Underwriter Networks, Investor Attention, and Initial Public Offerings

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Current version: December 2015

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For helpful comments and discussions, we thank Onur Bayar, Agnes Cheng, Raffaele Corrado, Gang Hu, Xiaoding Liu, Karthik Krishnan, Xuan Tian, Yong Zhang, seminar participants at Boston College, Hong Kong Polytechnic University, Suffolk University, and conference participants at the 2014 Financial Management Association Meetings. We alone are responsible for any errors or omissions.

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Abstract

Using various "centrality" measures from Social Network Analysis (SNA), we analyze how the location of a lead IPO underwriter in its network of investment banks affects various IPO characteristics. We hypothesize that investment banking networks allow lead IPO underwriters to induce institutions to pay attention to the firms they take public and to perform two information-related roles during the IPO process: an information dissemination role, where the lead underwriter uses its investment banking network to disseminate noisy information about various aspects of the IPO firm to institutional investors; and an information extraction role, where the lead underwriter uses its investment banking network to extract information useful in pricing the IPO firm equity from institutional investors. Based on these two roles, we develop testable hypotheses relating lead IPO underwriter centrality to the IPO characteristics of firms they take public. We find that more central lead IPO underwriters are associated with larger absolute values of offer price revisions; greater IPO and after-market valuations; larger IPO initial returns; greater institutional investor equity holdings and analyst coverage immediately post-IPO; greater stock liquidity post-IPO; and better long-run stock returns. Using a hand-collected data set of pre-IPO media coverage as a proxy for investor attention, we show that an important channel through which more central lead IPO underwriters achieve favorable IPO characteristics is by attracting greater investor attention to the IPOs underwritten by them.

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1. Introduction

Underwriting syndicates are information networks. The practitioner IPO literature points to the two-way information flow occurring during IPO road-shows and the book-building process between IPO underwriters and institutions: while, on the one hand, underwriters collect information about the demand schedule of institutional investors for the IPO firm's shares, they also address institutions' questions and concerns about the future strategy and performance of the IPO firm, thus disseminating information about the firm to them. The network of investment banks that a lead IPO underwriter is connected to (through participation in various IPO underwriting syndicates) may play a crucial role in the above information extraction and information dissemination that occurs during the IPO underwriting process.

The objective of this paper is to analyze how the central position of a lead IPO underwriter in a network of investment banks affects various IPO characteristics of the firms it takes public. By making use of data on the interactions between investment banks serving as part of underwriting syndicates for different IPOs, we are able to use measures from social network analysis (SNA) to characterize the relative position of each underwriter in the network of investment banks developed as a result of such interactions. We then empirically analyze how these measures of network centrality of lead IPO underwriters relate to the characteristics of the IPOs underwritten by them.

We measure the relative position of the lead IPO underwriter in the above network of investment banks by making use of six different "centrality" measures which are widely used in the SNA literature. The first measure is *Degree*, which is the number of other unique investment banks that the lead IPO underwriter had connections with (either as a lead IPO underwriter or as a member of an IPO syndicate) in the five-year period prior to the IPO year. The other measures of lead IPO underwriter centrality that we use are *Outdegree*, *Indegree*, *Eigenvector*, *Betweenness*, and 2-*StepReach*. We will define and discuss in detail these six measures of lead IPO underwriter centrality and illustrate them using a real-world investment banking network (shown in Figure 2) in Section 5.1.

Precisely how may a more central location of a lead IPO underwriter in an investment banking network affect the characteristics of IPOs underwritten by it? To see this, consider a lead IPO underwriter connected to a number of other investment banks through repeated participation in IPO syndicates, and whose position in this investment banking network is captured by the SNA measures mentioned above. Let each investment bank in the network be also connected to a number of institutional investors through repeated prior interactions. In such a setting, we can think of two ways in which a lead IPO underwriter's position in its network of investment banks may affect the characteristics of IPOs it is underwriting. First, the location of a lead IPO underwriter in its investment banking network may affect its ability to attract attention from institutional investors to the firm it is taking public using this network and to disseminate information about the IPO firm to these institutional investors. Second, this location may affect the lead IPO underwriter's ability to extract information from institutions about their demand for the IPO firm's equity after it attracts the attention of these institutions to the IPO firm.

We first discuss how lead IPO underwriter's centrality may affect its ability to attract attention from institutions to the firm it takes public and to disseminate information about the IPO firm to these institutions. The certification literature has argued that the role of an IPO underwriter is that of a producer of noisy information about various aspects of the firm it takes public and a transmitter of that information to potential investors in its IPO: see, e.g., Booth and Smith (1986) or Chemmanur and Fulghieri (1994). However, unlike this literature, which has argued that a lead underwriter transmits information about the IPO using its reputation as a certification mechanism, we postulate here that the lead underwriter disseminates noisy information about various characteristics of the IPO firm to potential investors through the network of investment banks connected to it, with each investment bank having repeated interactions with a set of institutions who may potentially invest in the IPO. We further assume that, for investors to consider investing in an IPO, they need to pay attention to that IPO: in other words, they not only need to receive information about the IPO firm, but also to pay attention to or "recognize" this information.

The last assumption above is in the spirit of Merton's (1987) "investor recognition" or "attention" model, which assumes that an investor will incorporate a security into his portfolio only if he pays attention to that security. The Merton (1987) model has been extended by Van Nieuwerburgh and Veldkamp (2009), who assume that such attention/information acquisition has a cost; see also the theoretical model in Liu, Sherman, and Zhang (2014b), who model IPO underpricing as a way of compensating investors for this attention cost. We make a similar assumption about investors having to incur such an attention/information acquisition cost. We further assume that this cost is lowest when information about various aspects of a particular IPO is brought to the investor's attention by an investment bank with which it has had repeated prior interactions. Given that it may be prohibitively costly to acquire this information from other investment banks, the last assumption above implies that an institution is more likely to pay attention to information about (and therefore invest in) a particular IPO if it receives this information from an investment bank with which it had repeated prior interactions.

The above theory has an important implication for information dissemination and investor attention. The implication is that a more central lead underwriter will be connected to a greater number of institutions (through the investment banks in its network), allowing it to induce a larger number of institutions to pay attention to the firm it takes public, thereby facilitating more efficient dissemination of information about the firm to these institutions. We will refer to the above hypothesis as the "investor attention and information dissemination" hypothesis.[1]

We now discuss how the network centrality of a lead IPO underwriter may affect its ability to extract information from institutions about their demand for the IPO firm's equity after it attracts the attention of these institutions to the firm. The theoretical book-building literature that originated with Benveniste and Spindt (1989) has modeled an IPO underwriter as concerned with extracting truthful information from institutional investors who have private information about their own valuation of the IPO firm (and therefore their demand schedule for the firm's shares), and using the IPO share allocation

[1] The information dissemination we have in mind is noisy information about various characteristics of the firm going public rather than favorable information about its intrinsic value. Therefore, while some institutional investors who pay attention may choose to invest in the equity of the IPO firm after they conduct their own valuation of the firm, others may decide not to invest in its equity at the IPO offer price chosen by the lead underwriter. However, for a given IPO firm, the larger the number of institutions paying attention to the information conveyed to them about the firm by the lead IPO underwriter through the network of investment banks it is connected to, the greater the expected number of institutions investing in its equity (for a given IPO offer price).

process to design an incentive compatible mechanism to extract this information. In the above setting, we introduce a network of investment banks connected to the lead IPO underwriter, with each investment bank having repeated interactions with a set of institutions who may potentially invest in the IPO. Each investment bank in such a network will be able to more efficiently extract information about the valuation of the IPO firm from the institutions with which it has interacted repeatedly. Further, a lead IPO underwriter who is better connected to various investment banks in its network will, in turn, be able to more efficiently extract this information from these investment banks and use it in pricing the IPO firm's shares. The implication here is that a more central lead IPO underwriter will be connected to a greater number of institutions (through its investment banking network), allowing it to induce a greater number of institutions to pay attention to the firm it takes public and to more efficiently extract information useful in pricing the IPO firm's shares from these institutions. We will refer to this hypothesis as the "investor attention and information extraction" hypothesis.

As we discuss in detail in Section 3, the effect of a lead IPO underwriter's centrality on its ability to induce a larger number of institutions to pay attention to the firm it takes public, and to disseminate and extract information about the IPO firm from these institutions significantly affects various characteristics of the IPO it underwrites. In particular, we argue that more central lead IPO underwriters are associated with larger absolute offer price revisions, higher IPO and immediate secondary market valuations of IPO firms' equity, greater participation by institutional investors and financial analysts (the former by holding IPO firms' equity and the latter by providing analyst coverage), greater secondary market stock liquidity, and better long-run post-IPO stock returns. We test the above hypotheses in our empirical analysis.

We also empirically analyze whether the mechanism that we postulate above through which more central lead underwriters are able to generate more favorable IPO characteristics for the firms they take public (namely, their ability to induce a larger number of institutions to pay attention to the firms they take public, and to more efficiently disseminate and extract information about these firms from the institutions) is indeed valid. In conducting this analysis, we make use of a proxy for investor attention developed by Liu, Sherman, and Zhang (2014a), namely, pre-IPO media coverage received by the firm going public (see also Liu, Sherman, and Zhang, 2014b). Liu, Sherman, and Zhang (2014a) argue that, since media sources compete to attract readers and advertising revenues, editors expect their reporters to cover those firms which have already received investor attention or are expected to receive such attention in the future. Consequently, the pre-IPO media coverage of firms going public serves as a good proxy for the degree of attention investors pay to such firms. We therefore make use of this proxy to test the notion that IPOs underwritten by more central lead underwriters are associated with greater investor attention.

Our empirical findings can be summarized as follows. First, we find that, consistent with the testable hypotheses we develop in Section 3, IPOs underwritten by more central lead underwriters are associated with larger absolute values of offer price revisions. Second, firms taken public by more central lead underwriters have greater IPO and secondary market valuations, and greater initial IPO returns. Third, IPO firms with more central lead underwriters generate greater interest on the part of some important financial market players: in particular, such firms are followed by a greater number of financial analysts immediately post-IPO and have larger institutional investor holdings. Finally, the shares of firms taken public by more central lead underwriters have greater secondary market liquidity and better post-IPO long-run (six-months and one-year) returns. It is important to note that all the above results hold even after controlling for underwriter reputation. Overall, our results are consistent with the notion that more central lead IPO underwriters are able to induce a larger number of institutions to pay attention to the IPOs underwritten by them, to more efficiently disseminate information about these IPO firms to these institutions, and to more efficiently extract information useful for pricing these IPO firms' equity from these institutions. Our direct tests of the mechanism through which lead underwriter centrality affects IPO characteristics indicate that more central lead underwriters are indeed able to garner greater investor attention to the firms they take public, as proxied by the pre-IPO media coverage received by these firms.

We also conduct an additional robustness test analyzing the relationship between lead underwriter centrality and IPO characteristics using the plausibly exogenous increase in underwriter centrality due to the repeal of the Glass-Steagall Act in 1999. The repeal of the Glass-Steagall Act essentially opened the door for commercial banks to enter the securities underwriting market and, in particular, the IPO market.

The resulting increase in the number of underwriters in the IPO market could be expected to create greater opportunities for such underwriters to establish new connections and expand their respective networks. This, in turn, could potentially affect the centrality of both existing investment banks in the IPO market as well as new commercial banks entering the IPO market. To study the effect of the above regulatory shift (that led to a potentially exogenous change in underwriter centrality) on the relationship between lead underwriter centrality and IPO characteristics, we utilize a two-stage least squares (2SLS) methodology. We make use of a categorical variable for the repeal of the Glass-Steagall Act as the predictor variable in the first stage regressions of our 2SLS analysis. The findings of the above robustness test are similar (with two exceptions) to those of our baseline regression analysis discussed earlier.[2]

The rest of this paper is organized as follows. Section 2 discusses how our paper is related to the existing literature and describes its contribution relative to this literature. Section 3 discusses the underlying theory and develops testable hypotheses. Section 4 describes our data and sample selection procedure. Section 5 describes our measures of lead IPO underwriter centrality and investor attention. Section 6 describes our empirical tests and results. Section 7 concludes.

2. Relation to the existing literature and contribution

The first literature our paper is related to is the prior research on IPOs. Apart from the papers in this body of work discussed in the previous section, our paper is related to several other strands in this area. The closest strand is the large empirical literature studying the information flows in IPOs: one example is the research on the partial adjustment phenomenon (e.g., Hanley, 1993) and the more recent studies on the efficiency of the IPO process in general (e.g., Lowry and Schwert, 2004).[3] There is also a

[2] The two exceptions are IPO initial returns and long-run post-IPO stock returns, where we do not find significant relationships between lead IPO underwriter centrality and these two IPO variables in our 2SLS analysis.

[3] There are also several information driven models of IPO underpricing indirectly related to this paper (see, e.g., Sherman, 1992; Chemmanur, 1993; Allen and Faulhaber, 1989; Welch, 1989; Welch, 1992). Further, to the extent that our study is related to information flows around a firm's IPO, it is also indirectly related to models of going public versus remaining private decision driven by the desire of firm insiders to avoid revealing private information (e.g., Bhattacharya and Ritter, 1983) or by considerations of minimizing duplication in information production by outsiders (e.g., Chemmanur and Fulghieri, 1999).

recent paper by Cooney, Madureira, Singh, and Yang (2015) who study whether social ties (through executives or directors) between an IPO firm and the investment bank serving as a book manager of its IPO increase the likelihood of that investment bank being included in the IPO syndicate. Unlike our paper, they do not study the effect of lead IPO underwriter centrality on IPO characteristics. The empirical literature on the role played by underwriters in the IPO process (see, e.g., Michaely and Womack, 1999; Ellis, Michaely, and O'Hara, 2000) and that played by institutional investors in IPOs (see, e.g., Aggarwal, 2003; Chemmanur, Hu, and Huang, 2010) is also distantly related.[4]

The second literature that our paper is related to is the emerging research on social networks in a financial market or in a financial intermediary setting. For example, Hochberg, Ljungqvist, and Lu (2007) study how networks of venture capitalists (VC) affect the investment performance of VC funds. They show that VC funds whose parent firms enjoy more influential network positions realize significantly better performance (measured by the proportion of portfolio investments successfully exited through an IPO or a sale to another company). Engelberg, Gao, and Parsons (2012) show that, when banks and firms are connected through interpersonal linkages, interest rates are markedly reduced. There is also a large body of work on board and CEO connectedness: for example, Larcker, So, and Wang (2013) investigate the "connectedness" of corporate board members across firms, and show that firms with the best-connected boards earn on average substantially higher future excess returns compared to firms with the worst-connected boards. In a similar vein, El-Khatib, Fogel, and Jandik (2015) study the effects of CEO connectedness on merger performance.

Despite the above large literature on how networks of financial intermediaries and corporate officers affect firm performance, there has been little research analyzing how investment banking networks affect IPO characteristics. A noteworthy exception is the contemporaneous paper by Chuluun (2015), who finds that the structure and characteristics of underwriter peer networks have implications for the quantity and quality of the information and the level of cooperative efforts shared among

[4] The empirical studies on the long-run performance of IPO firms are also related: see, e.g., Ritter (1991) and Loughran and Ritter (1995). See also Ritter and Welch (2002) for a review of the theoretical and empirical literature on IPOs.

underwriters. It should be noted that, while Chuluun (2015) shows that IPO book managers with more central and cohesive networks are associated with larger IPO offer price revisions and underpricing, all our other results are unique to our paper.

The contribution made by this paper relative to the existing literature is thus three-fold. First, this is the first paper to study the effectiveness of lead IPO underwriters in using their investment banking networks to induce institutions to pay attention to the IPOs underwritten by them, and in disseminating as well as in extracting information about these IPO firms from these institutions. We study this effectiveness by analyzing the relationship between various network centrality measures characterizing lead underwriters and the IPO characteristics (as well as the post-IPO liquidity and stock return performance) of the firms they take public. Second, making use of a large hand-collected dataset on pre-IPO media coverage received by firms going public, we document a positive relationship between a lead IPO underwriter's centrality and the investor attention paid to a firm whose IPO it underwrites (proxied by the pre-IPO media coverage received by that firm). Third, underwriter reputation has been seen in the existing IPO literature as an important measure capturing the effectiveness of investment banks in taking firms public. We extend this literature by showing that various SNA measures may serve as important additional variables to help us to assess the above effectiveness of IPO underwriters.

3. Theory and hypotheses development

The theoretical framework we rely on in developing our testable hypotheses borrows from two different strands in the IPO literature and from the broader literature on "investor recognition" or "investor attention." The first strand is the literature that has argued that the role of an underwriter in an IPO is that of a producer of noisy information about the firm it takes public and a transmitter of that information to potential investors in its IPO: see, e.g., Booth and Smith (1986) or Chemmanur and Fulghieri (1994). However, unlike this literature, which has argued that a lead underwriter transmits information about the IPO using its reputation as a certification mechanism, we postulate here that the lead underwriter transmits noisy information about the IPO firm to potential investors through a network of investment banks connected to it, with each investment bank having repeated interactions with a set of institutional investors who may potentially invest in the IPO. We further assume that, for investors to consider investing in a firm's IPO, they not only need to receive information about various aspects of that firm from an investment bank, but also to pay attention to or "recognize" this information. This last assumption is in the spirit of Merton's (1987) investor recognition or attention model, which assumes that an investor will incorporate a security into his portfolio only if he pays attention to that security. The Merton (1987) model has been extended by Van Nieuwerburgh and Veldkamp (2009), who assume that such attention/information acquisition has a cost; see also the theoretical IPO model in Liu, Sherman, and Zhang (2014b). We make a similar assumption about investors having to incur such an attention cost, and make the additional assumption that this cost is lowest when information about a particular IPO is brought to the investor's attention by an investment bank with which it has had repeated prior interactions. Given that it may be prohibitively costly to acquire this information from other investment banks, the last assumption above implies that an institution is more likely to pay attention to information about a particular IPO (and therefore to invest in that IPO) if it receives this information from an investment bank with which it had repeated prior interactions.[5]

The above theory has an important implication for investor attention and information dissemination. The implication is that a more central lead IPO underwriter will be connected to a greater number of institutions (through its investment banking network), allowing it to induce a greater number of institutions to pay attention to the firm it takes public, facilitating more efficient dissemination of information about the IPO firm to these institutions.[6] We will refer to the above hypothesis as the "investor attention and information dissemination" hypothesis.

