Our results show that the offer price is set closer to the fair price when more interactions occur before the IPO. More specifically, when different time frames of underwriters-investors interactions are considered (a quarter, one year, two years and three years before the IPO), the impact of repeated interactions on the price accuracy is positive and more significant for long lasting relationships (more than one year), whereas the influence is weaker for shorter intervals. The core of this finding is that relationships matter and, even more importantly, relationships might be a benefit for issuers, as the price is closer to its optimal value.

The rest of the paper is organized as follows. In Section 2.2 we review the literature and present our hypotheses. Section 2.3 summarizes the data and the methodology adopted in the empirical analysis. Results are presented in Section 2.4 and conclusions in Section 2.5.

2.2 Literature review and hypotheses

IPOs are always characterized by information asymmetry, mainly because of issuing firms that are new to the market and investors having limited knowledge about them (See and Rashid, 2011). The going-public decision represents a typical situation in which the value of the firm must be established without referring to a market value (Kim and Ritter, 1999). Consequently, the correct valuation of the issuing firm, that might allow to set IPO offer prices efficiently, depends on the due diligence and bookbuilding process in the primary market. Because the issuing firm is informationally opaque to investors and information is costly[14], the issuer retains an investment bank to act as its agent in pricing

[14] Generally, if information production is costly, underwriters need to decide how much information production to induce, resulting in a trade-off between the (issuer-specific) benefit of greater pricing accuracy and the cost of more information production (Sherman and Titman, 2002).

and marketing the new stocks (Ibbotson and Ritter, 1995). This makes multiple agency problems likely to come out at the IPO pricing stage (Baron, 1982). Agency-based studies have documented that the IPO share price can be set deliberately low in the primary market to allow for a large amount of money to be left on the table to the disadvantage of the issuing firm or the selling shareholders (Hanley, 1993; Ritter and Welch, 2002). Most of these studies take their cue from the partial adjustment phenomenon (Hanley, 1993) and measure the disadvantage for the issuer in terms of underpricing. Gondat-Larralde and James (2008) suggest that banks underprice each offering to the extent necessary to make remaining in the coalition the most profitable choice for informed investors. Based on a sample of 3,197 IPOs occurred in the period between 1980 and 2000, Binay, Gatchev and Pirinsky (2007) find that their measure of relationship participation positively affects the level of underpricing, thus arguing that regular investors benefit from economically significant favouritism to the detriment of issuing firms.

This literature, which supports the existence of agency-related problems between underwriters and regular investors, is opposed by a stream of literature usually referred to as 'bookbuilding theory'. Scholars in this branch maintain that interactions occurring between banks and funds in the primary market are likely to increase the information production process and lead to a more efficient pricing of the IPO, which is positive for the issuing firm. In particular, some authors argue that banks obtain valuable information from regular investors on the expected demand for the IPO (Benveniste and Spindt, 1989; Sherman and Titman, 2002) and use this information to price the offer more accurately, even using peer networks to produce information (Chuluun, 2015). In this context, the price mechanism of bookbuilding has a twofold goal: 1) to build a regular investor clientele and 2) to price and market the issue more efficiently, through the non-bidding indication of interest given by institutional investors. This repeated game setup benefits issuers by reducing underpricing, but it also helps investors by increasing their profits from participation in multiple offerings. Moreover, as suggested in Busaba (2001) and Benveniste et al. (2002), having the option to walk away in

bookbuilding practice leads to better offer pricing, because the underwriter bumps up the price to prevent withdrawal (Busaba, et al. 2018).

Both the above approaches, i.e. bookbuilding-based studies and agency-based studies have a methodological weakness as they extensively use underpricing as a key variable. As underpricing reflects the difference between the market price and the offer price, it is highly likely that the it might be influenced by the long-term or short-term attitude of investors, the price support operated by the investment banks and the media echo received by the offer. As a consequence, such a pricing measure is not totally suitable to draw primary market dynamics.

Starting from Hunt-McCool et al. (1996), studies based on a stochastic frontier approach have been proposed to deal with the bias that the offer price can be set deliberately low in the primary market (Koop and Li, 2001; Francis and Hasan, 2001; Chen et al., 2002; Chan et al., 2007; Meng et al., 2016). Results from these studies, where the difference between the efficient and the actual offer price is split into a primary market (deliberate underpricing) component, and a secondary market (misevaluation) component[15], show that the deliberate underpricing is the dominant component that makes up initial return. Specifically, Reber and Vencappa (2016) find that the presence of features like lock-in agreements, underwriter fees, number of uses of proceeds, demand for firm capital, and venture capital or private equity backing, have positive impacts on deliberate premarket underpricing, thus providing a partial solution to the issue of the divergence between the efficient and the actual offer price. However, despite the numerous underpricing factors involved in the analysis, the interactions between dealers, as a source of variability in the setting and the revisions of the offer price in primary markets, has not been explicitly considered. Along this line, we analyse to what extent the IPO offer price is set deliberately low in the primary market with respect to the firm's

[15] If there were no systematic underpricing, actual prices would fall below the frontier due to the presence of random factors, captured by idiosyncratic error term. The non-idiosyncratic disturbance error component represents deliberate underpricing.

intrinsic value when coalitions between investment banks and regular investors exist in the primary market. Specifically, we put forward the following hypothesis:

> Hyp (1): the larger the number of interactions in the years before the IPO, the closer the offer price will be to the intrinsic value of the issuing firm.

This hypothesis is based on the intuition that banks dealing repeatedly with the same investors are likely to develop a reputation for fair dealing, which helps in dealing with complex cases where it is impossible to specify all possible contingencies in an asset sale (Wilhelm, 2005).

To consider the dynamic structure of the deals, we explore the pricing-relationship between parties over time. We hypothesize that the prediction of the dynamic information model is confirmed when we consider interactions occurred at least one year before the IPO or more (HP1). By contrast, we expect that 'arm's length ties', i.e. relationships built in the quarter before the IPO (Daily et al., 2003; Granovetter, 2005), are not able to influence IPO price setting and have no impact on the level of price accuracy. In details, we test the following hypothesis:

> Hyp (2): the smaller the interval of interaction between underwriters and issuers, the less effective interactions are on the level of price accuracy

To sum up, only collaborations that are repeated over time and for a significant span of time can create enough trust to generate embedded ties on which resource pooling and cooperation can be based and that, in turn, support information production (Baker, 1990; Uzzi, 1999; Uzzi and Gillespie, 1999; Gulati and Higgins, 2003).

2.3 Data and Methods

2.3.1 Data and Sample Selection

We collected our sample of 2,925 US IPOs from the Thomson One Deals database (TOD). We searched for all the IPOs occurring on the NASDAQ and NYSE from January 2000 to December 2016. Following Ritter and Zhang (2007), we excluded IPOs with the following characteristics: offer

price below $5[16], non-common shares, closed-end funds, filings by foreign-domiciled firms, Master Limited Partnerships (MLPs), American Depository Receipts (ADRs), and Real Estate Investment Trusts (REITs)[17]. In order to build the network of relationships occurred between institutional investors and underwriters, we collected the name of lead managers from the TOD and the data about institutional investors' participation in 13F institutional ownership. As the information regarding actual allocation and, consequently, the participation in the offer is not publicly available, we used the first reported holding by investors at the end of the offering quarter as a proxy for participation in the IPO (Reuter, 2006; Ritter and Zhang, 2007; Field and Lowry, 2009; Goyal and Tam, 2013). We also included information regarding financial statements of issuing firms from Compustat.[18] Jay Ritter's website was also used to obtain information regarding the market conditions and the rankings on US underwriters' reputations. Our final sample, excluding observations with missing values on the variables of interest, consisted of 1,677 US IPOs.

2.3.2 The empirical model

The Stochastic Frontier Analysis (SFA) combines an ordinary linear regression model with a composite error term (Aigner et al., 1977; Jondrow et al., 1982). The error term can be broken down into a symmetric error term, which represents the usual stochastic error terms, and an asymmetric error component. This non-idiosyncratic disturbance represents a systematically negative bias due to some inefficient pars. Widely used in estimation of production efficiency, this methodology has been adopted also in pricing IPOs (Hunt-McCool et al., 1996). Under the IPO pricing scenario, the SFA allows an estimation of the maximum or "efficient" offer price that would prevail in a situation of full information, given the firm's characteristics.

[16] Stocks with a price below $5.00 per share are subject to the provisions of the Securities Enforcement Remedies and Penny Stock Reform Act of 1990, aimed at reducing fraud and abuse in the penny stock market (Ritter, 1991).
[17] The sample was then reduced to 2,219 IPOs.
[18] Some information about issuing firm characteristics is also included in the TOD. Because of the absence of some relevant financial items and for easier comparison, we prefer to use Compustat as the single source of financial statement information.

$$Y_i = f(X_i, \beta) + \varepsilon_i$$

$$\varepsilon_i = v_i - u_i$$

$$v_i \sim N(0; \sigma_v^2)$$

$$u_i \sim N^+(0; \sigma_u^2)$$

Typically, in the IPO pricing context, Y is the observed offer price of the issuer i; X is a vector of the observed firm's characteristics; β is a vector of parameters to be estimated; v_i is the symmetric error component with a normal distribution and u_i is the asymmetric error term with a half-normal distribution, truncated at zero.[19] In other terms, for a given IPO, a point on the frontier represents the unobserved "fair" offer price, that is the maximum price that investors are willing to pay given a set of "pricing factors" included in the vector of input X. The stochastic frontier assumes that a maximum price exists, and that actual prices fall below the maximum for some systematic reasons such as "economic inefficiency". This deviation from the maximum price can be measured by a one-sided error term. As pointed out in Hunt-McCool et al. (1996), the advantage of using this method in IPO pricing is to avoid using aftermarket information to compute IPO prices in the primary market.

Reber and Vencappa (2016) provided an additional contribution by modelling the exogenous factors that influence the gap from the frontier. In other terms, when fitting the IPO offer price frontier, they also explicitly model the heteroscedasticity of the one-sided error term (Kumbhakar and Lovell, 2003). Empirically, the one-sided error variance is modelled together with the frontier as:

$$\sigma_{u_i}^2 = f(Z_i \gamma)$$

Where σ_u^2 gives the dimension of the deliberate premarket underpricing and Z is the vector of parameters to be estimated. In the conditional variance model, the vector Z of parameters to be estimated includes a set of variables capturing the information asymmetry such as: the market conditions at the time of the IPO, the deal characteristics, the presence of third-party certification and, more generally, the uncertainty surrounding the IPO. Our model, that extends Reber and Vencappa

[19] To account for technical inefficiency, u_i can be assumed to follow either half normal, truncated normal, exponential, or two-parameter gamma and represents the independently distributed non-negative random variable.

(2016), introduces an additional variable that account for the type and intensity of the interactions between dealers before the IPO as predictors of the distance of the price set from the frontier. In details, we expect to observe deviations between the actual and optimal price correlated to the nature and intensity of the interaction between players before the IPO.