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[5] Unlike their role in the certification literature, the role of lead underwriters that we postulate here is essentially that of "marketing" IPOs to institutional investors using their investment banking networks and the ongoing relationships individual investment banks in these networks may have with various institutional investors. See also a related paper by Gao and Ritter (2004), who analyze the effects of marketing efforts by underwriters in seasoned equity offerings.
[6] The process of information transmission across the network of investment banks about various aspects of an IPO firm that we rely on here (which is consistent with both information dissemination as well as information extraction) is modeled in the seminal work of DeGroot (1974), who suggests that, in general, the structure of a network influences the spread of information among the agents in that network. More recently, information transmission

The second strand in the literature that we borrow from is the theoretical book-building literature that originated with Benveniste and Spindt (1989). This paper has modeled an IPO underwriter as concerned with extracting truthful information from institutional investors who have private information about their own valuation of the IPO firm (and therefore their demand schedule for the firm's shares), and using the IPO share allocation process to design an incentive compatible mechanism to extract this information. In the above setting, we introduce a network of investment banks connected to the lead IPO underwriter, with each investment bank having repeated interactions with a set of institutional investors who may potentially invest in the IPO. Each investment bank in such a network will be able to more efficiently extract information about the IPO firm's valuation from the institutions with which it has interacted repeatedly.[7] Further, a lead underwriter who is better connected to various investment banks in its network will, in turn, be able to more efficiently extract this information from these investment banks and use it in pricing the IPO firm's shares. The broad implication of this theory is that a more central lead IPO underwriter will be connected to a greater number of institutions, allowing it to induce a greater number of such institutions to pay attention to the firm it takes public and to more efficiently extract information useful in pricing the IPO firm's shares from these institutions. We will refer to this hypothesis as the "investor attention and information extraction" hypothesis.

We would like to emphasize that the two roles of IPO underwriting networks that we discuss above are not mutually exclusive, though, in some contexts, one or the other role may dominate. Indeed, the practitioner literature on IPOs points to the two-way information flow occurring during IPO road-shows and the book-building process between underwriters and institutions: while, on the one hand, underwriters collect information about the demand schedule of institutions for the IPO firm's shares, they also address investors' questions and concerns about the future performance of the firm going public, thus

across agents in a network has also been modeled by DeMarzo, Vayanos, and Zwiebel (2003). See Jackson (2008) for an excellent discussion of theoretical models of information transmission in social and economic networks.

[7] In a dynamic extension to their one-period model, Benveniste and Spindt (1989) show that extraction of truthful information from institutional investors is easier when an investment bank interacts repeatedly with these institutional investors. Sherman (2000) also models repeated interactions between underwriters and investors in IPOs in a setting with endogenous (and costly) information acquisition.

disseminating information about the IPO firm. It is therefore not our objective to empirically distinguish between the information dissemination and extraction roles of IPO underwriting networks here.

In the remainder of this section, we develop testable implications for the relationship between underwriter centrality and IPO characteristics based on the two broad hypotheses discussed above.

3.1. Underwriter networks and the IPO pricing process: setting the initial offer price range, the IPO offer price, and the secondary market price

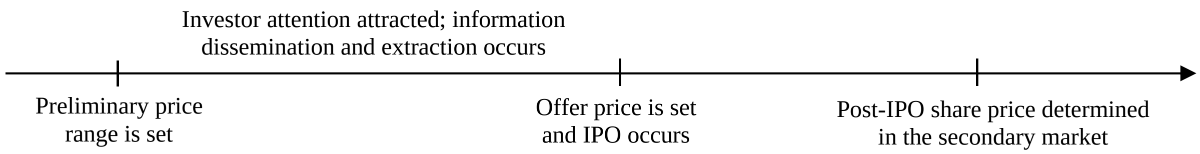

Figure 1. Timeline of the IPO pricing process

In order to develop testable implications, we now discuss the specific relation that we have in mind between the centrality of a lead IPO underwriter and the IPO pricing process. In particular, we characterize the setting of the initial IPO offer price range, offer price revision during the book-building process leading to the determination of the final IPO offer price, and the subsequent determination of the post-IPO share price in the immediate secondary market. The timing of various events (as depicted in Figure 1) is the following. First, the firm and its lead underwriter agree on the initial range of offer prices (sometimes referred to as the “preliminary price range” or “initial filing range”) within which they expect to set the final offer price. Second, the lead underwriter attempts to attract the attention of various institutions to the firm whose IPO it is underwriting, with the help of the various investment banks in its network. Third, the lead underwriter disseminates information about the characteristics of the IPO firm to the institutions whose attention it has been able to attract to the firm’s IPO. Finally, the lead underwriter extracts information from the above institutions about their demand schedule for the IPO firm’s equity, again making use of its investment banking network.[8]

[8] While, for concreteness, we have specified the timing of information extraction as occurring after information dissemination, our testable predictions remain qualitatively unchanged even if there is some overlap between the timing of information dissemination and information extraction by the lead underwriter.

Consider first the determination of the initial IPO offer price range by the lead underwriter. To the best of our knowledge, there has been no formal theoretical model in the existing literature regarding the process by which an underwriter and issuer choose this initial offer price range; our objective here is not to develop such a model. Rather, the process we describe below is meant only to capture the trade-offs facing a lead underwriter when setting this initial offer price range. We make two important assumptions here about this process. First, while the lead underwriter is aware of its position in its investment banking network (and therefore its expected ability to attract investor attention to a particular IPO) and the noisy information about the IPO firm that it wishes to convey to the investors, it will have residual uncertainty about the precise amount of attention it will be able to attract from institutions to the IPO and therefore about the amount of information it will be able to convey to these institutions about the firm going public.[9] This means that the lead underwriter will choose the initial IPO offer price range based on the expected value of the investor attention that it will be able to attract to the IPO and the expected value of the effect of its information dissemination on the firm's final IPO offer price, with the precise value of these variables being realized only subsequently (during the book-building process). Second, we assume that, while the lead underwriter is free to set the final offer price anywhere within the initial offer price range (and if necessary above or below this range), it is costly for the lead underwriter to set the offer price above or below the midpoint of this range: for simplicity, we assume that this cost is increasing in the distance of the final offer price from the midpoint of the initial IPO offer price range.[10, 11]

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[9] This uncertainty may arise for various reasons. For example, there may be other important (and unforeseen) events occurring at the time of a given IPO that may affect the stock market and the economy as a whole, which can affect the attention that institutions pay to the IPO: see, e.g., Liu, Sherman, and Zhang (2014a) who discuss the possibility of other contemporaneous news events affecting the investor attention (and media coverage) achieved by a particular firm's IPO.

[10] This cost of setting the final offer price away from the midpoint of the initial IPO offer price range may arise (for example) as follows. Institutions may have to devote some resources toward evaluating their potential demand for the firm's shares at each offer price, and some of these resources may be wasted if the final IPO offer price is set significantly away from the midpoint of the initial IPO offer price range. Given that institutions are likely to have a long-run relationship with underwriters in the IPO syndicate, such costs arising from wastage of resources by institutions in the event the final IPO offer price is set significantly away from the midpoint of the initial IPO offer price range are likely to be transmitted to these IPO underwriters in the long-run.

[11] This second assumption also implies that the initial IPO offer price range (and its midpoint) may convey some information to institutions about the location of the final IPO offer price, since they are aware that it is costly for the

The above two assumptions imply that the cost-benefit trade-off driving a lead underwriter's choice of the initial IPO offer price range is as follows. If a lead underwriter sets the midpoint of the initial IPO offer price range significantly below the expected final IPO offer price, it will have to incur the cost of updating the price upward in the event the demand from institutions for the IPO firm's shares is strong (in order to maximize IPO proceeds). If, however, the lead underwriter sets the midpoint of the initial IPO offer price range significantly above the expected final IPO offer price, it will have to incur the cost of updating the price downward in the event the demand from institutions for the IPO firm's shares is weak (to ensure that all the shares offered in the IPO are sold out, and the firm is able to raise the amount of financing it needs). The above trade-off implies that a lead underwriter will be set the midpoint of the initial IPO offer price range equal to its expectation of the final IPO offer price.[12, 13]

After the initial offer price range is chosen and the information about the IPO firm is disseminated to the institutions who pay attention to it, the lead underwriter makes use of its investment banking network to extract information from institutions about their demand for the IPO firm's shares. The offer price will be revised upward or downward from the midpoint of the initial offer price range depending on the above information extracted by the lead underwriter from institutions. A more central underwriter may be in a better position to extract information useful for valuing the IPO firm's shares from institutions, making use of the investment banks in its network. If this is the case, we would expect a

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lead underwriter to set the final offer price too far away from the midpoint of the filing range (though the underwriter may choose to do so if the benefits of such price-setting exceed the costs).

[12] The empirical and anecdotal evidence is somewhat consistent with the process of setting the initial IPO offer price (filing) range that we postulate here. While there is no consensus in the literature on this point, some of the empirical studies on IPOs have used the midpoint of the initial IPO offer price range as an unbiased predictor of the ultimate IPO offer price: see, e.g., Hanley (1993), Loughran and Ritter (2002), and Bradley and Jordan (2002). However, Lowry and Schwert (2004) document that the midpoint of the initial IPO offer price range is not always an unbiased predictor of the final IPO offer price: in their sample, the final IPO offer price is set about 1.4% below the midpoint of the initial IPO offer price range, on average.

[13] Since we do not test hypotheses related to the partial adjustment phenomenon of IPO price-setting discussed by Hanley (1993), this simple analysis of the lead underwriter's behavior in determining the initial IPO offer price (filing) range does not seek to explain this phenomenon. The partial adjustment phenomenon relates to the situation where negative feedback from potential IPO investors during the book-building process is fully incorporated into the IPO offer price, while positive feedback is only partially incorporated. For a theoretical model that predicts IPO price-setting consistent with the partial adjustment phenomenon, see Sherman and Titman (2002), who show, in a setting where evaluating the IPO firm is costly to institutions, that it is more efficient for underwriters' information extraction from institutions to concentrate underpricing in hot IPOs rather than spreading it out evenly over hot and cold IPOs.

positive relationship between lead underwriter centrality and the absolute value of the IPO offer price revision under the information extraction hypothesis (**H1A**). The above implication assumes that much of the information that a lead underwriter makes use of in setting the initial IPO offer price range is obtained from the process of writing the initial IPO prospectus, and the process of gathering more information from investors begins only after that. A lead IPO underwriter with a wider network is able to gather more information from investors, since each member of its network may have long-term relationships with at least a few additional investors, resulting in a larger absolute value of the IPO price revision.[14]

As we argued above, more central underwriters may also be in a better position to disseminate information about the IPO firm to institutions and to get them to pay attention to this information. This is because more institutions will pay attention to the information disseminated by a more central underwriter, since each member of its investment banking network may have a long-term relationship with a few additional institutions (and institutions will have a smaller cost of paying attention to or acquiring this information from such investment banks). Since the lead underwriter knows the expected value of the effect of its information dissemination on the final IPO offer price, the effect of this more efficient information dissemination will already be incorporated into the midpoint of the initial IPO filing range (recall that, as we discuss above, the underwriter sets the midpoint of the initial IPO offer price range equal to its expectation of the final IPO offer price). However, since more central lead underwriters will be able to disseminate information more efficiently (and accurately) to institutions, the realization of information dissemination during the book-building process will be closer to the midpoint of the initial IPO offer price range for offerings underwritten by such lead underwriters. This implies that we would expect a negative relationship between lead underwriter centrality and the absolute value of the IPO offer price revision under the information dissemination hypothesis (**H1B**).[15]

[14] The process of valuing IPO firm shares in the U.S. starts with establishing an initial IPO offer price (filing) range around the time of filing the preliminary prospectus with the SEC, continues with the book-building process, and culminates in establishing the IPO offer price (typically the night before the first trading day). However, Lowry and Schwert (2004) document that, in about 40% of cases, the initial IPO prospectus filed with the SEC does not include an IPO offer price range and that such a price range is released later in an amended filing.

[15] We thank an anonymous referee for suggesting this implication of the information dissemination hypothesis.

We now turn to the relationship between lead underwriter centrality and immediate post-IPO secondary market valuation (measured, for example, by the Q ratio at the first trading day closing price of the IPO firm's shares). More central lead underwriters will be able to induce more institutions to pay attention to the information they are disseminating about the IPO firms they take public, since each member of the underwriters' investment banking networks may have a long-term relationship with a few additional institutional investors (and, as we argued above, institutions will have a smaller cost of paying attention to or acquiring this information from such investment banks). This, in turn, implies that the secondary market demand for the shares of IPO firms underwritten by more central lead underwriters will be greater, leading to a higher market-clearing price for these shares. Assuming that the immediate after-market IPO firm share price is the market-clearing price, this implies that more central lead underwriters will be associated with higher immediate post-IPO secondary market valuations (**H2**).[16]

Next we discuss the relationship between lead underwriter centrality and IPO offer price. This relationship depends on the process of setting the offer price in IPOs. While there is no consensus in the theoretical and empirical literature on precisely how the IPO offer price is set, this price-setting process can be broadly thought of as the following. During the book-building and road-show the lead underwriter may attempt to convey information about the IPO firm to institutions (this, in turn, may affect their valuation of the firm). The lead underwriter may then extract information from institutions about their valuation of the IPO firm. Toward the end of the book-building and road-show process, once the lead underwriter establishes the highest uniform price at which it can sell all shares offered in the IPO (i.e., the market-clearing price, which is also the underwriter's expectation of the first day secondary market closing price), the underwriter may apply a "discount" to this price, thus establishing the actual IPO offer price (typically on the evening before the IPO). The theoretical literature has made various arguments regarding the main driving force behind this discount. A prominent reason for this discount advanced by

[16] A higher after-market price may also arise from considerations of information extraction, since more complete knowledge and more accurate valuation of the IPO firm's shares means less risk for investors, and hence a smaller risk premium (assuming that investors are risk-averse on average). Special thanks to an anonymous referee for pointing out that a positive relationship between lead underwriter centrality and higher after-market IPO share price may arise also from considerations of information extraction.

Benveniste and Spindt (1989) is that it ensures that institutions have the incentive to reveal their true demand for the firm's equity (i.e., it ensures that their incentive compatibility or truth-telling conditions will hold).[17] Since extraction of truthful information from institutions is easier when an investment bank interacts repeatedly with the same institutions, the dynamic extension of Benveniste and Spindt (1989) implies that more central lead underwriters need to apply only a smaller discount to the expected after-market price to arrive at the IPO offer price. This, in turn, implies that the relationship between lead underwriter centrality and the IPO offer price will be unambiguously positive (**H3A**).

On the other hand, if the discount from the expected after-market price is used to compensate institutional investors for their opportunity cost of paying attention to a particular IPO, as argued by Liu, Sherman, and Zhang (2014b), in addition to ensuring truthful revelation of information by these investors, as in Benveniste and Spindt (1989), then a more central lead IPO underwriter may apply a higher discount to the expected first day secondary market closing price. If this is indeed the case, the predicted relationship between lead underwriter centrality and the IPO offer price becomes ambiguous (**H3B**). This is because the greater after-market price associated with a more central lead underwriter (that we postulated earlier) may be overcome by a larger discount, so that the relationship between lead underwriter centrality and the IPO offer price may even turn negative.

Finally, we turn to the relationship between lead underwriter centrality and IPO initial returns (underpricing). Given our discussion above regarding the potentially ambiguous relationship between lead underwriter centrality and the discount applied by the underwriter to the market-clearing (expected after-market) price to arrive at the IPO offer price, we are agnostic about the relationship between lead IPO centrality and IPO initial returns.[18] Following our discussion above, if the above discount is driven purely by the need to extract truthful information from institutions, as argued by Benveniste and Spindt (1989),

[17] Such a discount is required to satisfy the investors' incentive compatibility conditions in the Benveniste and Spindt (1989) setting only in some situations. In particular, Benveniste and Spindt (1989) show that no discount is required if the underwriter is able to allocate zero IPO firm shares to institutional investors who report negative information about the IPO firm.

[18] Clearly, the greater the discount applied by the lead underwriter to the first day expected secondary market closing price of an IPO (assumed here to be the same as the market-clearing price) to arrive at the IPO offer price, the greater the initial return will be.

then we would expect this relationship to be negative (**H4A**), since more central lead underwriters will apply a smaller discount to the expected after-market price to arrive at the IPO offer price. If, however, this relationship is driven also by considerations of compensating institutions for their opportunity cost of paying attention to the IPO firm, as argued by Liu, Sherman, and Zhang (2014b), then we would expect the relationship between lead underwriter centrality and IPO initial returns to be positive (**H4B**).[19]

3.2. Underwriter networks and the participation of financial market players in the IPO

We have argued so far that more central lead IPO underwriters may be able to induce a larger number of institutions to pay attention to the firms they take public. This implies that participation by institutional investors will be greater for IPOs underwritten by more central lead underwriters. Given that financial analysts are either engaged in conveying information about the IPO firm to institutions (sell-side analysts affiliated with investment banks in the IPO underwriting syndicate) or in acquiring information on behalf of institutions (buy-side analysts affiliated with various institutions) we would also expect greater analyst coverage for IPOs underwritten by more central lead underwriters (**H5**).

3.3. Underwriter networks, secondary market liquidity, and the long-run stock returns of IPO firms

As we have discussed earlier, a more central lead underwriter may be able to induce a larger number of institutions to incur the cost of paying attention to (or acquiring information about) the IPO firm it takes public. If, following Merton (1987), we add the additional assumption that the cost incurred in paying attention to a firm is a "sunk cost," then IPO firms that attract investor attention should continue

[19] We thank an anonymous referee for suggesting the hypotheses **H3B** and **H4B**. To better understand why more central lead underwriters may apply a larger discount to the expected secondary market price to arrive at the IPO offer price, note, as we argued earlier, that such IPOs will attract greater investor attention. In equilibrium, such underwriters need to compensate these institutional investors for their opportunity cost of paying attention to these IPOs, as argued by Liu, Sherman, and Zhang (2014b). In the above setting, if institutions' aggregate cost of paying attention to IPOs underwritten by more central lead underwriters is greater (taking into account the greater attention paid to these IPOs by institutions), then the "money left on the table" (the dollar amount of the IPO discount multiplied by the number of shares sold) has to be greater for IPOs underwritten by more central lead underwriters.

to receive attention from the same investors for a significant period of time after the IPO.[20] In such a setting, we would expect IPOs underwritten by more central lead underwriters to have greater secondary market liquidity (**H6**) and better long-run post-IPO stock returns (**H7**).[21]

3.4. Underwriter networks and investor attention

We have argued above that more central lead underwriters may be able to obtain more favorable IPO characteristics (higher IPO and immediate secondary market valuations, greater institutional investor participation and financial analyst coverage, greater secondary market stock liquidity, and better long-run post-IPO stock returns) by inducing a larger number of investors to pay attention to the firms whose IPOs they underwrite. If indeed an important mechanism through which more central lead underwriters are able to obtain more favorable IPO characteristics for the firms they take public is by inducing a larger number of institutions to pay attention to these firms, then we would expect proxies for investor attention to be increasing in measures of lead IPO underwriter centrality. We follow Liu, Sherman, and Zhang (2014a) and use the pre-IPO media coverage received by a firm going public as a proxy for investor attention paid to that firm (see Section 5.2 for a detailed discussion of why this is an appropriate proxy). Thus, we expect greater pre-IPO media coverage for firms taken public by more central lead underwriters (**H8**).

4. Data and sample selection

The list of U.S. IPOs in 1980-2009 comes from the SDC/Platinum Global New Issues database. Following the IPO literature, we exclude real estate investment trusts, closed-end funds, unit IPOs and unit investment trusts, rights issues, spin-offs, equity carve-outs, financial firms (with SIC codes between 6000 and 6999), foreign firms, leveraged buy-outs, tracking stocks, and duplicate observations. Thus our

[20] Liu, Sherman, and Zhang (2014a), who analyze the relationship between media coverage and long-run post-IPO valuations, make a similar assumption. Another paper that makes a similar assumption is Van Nieuwerburgh and Veldkamp (2009), who argue in their analysis of home bias that one reason underlying home bias may be that individuals are more willing to pay attention to stocks with which they are already familiar.

[21] This long-run stock return effect will be weaker if the bulk of the information relevant for IPO firm valuation has been brought to investors' attention at the time of IPO (and is therefore reflected in first trading day closing price).

final sample consists of 6,217 IPOs.[22] Information on IPO underwriters and underwriting syndicates, as well as on various IPO characteristics, was taken from the SDC/Platinum Global New Issues database. Information on institutional shareholdings was obtained from Thomson Reuters' institutional (13F) holdings database. Accounting data came from Compustat and stock price data came from CRSP. Firm age data came from Jay Ritter's website and was supplemented from various other sources.

5. Measures characterizing underwriter networks and investor attention

5.1. Measures characterizing underwriter networks

In order to determine how central a lead IPO underwriter is within its network of investment banks, we make use of various SNA measures. It has been argued in the SNA literature that the central location of an agent in a network and the nature and extent of its connections to other agents in that network affect the flow of information to and from that agent. The seminal theoretical study of Lazarsfeld, Berelson, and Gaudet (1944) argues that social networks play an important role in information transmission among individuals. Katz and Lazarsfeld (1955) develop this theory further, and show empirically the importance of opinion leaders (who convey their information to other individuals who are less directly informed) in affecting the voting and household purchase decisions of various individuals. Another influential study (set in the labor market) is Granovetter (1995), who shows the importance of the social ties among individuals in determining how applicants learn about various job opportunities.

In a similar manner, we hypothesize that the nature and extent of IPO underwriter's connections to other investment banks in its network affect its ability to disseminate or to extract information about the IPO firm. We consider two investment banks as having a "connection" or "tie" if they have been part of the same IPO syndicate in the past. We characterize the location of an underwriter in the network of investment banks generated by its connections using various SNA measures described below: we will

[22] It is common in the empirical IPO literature to exclude issues with an offer price of less than $5. We, however, have not excluded such issues from our sample. For robustness, we have conducted our empirical analysis excluding such issues and the results were very similar to those reported in this paper. Given that the exclusion of the IPOs with an offer price of less than $5 does not affect our results, we have opted to retain such offerings in our sample.

refer to these measures as “centrality” measures from now on. Given the nature of the IPO underwriting business, the change in the composition and size of IPO syndicates, and the increasing concentration of the underwriting industry, we compute centrality measures using 5-year trailing periods, similar to Hochberg, Ljungqvist, and Lu (2007) in the context of VC syndicates. Thus, in order to analyze the effect of lead underwriter centrality on an IPO conducted in a given year, we consider the IPO underwriting syndicates in which that lead underwriter has participated during the previous five years.

There are several centrality concepts in the SNA literature which capture different aspects of social and economic networks. We make use of six of these centrality measures. Four of them (*Degree*, *Indegree*, *Outdegree*, and *Eigenvector*) essentially measure the number of ties of an underwriter with other investment banks. The idea here is that the higher the number of connections an underwriter has, the more centrally located it is within its network. The fifth measure (2-*StepReach*) counts the number of connections that are two steps away from a lead underwriter. This metric is similar to the first four measures of centrality (counting the number of connections) but under the assumption that indirect ties also matter. Finally, the last measure, *Betweenness*, assesses the extent to which an investment bank is able to act as a bridge between two groups of other investment banks which are not otherwise linked.

In order to compute the above centrality measures, we first need to construct an adjacency matrix X, which is an N by N matrix (where N is the number of investment banks in the network) with each cell taking a value of one if two underwriters have co-underwritten the same IPO over the five-year period considered ($x_{i,j} = 1$ if bank i has co-underwritten an IPO with bank j). In the case of “undirected networks” we ignore the information regarding which bank was the lead underwriter in a syndicate, and as a result, the adjacency matrix is necessarily symmetric. Thus, if banks i and j have participated in underwriting the same IPO and we do not consider which one is the lead underwriter, it follows that $x_{i,j} = x_{j,i} = 1$. However, with “directed networks” it also matters whether bank i has invited bank j into an IPO syndicate or vice versa. In this case, each cell in the adjacency matrix takes a value of one only if bank i has invited bank j to take part in an underwriting syndicate (thus, $x_{i,j} = 1$ and $x_{j,i} = 0$). By taking into consideration the direction of the connection, we can embed into some centrality measures the type of relationship that has been established between the two banks. As we discuss below, *Degree*, *Eigenvector*, 2-*StepReach*, and *Betweenness* use only undirected networks, while *Indegree* and *Outdegree* make use of directed networks.

5.1.1. Degree

Degree is the most intuitive and straightforward centrality measure. It counts the total number of connections that an agent has in the network. Given the adjacency matrix *X*, *Degree* (d_i) for agent *i* is

$$d_i = \sum_j x_{ij} \ , \qquad (1)$$

which is the sum of the row (or column) of the adjacency matrix. The networks that we study are comprised of investment banks acting as IPO underwriters (agents) which are tied to each other by participating in IPO syndicates at least once over the last five-year period. Thus, *Degree* measures the total number of IPO syndicate partners of a given investment bank. Despite its frequent use and the fact that it is considered the most important measure of network centrality, in a strict sense *Degree* does not provide complete information concerning the (central) position of an agent in a network, as it can be computed without having full information about the entire structure of the network.[23] However, it does provide useful information for our purpose, as it proxies for the capacity of an investment bank to either disseminate or extract information, since, the higher the number of ties, the greater the information flow.[24]

A clear shortcoming of *Degree* is that it is a function of the size of the network. Given the "centrality" of a particular agent, bigger networks produce a larger *Degree* as there are more connections in place. This may not be a problem in cross-sectional analysis; however it might introduce a time-bias. In fact, over the sample period IPO underwriter networks have changed both in size (became larger) and in composition (became more concentrated). To control for this potential bias, we normalize *Degree* by the maximum possible number of connections *N* – 1. Thus, the normalized *Degree* ($\hat{d}_i$) for underwriter *i* is:

[23] In fact, *Degree* uses only a vector of the adjacency matrix. If an agent is connected to *n* other agents with no ties, its *Degree* (equal to *n*) will be the same as in the case where the other agents are well connected themselves. Thus, in the second case the agent plays a more central role in the network than in the first case, despite the same *Degree*.
[24] It can be shown that, if a stochastic variable (i.e. information) follows a random walk through the network, the probability of reaching a specific node is proportional to its *Degree*.

$$\hat{d}_i = \frac{1}{N-1}\sum_j x_{ij} = \frac{d_i}{N-1} . \tag{2}$$

From now on, we refer to *Degree* in the sense of normalized *Degree*.

5.1.2. Indegree and outdegree

As mentioned above, undirected networks do not differentiate between who invites whom into an IPO syndicate. As a result, the adjacency matrix is symmetric and it is impossible to establish which investment bank is a leader in a syndicate and which one is a follower. Accordingly, *Degree* does not capture whether an investment bank has a leading position in the syndicate or not.

A possible solution to this problem is to use directed networks, where the direction of the relationship is also taken into consideration. This produces measures such as *Indegree* and *Outdegree*, which only consider the number of passive or active connections (respectively), and allows us to distinguish between the two cases. *Indegree* counts the number of ingoing connections where the underwriter is invited to act as a co-manager in an IPO syndicate. *Outdegree*, on the other hand, counts the number of outgoing connections where the underwriter, acting as a lead manager, selects and invites other members of the syndicate. An underwriter with a high level of *Outdegree* originates relationships and decides which other partners are more suitable to be a part of the syndicate. In that sense, a more central (high *Outdegree*) underwriter can select other banks based on the type of information needed to be disseminated or extracted. Conversely, an underwriter with a high level of *Indegree* is desirable as a co-manager and has access to valuable information (due to the number of underwriting co-partners) but may not necessarily have the capacity to propagate information (given its subordinate role).

Indegree and *Outdegree* are computed as in equation (2) after making certain changes in the adjacency matrix. Specifically, since we aim to isolate only a certain direction of the relationship, each cell of the matrix takes a value of one only if the ingoing (outgoing) tie has been detected. For instance, if the investment bank *i* is the lead underwriter who is inviting the investment bank *j* to take part in an IPO syndicate, we set $x_{ij} = 1$ and $x_{ji} = 0$ in measuring *Outdegree*, and we do the opposite (set $x_{ij} = 0$ and $x_{ji} = 1$)

in measuring *Indegree*. Unlike undirected networks (where the adjacency matrix is, by construction, symmetric), in directed networks the rows and the columns of the matrix are different. If rows (columns) capture the outgoing (ingoing) relationships, the sum of the row produces *Outdegree* whereas the sum of the column produces *Indegree*. As in the case of *Degree*, we normalize *Indegree* and *Outdegree* by dividing by the number of maximum connections $N - 1$.

5.1.3. Eigenvector

One of the limitations of the measures described above is that the simple count of connections does not necessarily capture the prominence of an agent within the network. Specifically, if an agent has high *Degree* centrality but most of his connections are to other agents who themselves are not well connected, then the power exercised by this agent over the network is somewhat limited. On the other hand, if the agent is tied to other agents who themselves are well connected (more central), this agent will have a greater influence in the network. This concept is captured by *Eigenvector* centrality, which is a variation of *Degree* centrality where connections are weighted by their relative importance in the network. In other words, *Eigenvector* does not simply count the number of ties that the agent has, but it weighs each connection by its centrality. Therefore, being connected to more central players generates a higher *Eigenvector* score than being connected to more peripheral players.[25] A higher *Eigenvector* measure indicates that an underwriter may be able to disseminate and extract information more efficiently as the information flows through other investment banks who themselves are more central and informed.

Formally, *Eigenvector* (e_i) for underwriter i is calculated as:

$$e_i = \lambda \sum_{j=1}^{N} x_{ij} e_j \, , \tag{3}$$

where λ is a constant represented by the biggest eigenvalue of the adjacency matrix and e is the eigenvector centrality score. Equation (3) is essentially a modified version of equation (1); it is not simply

[25] This measure is similar to the algorithm used by Google to rank the importance of web sites (PageRank). The algorithm takes into consideration both the quantity and the quality of links to other web pages, where the quality is determined by the importance of the websites from which the website receives links.

an algebraic sum but a weighted sum of all the connections in place. We normalize *Eigenvector* by dividing it by the maximum possible eigenvector element value for an *N* agent network.

5.1.4. 2-*StepReach*

2-*StepReach* centrality is a particular form of *k*-*StepReach* centrality which is the number of distinct agents within *k* ties of a given agent. Thus, this centrality measure counts the number of agents that can be reached directly (1-step) or indirectly via other agents that are 1-step away. In other words, 2-*StepReach* considers not only direct but also indirect connections.

With an additional layer of connections, 2-*StepReach* is a simple and more complete measure of an underwriter's ability to receive or send information within its network. For instance, if an underwriter has only one connection, but the agent it is connected to is a prominent and informed player, *Degree* will tell us about its (relatively high) central position in the network. *Eigenvector* will be a better measure than *Degree*, since it tells us that the underwriter's only connection in place has a higher weight. However, neither *Degree* nor *Eigenvector* measure indirect connections, which is accomplished by 2-*StepReach*.

Assuming that information flows not only through direct connections (partnerships in the same deal) but also indirectly through interposed relationships, 2-*StepReach* provides us with a better measure of underwriter centrality. This may be particularly true in the IPO underwriting business. For instance, if an investment bank is connected to only one prominent investment bank, which, in turn, has many connections to other investment banks, it is quite likely that the former will be able to benefit from these indirect connections in terms of disseminating or extracting information throughout the network.

5.1.5. Betweenness

The five centrality measures described above are somewhat similar since they make use of the number of connections that an agent has with other agents in the network. In contrast, *Betweenness* is constructed using a different idea of centrality, namely, the ability of an agent to serve as a link between two (or more) disconnected (or not directly connected) groups of other agents. *Betweenness* of an agent in a network is measured by making use of the concept of geodesic paths, which are the shortest chains or ties through which two agents are connected in a given network, and estimating the number of (shortest) paths passing through that agent. In other words, given the total number of possible paths between two other agents, the higher the number of cases where the shortest path passes through a given agent, the higher will be that agent's *Betweenness*. Formally, *Betweenness* (b_i) for agent i is

$$b_i = \sum_{j<k} \frac{p_{ijk}}{p_{jk}}, \quad (4)$$

where p_{ijk} is the number of geodesic paths between agents j and k passing through agent i and p_{jk} is the total number of geodesic paths between agents j and k. In other words, *Betweenness* measures how frequently a given agent represents the shortest path between two other agents. If an agent is isolated in the network or every other agent it is connected to is well-connected itself, its *Betweenness* will be zero. If an agent stands on every shortest path between any pair of other agents, that agent's *Betweenness* will be at the maximum. Intuitively, the highest *Betweenness* is achieved where two sub-networks are linked only through a single agent who acts as a bridge between them. In this case, every agent of one sub-group is connected to every other agent in the other sub-group through only one possible link.

In the SNA literature *Betweenness* is often interpreted as a measure of the ability to control flows within the network. An agent with high *Betweenness* will be able to act as a gatekeeper and consequently manage and mediate the relationships among other agents. In our setting, a more central (high *Betweenness*) underwriter will be in a position to act as a broker with respect to other underwriters. This privileged position is likely to allow the underwriter to more easily disseminate or extract information as well as to control the type of information conveyed. In fact, information in disconnected networks will be available to the agents of the same sub-network and to the gatekeeper, but not to all other agents. As a result, on the one hand, the more central (high *Betweenness*) underwriter will be the only one having access to information coming from each disconnected sub-network; on the other hand, if any information between sub-networks has to go through the more central (high *Betweenness*) underwriter, it will be able to filter and mediate the content. For instance, the more central (high *Betweenness*) underwriter may omit undesired elements or change the tone of the information to produce the desired sentiment.

5.1.6. Illustration of centrality measures using an investment banking network

In order to illustrate the centrality measures we defined above, we make use of Figure 2, which shows the network of IPO underwriters using our sample data from 1980. We chose the year 1980 to construct this graph as we had the least amount of connections in that year and thus the graphical presentation of the network was manageable compared to other years. The arrows represent connections established between investment banks that co-managed IPOs in the previous five-year period. The arrows originate from lead underwriters and point in the direction of non-lead members of IPO syndicates. Two-directional arrows (we have only one between Hambrecht & Quist and Alex Brown & Sons) indicate that each underwriter acted both as a lead and a non-lead member of IPO syndicates in the previous five years.

As this graph shows, Hambrecht & Quist had the highest *Degree* centrality in 1980 given that it had the highest number of established connections (eight in total) compared to other investment banks in the network. It also had the highest *Indegree* centrality given that it was invited the most (seven times) as a non-lead member of IPO syndicates. Hambrecht & Quist also had the highest *Eigenvector* centrality since it was connected to other investment banks which, in their turn, also had relatively central positions within the network (such as Alex Brown & Sons and CE Unterberg Towbin). Further, it had the highest 2-*StepReach* centrality in the network as, in addition to its own eight connections, it could potentially reach another 12 unique underwriters using the connections of the investment banks it was connected to. Hambrecht & Quist also had the highest *Betweenness* centrality given that it had the highest number of shortest paths from all investment banks in the network to all others passing through it. However, Hambrecht & Quist did not have the highest *Outdegree* centrality, since it acted as a lead underwriter in IPO syndicates only once (with Alex Brown & Sons as co-manager). CE Unterberg Towbin and Blyth Eastman Dillon had the highest *Outdegree* centrality. Each of these two investment banks acted as a lead underwriter in IPO syndicates four times, which is more than any other investment bank in the network.