2.3.3 Measurement of variables

Following Reber and Vencappa (2016), the model uses the offer price per share as the dependent variable. Explanatory variables are classified into two categories: "pricing factors" and "deliberate premarket factors". As for the first category, i.e. pricing factors, variables included in the empirical model are related to firm's characteristics and account for the profitability, risk, and growth potentialities of the issuing firm. These factors are indicated as main drivers of the offer price from the standard financial theory. Moreover, we followed Koop and Li (2001) by including data from the accounting period before the IPO as proxies for future profitability. As for the second category, i.e. "deliberate premarket factors", these variables include factors that explain the distance of the actual price from the maximum achievable offer price. This category involves exogenous factors that do not depend on the firm's potential performance or its intrinsic characteristics, but that can influence the magnitude of the deliberate premarket underpricing (Reben and Vencappa, 2016).

We used standard financial theory to select the variables to be included in the estimate of the potential maximum offer price. This theory posits that investors use issuing firm's characteristics such as profitability, riskiness, and extent of asymmetric information to judge the issuer's value (Myers and Majluf, 1984). Following Reber and Vencappa (2016), we proxied the future performance of cash flow using the logarithm of Earnings Before Interest and Taxes (EBIT) in the accounting period before the IPO[20]. We prefer using EBIT instead of cash flows because the latter are subject to higher annual volatility; we also use EBIT instead of EPS because the latter is subject to manipulation by

[20] Ritter (1984) and Krinsky and Rotenberg (1989) report a positive relation between accounting data prior to issuance and IPO firm value.

managers ("window-dressing") before the offering is launched (Jain and Kini, 1994; Teoh et al., 1998; Heaton, 2002). To account for negative EBIT values, we added a dummy variable coded one if the firm had a negative EBIT in the accounting period before the IPO (NEG_EBIT), and zero otherwise. By doing this, we avoided losing relevant information regarding the negative earnings performance because of the logarithm transformation. Following Hunt-McCool et al. (1996) and Chen et al. (2002), we controlled for firm size, using the logarithm of the book value of the asset in the accounting period before the offer (FIRM_SIZE). To account for the riskiness of the firm we computed the leverage (LEV) as the logarithm of long-term debt scaled by total assets in the accounting period before the IPO (Habib and Ljungqvist, 2001). As in Peng and Wang (2007), we expected a negative correlation between debt level and the IPO market price. To consider the potential role of asymmetric information, we added an industry dummy to account for the fact that firm's value is unlikely to be uniformly distributed across the industry (Ritter, 1991). In line with previous studies, we allocated IPO firms into 12 two-digit SIC industry sectors. The presence of different sectors allowed us to take into consideration not only differences in riskiness but also in growth opportunities. Table 1 provides a detailed review of all the variables that were used in this the study along with the data sources.

Table 1: **Variables: description and sources**

This table presents the definitions of the dependent and independent variables used in the SFA model. For all our models, offer price per share is the dependent variable. Pricing factors and deliberate premarket factors are the independent variables. The pricing factors are derived from standard financial theory and represent the main drivers of the offer price, the primary value drivers of equity. The deliberate premarket factors include factors which explain the distance from the maximum achievable offer price. This category involves exogenous factors that do not depend on the firm's potentiality or intrinsic characteristics but that can influence the magnitude of the deliberate premarket discount. It includes proxy variables relating to issuing firm attributes, deal (offer) characteristics, third-party certification, hot/cold market indicator, private firms' demand for capital and a proxy for the demand reviled during the bookbuilding by the institutional investors. The recurrence of the relationship between underwriters and regular investors is measured by the average number of relationships between underwriter and investors in the one, two, three years and the quarter before the IPO. Data sources include Thomson One Deal, Compustat, Jay Ritter's web site [http://bear.warrington.ufl.edu/ritter/ipodata.htm]. Formally, we used the logarithmic transformation of all the input variables, except for the dummy industries variables, the underwriter's ranking, the hot and cold indicator, the IPO demand, and the relationship measure.

	Variable	Source	Description of variable
Dependent variable	OFFER PRICE	Thomson	Offer price per share in U.S.$
Panel A: Pricing factors			
	EBIT	Compustat	Earnings before interest and taxes in the accounting period before IPO
	NEG_EBIT	Compustat	Dummy variable coded one if firm has negative EBIT in the accounting period before IPO
	FIRM_SIZE	Compustat	Total assets in the accounting period before the IPO
	LEV	Compustat	Long-term debt scaled by total assets in the accounting period before the IPO
	INDUSTRY	Compustat	Industry sector classification at the two-digit SIC level
Panel B: Deliberate premarket factors			
	OFFER_SIZE	Thomson	IPO Gross proceeds scaled by total assets in the accounting period before the IPO
	UW_REP	Jay Ritter Web site	Underwriter reputation rank
	HOT_COLD	Jay Ritter Web site	Net number of IPOs (exclude penny stocks, units, closed-end funds, etc) in the month before the issue date
	EQ_RET	Thomson	Logarithm $\left(1+\frac{Secondary\ shares\ retained}{Shares\ offered}\right)$ where Secondary shares retained= Share Outstanding – Total shares sold
	FEE	Thomson	Underwriting fees in U.S.$ million
	LOCK-IN	Thomson	Dummy variable coded one if the flotation prospectus discloses the presence of a 'lock-in' agreement, else coded zero.
	AGE	Jay Ritter Website	Logarithm (1+firm age) where firm age is the number of years between the date the company was founded and the IPO date

IPO_DEM	Thomson	Price adjustment from the midpoint of the filing price range to the offer price (in percent)
R_Q	Thomson	Average number of relationships between underwriter and investors in the quarter before the IPO
R_1Y	Thomson	Average number of relationships between underwriter and investors in the year before the IPO
R_2Y	Thomson	Average number of relationships between underwriter and investors in the two years before the IPO
R_3Y	Thomson	Average number of relationships between underwriter and investors in the three years before the IPO

We borrowed explanatory variables from the IPO pricing literature to serve as the deliberate premarket factors (e.g., Hanley, 1993; Hunt-McCool et al., 1996; Carter et al. 1998; Wu and Kwok, 2003). We included in this category variables that can explain the deviation of the offer price from the maximum achievable one. In other terms, we controlled for market features that, in a competitive primary market, might induce underwriters to deliberately tune the offer price downward to avoid the risk of IPO failure. We used (the logarithm of 1 plus) firm AGE as a proxy for a reduction in the ex-ante uncertainty (Ritter, 1987), and the proportion of stocks owned by insiders (EQ_RET) as a measure of the risk characteristics of the IPO that are negatively related to the offer price (Beatty and Ritter, 1986). As for the signalling effect on the IPO firm value, we argue that the larger the equity retained, the smaller the distance from the fair offer price for an IPO (Bradley and Jordan, 2002; Loughran and Ritter, 2004; Lowry and Murphy, 2007).[21] We use the logarithm of the amount of gross proceeds scaled by total assets in the accounting period before the IPO to account for the offer size (OFFER_SIZE) and as a signalling variable (Reber and Vencappa, 2016). We controlled for the size effect because it is reasonable to expect that larger firm size implies less uncertainty, better operation conditions, and higher efficiency (Peng and Wang, 2007). In line with Carter and Manaster (1990), we included the variable underwriter reputation (UW_REP). Generally, low risk firms attempt to

[21] The impact of the variable Equity Retained on underpricing is mixed when used in stochastic frontier models. On the one hand, Hunt-McCool et al. (1996) report a positive relationship between equity retained and estimated offer price. On the other hand, Chen et al. (2002) and Reber and Vencappa (2016) do not find a statistically significant relationship.

reveal their low risk characteristic to the market by selecting a highly prestigious underwriter: the more highly ranked the underwriter is, the higher the efficiency achieved in price setting. This means that if the firm is followed by underwriters with a good reputation, the offer price is expected to be set closer to the true value of the firm. We used the logarithm of fee (FEE) as a proxy for information risk because underwriters ask for a higher commission when facing more severe asymmetric information problems (Hughes, 1986; Meng et al., 2016).

We accounted for the market condition by including a hot and cold market indicator (HOT_COLD). This variable represents the net number of IPOs launched in the month before the issue date (excluding penny stocks, units, closed-end funds, etc.). Instead of adding a dummy for hot and cold years, we simply computed the number of IPOs by year, as we assumed that hot markets are characterized by a higher number of issues (Ibbotson and Jaffe, 1975; Ritter, 1984; Helwege and Liang, 2004; Ljungqvist et al., 2006). We used a dummy variable for the presence of lock-in agreements (LOCK-IN), which is a commitment that prohibits firm insiders from selling shares in the aftermarket for a specified period of time (it may vary from ninety days to two years in the U.S. market). In line with the findings of Brav and Gompers (2003) and Arthurs et al., (2008), we expect the demand for shares with a lock-in agreement to be higher than shares without such an agreement. This is because investors have a reduced 'moral hazard' problem during the period in which firm insiders cannot sell their equity stakes (Bradley, Jordan, Ha-Chin, and Roten, 2001; Field and Hanka, 2001). To better understand the role of regular investors in the bookbuilding process, we also controlled for the IPO demand (IPO_DEM) revealed during the bookbuilding by using the price adjustment from the midpoint of the filing price range to the offer price (Binay et al. 2007; Chan et al. 2007).[22] Following the argument proposed by Benveniste and Spindt (1989) and later empirically tested by Hanley (1993), we expected high (low) demand to reveal positive (negative) information

[22] Our findings are robust even if we control for another proxy to measure pre-issue demand for the IPO, calculated as the final offer size divided by the first filed offer size as suggested in Goldstein et al. (2011). To save space, we do not report this result.

that causes the offer price to be adjusted upward (downward). The intuition behind this hypothesis is that IPOs are not fully priced by underwriters because of the uncertainty they face as to demand for new shares.[23] Therefore, to increase the probability of success and to clear the aftermarket, the investment banker sets the offer price deliberately low. We would expect to find that repeated interactions allow investment banks to control the demand in the primary market, resulting in less uncertainty and a better price accuracy process. As we introduce a further premarket factor that accounts for the existence of a relationship between underwriters and regular investors, we control for the presence of past relationships between dealers – as potential influences of the distance from the frontier – by using of the average number of interactions which occurred between the underwriter and institutional investors before the IPO.

2.3.4 Measurement of the relationship variable

Previous literature dealing with the effects of interactions on the IPO results provided a number of relationship measures, which were mainly used to investigate whether favouritism was practiced by lead managers by allocating shares to regular clients, i.e. institutional investors. Pollock (2004) defined a Deal Network Embeddedness measure calculated using a Herfindahl index. Binay et al. (2007) proposed a measure of relationship participation that reflected the tendency of institutional investors to participate in an IPO, linked to their involvement in past IPOs managed by the same lead underwriter. More recently, Goyal and Tam (2013) developed a measure of long-term investing to examine whether long-term investors receive more IPO allocations than short-term investors. These scholars computed the strength of the relationship as the recurrence of the investor's presence in the underwriter's IPOs, with values close, or equal, to one indicating a strong relationship between the investor and the underwriter.