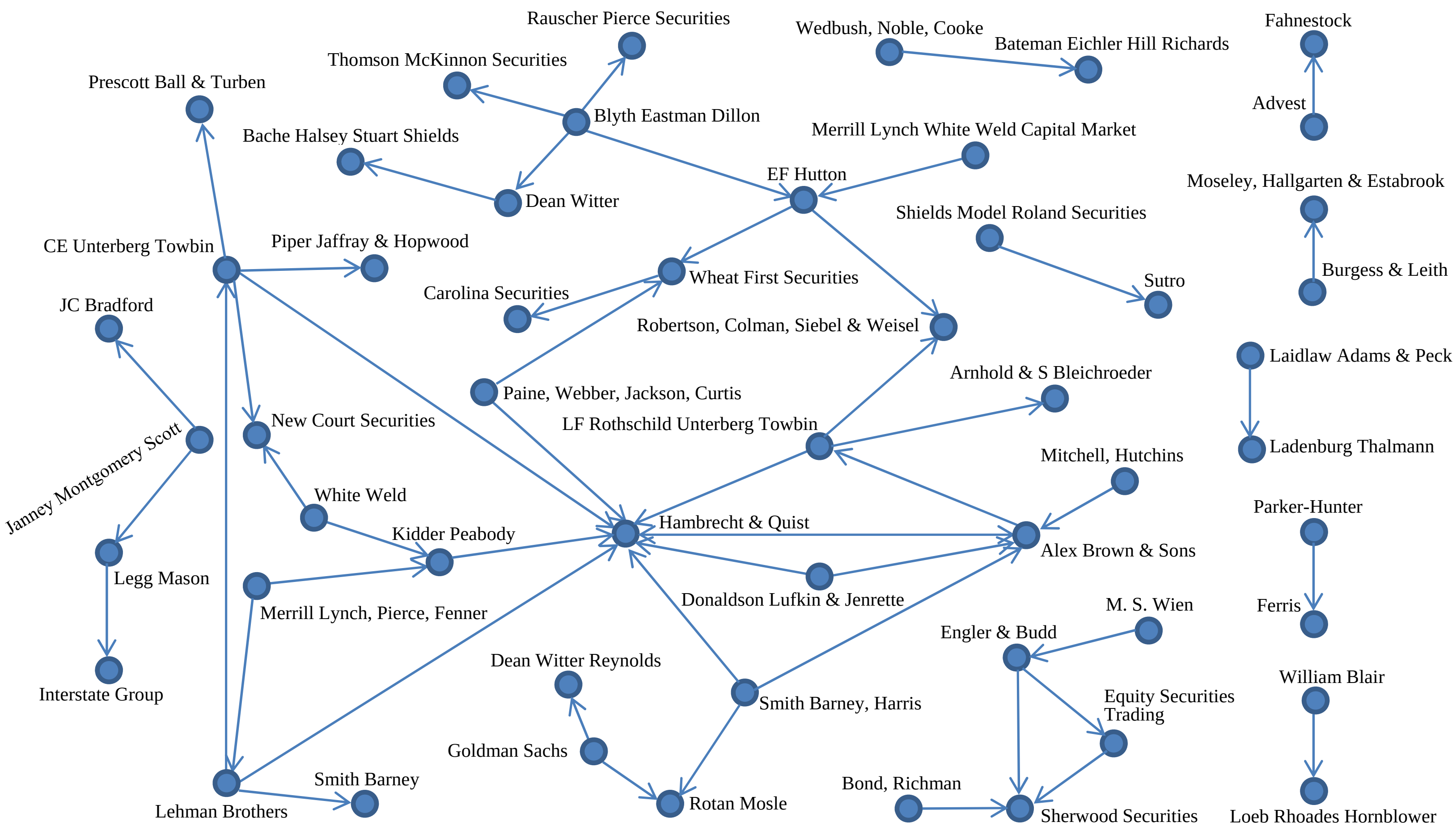

Figure 2. Network of IPO underwriters in 1980

Arrows between pairs of underwriters indicate that the pair was a part of an IPO syndicate in the previous five-year period (1975-1979). Arrows originate from lead underwriters and point in the direction of non-lead members of IPO syndicates. Two-directional arrows indicate that each underwriter acted both as a lead and a non-lead member of IPO syndicates in the previous five years. Investment banks which underwrote IPOs as sole underwriters and were not a part of any syndicate in the previous five-year period are omitted. We use the network of IPO underwriters in 1980 since it is more manageable for illustrative purposes. The networks of IPO underwriters in later years are much larger and more complex.

5.2. Proxies for investor attention

In order to assess the degree of attention that investors pay to IPO firms, we follow Liu, Sherman, and Zhang (2014a) and make use of two measures of pre-IPO media coverage of firms going public as proxies for investor attention. Liu, Sherman, and Zhang (2014a) argue that media sources compete to attract readers and advertising revenues and consequently editors expect their reporters to cover the firms which have already received investor attention or are expected to receive such attention in the future. Even though media coverage does not contain any new "hard" information about the IPO firm (such "hard" information must be disclosed in the IPO prospectus), the fact that the firm receives coverage indicates that reporters and/or their sources expect the firm to attract investor attention. According to Liu, Sherman, and Zhang (2014a), when choosing a firm to cover, reporters use not only their own judgment but also talk to Wall Street professionals, so that media coverage of IPO firms will be more than mere noise. While media coverage may include some firms due to short-term demand from retail investors (who are driven by sentiment), it will also include firms that sophisticated investors care about or that reporters expect to do well in the future. Given the above, the pre-IPO media coverage of firms going public is a good proxy for the degree of attention investors pay to such firms.

We construct two measures of pre-IPO media coverage of firms going public by searching all U.S. English language media sources in Factiva for news articles covering such firms. Our first measure is *Headline*, which is the number of times English language publications in the U.S. have mentioned the IPO firm's name in article headlines in the two months prior to the IPO. Our second measure is *Article*, which is the number of times English language publications in the U.S. have mentioned the IPO firm's name in an entire article in the two months prior to the IPO.

6. Empirical tests and results

In this section we present our methodology and empirical findings. Table 1 reports the summary statistics of both dependent (various IPO characteristics) and independent (lead IPO underwriter centrality measures and other controls) variables used in our regression analyses in subsequent sections. Table 1 shows that, on average, lead IPO underwriters in our sample were connected to 10.6% of investment banks in investment banking networks constructed for a given year (as described in the previous section) serving either as lead IPO underwriters or IPO underwriting syndicate members (*Degree*). They were connected to 3.2% of investment banks in investment banking networks serving as IPO underwriting syndicate members (*Indegree*) and connected to 9.4% of investment banks in investment banking networks serving as lead IPO underwriters (*Outdegree*). Table 1 also shows that, on average, lead IPO underwriters in our sample had *Eigenvector* centrality equal to 10.2%. Further, lead IPO underwriters could reach 43.8% of investment banks in investment banking networks using their indirect (two steps away) connections (2-*StepReach*). Finally, 2.6% of the shortest paths between two investment banks in investment banking networks passed through the lead IPO underwriters in our sample (*Betweenness*).

6.1. Underwriter centrality and the absolute value of IPO offer price revision

We study the relationship between lead underwriter centrality and the absolute value of IPO offer price revision by running regressions with the absolute value of the percentage difference between the IPO offer price and the midpoint of the initial filing range as a dependent variable (*AbsRevision*).

The independent variables in our regressions are the six lead IPO underwriter centrality measures and other controls. We control for underwriter reputation defined as the lead underwriter's share of total proceeds raised in the IPO market in the previous five years (*MktShare*).[26] Underwriter reputation has been shown in the literature to be an important determinant of various IPO characteristics. *MktShare* has a relatively high correlation with underwriter centrality measures creating multicollinearity problems in our regressions, and therefore we use the residuals from a regression of *MktShare* on six lead IPO underwriter centrality measures (*xMktShare*) as a control variable in our regressions. We also control for IPO offer size by including the natural logarithm of IPO total proceeds (*LnOffer*). Similar to *MktShare*, this variable

[26] For robustness, we also used another measure of underwriter reputation as a control variable in our regressions, namely, underwriter reputation as developed by Loughran and Ritter (2004) based on earlier work by Carter and Manaster (1990). This measure takes values from zero (least reputable underwriters) to nine (most reputable underwriters). Our results using this alternative measure of underwriter reputation are similar to those reported here.

has a relatively high correlation with underwriter centrality measures and therefore we use the residuals from a regression of *LnOffer* on six lead IPO underwriter network centrality measures (*xLnOffer*) as a control variable in our regressions.

Further, offer price revisions are more likely if there is more uncertainty about the IPO firm's value (see, e.g., Benveniste and Spindt, 1989). In order to control for such uncertainty we use several controls. First, we control for firm size and firm age by including the natural logarithm of the book value of assets at the end of the fiscal year prior to the IPO (*LnAssets*) and the natural logarithm of one plus the number of years from the IPO firm's founding year to the IPO year (*LnAge*). Larger and older firms are expected to have less uncertainty about their value. Second, we use two dummies for hi-tech (*HiTechDummy*) and VC-backed (*VCDummy*) firms, respectively. High technology and VC-backed firms tend to be younger, higher growth companies and therefore are expected to have a greater degree of uncertainty about their value. Third, the greater the uncertainty about the value of IPO shares to be issued, the greater the filing range set by underwriters. We control for such uncertainty by including a dummy for firms with filing width (i.e., the difference between the high filing price and the low filing price in the initial filing range divided by the high filing price) of 20% or more (*FilingWidth*20*Dummy*).[27]

Our next four control variables are *Retention*, *Expansion*, 1/*Midpoint*, and *AbsMktReturn*.[28] *Retention* is the ratio of the number of shares retained by IPO firm existing shareholders over the sum of the number of such retained shares and the number of secondary shares offered in the IPO by existing shareholders. *Expansion* is the ratio of the number of newly issued shares offered in the IPO over the sum of the number of such newly issued shares and the number of existing shares retained by IPO firm existing shareholders. Liu, Sherman, and Zhang (2014b) show that *Retention* and *Expansion* are important determinants of IPO offer price revision. 1/*Midpoint* is the reciprocal of initial filing range

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[27] The summary statistics in Table 1 indicate that 13% (or 737) of the IPOs in our sample have filing widths (as defined above) of exactly 20% or more. Of these 737 IPOs, 339 have filing widths of exactly 20% and 398 have filing widths of more than 20%. Further, of these 737 IPOs, 22 have filing ranges (the difference between high filing price and low filing price) of exactly $4, another 4 above $4, and the remaining 710 less than $4.

[28] We thank an anonymous referee for suggesting *FilingWidth*20*Dummy*, *Retention*, *Expansion*, and 1/*Midpoint* as control variables in our regressions.

midpoint; we use it to capture the effect of the choice of price level. *AbsMktReturn* is the absolute return on the CRSP value-weighted index between the filing date and the IPO issue date. The greater the movement in the stock market between the filing date and the IPO issue date, the greater the likelihood of offer price revision; therefore we include *AbsMktReturn* to control for such market movement. Finally, we also include year and 2-digit SIC industry dummies to control for differences in IPO characteristics across firms in different industries and time periods.

Our empirical results are presented in Table 2. All six lead IPO underwriter centrality measures have positive and statistically significant coefficient estimates suggesting that more central lead IPO underwriters are associated with larger absolute values of IPO offer price revisions. This finding provides support for our hypothesis **H1A** (but not for **H1B**). It indicates that more central lead IPO underwriters are able to extract information more efficiently from institutions and further, while both information dissemination and information extraction may occur during the IPO book-building process, the effects of information extraction dominate. Our regressions in Table 2 also show that the absolute value of IPO offer price revision increases with lead underwriter reputation, IPO offer size, the *Retention* variable, absolute stock market return between the filing and IPO issue dates, and filing width, and decreases with firm age and the *Expansion* variable. Further, we also find that the absolute value of IPO offer price revision is larger for VC-backed and hi-tech firms.

6.2. Underwriter centrality and secondary market valuation

In this section, we study the effect of lead underwriter centrality on secondary market valuation of IPO firms by regressing secondary market valuation measures on lead IPO underwriter centrality measures and other controls. We measure secondary market valuation using Tobin's Q, which is the ratio of the market value of assets over the book value of assets, where the market value of assets is equal to the book value of assets minus the book value of equity plus the product of the number of shares outstanding and share price. We measure secondary market valuation by using either the first trading day closing price as the share price in the above definition (*QFTD*) or the share price at the end of the first post-IPO fiscal quarter (*QFQ*). We also construct industry-adjusted Q ratios (*QFTDAdj* and *QFQAdj*) by subtracting contemporaneous 2-digit SIC code industry median Q ratios from the above proxies. The book value of assets and the book value of equity both for IPO firms and for industry peers are taken from the first available post-IPO quarter on Compustat. The number of shares outstanding and the share price for industry peers are measured as of the end of the first available post-IPO quarter on Compustat. The number of shares outstanding for IPO firms is measured as of the first trading day.

In our regressions, we control for underwriter reputation and IPO offer size. We expect firms underwritten by higher reputation underwriters to receive higher valuations. Further, we control for firm size and firm age since relatively younger and smaller firms are expected to have valuable growth opportunities and thus higher valuations. Next, we control for *Retention* and *Expansion*, since Liu, Sherman, and Zhang (2014b) show these variables to be important determinants of various IPO characteristics. We also include *VCDummy* and *HiTechDummy* in our regressions since VC-backed and hi-tech firms are expected to have larger growth options and higher valuations. Finally, we use 1/*Midpoint* to capture the effect of the choice of price level and also control for pre-IPO operating performance since better performing firms are expected to have higher valuations. We measure operating performance as the ratio of operating income before depreciation (OIBD) over the book value of assets at the end of the fiscal year prior to the IPO adjusted for the contemporaneous median OIBD/Assets of 2-digit SIC code industry peers (*OIBD*/*AssetsAdj*).

The results of our regressions using *QFTDAdj* and *QFQAdj* as dependent variables are presented in Panels A and B of Table 3, respectively. All six lead IPO underwriter centrality measures have significantly positive coefficient estimates in both panels, indicating that lead IPO underwriter centrality has a positive effect on immediate secondary market valuations. This provides support for our hypothesis **H2** which predicts that more central lead underwriters will be associated with higher immediate post-IPO secondary market valuations. These findings are also broadly consistent with those of Liu, Sherman, and Zhang (2014a), who find that firms that received more pre-IPO media coverage (a proxy for investor attention) later had higher valuations as measured by price-to-EBIT ratios, with the difference being significant even three years after the IPO. Our regressions in Table 3 also show that, as expected, smaller and younger firms, VC-backed firms, as well as those underwritten by higher reputation underwriters and those with larger offer sizes and with better pre-IPO operating performance receive higher secondary market valuations. We also find that firms offering more newly issued shares relative to the total shares outstanding immediately after the IPO are associated with lower secondary market valuations.

6.3. Underwriter centrality and IPO market valuation

In this section we study the effect of lead IPO underwriter centrality on IPO market valuation by regressing an IPO market valuation proxy on underwriter centrality variables and other controls. We measure IPO market valuation using Tobin's Q (described in Section 6.2) where the market value of assets is calculated using the IPO offer price (*QOP*). We further construct industry-adjusted Q ratio (*QOPAdj*) by subtracting contemporaneous 2-digit SIC code industry median Q ratio from the above proxy. The book value of assets and the book value of equity for IPO firms as well as for industry peers are measured as of the first available post-IPO quarter on Compustat. The number of shares outstanding and the share price for industry peers are measured as of the end of the first available post-IPO quarter on Compustat. The number of shares outstanding for IPO firms is measured as of the first trading day.

The results of our regressions with *QOPAdj* as the dependent variable are presented in Table 4. Our control variables are the same as when we studied secondary market valuation in the previous section. Similar to our findings in Table 3, all six lead IPO underwriter centrality measurers have significantly positive coefficient estimates indicating that firms taken public by more central lead underwriters are able to obtain higher IPO market valuations as well. Further, the coefficient estimates of underwriter centrality measures are much smaller in Table 4 than in Table 3 indicating that lead IPO underwriter centrality has a stronger effect on immediate secondary market valuations than on IPO market valuations. Finally, we also find that underwriter reputation, IPO offer size, firm size, and the *Expansion* variable have similar effects on IPO market valuations as on secondary market valuations.

Our finding that IPOs with more central lead underwriters are associated with higher IPO market valuations is consistent with both **H3A** (i.e., more central lead IPO underwriters are able to extract information from institutional investors more efficiently using their investment banking networks) and **H3B** (i.e., more central lead IPO underwriters may also need to compensate institutional investors for the greater attention paid by these investors to the IPOs underwritten by them, by pricing these IPOs at a larger discount to the expected secondary market price). However, the fact that we find a positive relationship between lead underwriter centrality and IPO valuations indicates that the amount of compensation paid by such underwriters to institutions through a larger discount is not so large as to overturn the effects of the positive relationship we documented earlier between lead underwriter centrality and secondary market valuations.

6.4. Underwriter centrality and IPO initial return

We study the effect of lead IPO underwriter centrality on IPO initial return by regressing *Underpricing*, which is the percentage difference between first trading day closing price and IPO offer price, on our lead IPO underwriter centrality measures and other controls. We control for underwriter reputation and IPO offer size since these variables were shown to have a significant influence on underpricing in the prior literature.[29] Carter and Manaster (1991) predict that more reputable underwriters will underwrite less risky issues and less reputable underwriters will underwrite more risky issues and empirically document a negative relationship between underwriter reputation and underpricing.[30] Sherman and Titman (2002) predict greater underpricing when the cost of investors' information acquisition is greater, for example due to increased uncertainty about the IPO firm. We control for such uncertainty by including firm size, firm age, and dummy variables for hi-tech and VC-backed firms as

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[29] Loughran and Ritter (2004) document a negative relationship between underpricing and IPO offer size in the 1980s and the beginning of the 2000s but a positive relationship in the 1990s.

[30] Although Carter and Manaster (1991) and Megginson and Weiss (1991) document a negative relationship between underwriter reputation and underpricing using data from the 1980s, later studies which make use of data from the 1990s and the 2000s document a positive relationship between underwriter reputation and underpricing (see, e.g., Aggarwal, Krigman, and Womack, 2002; or Hanley and Hoberg, 2012).

controls. Further, Sherman and Titman (2002) predict that underpricing will generally (except for extreme cases) be concentrated in issues with positive price revisions. Therefore, we use a dummy variable equal to one for IPO firms with positive IPO offer price revisions (*PosRevDummy*) as another control variable.

Next, we use *Retention* and *Expansion* as control variables. Liu, Sherman, and Zhang (2014b) predict (and empirically document) a positive (negative) relationship between *Retention* (*Expansion*) and initial returns.[31] We also include 1/*Midpoint* as a control variable to capture the effect of the choice of price level.[32] We further control for market movement in the pre-IPO period using the return on the CRSP value-weighted index over the 30-day period prior to the IPO (*PriorMktReturn*) to account for the flow of new information to the equity market prior to the IPO.[33] Lastly, we control for "hot" and "cold" IPO markets documented in previous studies by including the average underpricing of all IPOs in the previous month (*AveUnderpricing*). Finally, in addition to year and industry dummies, we also include trading exchange dummies in our regressions.

The results of our regressions are presented in Table 5. We find that all lead IPO underwriter centrality measures, except for *Indegree*, have significantly positive influences on IPO initial returns. We also find that IPO initial returns decrease with firm size and firm age. Further, we find larger IPO initial returns for firms with more reputable underwriters, lower midpoints of the initial filing range, positive price revisions, higher pre-IPO market returns, higher (lower) values of *Retention* (*Expansion*), and for VC-backed firms. Finally, higher average underpricing in the month prior to the IPO has a significantly positive effect on IPO initial returns suggesting a positive autocorrelation in initial returns and the existence of "hot" IPO markets.[34]

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[31] Aggarwal, Krigman, and Womack (2002) predict more underpricing for firms where managers retain more shares after the IPO.
[32] Beatty and Welch (1996) argue that, on the one hand, lower IPO offer prices increase brokerage commissions and analyst coverage and therefore may result in lower underpricing; and, on the other hand, lower IPO offer prices increase the transaction costs of investors and therefore may result in higher underpricing. Booth and Chua (1996) use the IPO offer price as a proxy for information costs incurred to achieve secondary market liquidity and argue that IPOs with lower offer prices tend to have higher information costs and therefore higher underpricing.
[33] Derrien and Womack (2003) show that pre-IPO market return is a significant determinant of IPO underpricing using French IPO data.
[34] Bradley and Jordan (2002) and Bradley, Cooney, Jordan, and Singh (2004) report similar results.

Our finding that the relationship between lead IPO underwriter centrality and IPO initial returns (underpricing) is positive provides support for our hypothesis **H4B** (but not **H4A**). This indicates that lead underwriters use IPO underpricing as a means of compensating institutions not only for truthful revelation of information about their demand for the IPO firm's equity, but also for their opportunity cost of paying attention to the IPOs underwritten by them.

6.5. Underwriter centrality and the participation of financial market players in IPOs

In this section we study how underwriter centrality affects the participation of financial market players, such as financial analysts and institutional investors, in IPOs in a multivariate regression setting. Our dependent variables are the number of analysts following the IPO firm at the end of the fiscal year of the issue as reported by IBES (*NumAn*), the number of institutional investors holding IPO firms' shares at the end of the first calendar quarter after the IPO (*InstN*), and the proportion of IPO firm shares held by institutional investors at the end of the first calendar quarter after the IPO (*InstP*).

Our independent variables are the six lead IPO underwriter centrality measures and other controls. We control for underwriter reputation since it is expected to positively influence participation by financial market players in the IPO. Next, we control for firm size, firm age, and offer size since larger and older firms as well as those making larger offers are likely to have greater participation by financial market players. We also include *Retention*, *Expansion*, 1/*Midpoint*, *VCDummy*, *HiTechDummy*, and *Underpricing* as control variables.[35] Bradley, Jordan, and Ritter (2003) show that analyst coverage initiation is more likely for IPO firms which are larger, VC-backed, and more underpriced.[36] Aggarwal, Krigman, and Womack (2002) also show that managers use underpricing as a strategic tool to generate information momentum, which, in turn, positively affects research coverage and the demand for the stock (see also the information production model of Chemmanur (1993)). Finally, we also control for IPO firm

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[35] Brennan and Hughes (1991) show that the number of analysts following a firm is inversely related to its share price. See also Beatty and Welch (1996).

[36] Bradley, Jordan, and Ritter (2003) also find that analysts are somewhat more likely to initiate coverage of firms in hi-tech industries.

secondary market valuation (*QFTDAdj*) and pre-IPO operating performance (*OIBD*/*AssetsAdj*), since firms which receive higher valuations and perform better are likely to have greater participation by financial market players.

The results of our analysis are presented in Tables 6 and 7. Table 6 reports our findings on the number of analysts following the IPO firm. Since our dependent variable is a count variable, we make use of the Poisson maximum-likelihood estimation technique instead of OLS.[37] The coefficient estimates of lead IPO underwriter centrality measures are all positive and highly significant indicating that IPOs underwritten by more central underwriters are likely to be followed by more financial analysts post-IPO.[38]

Table 6 also shows that larger firms, firms with higher valuations and lower values of *Expansion*, those making larger offers and underwritten by higher reputation underwriters are followed by a greater number of financial analysts. Also, as expected, VC-backed and hi-tech firms, firms which are underpriced more, and those with a higher midpoint of the initial filing range are followed by a greater number of financial analysts. Finally, younger firms are followed by a greater number of analysts as well. This last finding is perhaps due to the fact that VC-backed and hi-tech firms which receive more attention from financial analysts go public at a relatively younger age compared to other firms.

In Panels A and B of Table 7, we report our findings on the participation of institutional investors in the IPO. For regressions with *InstN* as the dependent variable (Panel A of Table 7) we make use of the negative binomial maximum-likelihood estimation technique since the number of institutional investors holding IPO firm shares is a count variable exhibiting a great degree of overdispersion (ranging between 1

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[37] Since the number of analysts in our sample exhibits a certain degree of overdispersion (ranging between 1 and 24 with the mean of 3.14 and the median of 3), we have also estimated our regressions using the negative binomial maximum-likelihood estimation technique since it is more appropriate for non-negative count data with overdispersion. The negative binomial model assumes the overdispersion parameter α to be greater than zero whereas the Poisson model assumes $\alpha = 0$. However, the likelihood ratio test in our negative binomial regressions could not reject the null hypothesis of $\alpha = 0$ (and thus our negative binomial estimation defaulted to Poisson estimation). Therefore, in Table 6 we make use of the Poisson maximum-likelihood estimation directly.

[38] The number of observations in our regressions is 3,945 since many firms in our sample are missing financial analyst data in IBES at the end of the fiscal year of the IPO. As a robustness test, we assumed that such firms are not covered by financial analysts and set *NumAn* equal to zero for such firms. Then we re-estimated our regressions with this alternative definition of *NumAn* (with 5,087 observations). The results were similar (and somewhat stronger) compared to those reported in Table 6; all six lead IPO underwriter centrality measures had positive and highly significant coefficient estimates.

and 259, with the mean of 22.05 and the median of 17). We find that all six lead IPO underwriter centrality measures have positive and highly significant coefficient estimates indicating that firms underwritten by more central lead underwriters are more likely to have a greater number of institutional investors holding their shares post-IPO. Panel B of Table 7 shows that firms underwritten by more central underwriters are also more likely to have a greater proportion of their shares held by institutional investors post-IPO.[39] These results provide support for our hypothesis **H5.** Our findings are broadly consistent with those of Liu, Sherman, and Zhang (2014a), who show that firms which received more media coverage pre-IPO (a proxy for investor attention) had greater coverage by financial analysts post-IPO as well as a greater number of institutional investors holding their shares in the years after the IPO.

We also find significantly positive coefficient estimates for offer size, firm size, VC-backed dummy, and underpricing variables, and significantly negative coefficient estimates for *Retention* both in our *InstN* and *InstP* regressions. Further, we find hi-tech firms and firms with lower values of *Expansion* and 1/*Midpoint* to be associated with a greater number of institutional investors holding their shares post-IPO. Finally, we find that institutional investors are likely to hold a larger proportion of shares in older firms, firms with higher values of *Expansion*, and those with lower IPO valuations.

6.6. Underwriter centrality and secondary market liquidity

In this section, we study the relationship between lead IPO underwriter centrality and secondary market liquidity. We regress *LnTurnover*, which is the natural logarithm of the average monthly shares traded as a percentage of total shares outstanding over the one-year period post-IPO, on our underwriter centrality measures and a set of control variables similar to those used in the previous section. Liu, Sherman, and Zhang (2014a) show that younger and VC-backed firms and those underwritten by more

[39] As a robustness test we set *InstN* and *InstP* equal to zero for those firms which do not have institutional investor data available in the Thomson Reuters institutional (13F) holdings database (essentially assuming that institutional investors do not hold shares in such firms). We then re-estimated our regressions with these alternative definitions of *InstN* and *InstP* (this increased the number of observations in our regressions from 4,700 to 5,087). The results of these regressions were similar to those reported in Table 7; all six lead IPO underwriter centrality measures had positive and highly significant coefficient estimates both in *InstN* and *InstP* regressions.

reputable underwriters have higher secondary market liquidity. Booth and Chua (1996) predict a positive relationship between IPO underpricing and secondary market liquidity.

The results of our regressions are presented in Table 8. We find that all six underwriter centrality measures have significantly positive coefficient estimates, indicating that the shares of firms taken public by more central lead IPO underwriters are significantly more liquid. This provides support for our hypothesis **H6**. Our findings here are broadly consistent with those of Liu, Sherman, and Zhang (2014a), who show that firms which received more media coverage pre-IPO (a proxy for investor attention) were associated with greater secondary market stock liquidity in the years after the IPO. We also find that smaller, younger, hi-tech, and VC-backed firms, as well as those with larger offer sizes, more underpricing, higher midpoints of their initial IPO filing range, better pre-IPO operating performance, and greater values of *Expansion* have more liquid shares; while those with higher secondary market valuations and greater values of *Retention* have less liquid shares.

6.7. Underwriter centrality and post-IPO stock return performance

In this section, we study the effect of lead IPO underwriter centrality on the post-issue stock return performance of IPO firms by regressing 1*YearHPRAdj* on our six lead IPO underwriter centrality measures and other controls. 1*YearHPRAdj* is the IPO firm's post-issue one-year holding period return calculated by compounding daily returns over 252 trading days after the IPO (excluding the first trading day's return) and subtracting the holding period return of the NASDAQ value-weighted index over the same period. If an IPO firm is delisted before the end of the one-year period, the returns of the IPO firm and NASDAQ value-weighted index are compounded until the delisting date.

We control for underwriter reputation given that Carter, Dark, and Singh (1998) find underwriter reputation to have a positive effect on long-run post-IPO returns. Our control variables also include offer size, firm age, and underpricing since Ritter (1991) documents a somewhat positive effect of offer size and firm age on the post-issue long-run performance of IPO firms and a somewhat negative effect of underpricing on the same performance. We also make use of firm size and VC dummy as control variables since Brav and Gompers (1997) find better post-IPO long-run stock return performance for larger firms and VC-backed firms. Finally, we include *HiTechDummy*, *Retention*, *Expansion*, 1/*Midpoint*, and immediate post-IPO secondary market valuation variable as controls, since these variables may potentially affect post-IPO stock return performance as well.

The results of our regressions are presented in Table 9. Four out of the six lead IPO underwriter centrality measures (except *Eigenvector* and 2-*StepReach*) have positive and statistically significant coefficient estimates. This indicates that lead IPO underwriter centrality has a positive influence on the one-year post-IPO market-adjusted stock return performance of firms going public. We estimated our regressions also using post-IPO three-month and six-month stock return performance and found lead IPO underwriter centrality to have a significantly positive effect on such short-run performance as well. We then estimated our regressions using two-year, three-year, and five-year stock return performance, but did not find lead IPO underwriter centrality to have a statistically significant effect on such long-run performance. Thus, our findings suggest that lead IPO underwriter centrality positively affects post-IPO stock return performance up to one year after going public; however this positive effect disappears after one year. This provides partial support for our hypothesis **H7**.

Our results in Table 9 also show that larger firms and hi-tech firms realize significantly better post-IPO market-adjusted stock returns compared to other IPO firms, whereas the post-IPO stock returns of firms with larger values of *Expansion* and larger offer sizes are significantly worse.

6.8. The repeal of the Glass-Steagall Act, changes in lead underwriter centrality, and IPO characteristics

As a robustness test, in this section we study the effect of a regulatory shift in the IPO market, namely, the repeal of the Glass-Steagall Act in 1999, on the relationship between lead underwriter centrality and various IPO characteristics. The repeal of the Glass-Steagall Act essentially opened the door for commercial banks to enter the securities underwriting market and, in particular, the IPO market.[40] The resulting increase in the number of underwriters in the IPO market could be expected to create greater opportunities for such underwriters to establish new connections and expand their respective investment banking networks. This, in turn, potentially affected the centrality of both existing investment banks in the IPO market as well as the new commercial banks entering the IPO underwriting market within the network of underwriting institutions.[41]

In order to study the effect of the above regulatory shift (that led to a potentially exogenous change in underwriter centrality) on the relationship between lead underwriter centrality and various IPO characteristics, we utilize a two-stage least squares (2SLS) methodology and make use of a categorical variable for the repeal of the Glass-Steagall Act in 1999 (denoted as *GS*). Given that our underwriter centrality measures are computed using the data from the previous five years, *GS* takes values of zero, one, and two for IPO firms which went public in 1980-1999, 2000-2004, and 2005-2009, respectively. Thus, a value of zero indicates IPO firms whose lead underwriters' centrality is calculated only using data from before the repeal of the Glass-Steagall Act, a value of one indicates IPO firms whose lead underwriters' centrality is calculated using data both from before and after the repeal of the Glass-Steagall Act, and a value of two indicates IPO firms whose lead underwriters' centrality is calculated only using data from the period after the repeal of the Glass-Steagall Act.

The results of our 2SLS estimation are presented in Panels A and B of Table 10. To conserve space, we present here our analysis using only one measure of lead IPO underwriter centrality, namely, *Degree* (our untabulated results using other measures of lead IPO underwriter centrality are similar to

[40] On November 12, 1999 the Gramm-Leach-Bliley Act was enacted repealing the part of the Glass-Steagall Act which prohibited any one institution from acting as a combination of an investment bank, a commercial bank, and an insurance company. Thus, it removed barriers in the securities underwriting market among commercial banks, investment banks, securities firms, and insurance companies, and allowed such institutions to consolidate.

[41] In principle, the entrance of new banks (previously restricted from IPO underwriting due to their commercial banking activities by the Glass-Steagall Act) into the IPO underwriting market may either increase or decrease the centrality of lead IPO underwriters. For example, *Degree* is defined as "the number of connections formed" over "the number of possible connections," and we would expect both the numerator and denominator of *Degree* to increase after the repeal of the Act. However, if the majority of new underwriters entering the IPO underwriting market form connections with existing underwriters, then we can expect the centrality of lead IPO underwriters as measured by *Degree* to increase after the repeal of the act. This is what happened after the repeal of the Glass-Steagall Act: our empirical findings presented here indicate that the average *Degree* centrality of lead IPO underwriters indeed increased significantly from the period before the Glass-Steagall Act was repealed to the period after the repeal. This is broadly true not only for *Degree* but also for our other centrality measures.

those reported here for *Degree*). Due to multicollinearity concerns, we drop year dummies from our estimation, since *GS* is essentially a time indicator. For each dependent variable that we study, we present both first and second stage regressions of our 2SLS estimation. Regressions 1, 3, 5, and 7 in Panels A and B of Table 10 present first stage regressions of *GS* and other control variables on *Degree*. The coefficient estimates of *GS* are positive and highly significant indicating a strong positive correlation between *GS* and *Degree*. This suggests that, on average, lead IPO underwriter centrality significantly increased after the repeal of the Glass-Steagall Act. We also report the F-statistics of first stage regressions: these are highly significant, indicating a strong positive relation between *GS* and lead IPO underwriter centrality.

Our second stage regressions indicate that, even in the context of the above regulatory change in the IPO market that led to a potentially exogenous change in lead IPO underwriter centrality, most of the relationships we documented in earlier sections continue to hold. In other words, lead IPO underwriter centrality has a significantly positive effect on the absolute value of IPO offer price revision (*AbsRevision*), both IPO and secondary market valuation (*QOPAdj* and *QFTDAdj*), the number of analysts following the firm (*LnNumAn*), the number of institutional investors holding IPO firm shares (*LnInstN*), and the secondary market liquidity of IPO firms' shares (*LnTurnover*).[42] We, however, do not find a significant relationship between lead IPO underwriter centrality and IPO initial return (*Underpricing*) or between lead IPO underwriter centrality and post-IPO stock return performance (1*YearHPRAdj*) in the second stage of our 2SLS analysis.

It should be noted that we do not claim, based on the above 2SLS analysis, that the relationships we documented above between lead underwriter centrality and various IPO characteristics are necessarily causal: in other words, we are not able to completely rule out the possibility that the above relationships may be driven partly by matching between more central lead IPO underwriters and higher quality IPO firms. This is because of various possible changes that may have occurred in the IPO market from before the repeal of the Glass-Steagall Act to after. For example, the Internet bubble collapsed in early 2000, just

[42] Since, in the second stage of 2SLS, we cannot implement Poisson or negative binomial maximum-likelihood estimations and need to run OLS regressions, we use the natural logarithms of one plus *NumAn* (*LnNumAn*) and one plus *InstN* (*LnInstN*) as our dependent variables in our 2SLS estimation instead of *NumAn* and *InstN*.

a few months after the repeal of the Glass-Steagall Act, so that the IPO market was much quieter in the year after the repeal. The September 11, 2001 terrorist attacks further affected the market. It is possible that, in a very slow market, underwriters formed larger IPO syndicates since investment banks had excess capacity and were eager to participate in the few offerings being completed, while lead underwriters were anxious to spread some of the offering risk that arose from the greater uncertainty in the market. It is also possible that the few firms which completed IPOs in early 2000s were of higher quality and therefore attracted larger syndicates. Given the above changes in the IPO market around the repeal of the Glass-Steagall Act, we will not characterize our 2SLS analysis above as an instrumental variable (IV) analysis, since our *GS* variable may not fully satisfy the exclusion restriction required for a valid instrument.[43]

However, in order to address the concern that the IPO underwriting markets were different in the early 2000s compared to previous years to the extent possible, we have also estimated our 2SLS regressions by excluding firms which went public in 1999-2004. The results of this estimation were similar to those reported in Table 10, further establishing the robustness of our findings on the positive relationship between lead IPO underwriter centrality and various IPO characteristics (the results of this untabulated analysis are available to interested readers upon request).

6.9. Underwriter centrality and investor attention

In this section we directly test whether more central lead IPO underwriters are better at attracting investor attention to the firms they take public. We regress our IPO firm media coverage variables *Headline* and *Article* as described in Section 5.2 (which serve as our proxies for investor attention) on our six lead IPO underwriter centrality measures and other controls. Our control variables include underwriter reputation, IPO firm size and age, dummies for VC-backed and hi-tech firms, as well as industry and trading exchange dummies. Similar control variables were used by Liu, Sherman, and Zhang (2014a) in their study of the relationship between media coverage of firms going public and their IPO characteristics.