[23] There is an asymmetry in the bankers' expected profits as the result of the SEC institutional constraint which prohibits adjusting the offer price ex post to clear the primary market and the uncertainty about the exact realization of demand for the issue (Marchard and Roufagalas, 1996)

Following an established empirical approach, we use the first reported holdings at the end of the offering quarter as a proxy for participation in the IPO (Reuter, 2006; Ritter and Zhang, 2007; Goyal and Tam, 2013; Field and Lowry, 2009). In details, we first identified for each IPO the name of the lead managers and the name of investors who declared holdings at the end of the offering quarter. Then, we computed all the possible pairs of underwriters-funds and searched for the recurrence of these pairs in different time spans: a quarter, a year, two and three years before the IPO. Finally, we scaled each value by the number of different couples in the IPO to account for the relative effect of these relationships. Formally, we have:

$$Relationship_k = \frac{\sum D_{ij}}{N_{ij}}$$

Where k is the IPO of our sample, D_{ij} is the number of deals in the years before the IPO k, in which underwriter j took part and the institutional investor i owned shares. N_{ij} represents the number of different pairs of underwriter j and investor i present in the IPO k.

2.4 Empirical results

2.4.1 Summary statistics

Table 2 presents summary statistics for the 1,677 IPOs in our sample. The average offering price is US$14.38 per share. The average value of total assets of the listing firms prior to the offer, as a measure of the level of operations, is US$1.55 billion. The mean EBIT of IPO firms is US$32 million, and, on average, firms with negative EBIT constitute 40% of the sample. The leverage, which is measured by the long-term debt scaled by the book value of assets, shows a 26% mean value. In our sample, firms go public, on average, 16 years after their foundation. The offer size variable indicates that, on average, firms have US$95 million. On average, underwriting fees are $11 million. Figure 2 shows the dynamic of the fee across our sample period. In 2008, the number of firms that went public decreased; at the same time, the compensation required by lead managers increased. Almost all of the

issues in the sample have a lock-in agreement in their prospectus. The average rank of an underwriter is 8.2, out of a maximum attainable of 9; so, we can conclude that, on average, only highly ranked underwriters followed the issues in our sample. The average number of past relationships for the sample firms ranges from a minimum of 0.6 in the quarter before the issue to a maximum of 4.9 in the previous three years. The shares owned by insiders' amount to approximatively 60%, which could be a positive signal of how confident the insiders are regarding the firm's prospects.

Table 2: **Summary statistics**.

This table presents summary statistics of the 1,677 US IPO of the sample. All accounting data is measured in the year prior to the offer. Offer price is the offer price per shares in US$. EBIT represents the earnings before interest and taxes in the accounting period before IPO. Negative EBIT is a dummy value coded one if firm has negative EBIT, zero otherwise. Firm size is the book value of assets in the accounting period before the IPO. Leverage is the ratio between long-term debt and total assets in the accounting period before IPO. We also include: the firm age, the equity retained as the logarithm of (1+ (Secondary shares retained)/(Shares offered)), a dummy variable for the presence of lock-in agreements, the underwriting fees in million U.S.$. The hot and cold markets indicator represents the net number of IPOs (excluding penny stocks, units, closed-end funds, etc.) in the month before the issue date. Underwriter reputation is based on tombstone rankings used in Carter and Manaster (1990) and updated on Jay Ritter's web page. The offer size is the gross proceeds scaled by total assets in the accounting period before the IPO. IPO demand is the price adjustment from the midpoint of the filing price range to the offer price (in percent). The relationship measure represents the average number of relationships that occur between the underwriter and institutional investors, following the issuing firm, in the different horizons of time before the IPO.

VARIABLES	mean	median	Std.dev.	min	max
Panel A: pricing factors					
Offer price (US$)	14.38	14	5.733	5	91
EBIT (US$ million)	32.61	2.096	372.2	-12,193	4,165
NEG_EBIT (0/1)	0.441	0	0.497	0	1
FIRM_SIZE (US$ million)	1,550	86.18	12,407	0.00100	272,753
LEV	0.267	0.0933	0.437	0	8.448
Panel B: deliberate premarket factors					
AGE (year)	16.13	8	23.13	0	158
EQ_RET	0.604	0.652	1.165	-12.43	4.220
LOCK-IN (0/1)	0.919	1	0.273	0	1
FEE (US$ million)	11.09	6.762	14.73	0	194.6
UW_REP	8.250	8.501	1.147	2.001	9.001
HOT_COLD	14.62	12	11.49	0	63
OFFER_SIZE (US$ million)	95.05	0.930	3,253	0	124,475
IPO_DEM (%)	-0.0138	0	0.127	-0.500	0.667
R_Q	0.657	0.430	0.794	0	11
R_1Y	2.336	1.769	2.325	0	19
R_2Y	3.834	2.779	3.895	0	36
R_3Y	4.947	3.630	4.998	0	57

Table 3 provides a breakdown of SIC codes for our sample IPOs. The industry distribution across sectors shows that there is a higher concentration of IPOs in the chemical, computer, and financial sectors.

Table 3: **Sample characteristics: industry distribution**

Industry	Two-digit SIC codes	IPO sample	Percentage of the sample
Oil and gas (OIL_GAS)	13, 29	54	3.2
Chemical products	28	320	19
Manufacturing (MFG)	30–34	26	1.5
Computers	35, 73	359	21
Electronic equipment	36	124	7.2
Transportation (TRANS)	37, 39, 40–42, 44, 45	42	2.5
Scientific instruments	38	105	6.2
Communications (COMM)	48	31	1.8
Utilities	49	16	0.9
Retail	53, 54, 56, 57, 59	49	2.9
Financial services	60–65, 67	200	1.1
Health	80	37	2.2
All others	1, 2, 6, 7, 8, 9, 10, 15, . . .	314	49.4
Total		1,677	100

2.4.2 Findings

Table 4 presents the estimates of the Stochastic Frontier model. The output used in the stochastic frontier model is the natural logarithm of the offer price. The inputs or pricing factors X and the deliberate premarket factors Z used to model the variance of the non-idiosyncratic error component are those already discussed in Section 2.3.3.

Model 1 in Table 4 reports the results of the model used to estimate the maximum offer price achievable, according to the Reber and Vencappa (2016) framework. It only provides the basic baseline regression without the relationship variables related to deals.

Table 4: **Stochastic Frontier Approach estimates**.

All six models use the same pricing factors. Model 1 is the basic model and estimates the fair offer price as a function of ex ante uncertainty surrounding firm value; we add deliberate premarket factors that explain variations from the maximum achievable offer price. Model 2 augments Model 1 with variables that capture the level of IPO DEMAND. Model 3 augments the previous models with RELATIONSHIP1Y variable that accounts for the average number of relationships between underwriter and investors in the year before the IPO. Model 4 replaces RELATIONSHIP1Y with average number of relationships between underwriter and investors in the two years before the IPO (RELATIONSHIP2Y). Model 5 replaces RELATIONSHIP2Y with average number of relationships between underwriter and investors in the three years before the IPO (RELATIONSHIP3Y). Model 6 replaces RELATIONSHIP3Y with average number of relationships between underwriter and investors in the quarter before the IPO (RELATIONSHIP).∗∗∗, ∗∗, and ∗ denotes the statistical significance at the 1%, 5%, and 10% level, respectively. T statistics are reported in the parentheses.

	(1)	(2)	(3)	(4)	(5)	(6)
EBIT	0.0224**	0.0223**	0.0142	0.0133	0.0136	0.0145
	(2.59)	(2.58)	(1.42)	(1.34)	(1.37)	(1.42)
NEG_EBIT	-0.0248	-0.0201	-0.00834	-0.00505	-0.00443	-0.0121
	(-0.96)	(-0.77)	(-0.26)	(-0.16)	(-0.14)	(-0.38)
FIRM_SIZE	0.0236**	0.0235**	0.0392**	0.0406**	0.0404**	0.0373**
	(2.40)	(2.38)	(3.06)	(3.26)	(3.26)	(2.96)
LEV	-0.0237***	-0.0229***	-0.0356***	-0.0353***	-0.0353***	-0.0349***
	(-4.03)	(-3.87)	(-4.53)	(-4.51)	(-4.51)	(-4.40)
OIL_GAS	-0.0206	-0.0191	-0.0416	-0.0392	-0.0390	-0.0423
	(-0.44)	(-0.41)	(-0.80)	(-0.76)	(-0.76)	(-0.81)
CHEMICAL	-0.130***	-0.133***	-0.154***	-0.155***	-0.154***	-0.150***
	(-3.45)	(-3.53)	(-3.42)	(-3.50)	(-3.49)	(-3.29)
MFG	-0.0158	-0.0112	0.0450	0.0421	0.0428	0.0425
	(-0.21)	(-0.15)	(0.53)	(0.50)	(0.51)	(0.50)
COMPUTERS	-0.0460	-0.0424	-0.0275	-0.0296	-0.0302	-0.0270
	(-1.54)	(-1.42)	(-0.77)	(-0.83)	(-0.85)	(-0.75)
ELECT_EQUIP	-0.0443	-0.0421	-0.0830*	-0.0854*	-0.0858*	-0.0787
	(-1.08)	(-1.03)	(-1.75)	(-1.81)	(-1.82)	(-1.63)
TRANS	0.0670	0.0698	0.0860	0.0816	0.0809	0.0900
	(1.20)	(1.25)	(1.15)	(1.11)	(1.11)	(1.20)
SCIENT_ INSTR	-0.103**	-0.0999**	-0.0790	-0.0830	-0.0850	-0.0763
	(-2.19)	(-2.10)	(-1.36)	(-1.45)	(-1.49)	(-1.30)
COMM	-0.0130	-0.0288	-0.0539	-0.0567	-0.0574	-0.0503
	(-0.21)	(-0.46)	(-0.75)	(-0.80)	(-0.81)	(-0.70)
UTILITIES	0.0677	0.0660	0.0316	0.0299	0.0316	0.0232
	(0.76)	(0.74)	(0.24)	(0.22)	(0.24)	(0.17)
RETAIL	0.00266	-0.00178	0.00440	0.00319	0.00287	0.0128
	(0.05)	(-0.04)	(0.08)	(0.06)	(0.05)	(0.22)
FINANCIAL	0.00456	0.00925	-0.00543	-0.0000944	-0.000269	-0.00652
	(0.12)	(0.24)	(-0.11)	(-0.00)	(-0.01)	(-0.13)
HEALTH	0.122**	0.115**	0.0907	0.0887	0.0861	0.0943
	(2.18)	(2.08)	(1.41)	(1.39)	(1.35)	(1.45)