[43] We thank an anonymous referee for pointing out these possible changes in the IPO market from before to after the repeal of the Glass-Steagall Act.

We also include *SpecialReports* as another control variable. *SpecialReports* is the number of special reports aired on the three major U.S. television networks (ABC, CBS, and NBC) in the two months prior to the IPO. The data on the number of special reports is collected from the Vanderbilt University Television News Archive. Liu, Sherman, and Zhang (2014a) use *SpecialReports* as an instrument for media coverage in their above-mentioned study of the relationship between media coverage of firms going public and their IPO characteristics. We include *SpecialReports* in our estimation to control for the possibility that media coverage (as well as investor attention) may be drawn away from IPO firms when a greater number of unexpected breaking news events (unrelated to the IPO market) dominate news media.

Due to the large size of our dataset, in order to keep our task of hand-collection within manageable proportions, we have opted to use a random sample of 3,482 IPO firms to construct our media coverage variables.[44] We make use of the negative binomial maximum-likelihood estimation technique, given that *Headline* and *Article* are count variables exhibiting a great degree of overdispersion (*Headline* ranges from 0 to 131 with the mean of 5.04 and the median of 2; and *Article* ranges from 0 to 1,165 with the mean of 28.76 and the median of 10). The results of our estimation are presented in Table 11. Five out of the six lead IPO underwriter centrality measures have significantly positive coefficient estimates both in our *Headline* and *Article* regressions (except for *Eigenvector*, which has negative and statistically insignificant coefficient estimates).[45] These findings indicate that firms underwritten by more central lead IPO underwriters receive more pre-IPO attention in the news media, which is indicative of more investor attention being paid to such firms. These findings provide support for our hypothesis **H8**.

7. Conclusion

Using several SNA measures, we analyze how various IPO characteristics are affected by the location of a lead IPO underwriter in its network of investment banks generated by participation in

[44] Note that this amounts to more than half (56%) of our original IPO sample, appropriately spread out over our entire sample period.
[45] We have estimated our regressions by also winsorizing *Headline* and *Article* at the 99th percentile. The results of these regressions were similar to those reported here.

previous IPO underwriting syndicates. We hypothesize that investment banking networks allow lead IPO underwriters to induce institutions to pay attention to the firms they take public and to perform two possible information-related roles during the IPO process: an information dissemination role, where the lead underwriter is able to use its investment banking network to convey noisy information about these IPO firms to various institutional investors; and an information extraction role, where its investment banking network helps the lead IPO underwriter to extract information useful in pricing the firms' IPOs from various institutional investors.

Our empirical results can be summarized as follows. First, we find that IPOs underwritten by more central lead underwriters are associated with larger absolute values of IPO offer price revisions. Second, IPOs underwritten by more central lead underwriters are associated with greater IPO and secondary market valuations, and greater IPO initial returns. Third, IPO firms which are underwritten by more central lead underwriters generate greater participation on the part of some financial market players; such firms are followed by a greater number of financial analysts and have larger institutional investor holdings. Finally, the shares of firms taken public by more central lead underwriters have greater secondary market liquidity and better post-IPO long-run (six-months and one-year) returns. Most of the above results are also confirmed by our robustness tests analyzing the relationship between lead underwriter centrality and IPO characteristics making use of the plausibly exogenous increase in underwriter centrality due to the repeal of the Glass-Steagall Act in 1999. Our direct tests of the mechanism through which lead underwriter centrality affects IPO characteristics indicate that more central lead underwriters are indeed able to garner greater investor attention for the firms they take public, as proxied by the pre-IPO media coverage received by these firms.

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Table 1. Summary statistics

The sample consists of IPOs conducted in 1980-2009. Degree, Indegree, Outdegree, Betweenness, Eigenvector, and 2-StepReach are measures of lead IPO underwriter centrality as described in Section 5.1. AbsRevision is the absolute percentage difference between the IPO offer price and the midpoint of initial filing range. QOPAdj, QFTDAdj, and QFQAdj are the industry-adjusted Tobin's Q ratios calculated using the IPO offer price, the first trading day closing price, and the price at the end of the first post-IPO fiscal quarter, respectively. Tobin's Q is the ratio of the market value of assets to the book value of assets, where the market value of assets is equal to the book value of assets minus the book value of common equity plus the number of shares outstanding times the share price. The number of shares outstanding for IPO firms is as of the first trading day and the share price is the IPO offer price (for QOPAdj), the first trading day closing price (for QFTDAdj), or the price at the end of the first post-IPO fiscal quarter (for QFQAdj). The number of shares outstanding and the share price for industry peers is taken from the first available post-IPO quarter on Compustat. The book value of assets and the book value of equity both for IPO firms and industry peers are taken from the first available post-IPO quarter on Compustat. Industry adjustment is performed by subtracting the contemporaneous median Tobin's Q of IPO firm's 2-digit SIC code industry peers. Underpricing is the percentage difference between the first trading day closing price and the IPO offer price. NumAn is the number of analysts following the firm at the end of the fiscal year of the IPO. InstN is the number of institutional investors holding IPO firm shares at the end of the first calendar quarter after the IPO. InstP is the proportion of IPO firm shares held by institutional investors at the end of the first calendar quarter after the IPO. LnTurnover is the natural logarithm of the average monthly shares traded as a percentage of total shares outstanding over the one-year period after the IPO. 1YearHPRAdj is the IPO firm's one-year holding period return calculated by compounding daily returns over 252 trading days after the IPO (excluding the first trading day's return) adjusted for (minus) the holding period return of the NASDAQ value-weighted index over the same period. If an IPO firm is delisted before the end of the one-year period, returns of the IPO firm and NASDAQ value-weighted index are compounded until the delisting date. Headline is the number of times English language publications in the U.S. have mentioned the IPO firm name in article headlines in the two months prior to the IPO. Article is the number of times English language publications in the U.S. have mentioned the IPO firm name in full articles in the two months prior to the IPO. MktShare is the lead underwriter's share of total proceeds raised in the IPO market in the previous five years. LnOffer is the natural logarithm of the IPO issue offer size. LnAssets is the natural logarithm of the book value of total assets at the end of the fiscal year prior to the IPO. LnAge is the natural logarithm of one plus the number of years from IPO firm founding year to the IPO issue year. VCDummy is a dummy equal to one for VC-backed IPOs. HiTechDummy is a dummy equal to one for hi-tech IPOs. AbsMktReturn is the absolute return on the CRSP value-weighted index between the filing date and the IPO issue date. FilingWidth20Dummy is a dummy equal to one for IPOs with filing width (the difference between the high filing price and the low filing price in the initial filing range divided by the high filing price) of 20% or more. PosRevDummy is a dummy equal to one for firms with positive price revision. Retention is the ratio of the number of shares retained by IPO firm existing shareholders over the sum of the number of such retained shares and the number of secondary shares offered in the IPO by existing shareholders. Expansion is the ratio of the number of newly issued shares offered in the IPO over the sum of the number of such newly issued shares and the number of existing shares retained by IPO firm existing shareholders. 1/Midpoint is the reciprocal of the midpoint of the initial filing range. OIBD/AssetsAdj is the operating income before depreciation over the book value of assets at the end of the fiscal year prior to the IPO adjusted for the contemporaneous median OIBD/Assets of 2-digit SIC code industry peers. PriorMktReturn is the return on the CRSP value-weighted index over the 30-day period prior to the IPO. AveUnderpricing is the average underpricing of all IPOs in the previous month. SpecialReports is the number of special reports aired on ABC, CBS, and NBC in the two months prior to the IPO.

	N	Minimum	Mean	Median	Maximum	St.Dev.
Lead IPO Underwriter Centrality Measures						
Degree	6,217	0	0.106	0.072	0.483	0.114
Indegree	6,217	0	0.032	0.034	0.154	0.029
Outdegree	6,217	0	0.094	0.039	0.473	0.115
Betweenness	6,217	0	0.026	0.008	0.400	0.039
Eigenvector	6,217	0	0.102	0.104	0.569	0.093
2-StepReach	6,217	0	0.438	0.559	0.926	0.338
IPO Characteristics and Media Coverage Variables						
AbsRevision	5,667	0	0.149	0.1	3.444	0.173
QOPAdj	5,823	-3.049	1.139	0.644	67.870	2.801
QFTDAdj	5,823	-2.549	1.889	0.911	120.983	4.494
QFQAdj	5,766	-3.376	1.970	0.922	96.939	4.322
Underpricing	6,107	-70.455	20.369	7.692	697.500	42.290
NumAn	4,267	1	3.135	3	24	2.097
InstN	5,476	1	22.049	17	259	20.266
InstP	5,474	0	0.211	0.174	1	0.175
LnTurnover	6,183	-2.546	2.417	2.441	5.820	0.790
1YearHPRAdj	6,206	-1.867	-0.050	-0.198	11.912	0.842
Headline	3,482	0	5.041	2	131	10.326
Article	3,482	0	28.758	10	1,165	63.482

	N	Minimum	Mean	Median	Maximum	St.Dev.
Control Variables						
MktShare	6,217	0	0.028	0.009	0.215	0.040
LnOffer	6,217	12.930	16.984	17.059	22.199	1.254
LnAssets	5,875	0	16.749	16.691	23.645	1.861
LnAge	6,175	0	2.137	2.079	5.112	0.975
VCDummy	6,217	0	0.428	0	1	0.495
HiTechDummy	6,217	0	0.522	1	1	0.500
AbsMktReturn	5,676	0	0.051	0.037	0.870	0.054
FilingWidth20Dummy	5,667	0	0.130	0	1	0.336
PosRevDummy	5,667	0	0.587	0	1	0.492
Retention	6,217	0	0.954	1	1	0.099
Expansion	6,217	0	0.289	0.263	1	0.163
1/Midpoint	5,667	0.008	0.175	0.083	100	1.604
OIBD/AssetsAdj	5,535	-125.732	-0.192	0.023	6.157	1.860
PriorMktReturn	6,217	-0.291	0.014	0.015	0.183	0.037
AveUnderpricing	6,201	-7.4	21.208	14.1	121.4	21.799
SpecialReports	6,217	0	15.128	13	151	12.867

Table 2. Relationship between lead IPO underwriter centrality and the absolute value of IPO offer price revision

The sample consists of IPOs conducted in 1980-2009. Degree, Indegree, Outdegree, Betweenness, Eigenvector, and 2-StepReach are measures of lead IPO underwriter centrality as described in Section 5.1. AbsRevision is the absolute percentage difference between the IPO offer price and the midpoint of initial filing range. MktShare is the lead underwriter's share of total proceeds raised in the IPO market in the previous five years. xMktShare is the residuals from a regression of MktShare on six lead IPO underwriter centrality measures. LnOffer is the natural logarithm of the IPO issue offer size. xLnOffer is the residuals from a regression of LnOffer on six lead IPO underwriter centrality measures. LnAssets is the natural logarithm of the book value of total assets at the end of the fiscal year prior to the IPO. LnAge is the natural logarithm of one plus the number of years from IPO firm founding year to the IPO issue year. Retention is the ratio of the number of shares retained by IPO firm existing shareholders over the sum of the number of such retained shares and the number of secondary shares offered in the IPO by existing shareholders. Expansion is the ratio of the number of newly issued shares offered in the IPO over the sum of the number of such newly issued shares and the number of existing shares retained by IPO firm existing shareholders. VCDummy is a dummy equal to one for VC-backed IPOs. HiTechDummy is a dummy equal to one for hi-tech IPOs. 1/Midpoint is the reciprocal of the midpoint of the initial filing range. AbsMktReturn is the absolute return on the CRSP value-weighted index between the filing date and the IPO issue date. FilingWidth20Dummy is a dummy equal to one for IPOs with filing width (the difference between the high filing price and the low filing price in the initial filing range divided by the high filing price) of 20% or more. All regressions include year and 2-digit SIC industry code dummies. *t*-statistics are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable	AbsRevision	AbsRevision	AbsRevision	AbsRevision	AbsRevision	AbsRevision
Intercept	0.051	0.022	0.041	0.022	0.092	0.072
	(0.58)	(0.25)	(0.47)	(0.25)	(1.05)	(0.83)
Degree	0.173					
	(6.20)***					
Indegree		0.529				
		(5.56)***				
Outdegree			0.147			
			(5.42)***			
Betweenness				0.235		
				(3.69)***		
Eigenvector					0.270	
					(8.40)***	
2-StepReach						0.097
						(9.22)***
xMktShare	0.262	0.278	0.266	0.281	0.279	0.257
	(2.80)***	(2.98)***	(2.85)***	(3.01)***	(3.00)***	(2.76)***
xLnOffer	0.006	0.002	0.004	-0.001	0.007	0.013
	(1.78)*	(0.69)	(1.26)	(0.19)	(2.09)**	(3.74)***
LnAssets	-0.000	0.002	0.001	0.003	-0.002	-0.004
	(-0.11)	(1.42)	(0.47)	(1.95)*	(-1.14)	(-2.16)**
LnAge	-0.010	-0.011	-0.010	-0.010	-0.010	-0.010
	(-3.67)***	(-4.07)***	(-3.66)***	(-3.86)***	(-3.72)***	(-3.86)***
Retention	0.034	0.043	0.030	0.026	0.045	0.060
	(1.51)	(1.87)*	(1.32)	(1.13)	(1.96)**	(2.61)***
Expansion	-0.074	-0.073	-0.074	-0.074	-0.070	-0.073
	(-5.11)***	(-5.05)***	(-5.12)***	(-5.11)***	(-4.85)***	(-5.11)***
VCDummy	0.039	0.038	0.039	0.041	0.034	0.033
	(7.57)***	(7.35)***	(7.75)***	(8.09)***	(6.62)***	(6.38)***
HiTechDummy	0.021	0.021	0.022	0.023	0.019	0.018
	(3.23)***	(3.15)***	(3.33)***	(3.48)***	(2.84)***	(2.76)***
1/Midpoint	-0.003	-0.003	-0.003	-0.003	-0.002	-0.002
	(-1.18)	(-1.10)	(-1.25)	(-1.27)	(-0.94)	(-0.79)
AbsMktReturn	0.116	0.116	0.113	0.105	0.118	0.131
	(2.70)***	(2.68)***	(2.61)***	(2.43)**	(2.76)***	(3.04)***
FilingWidth20Dummy	0.048	0.046	0.047	0.044	0.049	0.050
	(7.16)***	(6.90)***	(7.05)***	(6.68)***	(7.38)***	(7.49)***
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Ind. Dummies	Yes	Yes	Yes	Yes	Yes	Yes
R^2	5,486	5,486	5,486	5,486	5,486	5,486
N	0.1674	0.1662	0.1660	0.1636	0.1723	0.1745

Table 3. Relationship between lead IPO underwriter centrality and secondary market valuation

The sample consists of IPOs conducted in 1980-2009. Degree, Indegree, Outdegree, Betweenness, Eigenvector, and 2-StepReach are measures of lead IPO underwriter centrality as described in Section 5.1. MktShare is the lead underwriter's share of total proceeds raised in the IPO market in the previous five years. xMktShare is the residuals from a regression of MktShare on six lead IPO underwriter centrality measures. LnOffer is the natural logarithm of the IPO issue offer size. xLnOffer is the residuals from a regression of LnOffer on six lead IPO underwriter centrality measures. LnAssets is the natural logarithm of the book value of total assets at the end of the fiscal year prior to the IPO. LnAge is the natural logarithm of one plus the number of years from IPO firm founding year to the IPO issue year. Retention is the ratio of the number of shares retained by IPO firm existing shareholders over the sum of the number of such retained shares and the number of secondary shares offered in the IPO by existing shareholders. Expansion is the ratio of the number of newly issued shares offered in the IPO over the sum of the number of such newly issued shares and the number of existing shares retained by IPO firm existing shareholders. 1/Midpoint is the reciprocal of the midpoint of the initial filing range. VCDummy is a dummy equal to one for VC-backed IPOs. HiTechDummy is a dummy equal to one for hi-tech IPOs. OIBD/AssetsAdj is the operating income before depreciation over the book value of assets at the end of the fiscal year prior to the IPO adjusted for the contemporaneous median OIBD/Assets of 2-digit SIC code industry peers. All regressions include year dummies. *t*-statistics are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Relationship between lead IPO underwriter centrality and secondary market valuation measured using the first trading day closing price
QFTDAdj is the industry-adjusted Tobin's Q ratio calculated using the first trading day closing price. Tobin's Q is the ratio of the market value of assets to the book value of assets, where the market value of assets is equal to the book value of assets minus the book value of common equity plus the number of shares outstanding times the share price. The number of shares outstanding for IPO firms is as of the first trading day and the share price is the first trading day closing price. The number of shares outstanding and the share price for industry peers is taken from the first available post-IPO quarter on Compustat. The book value of assets and the book value of equity both for IPO firms and industry peers are taken from the first available post-IPO quarter on Compustat. Industry adjustment is performed by subtracting the contemporaneous median Tobin's Q of IPO firm's 2-digit SIC code industry peers.