_cons	2.660***	2.661***	2.604***	2.608***	2.610***	2.602***
	(49.27)	(48.84)	(40.97)	(41.25)	(41.47)	(39.47)
lnsig2v						
_cons	-3.177***	-3.189***	-3.403***	-3.454***	-3.462***	-3.325***
	(-31.60)	(-31.02)	(-15.98)	(-18.61)	(-18.91)	(-15.85)
lnsig2u						
AGE	0.137	0.144	0.0653	0.0294	0.0259	0.107
	(1.35)	(1.41)	(0.43)	(0.25)	(0.23)	(0.55)
EQ_RET	-0.301**	-0.300**	-0.199**	-0.196**	-0.194**	-0.199*
	(-3.24)	(-3.18)	(-2.02)	(-2.03)	(-2.02)	(-1.93)
LOCK-IN	0.897	0.863	0.573	0.534	0.517	0.513
	(1.48)	(1.46)	(0.64)	(0.63)	(0.61)	(0.53)
FEE	-1.618***	-1.622***	-1.517***	-1.448***	-1.453***	-1.626***
	(-8.65)	(-8.46)	(-4.51)	(-5.84)	(-5.96)	(-3.95)
UW_REP	0.0148	0.000575	0.102	0.0915	0.103	0.0587
	(0.21)	(0.01)	(1.10)	(1.01)	(1.13)	(0.61)
HOT_COLD	-0.0143*	-0.0143*	-0.00468	-0.00476	-0.00467	-0.00460
	(-1.79)	(-1.77)	(-0.52)	(-0.54)	(-0.54)	(-0.48)
OFFER_SIZE	-0.218**	-0.217**	-0.408***	-0.417***	-0.418***	-0.382***
	(-2.63)	(-2.61)	(-3.90)	(-4.24)	(-4.28)	(-3.54)
IPO_DEM		-1.157*	-1.333*	-1.353*	-1.335*	-1.366*
		(-1.77)	(-1.82)	(-1.92)	(-1.90)	(-1.76)
R_1Y			-0.102*			
			(-1.94)			
R_2Y				-0.0482*		
				(-1.74)		
R_3Y					-0.0429*	
					(-1.92)	
R_Q						-0.161
						(-0.84)
_cons	-0.633	-0.505	-0.873	-0.762	-0.789	-0.619
	(-0.72)	(-0.58)	(-0.72)	(-0.65)	(-0.68)	(-0.48)
N	771	763	507	507	507	507

As for the control variables, estimated results show that EBIT is strongly and positively associated with the offer price of the issuing firm, while the leverage has a strong negative association. Basically, these findings show that the offer price should be higher when the firm has stronger earning power and lower when it has greater risk and distress costs (Teoh et al., 1998; Chen et al., 2002). In contrast

with Chen et al. (2002), but in line with Hunt-McCool et al. (1996) and Peng and Wang (2007) we found a positive impact of the asset book value on the IPO offer price. Contrary to Koop and Li (2001), however, we found that firms belonging to industries with great growth potential, such as chemical products and scientific instruments, are undervalued.

When the characteristics of the deal are considered, we find that the higher the equity retained by the insiders, the smaller the distance from the maximum achievable offer price. This result suggests that underwriters might take into account equity retention when pricing the IPO because the greater the retention, the lower the probability of required aftermarket price support and, consequently, the lower the variance of the inefficient error component. Also, we find evidence that the proportion of stocks owned by insiders has a positive signalling effect on the IPO firm value, whereas the offer size is negatively related to the offer price, as found by Peng and Wang (2007) and Reber and Vencappa (2016). Moreover, empirical findings support the idea that smaller issues are perceived as more speculative, as the higher size of the offer is associated with a lower distance from the frontier (Hunt-McCool et al., 1996 and Tinic, 1988), and that the underwriter reputation is not a critical variable in explaining the offer pricing. This last result is in line with Reber and Vencappa (2016) who conclude that underwriters' reputation does not affect the level of deliberate premarket underpricing and suggest that it is the amount of money spent on underwriting, rather than the choice of a particular underwriter, which is important in the primary market pricing (Koop and Li, 2001). Finally, we found a significant influence of the market conditions on pricing: specifically, we found that the higher the number of IPOs occurring in the month before the issue, the lower the distance from the frontier. In other terms, if the market is 'hot' there is no need for the investment bank to apply an intentional discount to guarantee the complete subscription of the offer.

Model 2 provides a correction to the baseline by including a proxy for the IPO demand (Binay et al. 2007; Chan et al. 2007). The variable added is the price adjustment from the midpoint of the filing price range to the offer price (IPO_DEM), and it shows that when high demand is revealed during the bookbuilding process, the offer price is set closer to its potential. In general, the results found in

Model 1 are valid also when the correction for the IPO demand is included (Model 2).

Model 3 to 6 present the central results of the paper by including the variables related to relationships occurred respectively in the shorter (the quarter before the IPO) and longer time frames (one, two and three years) before the deal. The variable R_1Y represents our focal variable, as it informs about the interactions that occurred between the underwriter and institutional investors in the year before the IPO. The coefficient of this variable is negative and significant: this means that IPOs characterized by a coalition of dealers one year before the IPO tend to experience a lower variance on the asymmetric error term. Accordingly, the distance from the frontier is lower, that is the offer price is closer to its intrinsic value, as expected in HP1. The core of this finding is that relationships matter and, even more importantly, relationships might be a benefit for issuers, as the price is closer to the optimal one. Such a result is consistent with Benveniste and Spindt (1989) in that bookbuilding is a way of collecting relevant information. However, despite our model reveals that the price is set closer to the fair offer price, previous theories of partial adjustment suggest that it is not set equal to the true value of the issuing firm. Indeed, Hanley (1993) suggests that the offer price is raised less that it could be in order to guarantee a premium for the investors for revealing their indication of interest to underwriters.

Models 4 and 5 replace the variable relative to the relationships in the year before the IPO with the two- and three- year specification, which is the average number of relationships that occurred in the two and three years prior the IPO. A negative impact on the distance from the frontier continues to be observed. Therefore, HP1 is confirmed even in a larger time interval, as a longer horizon does not change the positive effect of the relationships on the level of price accuracy. Model 6 replaces the yearly relationship variable with a measure that refers to the quarter before the offering. This change is motivated by the need to test the role of stricter relationships occurred just before the deal. Estimated results show that this variable is not significant and support the intuition of HP2, that is relationships occurred in the quarter before the IPO – i.e. arm's length ties – are not able to influence the IPO price setting mechanism significantly. By contrast, only when the collaboration is ongoing

and repeated over time, a stock of trust is created large enough to generate embedded ties which, in turn, favour economic action, resource pooling, and cooperation (Daily et al., 2003; Granovetter, 2005). These results suggest that repeated interactions are able to generate more favourable information for the IPO firms and that underwriters use this information to more efficiently price the IPO. This allows underwriters to preserve their reputation and to generate future business.

2.5 Conclusion

In this work, we investigate the role of interactions between lead managers and institutional investors in the IPO primary market pricing. Building on the roles traditionally assigned to investment banks, we test hypotheses about the role played by the bank's relationships with regular investors in IPO pricing by exploiting the role played by different periods of time. We fill a gap in the extant literature by proposing a model of primary market pricing where a measure of the incomplete adjustment of the offer price to its maximum achievable is related to the intensity of interactions between IPO players in the years before the IPO. To empirically capture the extent of dealer coalition, we made use of the average number of relationships between regular investors and lead managers in different periods before the IPO (one quarter, one year, two years, and three years). We checked our intuition within a stochastic frontier approach in order to investigate the effects of relationships between dealers on pricing, more specifically on the variance of the asymmetric error component.

Our main finding is that IPOs with a stronger bank-investor relationship are set with offer prices that are closer to the intrinsic value. Moreover, by controlling for the demand revealed during bookbuilding, the analysis shows that the existence of repeated interactions allows the banks to have a control on the demand in the primary market, which reduces uncertainty and leads to a higher price efficiency to the benefit of issuers.

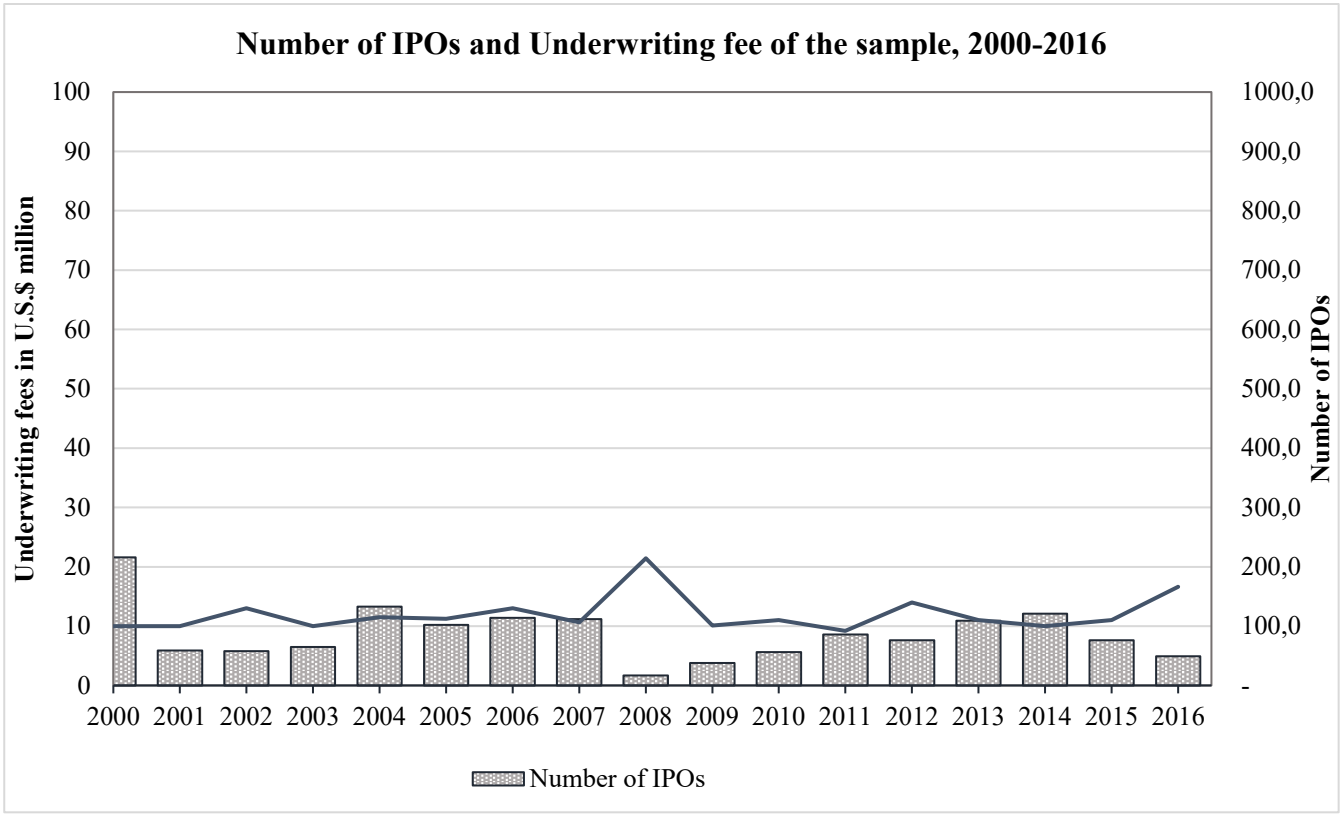
Our paper provides additional contributes to the debate on why bookbuilding is still the most common and dominant going-public method (Lowry et al., 2017), despite its higher costs. We provide evidence

that the main advantage of bookbuilding is that it takes place within a network of relationships between the book manager and institutional investors who participate in the bookbuilding effort (Wilhelm, 2005). Building a clientele of regular investors allows the investment bank to lessen the dilemma of pricing the IPOs and to balance competing interests in strategic information. According to our results, banks that engage in a repeated "game" with a coalition of investors can acquire information that is useful for setting the offer price during bookbuilding. At the same time, banks may compensate investors for the information they generate by favouring them with the participation and allocation of future IPOs, and benefit issuers in terms of a smaller gap between the actual and the maximum potential offer price.

To sum up, although our results are not directly comparable with previous studies whose focus on allocations of underpriced shares, our findings provide a contribution to the growing literature on the role of coalitions. Following the view of Ritter and Welch (2002, page 1803) - "the solution to the underpricing puzzle has to lie in focusing on the setting of the offer price"-, we also contribute to the lively debate on how the offer price is fixed.

Figure 2: **Underwriting fee and numbers of IPOs in our sample period**.

The number of 1,677 US IPOs are collected from the Thomson One Deals database (TOD). We searched for all the IPOs occurring from January 2000 to December 2016, on the NASDAQ and NYSE. We then excluded IPOs with the following characteristics (as previously suggested by Ritter and Zhang (2007)): offer price below $5 , non-common shares, closed-end funds, filings by foreign-domiciled firms, Master Limited Partnerships (MLPs), American Depository Receipts (ADRs) and Real Estate Investment Trusts (REITs). The underwriting fees in US$ million is the mean value for each year of our sample.



Chapter 3: IPO range, investor attention and underwriter-institutional investors network

3.1 Introduction

For years, literature on IPOs has been providing a substantial body of studies regarding the initial public offering process; nevertheless, unresolved questions remain on how IPOs are priced. The price of an IPO is the result of information, interactions and negotiations which unfold over the entire process. After the issuer chooses an underwriter, there are three steps in the pricing of an IPO. First, the underwriter and the issuing firm conduct the due diligence, draft an initial prospectus that is filed with the SEC, and set the initial offer price range. Second, a final offer price is specified using information gathered from investors during bookbuilding. Finally, a market price is established once trading begins and the initial return is determined.

Much of the literature on IPOs has focused on how final offer prices are set, with an emphasis on the role of bookbuilding in pricing an issue (Hanley and Hoberg, 2010). Many of the theories advanced in the literature deal with the price variations of the final offer price from the midpoint of the range, based on the existence of information asymmetry between the underwriter, the company and the institutional investors (Benveniste and Spindt, 1989; Hanley, 1993; Cornelli and Goldreich, 2003; Rocholl, 2009; see Lowry, Michaely and Volkova, 2017 for a review). Each of the above mentioned players has a certain information advantage, but at the same time lacks other critical information, which brings about agency-related issues such as favouritism or quid-pro-quo in pricing the issue.

A second critical component of most of the fundamental models of IPO pricing deals with the role of the underwriter during bookbuilding: a distinguishing feature of this price mechanism is that the underwriter both sets the price at which the company goes public and controls allocations to investors; both these factors generate potential advantages as well as potential disadvantages for the issuing firm which are largely discussed in the literature (Habib and Ljungqvist, 2001; Ljungqvist and Wilhelm, 2003; Reuter, 2006; Ritter and Zhang, 2007; Goldstein, Irvine and Puckett, 2011).

Despite the large body of literature regarding the adjustment of the offer price to the midpoint of the price range and the allocation discretion during the bookbuilding, no theoretical or empirical model has been presented regarding the process by which underwriters and issuers choose the initial offer price range in the due diligence (Bajo et al., 2016). There has been some research on how issuers and underwriters determine the initial value of the IPO in terms of discounted cash flow, dividend discount model and valuation approaches that rely on multiples of firms (Brealey and Myers, 1977; Kim and Ritter, 1999; Deloof, 2009; Roosenboom, 2012). In addition to this, a greater uncertainty about the value of IPO shares has been associated with larger filing ranges set by underwriters (Butler et al., 2005; Bajo et al., 2016) but no empirical investigation has unveiled the reasons behind the width of the IPO price range. A motivation for this lack of interest could be connected to the general principles provided, in the US, by the Securities and Exchange Commission Regulation which influence the way the price range is set in the preliminary prospectus. Following the Item 501(b)(3) of SEC Regulation S-K, the price range must reflect a "bona fide estimate" of the final offering price. This leaves open to interpretation the required precision of a bona fide estimate of the price range. The SEC guidance provides a 'safe harbor' for issuers who limit their price range to the greater of $2 or a designated percentage that has changed over time[24]. More specifically, the company are strongly suggested to increase (decrease) the price range if the expected offering proceeds will differ by more than the SEC's designated percentage (Lowry et al., 2017). This means that, in most of the cases, the price range complies with the safe harbour rule but sometimes IPOs are issued with an excess range (i.e. a price range that is set outside the safe harbour).

With this paper we investigate to what extent the characteristics of underwriter-investors networks might influence: 1) the probability that IPO price ranges are set within the 'safe harbour' and 2) the dimension of the IPO range. Although some studies investigated the impact of underwriter network

[24] Until September 2001 SEC Staff generally takes the position of bona fide estimate a price range greater of $2 or 10% of the lower price; this indication has been relaxed in the volatile post-September 2001 to the greater of $2 or 20% of the lower price (Jenkinson et al., 2006). However, the SEC staff has also asserted that a bona fide estimate for the price range used in an IPO should be no more than $2 or 20% of the high end of the range (Bloomberg Corporate Law Journal, 2007).

characteristic on the dynamics of price revision during bookbuilding, to the best of our knowledge, no previous study has analyzed the importance of relationships network (especially between banks and regular investors) in setting the price range. We also account for the fact that in this restricted information environment retail investor attention may contain valuable clues about latent investor demand for the IPO (Colaco et al., 2017). Incorporating retail attention could help firms and underwriters to get more appropriate valuations for newly public firms reducing the need for underwriters to engage in costly price stabilisation activities when trading begins (Chowdhry and Nanda, 1996). Consequently, we also empirically analyze whether the presence of a higher retail investor attention, proxied by aggregate search frequency in Google Trends, is able to generate some effect on the price range.

Based on a sample of 1,246 US IPOs listed on the NASDAQ and NYSE between January 2004 and December 2016, we propose a Logit model which relates the probability of setting an IPO range, that complies with the SEC's indication, with a series of IPO characteristics (as discussed in the following paragraph 3.3) and network centrality measures. In addition, we employ this set of variables to explore the determinants of the magnitude of the price rage. Our results show that IPOs underwritten by book managers with more central networks, as well as IPOs with higher retail investor attention, experience a reduction in the uncertainty faced (expressed as a higher probability to set the price range within the safe harbour) while the width of the range (that capture the dimension of uncertainty) is not related the investors' network characteristics.

This paper contributes the existing literature on the IPO pricing in two ways: first, it provides the first effort towards a better comprehension of the mechanisms that are behind the way IPO price ranges are set in the due diligence step. In addition to this, we add to the growing body of literature suggesting that book manager network affects information production in the primary market (Cowrin and Schultz, 2005; Chuluun, 2015; Bajo et al., 2016; Lu and Liu, 2016; Rumokoy et al., 2017) by enlarging the perspective to the networking patterns of underwriters and institutional investors, which were previously unexplored.

The rest of the paper is organized as follows: in Section 3.2 we review the literature and present our hypothesises; Section 3.3 reports the data and methodology adopted in the empirical analyses, while a discussion of our key findings is presented in Section 3.4; Section 3.5 concludes.

3.2 Literature review and hypotheses

An IPO initial valuation typically occurs in the form of a price range[25]. When firms decide to issue equity securities in public markets for the first time they usually engage an investment bank who performs an initial due diligence investigation of the firm and helps pricing and marketing new shares (Ibbotson and Ritter, 1995). Underwriters and companies first distribute the so called *red herring prospectus*, a preliminary document submitted to the SEC. The *red herring prospectus* contains information about the proposed offering, company background, risk factors, auditors and underwriters involved in the issuance. The prospectus generally includes a proposed price range (Thornton et al., 2009): it represents a high and low filing price estimated before the underwriters market the stock. Then, the marketing campaign, known as road show, is conducted, and the filing price, provided in the preliminary prospectus, can be revised. As a matter of the fact, the final offer price is set after a waiting period in which firm's managers and underwriters acquire nonbinding indication of interest from regular investors, helpful on estimating the demand curve (Ritter and Welch, 2002). There has been little research on how issuers and underwriters determine the initial value of the IPO and how this estimate is reflected in the initial range. Theory suggests the use of discounted cash flow as the conceptual foundation of valuation (Brealey and Myers, 1977). However, there are several methods available for stock valuation such as the dividend discount model (DDM), the discounted free cash flow (DFCF) method, and valuation approaches that rely on multiples of firms in similar industries and firms involved in similar transactions (Deloof, 2009). Purnanandam

[25] In many studies the midpoint of the initial price range (i.e., average of high and low prices) is used as an unbiased estimator of final valuation (offer price) (Hanley, 1993; Loughran and Ritter, 2002 and Bradley and Jordan, 2002). However, Lowry and Schwert (2004) find that the midpoint is not an unbiased predictor of the final offer price since public information is not fully incorporated into the initial price range.

and Swaminathan (2001) construct, for a sample of over 2,000 IPOs from 1980 to 1997, a measure of intrinsic value based on industry-matched Price/Sales and Price/Ebitda from comparable publicly traded firms. Kim and Ritter (1999) examine the use of price-earnings and other multiples of comparable firms as benchmarks for valuing IPOs. They sustain that accounting information and comparable firm multiples alone are not sufficient to ensure accurate pricing when determining the initial price range because IPO pricing is largely related to information about the market's demand revealed during the bookbuilding. On the contrary, Beatty et al. (2000) suggest that underwriters do not use any additional accounting information in setting offer price not previously considered in setting the filing price range. Roosenboom (2012) shows that underwriters often use multiples valuation, dividend discount models and discounted cash flow models to determine fair value and these three valuation techniques have similar bias, accuracy and explainability. As proposed by Hanley and Hoberg (2010) the initial valuation depends on the issuers and underwriters' preference to engage in price discovery in the premarket, using accounting information, or during the bookbuilding. In the first case, the benefit associated with a more accurate pricing, because of greater information produced during the premarket due diligence, must compensate the cost of revealing proprietary information to rivals. Although there are some studies that links uncertain in the preliminary prospectus language with offer price revision in bookbuilding and volatility in the secondary market (Loughran and McDonald, 2013), there is no specific paper that deals with the width of the price range as a measure of the uncertainty surrounding the value of the firm. Generally, the greater the uncertainty about the value of IPO shares to be issued, the greater the filing range set by underwriters (Bajo et al., 2016). In the US, the Securities and Exchange Commission Regulation provides general principles guiding the price range that must be included in the preliminary prospectus. The SEC guidance provided a "safe harbor" for issuers who limited their price range to the value of $2 or a designated percentage that has changed over time. With this paper we consider the determination of the initial IPO offer price range by the lead underwriter. To the best of our knowledge, there has been no study regarding the process by which an underwriter and issuer choose

this initial offer price range. We analyse if the characteristics of underwriter-investor networks are able to reduce uncertainty when the price range is set. It is quite intuitive that the existence of a network of relationships between underwriters and regular investors can be useful in terms of forming a view on valuation. Underwriters might be able to gather more precise information even before the roadshow begins, during the due diligence process, through previous interactions with regular investors [26]. Such advantages would cause their initial price ranges to be more precise. Although peer relationships between banks and of institutional investors help investment banks win trust from investors, making the market more optimistic (Lu and Liu, 2016), the impact of investors network on IPO pricing has not been explicitly examined[27] (Rumokoy et al., 2017). Much of the existing research has examined whether and how characteristics of underwriting network (Cowrin and Schultz, 2005; Chuluun, 2015; Bajo et al., 2016; Lu and Liu, 2016; Rumokoy et al., 2017) or networks among incumbent venture capitalists (Hochberg et al., 2007) affect IPO pricing. In particular, previous authors maintain that IPOs underwritten by book managers with more central and cohesive networks are associated with a more information production, resulting in a higher likelihood of an offer price revision and larger price revisions (Chuluun, 2015; Bajo et al., 2016). However, none of these studies have analysed the effect of dealers' interactions, on the IPO price range setting or, more generally, on the IPO primary market pricing. Our argument is that IPO underwritten by book managers with more central networks are associated with a higher probability that IPO price range is set within the "safe harbor" because of the reduction in the uncertainty faced. In other terms, we expect networks of underwriters and institutional investors to help evaluate and incorporate information into the IPO

[26] Consistent with this idea that information production can occur prior to the IPO, a number of countries have variations in issuing strategies, which offer potential benefits. For example, some firms in the United Kingdom use a two-stage issuing strategy, where they list without issuing equity and then subsequently issue (Derrien, 2005). Jenkinson et al (2006) suggest that the extent of information collection prior to the IPO filing is even more extensive in Europe, since regulations governing pre-IPO (and prior to the intent to file an IPO) interactions between investors and underwriters are less stringent with respect to the US.