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable	QFTDAdj	QFTDAdj	QFTDAdj	QFTDAdj	QFTDAdj	QFTDAdj
Intercept	16.811	13.784	16.787	15.417	16.191	16.018
	(12.04)***	(9.92)***	(12.04)***	(11.01)***	(11.41)***	(11.39)***
Degree	8.694					
	(11.55)***					
Indegree		8.433				
		(3.28)***				
Outdegree			8.518			
			(11.72)***			
Betweenness				13.468		
				(7.83)***		
Eigenvector					7.186	
					(8.14)***	
2-StepReach						2.559
						(8.74)***
xMktShare	13.001	14.508	13.021	13.940	14.250	13.763
	(5.27)***	(5.82)***	(5.29)***	(5.62)***	(5.75)***	(5.56)***
xLnOffer	0.964	0.514	0.936	0.634	0.725	0.897
	(10.02)***	(5.66)***	(9.88)***	(7.14)***	(7.83)***	(8.89)***
LnAssets	-0.899	-0.604	-0.884	-0.709	-0.786	-0.841
	(-16.55)***	(-12.29)***	(-16.58)***	(-14.24)***	(-14.53)***	(-14.88)***
LnAge	-0.185	-0.237	-0.180	-0.218	-0.211	-0.217
	(-2.58)***	(-3.27)***	(-2.52)**	(-3.02)***	(-2.94)***	(-3.02)***
Retention	0.715	0.525	0.540	0.246	0.770	1.146
	(1.18)	(0.85)	(0.89)	(0.40)	(1.26)	(1.86)*
Expansion	-4.693	-4.748	-4.718	-4.769	-4.611	-4.679
	(-11.83)***	(-11.82)***	(-11.90)***	(-11.94)***	(-11.53)***	(-11.72)***
VCDummy	0.239	0.330	0.266	0.361	0.193	0.164
	(1.76)*	(2.40)**	(1.97)**	(2.66)***	(1.40)	(1.19)
HiTechDummy	-0.105	0.015	-0.090	0.001	-0.092	-0.121
	(-0.76)	(0.10)	(-0.65)	(0.00)	(-0.66)	(-0.86)
1/Midpoint	0.067	0.062	0.059	0.057	0.080	0.094
	(0.85)	(0.77)	(0.75)	(0.71)	(1.00)	(1.17)
OIBD/AssetsAdj	0.027	0.001	0.026	0.010	0.018	0.022
	(0.85)	(0.04)	(0.84)	(0.32)	(0.57)	(0.69)
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.1775	0.1576	0.1782	0.1659	0.1667	0.1684
N	5,087	5,087	5,087	5,087	5,087	5,087

Table 3. Relationship between lead IPO underwriter centrality and secondary market valuation (continued)

Panel B: Relationship between lead IPO underwriter centrality and secondary market valuation measured using the price at the end of the first post-IPO fiscal quarter

QFQAdj is the industry-adjusted Tobin's Q ratio calculated using the price at the end of the first post-IPO fiscal quarter. Tobin's Q is the ratio of the market value of assets to the book value of assets, where the market value of assets is equal to the book value of assets minus the book value of common equity plus the number of shares outstanding times the share price. The number of shares outstanding for IPO firms is as of the first trading day and the share price is the price at the end of the first post-IPO fiscal quarter. The number of shares outstanding and the share price for industry peers is taken from the first available post-IPO quarter on Compustat. The book value of assets and the book value of equity both for IPO firms and industry peers are taken from the first available post-IPO quarter on Compustat. Industry adjustment is performed by subtracting the contemporaneous median Tobin's Q of IPO firm's 2-digit SIC code industry peers.

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable	QFQAdj	QFQAdj	QFQAdj	QFQAdj	QFQAdj	QFQAdj
Intercept	14.983	11.929	14.968	13.649	14.312	13.777
	(10.58)***	(8.43)***	(10.58)***	(9.59)***	(9.97)***	(9.68)***
Degree	8.814					
	(12.71)***					
Indegree		10.029				
		(4.22)***				
Outdegree			8.646			
			(12.90)***			
Betweenness				14.155		
				(8.87)***		
Eigenvector					7.540	
					(9.25)***	
2-StepReach						2.461
						(9.15)***
xMktShare	11.089	12.683	11.110	12.089	12.378	11.975
	(4.87)***	(5.50)***	(4.89)***	(5.28)***	(5.41)***	(5.23)***
xLnOffer	0.834	0.400	0.806	0.508	0.603	0.742
	(9.43)***	(4.78)***	(9.26)***	(6.22)***	(7.08)***	(7.99)***
LnAssets	-0.773	-0.485	-0.758	-0.585	-0.667	-0.699
	(-15.47)***	(-10.70)***	(-15.46)***	(-12.78)***	(-13.40)***	(-13.43)***
LnAge	-0.202	-0.256	-0.199	-0.236	-0.228	-0.237
	(-3.08)***	(-3.84)***	(-3.02)***	(-3.57)***	(-3.44)***	(-3.58)***
Retention	0.304	0.153	0.124	-0.171	0.381	0.699
	(0.55)	(0.27)	(0.22)	(-0.31)	(0.68)	(1.24)
Expansion	-4.849	-4.903	-4.871	-4.911	-4.763	-4.855
	(-13.30)***	(-13.26)***	(-13.37)***	(-13.37)***	(-12.96)***	(-13.22)***
VCDummy	0.035	0.116	0.062	0.160	-0.016	-0.030
	(0.28)	(0.92)	(0.50)	(1.28)	(-0.13)	(-0.23)
HiTechDummy	0.033	0.149	0.049	0.138	0.042	0.025
	(0.26)	(1.15)	(0.38)	(1.07)	(0.33)	(0.19)
1/Midpoint	0.040	0.039	0.032	0.032	0.056	0.065
	(0.58)	(0.55)	(0.46)	(0.46)	(0.80)	(0.92)
OIBD/AssetsAdj	0.073	0.048	0.072	0.057	0.065	0.067
	(2.46)**	(1.60)	(2.45)**	(1.89)*	(2.17)**	(2.23)**
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.2198	0.1975	0.2206	0.2071	0.2082	0.2079
N	5,049	5,049	5,049	5,049	5,049	5,049

Table 4. Relationship between lead IPO underwriter centrality and IPO market valuation

The sample consists of IPOs conducted in 1980-2009. Degree, Indegree, Outdegree, Betweenness, Eigenvector, and 2-StepReach are measures of lead IPO underwriter centrality as described in Section 5.1. QOPAdj is the industry-adjusted Tobin's Q ratio calculated using the IPO offer price. Tobin's Q is the ratio of the market value of assets to the book value of assets, where the market value of assets is equal to the book value of assets minus the book value of common equity plus the number of shares outstanding times the share price. The number of shares outstanding for IPO firms is as of the first trading day and the share price is the IPO offer price. The number of shares outstanding and the share price for industry peers is taken from the first available post-IPO quarter on Compustat. The book value of assets and the book value of equity both for IPO firms and industry peers are taken from the first available post-IPO quarter on Compustat. Industry adjustment is performed by subtracting the contemporaneous median Tobin's Q of IPO firm's 2-digit SIC code industry peers. MktShare is the lead underwriter's share of total proceeds raised in the IPO market in the previous five years. xMktShare is the residuals from a regression of MktShare on six lead IPO underwriter centrality measures. LnOffer is the natural logarithm of the IPO issue offer size. xLnOffer is the residuals from a regression of LnOffer on six lead IPO underwriter centrality measures. LnAssets is the natural logarithm of the book value of total assets at the end of the fiscal year prior to the IPO. LnAge is the natural logarithm of one plus the number of years from IPO firm founding year to the IPO issue year. Retention is the ratio of the number of shares retained by IPO firm existing shareholders over the sum of the number of such retained shares and the number of secondary shares offered in the IPO by existing shareholders. Expansion is the ratio of the number of newly issued shares offered in the IPO over the sum of the number of such newly issued shares and the number of existing shares retained by IPO firm existing shareholders. VCDummy is a dummy equal to one for VC-backed IPOs. HiTechDummy is a dummy equal to one for hi-tech IPOs. 1/Midpoint is the reciprocal of the midpoint of the initial filing range. OIBD/AssetsAdj is the operating income before depreciation over the book value of assets at the end of the fiscal year prior to the IPO adjusted for the contemporaneous median OIBD/Assets of 2-digit SIC code industry peers. All regressions include year dummies. *t*-statistics are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable	QOPAdj	QOPAdj	QOPAdj	QOPAdj	QOPAdj	QOPAdj
Intercept	12.421	10.902	12.381	11.746	12.343	12.130
	(14.09)***	(12.48)***	(14.06)***	(13.32)***	(13.83)***	(13.70)***
Degree	4.832					
	(10.17)***					
Indegree		6.990				
		(4.33)***				
Outdegree			4.672			
			(10.18)***			
Betweenness				8.085		
				(7.46)***		
Eigenvector					4.632	
					(8.34)***	
2-StepReach						1.558
						(8.45)***
xMktShare	2.959	3.743	2.983	3.447	3.613	3.333
	(1.90)*	(2.39)**	(1.92)*	(2.21)**	(2.32)**	(2.14)**
xLnOffer	0.598	0.378	0.578	0.424	0.493	0.586
	(9.83)***	(6.62)***	(9.66)***	(7.59)***	(8.47)***	(9.23)***
LnAssets	-0.646	-0.500	-0.636	-0.548	-0.606	-0.630
	(-18.86)***	(-16.18)***	(-18.88)***	(-17.50)***	(-17.80)***	(-17.71)***
LnAge	-0.051	-0.079	-0.049	-0.069	-0.064	-0.068
	(-1.13)	(-1.74)*	(-1.08)	(-1.51)	(-1.40)	(-1.50)
Retention	0.366	0.333	0.266	0.104	0.442	0.652
	(0.96)	(0.86)	(0.70)	(0.27)	(1.15)	(1.68)*
Expansion	-2.801	-2.822	-2.815	-2.843	-2.740	-2.788
	(-11.18)***	(-11.17)***	(-11.24)***	(-11.30)***	(-10.89)***	(-11.09)***
VCDummy	0.047	0.081	0.064	0.114	0.004	-0.006
	(0.56)	(0.93)	(0.74)	(1.33)	(0.05)	(0.07)
HiTechDummy	-0.130	-0.076	-0.121	-0.074	-0.136	-0.148
	(-1.49)	(-0.86)	(-1.38)	(-0.84)	(-1.55)	(-1.68)*
1/Midpoint	-0.018	-0.018	-0.022	-0.023	-0.008	-0.001
	(-0.36)	(-0.35)	(-0.44)	(-0.46)	(-0.16)	(-0.02)
OIBD/AssetsAdj	-0.005	-0.018	-0.006	-0.014	-0.008	-0.006
	(-0.26)	(-0.89)	(-0.28)	(-0.69)	(-0.41)	(-0.33)
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.1151	0.1003	0.1151	0.1068	0.1093	0.1096
N	5,087	5,087	5,087	5,087	5,087	5,087

Table 5. Relationship between lead IPO underwriter centrality and IPO initial return

The sample consists of IPOs conducted in 1980-2009. Degree, Indegree, Outdegree, Betweenness, Eigenvector, and 2-StepReach are measures of lead IPO underwriter centrality as described in Section 5.1. Underpricing is the percentage difference between the first trading day closing price and the IPO offer price. MktShare is the lead underwriter's share of total proceeds raised in the IPO market in the previous five years. xMktShare is the residuals from a regression of MktShare on six lead IPO underwriter centrality measures. LnOffer is the natural logarithm of the IPO issue offer size. xLnOffer is the residuals from a regression of LnOffer on six lead IPO underwriter centrality measures. LnAssets is the natural logarithm of the book value of total assets at the end of the fiscal year prior to the IPO. LnAge is the natural logarithm of one plus the number of years from IPO firm founding year to the IPO issue year. Retention is the ratio of the number of shares retained by IPO firm existing shareholders over the sum of the number of such retained shares and the number of secondary shares offered in the IPO by existing shareholders. Expansion is the ratio of the number of newly issued shares offered in the IPO over the sum of the number of such newly issued shares and the number of existing shares retained by IPO firm existing shareholders. 1/Midpoint is the reciprocal of the midpoint of the initial filing range. VCDummy is a dummy equal to one for VC-backed IPOs. HiTechDummy is a dummy equal to one for hi-tech IPOs. PosRevDummy is a dummy equal to one for firms with positive price revision. PriorMktReturn is the return on the CRSP value-weighted index over the 30-day period prior to the IPO. AveUnderpricing is the average underpricing of all IPOs in the previous month. All regressions include year, 2-digit SIC industry code, and trading exchange dummies. *t*-statistics are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable	Underpricing	Underpricing	Underpricing	Underpricing	Underpricing	Underpricing
Intercept	3.411	-12.574	4.232	-2.836	-2.772	-4.561
	(0.17)	(-0.63)	(0.21)	(-0.14)	(-0.14)	(-0.23)
Degree	47.820					
	(7.16)***					
Indegree		-6.886				
		(-0.31)				
Outdegree			49.807			
			(7.69)***			
Betweenness				72.501		
				(4.85)***		
Eigenvector					25.888	
					(3.41)***	
2-StepReach						9.369
						(3.61)***
xMktShare	97.569	104.211	97.687	101.928	103.211	100.862
	(4.56)***	(4.85)***	(4.57)***	(4.75)***	(4.81)***	(4.69)***
xLnOffer	2.724	-0.704	2.802	0.772	0.603	1.252
	(3.15)***	(-0.89)	(3.29)***	(0.99)	(0.74)	(1.40)
LnAssets	-1.628	-0.089	-1.655	-0.815	-0.822	-0.958
	(-3.52)***	(-0.21)	(-3.62)***	(-1.87)*	(-1.78)*	(-2.03)**
LnAge	-2.374	-2.648	-2.321	-2.523	-2.565	-2.587
	(-3.84)***	(-4.28)***	(-3.76)***	(-4.08)***	(-4.15)***	(-4.18)***
Retention	15.128	12.848	14.346	12.956	14.605	15.866
	(2.89)***	(2.43)**	(2.74)***	(2.47)**	(2.77)***	(2.99)***
Expansion	-20.255	-20.049	-20.338	-20.232	-19.769	-20.159
	(-6.11)***	(-6.02)***	(-6.14)***	(-6.09)***	(-5.94)***	(-6.06)***
1/Midpoint	3.301	3.169	3.277	3.227	3.264	3.307
	(5.22)***	(4.98)***	(5.18)***	(5.09)***	(5.14)***	(5.20)***
VCDummy	2.893	3.839	2.926	3.520	3.097	3.083
	(2.43)**	(3.20)***	(2.46)**	(2.96)***	(2.57)**	(2.56)**
HiTechDummy	-0.544	0.083	-0.498	-0.148	-0.369	-0.374
	(-0.36)	(0.05)	(-0.33)	(-0.10)	(-0.24)	(-0.24)
PosRevDummy	17.827	19.069	17.640	18.559	18.737	18.705
	(16.09)***	(17.33)***	(15.90)***	(16.83)***	(16.99)***	(16.96)***
PriorMktReturn	75.336	73.494	75.963	74.969	73.134	72.445
	(5.17)***	(5.02)***	(5.22)***	(5.13)***	(5.00)***	(4.96)***
AveUnderpricing	0.405	0.407	0.405	0.409	0.406	0.402
	(9.54)***	(9.55)***	(9.56)***	(9.61)***	(9.53)***	(9.45)***
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Ind. Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Exch. Dummies	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.3160	0.3094	0.3170	0.3125	0.3109	0.3111
N	5,450	5,450	5,450	5,450	5,450	5,450

Table 6. Relationship between lead IPO underwriter centrality and financial analyst following

The sample consists of IPOs conducted in 1980-2009. Degree, Indegree, Outdegree, Betweenness, Eigenvector, and 2-StepReach are measures of lead IPO underwriter centrality as described in Section 5.1. NumAn is the number of analysts following the firm at the end of the fiscal year of the IPO. MktShare is the lead underwriter's share of total proceeds raised in the IPO market in the previous five years. xMktShare is the residuals from a regression of MktShare on six lead IPO underwriter centrality measures. LnOffer is the natural logarithm of the IPO issue offer size. xLnOffer is the residuals from a regression of LnOffer on six lead IPO underwriter centrality measures. LnAssets is the natural logarithm of the book value of total assets at the end of the fiscal year prior to the IPO. LnAge is the natural logarithm of one plus the number of years from IPO firm founding year to the IPO issue year. Retention is the ratio of the number of shares retained by IPO firm existing shareholders over the sum of the number of such retained shares and the number of secondary shares offered in the IPO by existing shareholders. Expansion is the ratio of the number of newly issued shares offered in the IPO over the sum of the number of such newly issued shares and the number of existing shares retained by IPO firm existing shareholders. 1/Midpoint is the reciprocal of the midpoint of the initial filing range. VCDummy is a dummy equal to one for VC-backed IPOs. HiTechDummy is a dummy equal to one for hi-tech IPOs. Underpricing is the percentage difference between the first trading day closing price and the IPO offer price. QFTDAdj is the industry-adjusted Tobin's Q ratio calculated as the ratio of the market value of assets to the book value of assets, where the market value of assets is equal to the book value of assets minus the book value of common equity plus the number of shares outstanding times the first trading day closing price. The number of shares outstanding is as of the first trading day. The number of shares outstanding and the share price for industry peers is taken from the first available post-IPO quarter on Compustat. The book value of assets and the book value of equity both for IPO firms and industry peers are taken from the first available post-IPO quarter on Compustat. Industry adjustment is performed by subtracting the contemporaneous median Tobin's Q of IPO firm's 2-digit SIC code industry peers. All regressions are Poisson maximum likelihood estimations. OIBD/AssetsAdj is the operating income before depreciation over the book value of assets at the end of the fiscal year prior to the IPO adjusted for the contemporaneous median OIBD/Assets of 2-digit SIC code industry peers. All regressions include year and 2-digit SIC industry code dummies. *z*-statistics are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable	NumAn	NumAn	NumAn	NumAn	NumAn	NumAn
Intercept	-0.527	-0.921	-0.488	-0.620	-0.452	-0.853
	(-0.85)	(-1.49)	(-0.79)	(-1.00)	(-0.73)	(-1.38)
Degree	1.228					
	(10.77)***					
Indegree		1.904				
		(4.50)***				
Outdegree			1.139			
			(10.56)***			
Betweenness				1.808		
				(7.51)***		
Eigenvector					2.046	
					(12.29)***	
2-StepReach						0.791
						(13.16)***
xMktShare	0.794	1.144	0.817	0.987	0.970	0.897
	(2.62)***	(3.73)***	(2.70)***	(3.23)***	(3.20)***	(2.93)***
xLnOffer	0.140	0.068	0.131	0.080	0.153	0.207
	(9.11)***	(4.92)***	(8.75)***	(5.99)***	(10.01)***	(11.86)***
LnAssets	0.087	0.127	0.088	0.110	0.088	0.082
	(9.32)***	(14.93)***	(9.38)***	(12.27)***	(9.61)***	(8.97)***
LnAge	-0.025	-0.030	-0.024	-0.028	-0.026	-0.024
	(-2.10)**	(-2.59)***	(-2.05)**	(-2.41)**	(-2.21)**	(-2.07)**
Retention	0.011	0.010	0.000	-0.038	0.025	0.100
	(0.12)	(0.11)	(0.00)	(-0.42)	(0.28)	(1.09)
Expansion	-0.191	-0.176	-0.186	-0.181	-0.203	-0.231
	(-3.10)***	(-2.84)***	(-3.02)***	(-2.93)***	(-3.30)***	(-3.73)***
1/Midpoint	-2.370	-3.297	-2.521	-3.141	-1.710	-1.100
	(-4.91)***	(-6.78)***	(-5.27)***	(-6.60)***	(-3.46)***	(-2.16)**
VCDummy	0.131	0.130	0.130	0.136	0.118	0.126
	(5.95)***	(5.95)***	(5.91)***	(6.19)***	(5.37)***	(5.72)***
HiTechDummy	0.112	0.124	0.114	0.122	0.105	0.102
	(3.91)***	(4.32)***	(3.97)***	(4.24)***	(3.63)***	(3.56)***
Underpricing	0.001	0.001	0.001	0.001	0.001	0.001
	(4.37)***	(5.21)***	(4.38)***	(4.88)***	(4.42)***	(4.22)***
QFTDAdj	0.004	0.005	0.004	0.005	0.004	0.004
	(1.84)*	(2.65)***	(1.87)*	(2.32)**	(1.93)*	(1.90)*
OIBD/AssetsAdj	0.003	-0.001	0.003	0.000	0.003	0.004
	(0.39)	(-0.16)	(0.39)	(0.06)	(0.47)	(0.59)
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Ind. Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.1098	0.1038	0.1095	0.1060	0.1120	0.1137
N	3,945	3,945	3,945	3,945	3,945	3,945