[27] One limitation to empirically examining underwriters – institutional investors networks is that investment banks are not required to disclose their order book and allocations' schedule.

price through the book-building process. We also analyze if the width of the price range is related to the characteristics of the banks-institutional investors network in place of firm's characteristics.

Moreover, given the recent findings of Colaco et al. (2017) and Da et al. (2011) about the relevance of retail investor attention to get more appropriate valuations, we also explore the impact of retail investor attention on the reduction of the uncertainty when setting the price range. Contrary to studies of Liu, Sherman, and Zhang (2009) and Bajo et al. (2016) that use the pre-IPO media coverage as an indirect measure of investor attention, Da et al. (2011) propose a direct measure of investor attention using the aggregate search on Google Trends. In particular, using the Google's search volume index (SVI), Colaco et al. (2017) conclude that retail investor attention plays a critical role in the early stages of IPO valuation. Indeed, an increase in retail attention in the pre-IPO phase is positively related to initial valuations. Following this evidence, we sustain that the retail investor attention plays an important role on the reduction of the uncertainty on IPO valuation, rising the probability that IPO price range compliances the SEC's indication.

3.3 Data and Methods

3.3.1 Sample Selection

We collected our sample of US IPOs from the Thomson One Deals database (TOD). We searched for all the IPOs occurring from January 2004 to December 2016, on the NASDAQ and NYSE. We then excluded IPOs with the following characteristics (as previously suggested by Ritter and Zhang, 2007): offer price below \$5 [28], non-common shares, closed-end funds, filings by foreign-domiciled firms, Master Limited Partnerships (MLPs), American Depository Receipts (ADRs) and Real Estate Investment Trusts (REITs). The final sample consist of 1,246 IPOs. In order to build the network and to observe the relationships that occurred between institutional investors and underwriters, we collected the name of lead managers from the TOD and the data about institutional investors

[28] Stocks with a price below \$5.00 per share are subject to the provisions of the Securities enforcement Remedies and Penny Stock Reform Act of 1990, aimed at reducing fraud and abuse in the penny stock market (Ritter, 1991).

participation on 13F institutional ownership. The information regarding actual allocation and, consequently, the participation to the offer are not publicly available. Therefore, as many of previous authors did, we made use of the first reported holding by investors at the end of the offering quarter as a proxy for the participation to the IPO (Reuter, 2006; Ritter and Zhang, 2007; Field and Lowry, 2009; Goyal and Tam, 2013). We also included information regarding financial statements of issuing firms from Compustat[29]. Jay Ritter's web site was also used to obtain information regarding the market's conditions and the rankings on US underwriters' reputation.

We then searched for the frequency in Google (Search Volume Index (SVI)) to directly measure the retail investor attention as in Da et al. (2011) and Colaco et al. (2017). The company's name and/or the ticker symbol drove our search term in Google Trends. As Da et al. (2011) point out, valid SVI values are not available for some stocks because individuals may not use the SDC company name to search for the stock using Google. In addition to this, Google Trends truncates the output and returns missing values for SVIs with insufficient searches (Colaco et al. 2017).

3.3.2 Network Measures

The underwriters-investors network is constructed using connections that underwriters establish with each other when they are involved in the same equity underwriting syndicates as in Chuluun (2015) and Bajo et al. (2016). Following Chuluun (2015), Cooney et al. (2015) and Rumokoy et al. (2017) we performed a manual correction when working with underwriter data because multiple variations of the same underwriter names appeared in the reported underwriter names. We checked for all the underwriter names and manually corrected the names when abbreviation, punctuation or spelling imply the same agent. To investigate the impact of banks-funds relationships on the excess IPO range, we first built institutional investors-underwriters network measures. In our network, two agents are

[29] Some information about issuing firm characteristics are also included into TOD. Because of the absence of some relevant financial items and for an easily comparison we prefer to use Compustat as unique source of financial statement information

considered connected if they were active members of the same IPO at the same time. The purpose is to observe past interactions between regular investors and underwriters who participated at the same IPO (Rumokoy et al., 2012). The intuition is that the higher the number of connections an underwriter has (with other institutional investors), the more centrally located is within its network and the more relevant price information is produced. Following Chuluun (2015), Bajo et al. (2016) and Hochberg et al. (2010), we calculate a series of network centrality measures using the institutional investors-underwriters' connections formed in the three years before the IPO. Such centrality measures are designed to grab how each lead manager is positioned in the network, and how much information flows through each agent.

Following Hochberg et al. (2007), Larcker et al. (2013) and Houston et al. (2018) we first construct an nXn adjacency matrix whose (i, j)-element is a dummy which takes a value of one if agent- i and agent- j are socially connected and N denotes the total number of agents in the network: in our analysis i are banks and j regular investors. In this case, we weight the adjacency matrix by the number of collaboration occurred in the three years previous to the IPO. We then calculated centrality measures - which are commonly used to position the lead manager in the network - including degree, closeness, betweenness and eigenvector (Lu and Liu, 2016). The network measures are computed using directed binary data. More specifically, we construct the following four measures of network centrality:

- *Degree* is a way of measuring node activity by counting the total number of connections that an agent has in the network. It represents the sum of the row (or column) of the adjacency matrix. Because it is a function of the size of the network we normalize Degree by the maximum possible number of connections N –1.

$$Degree_i = \frac{\sum_j x_{ij}}{N-1}$$

where x_{ij} equals to one when there is a tie between underwriters i and investor j, and N equals to the number of agents in the network.

- *Eigenvector centrality* is a way of measuring the total effects centrality of a node position by capturing how close an underwriter is to all other dealers. In other terms, agents having higher eigenvector tend to connect to others who are well connected with the center of the network:

$$e_i = \lambda \sum_j x_{ij} e_j$$

where lambda is a constant represented by the biggest eigenvalue of the adjacency matrix and e is the eigenvector centrality score. We normalize Eigenvector by dividing it by the maximum possible eigenvector element value for an N agent network.

- *Betweenness* measures the node control: it captures the capacity each underwriter has to act as an intermediary and to control valuable resources. Higher betweenness can lead to more access to information and more advantageous position to control resources.

$$Betweenness_{\ i} = \sum_{jk} b_{ijk}$$

where b_{ijk} is the proportion of all paths linking distinct investor j and k that pass-through underwriter i, and we normalize it by the maximum possible betweenness in the network.

- *Closeness* measures the node efficiency. It represents how close on average a node is to every other node in the network and can be seen as a measure of the speed in which information from an agent spreads through the network. Agents with higher closeness are less likely to be the core member of the network and more dependent on others.

$$Closeness^{-1} = \frac{\sum_j d_{ij}}{N-1}$$

In the equation above, d_{ij} is the number of paths between underwriter i and investor j.

3.3.3 Methodology

To investigate the impact of network characteristics on the excess price range, we define a Logit scheme as follows:

$$\Pr (Y=1|L, K)$$

Where:

Y=1 if width of the range lower or equal to $2.

L= is a vector that includes network centrality measures.

K= is a vector that includes proxies for the IPO firm value.

Furthermore, to explore the determinants of the width of the price rage we estimate an OLS regression as follows:

$$Width = \alpha + \gamma L + \delta K + \varepsilon$$

Where:

Width= (high filing price - low filing price)/midpoint of the range

L= is a vector that includes network centrality measures.

K= is a vector that includes proxies for the IPO firm value.

Table 5 presents the definitions and sources of the dependent and independent variables used in this analysis. Our dependent variable, for the Logit model, is a dummy variable equal to one if the width of the range (high filing price - low filing price) is lower or equal to $2. We made use of this dummy because, despite in years the SEC revised more than once the thresholds for the safe harbour, the $2

limit remained stable and allows for the identification of IPO that are characterized by lower uncertainty.

In the OLS model, our dependent variable is the difference between high filing price and low filing price of the range scaled by the midpoint of the range. Independent variables are classified in Panel A, Panel B of Table 5, representing respectively the network centrality measures and characteristic of the IPO. In particular, Panel A includes the network variables we already discussed in Section 3.3.2. In Panel B we make use of the gross spread (GS), as a percentage of proceeds, to account for the compensation required by underwriters: it is reasonable to expect that the effort in the IPO evaluation might somehow be linked to the compensation required (Butler and Wan, 2005; Chen and Ritter, 2000). The underwriter reputation (UW) is also expected to increase the probability to be in the "safe harbour": according to Carter and Manaster (1990) low risk firms might reveal their low risk by selecting a high prestige underwriter. We included the proportion of stocks owned by insiders (EQ_ RET) because of the signalling effect it might have on the uncertainty surrounding the IPO (Leland and Pyle, 1977; Downes and Heinkel, 1982; Ritter, 1984; Feltham, Hughes, and Simunic, 1991; Bradley and Jordan, 2002; Loughran and Ritter, 2004; Lowry and Murphy, 2007). Moreover, the greater the retention, the lower the probability of required aftermarket price support. We also include a set of variables (AGE, LEV, TECH and the firm SIZE) to account for the firm intrinsic value, riskiness and growth potentialities. The logarithm of the firm's AGE and the firm SIZE are here used as a proxy for riskiness of the issuer (Beatty and Ritter, 1986; Ritter, 1987). Prior studies suggest that younger and smaller companies are perceived as riskier (Field and Karpoff, 2002; Loughran and Ritter, 2004; Crain et al., 2017). Moreover, we computed the leverage (LEV) as the logarithm of long-term debt scaled by total assets in the accounting period before the IPO (Habib and Ljungqvist, 2001) to control for ex ante uncertainty. A dummy variable (TECH) is included to evaluate industry focus. It takes the value of unity if the IPO firm is classified as high-tech, following the high-technology SIC codes identified in Kile and Phillips (2009), and zero otherwise. We control for hot issue market with a hot and cold market indicator (HOT_COLD) that represents the net

number of IPOs occurred in the month before the issue date (excluding penny stocks, units, closed-end funds, etc). We computed the number of IPOs rather than inserting a dummy for hot and cold year because we straightforward assumed that hot markets are characterized by a high number of issues (Ibbotson and Jaffe, 1975; Ritter, 1984; Helwege and Liang, 2004; Ljungqvist et al., 2006). We also included the search frequency in Google (Search Volume Index -SVI-) in the mouth before the IPO as a proxy for retail investor attention (INV_ATT) (Da et al., 2011 and Colaco et al., 2017). In the Logit model we control for the midpoint of the price range (MIDP) because historically the SEC suggested a tuning safe harbour depending on the level of IPO price; in particular, the price range spread could not exceed $2 when top of the range was 20$ or less but it was allowed a larger range for IPOs with a top of the range above $20.

Table 5: **Variables description and sources**

This table presents the definitions of the dependent and independent variables used in the Logit and OLS regression. The dependent variable of the Logit model is a dummy variable equal to one if the width of the IPO range lower or equal of $2. In the OLS model the dependent variable is the width of the price range scaled by the midpoint of the filing range. Panel A presents the centrality measures used to the describe the position of the lead underwriter in the underwriter networks and in the networks of institutional investors - underwriters. Panel B includes proxy variables relating to issuing firm attributes, deal (offer) characteristics, third-party certification, hot/cold market indicator and a proxy for retail investor attention. Data sources include Thomson One Deal, Compustat, Google Trends and Jay Ritter's web site [http://bear.warrington.ufl.edu/ritter/ipodata.htm].

Variable	Source	Description of variable
Dependent variable		
Dwidth	Thomson	Dummy variable equal to one if the width of the IPO range is lower or equal of $2
Width	Thomson	High filing price-low filing price/midpoint of the filing range
Panel A: Centrality measures		
BIWdeg	Thomson	Degree of the directed and weighted network of underwriters-institutional investors
BIWevc	Thomson	Eigenvector centrality of the directed and weighted network of underwriters-institutional investors
BIWbtw	Thomson	Betweenness of the directed and weighted network of underwriters-institutional investors

BIWclo	Thomson	Closeness of the directed and weighted network of underwriters-institutional investors

Panel B: IPO characteristics

GS	Thomson	Gross spread required by the underwriter as a percentage of the proceeds
UWR	Jay Ritter Web site	Underwriter reputation rank
LEV	Compustat	Long-term debt scaled by total assets in the accounting period before the IPO
EQ_ RET	Thomson	Logarithm $\left(1 + \frac{Secondary\ shares\ retained}{Shares\ offered}\right)$ where Secondary shares retained= Share Outstanding – Total shares sold
AGE	Jay Ritter Web site	Firm age is the number of years between the date the company was founded and the IPO date
TECH	Compustat	Dummy variable equal to one if SIC code equal the ones identified in Kile and Phillips (2009)
SIZE	Compustat	Logarithm of total asset in the accounting period before the IPO
HOT_COLD	Jay Ritter Web site	Net number of IPOs (exclude penny stocks, units, closed-end funds, etc) in the month before the issue date
INV_ATT	Google Trends	Logarithm of search frequency in Google (Search Volume Index (SVI)) in the mouth before the IPO
MIDP	Thomson	Midpoint of the initial price range

3.4 Empirical results

3.4.1 Descriptive Statistical Analysis

Table 6 and 7 provides some descriptive statistics regarding the underwriters-funds network.

Table 6 shows correlations across different network centrality measures. *Degree* and *eigenvector centrality* appear to be positively and significantly correlated. This implies that lead managers who have a larger number of connections (higher degree) with other investors are associated with peers who themselves are well-connected (eigenvector) (Rumokoy et al., 2017). Correlations between other measures are somewhat low, suggesting a moderate linear relationship between the variables. Overall, the correlation coefficients suggest that network measures grab different aspects of the network.

Table 6: ***Correlations across different centrality measures****.*

Table 6 presents the correlation among the network measures. Betweenness centrality is the number of shortest paths between all bank pairs that a bank lies on. Eigenvector centrality gives large values to those banks that have many links, links that are important or both. Closeness centrality is defined as the inverse value of the average distance between a bank and all other banks in the networks where distance is defined as the shortest path. Degree centrality denotes the number of first-degree links that a bank has in the network. All measures are calculated based on the participation in the same IPO in the previous three years. Sample period is 2004–2016.

Variable	BIWevc	BIWdeg	BIWbtw	BIWclo
BIWevc	1.0000			
BIWdeg	0.7698	1.0000		
BIWbtw	0.5438	0.5504	1.0000	
BIWclo	-0.0441	-0.0385	0.4465	1.0000

Table 7 shows the correlation between underwriters' reputation and the network variables suggesting that reputation and network measures do not necessary depend on one other.

Table 7: ***Correlations across different centrality measures and underwriter reputation****.*

Table 7 presents correlation between the network measures the bank reputation measure (UWR). All measures are calculated based on the participation in the same IPO in the previous three years. Sample period is 2004–2016.

Variable	BIWevc	BIWdeg	BIWbtw	BIWclo
UWR	0.3801	0.4248	0.3390	0.1300

Figure 3 presents the number of IPO that set the offer price range lower, equal or greater of $2 across our sample period. In each year of our sample period the number of IPO with price range equal to 2 represent the majority.

Table 8 presents summary statistics for the 1,246 IPOs belonging to our sample. The percentage of firms with an IPO range equal or lower than $2 represents the 94% of the sample. This suggest that it is not suitable for the issuing firm nor for the underwriter to set a price range that doesn't comply with the safe harbour. The magnitude of the range scaled by the midpoint of the range varies from a minimum of 0 to a maximum 0.66. The descriptive statistics of variables capturing the company characteristics indicate that, in our sample, firms go public, on average, 16 years after the foundation. The average value of total assets of the listing firms prior to the offer, as a measure of the firm size, is US$1,550 million. The leverage, which is measured by the long-term debt scaled by the book value of assets, shows a 26% mean value. On average, the gross spread is 11%, this percentage suggests that, in our sample, the compensation required by the underwriters is higher than the 7.0 percent commonly paid by issues (Chen and Ritter, 2000). In addition, the average rank of underwriter is 8.2: as the maximum value of the range is 9, this implies that only highly ranked underwriters followed issues in our sample. The shares owned by insiders are approximatively 60%, which could be a positive signal of how confident the insiders are about the firm's prospects. The market conditions, captured by the net number of IPO in the 30 days before the offering, show a normal situation of new issues market activity. Concerning our measure of investor attention, in our sample, in the month before, the IPO the company name and/or the ticker symbol has been searched on Google Trend 33.75 times on a maximum of 100. The mean value of the midpoint of the range is 14.36. As in Lu and Liu (2016) our centrality measures vary widely across the whole network and the maximum value is much different from the minimum. The descriptive statistics of the centrality measure for the network of underwriters- institutional investors suggest that on average, in our sample, lead IPO underwriters had *Eigenvector* centrality equal to 73.4%. Mean *Degree* centrality over all periods is 1 link; *Betweenness* is 11.1% and $Closeness^{-1}$ is 0.06 %.

Table 8: **Summary Statistics**.

This table presents summary statistics of the 1,246 US IPO of the sample. All accounting data are measured in the year prior to the offer. Dwidth is a dummy variable equal to one if the width of the IPO range is lower or equal to $2. Width is the distance of low filing price from the high filing price/midpoint of the filing range. Size is logarithm of the book value of assets in the accounting period before IPO. The firm age is the number of years from foundation. Equity retain is the logarithm of (1+ (Secondary shares retained)/ (Shares offered)). The gross spread represents a percentage of the proceeds. Underwriter reputation is based on tombstone rankings used in Carter and Manaster (1990) and updated on the Jay Ritter's web page. Leverage is the logarithm of long-term debt scaled by total assets in the accounting period before the IPO. we also include: the hot and cold markets indicator that represents the net number of IPOs (excluding penny stocks, units, closed-end funds, etc) in the month before the issue date; the retail investor attention is proxied as the logarithm of search frequency in Google (Search Volume Index (SVI)) in the mouth before the IPO. The underwriter network and the underwriter-investor network are described by the following centrality measures: degree, eigenvector centrality, betweenness, density and closeness.

	(1)	(2)	(3)	(4)	(5)
VARIABLES	mean	median	sd	min	max
Dependent variables					
Dwidth	0.94	1	0.21	0	1
Width	0.12	0.13	0.06	0	0.66
Panel A: Centrality measures					
BIWevc(%)	0.734	0.457	0.775	0	2.863
BIWdeg	1.055	0.962	0.835	0.00169	3.703
BIWbet(%)	0.111	0.0948	0.0906	0	0.536
BIWclo(%)	0.000663	0.000607	0.000308	2.84e-06	0.00255
Panel B: IPO characteristics					
AGE (year)	16.13	8	23.13	0	158
SIZE (US$ million)	1,550	86.18	12,407	0.001	272,753
LEV	0.267	0.0933	0.437	0	8.448
GS (%)	11.93	7.128	16.61	0	263.2
UWR	8.250	8.501	1.147	2.001	9.001
EQ_RET	0.604	0.652	1.165	-12.43	4.220
HOT_COLD	14.62	12	11.49	0	63
INV_ATT	33.75	30	26.82	0	100
MIDP	14.36	14	4.55	0	32.5

3.4.2 Findings

Table 9 provides the estimated coefficients of the Logit model[30]. In models 1 to 4 the probability of been in the safe harbor is individually regressed over the network measures showing that the position of the lead underwriter in the network of institutional investor has a positive and significant signalling effect. In models from 5 to 8 we added a series of control variables as described in Section 3.3.3. Network variables are still significant and positively linked to the probability of as excess IPO range (apart from the closeness which is non-significant as before), suggesting that larger networks are likely to contribute to the information production process. Moreover, centrally located networks have more easily access to information (Chuluun, 2015), thus reducing the uncertainty in the IPO pricing. As a matter of the fact, when networks are in place, underwriters face a reduction in the uncertainty surrounding the estimate value of the issuing firm that is reflected in a higher probability to set a price range that follows the SEC's recommendations[31]. This result reveals that investment banks with established investor networks could incur lower costs of searching for investors (Huang et al., 2008). The retail investor attention has a positive significant coefficient in all models suggesting that having a higher interest from retail investors, increase the probability of setting price range more prudently. As in Colaco et al. (2017) we find that an increase in the retail attention is positively related to more precise initial valuations thus revealing that retail investors' attention can be used as a forerunner variable for the retail demand in the aftermarket (Barber and Odean, 2008). The positive effect of the centrality measures and the INV_ATT measure, on our dependent variable, suggests that controlling for both the institutional investors and retail demand allows a reduction of the uncertainty.

As far as control variables are concerned, the AGE and the midpoint of the range (MIDP) of the firm are the only significant variables within the IPO characteristics panel[32]. We find a negative

[30] Formally, we used the logarithmic transformation of the retail investor attention, the value of the asset and leverage.

[31] Our result remains stable if we employ the *page rank* algorithm as a centrality measure. In addition, our results are robust if we use different configuration of the institutional investors-underwriter network, such as the undirected and unweighted ones.

[32] As a robustness check we use a categorical dependent variable to run a Multinomial logistic regression and an Ordered Logit. The variable takes the value of 1, 2 and 3 for the outcomes: "width of the filing range <2", "width of the filing range =2", "width of the filing range >2", respectively. The test for combining dependent categories in the Multinomial

relationship between the midpoint of the range and the probability of being in the safe harbour. Such an empirical evidence is not totally unexpected given that historically the SEC view was that the price range spread could not exceed $2 when top of the range was 20$ or less but it was allowed a larger range for IPOs with a top of the range above $20. Accordingly, IPOs with higher top of the range and, consequently, higher midpoint, relapse into the less stringent limit.

Table 10 provides results for the OLS model. In model 1-8 we find that all the network variables are insignificant. These results indicate that centrality measures can influence only the probability that the price range is set within the indication of the SEC but, not the width of the price range. As far as the AGE continue to be significant also in the OLS model. On the contrary, we find to be significant some control variables that were not relevant in the Logit model. Our evidences suggest that the underwriter reputation (in model 7 and 8), as well as the firms' SIZE, plays an important role in lowering the dimension of the IPO range. On the contrary, high-tech (TECH) and older firms are perceived as riskier, resulting in a higher magnitude of the IPO filing range.

The implication of these findings is that much of the information underwriters make use to set the initial IPO price range is obtained before the bookbuilding begins, through the process of information transmission across the network of institutional investors-underwriters created by repeated dealings. The relationship with investors could help investment banks to certify, market and distribute securities, allowing a reduction in the uncertainty faced by underwriters when setting the IPO price range.

Logit and the test for the significance of the cut off in the Ordered Logit suggest the possibility of combining the categories 1 and 2.

Table 9: **Logit model estimates and retail investor attention**

This table presents the estimated coefficients of the Logit model. The dependent variable equal to one if width of the range is lower or equal of $2 and zero otherwise. Variable descriptions are provided in the Table 6. In Model 1-4 we regress the network measures individually. In Model 4 -8 we add a series of control variables as described in Section 3.3. Standard errors are reported in the brackets. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
BIWevc	0.925**				1.110*			
	(0.325)				(0.632)			
BIWdeg		0.744**				1.028**		
		(0.254)				(0.453)		
BIWbet			5.785**				8.268*	
			(2.354)				(5.594)	
BIWclo				595.6				1355.1
				(602.3)				(1723.5)
INV_ATT					1.090**	1.136**	0.977**	1.035**
					(0.368)	(0.375)	(0.352)	(0.341)
UWR					0.0717	0.00911	0.123	0.286
					(0.282)	(0.289)	(0.287)	(0.260)
EQ_RET					0.188	0.153	0.137	0.104
					(0.404)	(0.429)	(0.409)	(0.410)
AGE					-0.0160*	-0.0173*	-0.0146*	-0.0136*
					(0.00871)	(0.00881)	(0.00863)	(0.00880)
HOT_COLD					0.0288	0.0326	0.0316	0.0396
					(0.0397)	(0.0394)	(0.0403)	(0.0411)
SIZE					-0.274	-0.207	-0.231	-0.220
					(0.209)	(0.204)	(0.209)	(0.208)
LEV					0.0449	0.0691	0.0888	0.0812
					(0.206)	(0.205)	(0.208)	(0.204)

GS					0.0132	0.0116	0.0151	0.0139
					(0.0268)	(0.0265)	(0.0275)	(0.0280)
TECH					1.321	1.501	1.372	1.660
					(1.183)	(1.165)	(1.168)	(1.184)
MIDP					-0.403***	-0.440***	-0.411***	-0.415***
					(0.0914)	(0.0979)	(0.0920)	(0.0936)
_cons	2.590***	2.449***	2.541***	2.696***	6.650**	6.979**	6.417**	4.667
	(0.205)	(0.237)	(0.244)	(0.403)	(3.109)	(3.152)	(3.206)	(2.975)
N	859	859	859	859	390	390	390	390

Table 10: **OLS model estimates and retail investor attention**

This table presents the estimated coefficients of the OLS model. The dependent variable is the width of the filing range scaled by the midpoint of the filing range. Variable descriptions are provided in the Table6. In Model 1-4 we regress the network measures individually. In Model 4 -8 we add a series of control variables as described in Section 3.3. Standard errors are reported in the brackets. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
BIWevc	-0.00117				-0.00318			
	(0.00265)				(0.00365)			
BIWdeg		-0.000911				-0.00376		
		(0.00248)				(0.00371)		
BIWbet			-0.00652				-0.0103	
			(0.0223)				(0.0401)	
BIWclo				-2.289				-1.575
				(6.563)				(13.78)
UWR					-0.00352	-0.00318	-0.00424*	-0.00449*
					(0.00274)	(0.00282)	(0.00273)	(0.00251)
EQ_RET					-0.00000414	-0.0000358	-0.000137	-0.000103
					(0.00298)	(0.00297)	(0.00297)	(0.00299)
AGE					0.000218*	0.000224*	0.000215*	0.000215*
					(0.000118)	(0.000118)	(0.000118)	(0.000119)
HOT_COLD					0.0000321	0.0000221	0.0000204	0.0000206
					(0.000250)	(0.000249)	(0.000250)	(0.000250)
SIZE					-0.00497**	-0.00503**	-0.00500**	-0.00499**
					(0.00175)	(0.00175)	(0.00175)	(0.00175)
LEV					-0.00129	-0.00131	-0.00135	-0.00135
					(0.00173)	(0.00173)	(0.00173)	(0.00173)
GS					-0.000222	-0.000228	-0.000218	-0.000217
					(0.000176)	(0.000176)	(0.000176)	(0.000176)

TECH					0.0136**	0.0136**	0.0136**	0.0134**
					(0.00651)	(0.00650)	(0.00654)	(0.00651)
INV_ATT					-0.000569	-0.000689	-0.000599	-0.000716
					(0.00294)	(0.00294)	(0.00298)	(0.00294)
_cons	0.126***	0.126***	0.126***	0.127***	0.174***	0.173***	0.179***	0.181***
	(0.00282)	(0.00330)	(0.00322)	(0.00477)	(0.0266)	(0.0264)	(0.0264)	(0.0259)
N	850	850	850	850	389	389	389	389

3.5 Concluding remarks

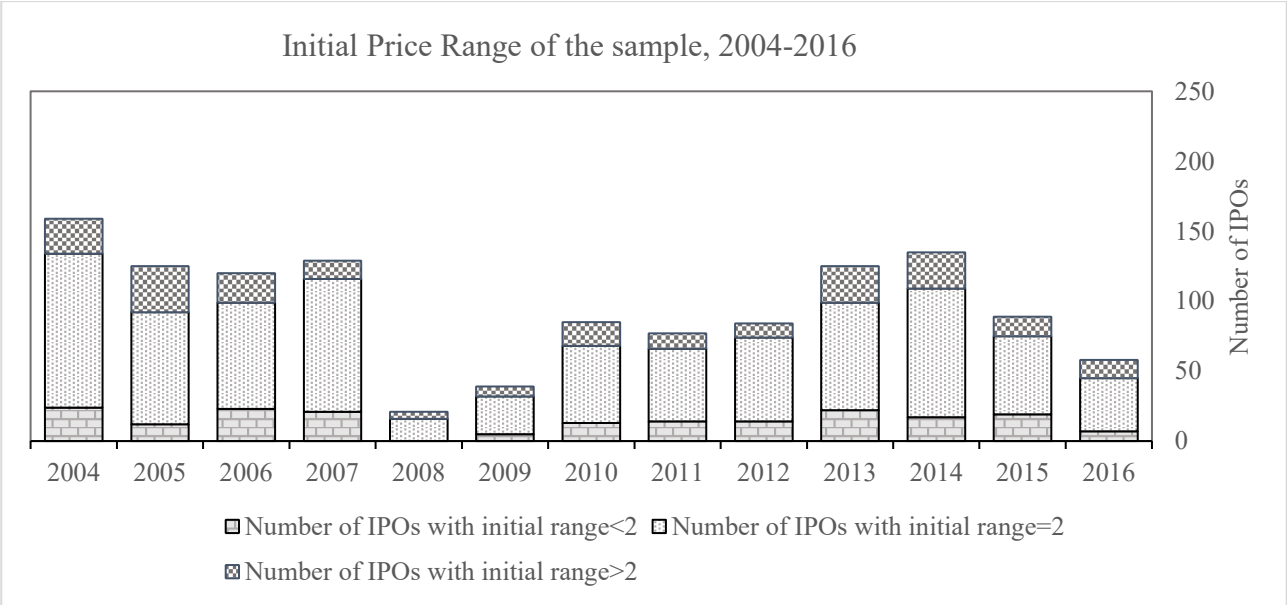
In this study, we assess the impact of underwriter- institutional investors networks on the IPO price range setting, using measures from social network analysis and a sample of U.S. IPOs issued between 2004 and 2016. We also analyze how the retail investor attention, proxied by the search frequency in Google (Search Volume Index (SVI)), affects the setting of the price range. Given the price range indication ("safe harbour") provided by the SEC, we consider if the likelihood that the price range is set within this suggestion, as well as the width of the price range, are related to the uncertainty surrounding: the market demand (centrality measures and investor attention) and the firms' value. We use various network centrality measures, to capture the location of a lead IPO underwriter in its network of regular investors and to illustrate that the existence of a network of relationships between underwriters and regular investors can be useful in terms of forming a view on valuation. We hypothesized that the existence of more central networks can overcame some problems associated with underwriting because underwriters, might be able to gather more precise information even before the roadshow begins, during the due diligence process, through previous interactions with regular investors. Our results reveal that IPOs underwritten by book managers with more central networks experience a higher likelihood that IPO price range is set within the 'safe harbor', especially when the retail investor attention is high, but we find no significant impact of the centrality measures on the magnitude of the range. We find the size of the network (*degree* and the *eigenvector centrality* measures) and the position in the network (*betweenness*) to be relevant in reducing the uncertainty. In line with Colaco et al. (2017), we provide evidence that retail investor attention, a precursor of retail demand for shares in the aftermarket (Barber and Odean, 2008), positively impact initial valuations. Moreover, our empirical analysis on the dimension of the range reveals that it is related to the firms' and IPOs' characteristics and is able to signal the firms' uncertainty.

Our contribution lies in providing new evidence on the mechanisms that are behind the way IPO price ranges are set in the due diligence step. Our study sheds light on the role of retail investor attention and institutional investors in primary market pricing. In addition to the previously discussed

underwriting networks (Cowrin and Schultz, 2005; Chuluun, 2015; Bajo et al., 2016; Lu and Liu, 2016; Rumokoy et al., 2017) or networks among incumbent venture capitalists (Hochberg et al., 2010), we propose that the underwriters-regular investors relationships affect IPO pricing.

Figure 3: **Initial Price Range of the sample, 2004-2016**

This figure presents the number of IPOs with initial range lower, equal or greater of $2 across our sample period 2004—2016.



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