Table 7. Relationship between lead IPO underwriter centrality and the participation of institutional investors

The sample consists of IPOs conducted in 1980-2009. Degree, Indegree, Outdegree, Betweenness, Eigenvector, and 2-StepReach are measures of lead IPO underwriter centrality as described in Section 5.1. xMktShare is the residuals from a regression of MktShare on six lead IPO underwriter centrality measures. LnOffer is the natural logarithm of the IPO issue offer size. xLnOffer is the residuals from a regression of LnOffer on six lead IPO underwriter centrality measures. LnAssets is the natural logarithm of the book value of total assets at the end of the fiscal year prior to the IPO. LnAge is the natural logarithm of one plus the number of years from IPO firm founding year to the IPO issue year. Retention is the ratio of the number of shares retained by IPO firm existing shareholders over the sum of the number of such retained shares and the number of secondary shares offered in the IPO by existing shareholders. Expansion is the ratio of the number of newly issued shares offered in the IPO over the sum of the number of such newly issued shares and the number of existing shares retained by IPO firm existing shareholders. 1/Midpoint is the reciprocal of the midpoint of the initial filing range. VCDummy is a dummy equal to one for VC-backed IPOs. HiTechDummy is a dummy equal to one for hi-tech IPOs. Underpricing is the percentage difference between the first trading day closing price and the IPO offer price. QFTDAdj is the industry-adjusted Tobin's Q ratio calculated as the ratio of the market value of assets to the book value of assets, where the market value of assets is equal to the book value of assets minus the book value of common equity plus the number of shares outstanding times the first trading day closing price. OIBD/AssetsAdj is the operating income before depreciation over the book value of assets at the end of the fiscal year prior to the IPO adjusted for the contemporaneous median OIBD/Assets of 2-digit SIC code industry peers. All regressions include year and 2-digit SIC industry code dummies. *z*-statistics are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Relationship between lead IPO underwriter centrality and the number of institutional investors holding IPO firm shares
InstN is the number of institutional investors holding IPO firm shares at the end of the first calendar quarter after the IPO. All regressions in this panel are negative binomial maximum-likelihood estimations.

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable	InstN	InstN	InstN	InstN	InstN	InstN
Intercept	2.021	1.151	2.079	1.744	2.125	1.457
	(6.38)***	(3.48)***	(6.51)***	(5.25)***	(6.82)***	(4.94)***
Degree	2.764					
	(31.87)***					
Indegree		7.318				
		(22.28)***				
Outdegree			2.432			
			(29.47)***			
Betweenness				3.595		
				(17.71)***		
Eigenvector					4.031	
					(35.90)***	
2-StepReach						1.793
						(51.20)***
xMktShare	0.196	0.567	0.270	0.525	0.434	0.106
	(0.77)	(2.20)**	(1.06)	(1.99)**	(1.79)*	(0.47)
xLnOffer	0.437	0.337	0.407	0.305	0.448	0.612
	(38.20)***	(30.74)***	(36.20)***	(28.18)***	(40.46)***	(54.29)***
LnAssets	0.069	0.141	0.075	0.123	0.072	0.040
	(10.48)***	(22.28)***	(11.34)***	(18.49)***	(11.34)***	(6.60)***
LnAge	0.003	-0.012	0.003	-0.004	0.000	0.001
	(0.35)	(-1.34)	(0.38)	(-0.50)	(0.00)	(0.13)
Retention	-0.394	-0.317	-0.428	-0.489	-0.355	-0.144
	(-5.90)***	(-4.53)***	(-6.33)***	(-6.84)***	(-5.44)***	(-2.37)**
Expansion	-0.147	-0.128	-0.133	-0.112	-0.156	-0.245
	(-3.36)***	(-2.77)***	(-3.00)***	(-2.40)**	(-3.61)***	(-6.04)***
1/Midpoint	-3.633	-3.886	-4.141	-4.952	-2.290	-0.278
	(-13.40)***	(-13.43)***	(-15.29)***	(-17.55)***	(-8.30)***	(-1.85)*
VCDummy	0.168	0.163	0.169	0.184	0.133	0.136
	(10.87)***	(9.94)***	(10.83)***	(11.22)***	(8.76)***	(9.48)***
HiTechDummy	0.039	0.039	0.046	0.064	0.012	0.003
	(1.92)*	(1.81)*	(2.26)**	(2.97)***	(0.58)	(0.14)
Underpricing	0.004	0.004	0.004	0.004	0.004	0.003
	(18.39)***	(19.61)***	(18.42)***	(18.96)***	(19.16)***	(18.56)***
QFTDAdj	-0.002	0.003	-0.002	0.001	-0.001	-0.002
	(-1.18)	(1.48)	(-0.99)	(0.40)	(-0.75)	(-1.09)
OIBD/AssetsAdj	0.005	-0.001	0.005	-0.000	0.006	0.009
	(1.37)	(-0.22)	(1.24)	(-0.00)	(1.53)	(2.42)**
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Ind. Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.1553	0.1432	0.1517	0.1387	0.1617	0.1819
N	4,700	4,700	4,700	4,700	4,700	4,700

Table 7. Relationship between lead IPO underwriter centrality and the participation of institutional investors (continued)

Panel B: Relationship between lead IPO underwriter centrality and the proportion of IPO firm shares held by institutional investors
InstP is the proportion of IPO firm shares held by institutional investors at the end of the first calendar quarter after the IPO.

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable	InstP	InstP	InstP	InstP	InstP	InstP
Intercept	0.277	0.202	0.264	0.206	0.318	0.320
	(3.17)***	(2.31)**	(3.01)***	(2.34)**	(3.64)***	(3.71)***
Degree	0.299					
	(11.43)***					
Indegree		0.876				
		(9.91)***				
Outdegree			0.261			
			(10.33)***			
Betweenness				0.365		
				(6.22)***		
Eigenvector					0.393	
					(12.78)***	
2-StepReach						0.170
						(16.35)***
xMktShare	-0.108	-0.084	-0.101	-0.078	-0.080	-0.116
	(-1.31)	(-1.02)	(-1.22)	(-0.94)	(-0.97)	(-1.42)
xLnOffer	0.043	0.035	0.040	0.029	0.042	0.057
	(12.73)***	(11.16)***	(11.97)***	(9.44)***	(12.96)***	(16.23)***
LnAssets	0.017	0.024	0.019	0.025	0.017	0.011
	(8.72)***	(13.51)***	(9.63)***	(13.69)***	(8.59)***	(5.48)***
LnAge	0.011	0.009	0.011	0.010	0.011	0.010
	(4.26)***	(3.61)***	(4.25)***	(3.87)***	(4.13)***	(4.10)***
Retention	-0.274	-0.265	-0.280	-0.289	-0.266	-0.238
	(-13.34)***	(-12.77)***	(-13.61)***	(-13.97)***	(-12.99)***	(-11.63)***
Expansion	0.282	0.284	0.282	0.283	0.285	0.280
	(20.03)***	(20.13)***	(19.99)***	(19.90)***	(20.33)***	(20.18)***
1/Midpoint	-0.019	-0.018	-0.021	-0.024	-0.014	-0.005
	(-1.70)*	(-1.63)	(-1.90)*	(-2.17)**	(-1.24)	(-0.47)
VCDummy	0.034	0.033	0.035	0.038	0.029	0.027
	(7.27)***	(6.93)***	(7.45)***	(7.94)***	(6.20)***	(5.81)***
HiTechDummy	-0.006	-0.007	-0.005	-0.003	-0.010	-0.012
	(-1.05)	(-1.10)	(-0.88)	(-0.55)	(-1.61)	(-1.91)*
Underpricing	0.000	0.000	0.000	0.000	0.000	0.000
	(3.56)***	(4.22)***	(3.58)***	(3.99)***	(3.94)***	(3.58)***
QFTDAdj	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003
	(-5.18)***	(-4.28)***	(-5.04)***	(-4.37)***	(-5.16)***	(-5.46)***
OIBD/AssetsAdj	0.000	-0.000	0.000	-0.000	0.000	0.001
	(0.28)	(-0.20)	(0.17)	(-0.34)	(0.39)	(0.82)
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Ind. Dummies	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.3962	0.3921	0.3932	0.3843	0.4004	0.4132
N	4,700	4,700	4,700	4,700	4,700	4,700

Table 8. Relationship between lead IPO underwriter centrality and secondary market liquidity

The sample consists of IPOs conducted in 1980-2009. Degree, Indegree, Outdegree, Betweenness, Eigenvector, and 2-StepReach are measures of lead IPO underwriter centrality as described in Section 5.1. LnTurnover is the natural logarithm of the average monthly shares traded as a percentage of total shares outstanding over the one-year period after the IPO. MktShare is the lead underwriter's share of total proceeds raised in the IPO market in the previous five years. xMktShare is the residuals from a regression of MktShare on six lead IPO underwriter centrality measures. LnOffer is the natural logarithm of the IPO issue offer size. xLnOffer is the residuals from a regression of LnOffer on six lead IPO underwriter centrality measures. LnAssets is the natural logarithm of the book value of total assets at the end of the fiscal year prior to the IPO. LnAge is the natural logarithm of one plus the number of years from IPO firm founding year to the IPO issue year. Retention is the ratio of the number of shares retained by IPO firm existing shareholders over the sum of the number of such retained shares and the number of secondary shares offered in the IPO by existing shareholders. Expansion is the ratio of the number of newly issued shares offered in the IPO over the sum of the number of such newly issued shares and the number of existing shares retained by IPO firm existing shareholders. 1/Midpoint is the reciprocal of the midpoint of the initial filing range. VCDummy is a dummy equal to one for VC-backed IPOs. HiTechDummy is a dummy equal to one for hi-tech IPOs. Underpricing is the percentage difference between the first trading day closing price and the IPO offer price. QFTDAdj is the industry-adjusted Tobin's Q ratio calculated as the ratio of the market value of assets to the book value of assets, where the market value of assets is equal to the book value of assets minus the book value of common equity plus the number of shares outstanding times the first trading day closing price. The number of shares outstanding is as of the first trading day. The number of shares outstanding and the share price for industry peers is taken from the first available post-IPO quarter on Compustat. The book value of assets and the book value of equity both for IPO firms and industry peers are taken from the first available post-IPO quarter on Compustat. Industry adjustment is performed by subtracting the contemporaneous median Tobin's Q of IPO firm's 2-digit SIC code industry peers. OIBD/AssetsAdj is the operating income before depreciation over the book value of assets at the end of the fiscal year prior to the IPO adjusted for the contemporaneous median OIBD/Assets of 2-digit SIC code industry peers. All regressions include year and 2-digit SIC industry code dummies. *t*-statistics are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable	LnTurnover	LnTurnover	LnTurnover	LnTurnover	LnTurnover	LnTurnover
Intercept	4.409	4.231	4.354	4.098	4.532	4.598
	(12.71)***	(12.27)***	(12.54)***	(11.77)***	(13.04)***	(13.37)***
Degree	0.893					
	(8.52)***					
Indegree		2.883				
		(8.26)***				
Outdegree			0.772			
			(7.61)***			
Betweenness				0.658		
				(2.78)***		
Eigenvector					1.152	
					(9.53)***	
2-StepReach						0.502
						(12.58)***
xMktShare	-0.125	-0.054	-0.107	-0.026	-0.033	-0.135
	(-0.37)	(-0.16)	(-0.32)	(-0.08)	(-0.10)	(-0.40)
xLnOffer	0.144	0.124	0.135	0.096	0.138	0.184
	(10.81)***	(10.05)***	(10.24)***	(7.90)***	(10.90)***	(13.36)***
LnAssets	-0.080	-0.064	-0.075	-0.051	-0.083	-0.103
	(-10.28)***	(-9.27)***	(-9.68)***	(-7.10)***	(-10.77)***	(-12.91)***
LnAge	-0.016	-0.021	-0.016	-0.019	-0.017	-0.018
	(-1.58)	(-2.03)**	(-1.57)	(-1.85)*	(-1.67)*	(-1.78)*
Retention	-0.972	-0.931	-0.994	-1.023	-0.941	-0.846
	(-11.68)***	(-11.11)***	(-11.94)***	(-12.24)***	(-11.28)***	(-10.12)***
Expansion	0.872	0.886	0.870	0.875	0.891	0.879
	(15.78)***	(16.02)***	(15.72)***	(15.73)***	(16.15)***	(16.05)***
1/Midpoint	-0.021	-0.021	-0.022	-0.023	-0.019	-0.016
	(-1.97)**	(-1.88)*	(-2.05)**	(-2.10)**	(-1.76)*	(-1.45)
VCDummy	0.162	0.154	0.166	0.175	0.145	0.133
	(8.69)***	(8.22)***	(8.91)***	(9.37)***	(7.69)***	(7.11)***
HiTechDummy	0.086	0.083	0.089	0.096	0.076	0.069
	(3.54)***	(3.42)***	(3.68)***	(3.97)***	(3.15)***	(2.85)***
Underpricing	0.004	0.005	0.004	0.005	0.005	0.005
	(18.63)***	(19.26)***	(18.60)***	(18.96)***	(19.03)***	(18.98)***
QFTDAdj	-0.017	-0.016	-0.017	-0.015	-0.017	-0.017
	(-7.70)***	(-7.16)***	(-7.58)***	(-6.93)***	(-7.63)***	(-8.02)***
OIBD/AssetsAdj	0.008	0.007	0.008	0.006	0.009	0.010
	(2.00)**	(1.69)*	(1.90)*	(1.41)	(2.09)**	(2.46)**
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Ind. Dummies	Yes	Yes	Yes	Yes	Yes	Yes
R^2	5,087	5,087	5,087	5,087	5,087	5,087
N	0.4287	0.4282	0.4270	0.4213	0.4307	0.4382

Table 9. Relationship between lead IPO underwriter centrality and post-IPO stock return performance

The sample consists of IPOs conducted in 1980-2009. Degree, Indegree, Outdegree, Betweenness, Eigenvector, and 2-StepReach are measures of lead IPO underwriter centrality as described in Section 5.1. 1YearHPRAdj is the IPO firms' one-year holding period return calculated by compounding daily returns over 252 trading days after the IPO (excluding the first trading day's return) adjusted for (minus) the holding period return of the NASDAQ value-weighted index over the same period. If an IPO firm is delisted before the end of the one-year period, returns of the IPO firm and NASDAQ value-weighted index are compounded until the delisting date. MktShare is the lead underwriter's share of total proceeds raised in the IPO market in the previous five years. xMktShare is the residuals from a regression of MktShare on six lead IPO underwriter centrality measures. LnOffer is the natural logarithm of the IPO issue offer size. xLnOffer is the residuals from a regression of LnOffer on six lead IPO underwriter centrality measures. LnAssets is the natural logarithm of the book value of total assets at the end of the fiscal year prior to the IPO. LnAge is the natural logarithm of one plus the number of years from IPO firm founding year to the IPO issue year. Retention is the ratio of the number of shares retained by IPO firm existing shareholders over the sum of the number of such retained shares and the number of secondary shares offered in the IPO by existing shareholders. Expansion is the ratio of the number of newly issued shares offered in the IPO over the sum of the number of such newly issued shares and the number of existing shares retained by IPO firm existing shareholders. 1/Midpoint is the reciprocal of the midpoint of the initial filing range. VCDummy is a dummy equal to one for VC-backed IPOs. HiTechDummy is a dummy equal to one for hi-tech IPOs. Underpricing is the percentage difference between the first trading day closing price and the IPO offer price. QFTDAdj is the industry-adjusted Tobin's Q ratio calculated as the ratio of the market value of assets to the book value of assets, where the market value of assets is equal to the book value of assets minus the book value of common equity plus the number of shares outstanding times the first trading day closing price. The number of shares outstanding is as of the first trading day. The number of shares outstanding and the share price for industry peers is taken from the first available post-IPO quarter on Compustat. The book value of assets and the book value of equity both for IPO firms and industry peers are taken from the first available post-IPO quarter on Compustat. Industry adjustment is performed by subtracting the contemporaneous median Tobin's Q of IPO firm's 2-digit SIC code industry peers. All regressions include year dummies. *t*-statistics are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable	1YearHPRAdj	1YearHPRAdj	1YearHPRAdj	1YearHPRAdj	1YearHPRAdj	1YearHPRAdj
Intercept	-0.629	-0.703	-0.630	-0.680	-0.678	-0.715
	(-2.10)**	(-2.38)**	(-2.11)**	(-2.28)**	(-2.26)**	(-2.40)**
Degree	0.377					
	(2.61)***					
Indegree		1.131				
		(2.33)**				
Outdegree			0.368			
			(2.62)***			
Betweenness				0.603		
				(1.83)*		
Eigenvector					0.265	
					(1.60)	
2-StepReach						0.068
						(1.24)
xMktShare	0.057	0.075	0.060	0.086	0.096	0.083
	(0.12)	(0.16)	(0.12)	(0.18)	(0.20)	(0.17)
xLnOffer	-0.035	-0.044	-0.037	-0.049	-0.047	-0.046
	(-1.93)*	(-2.59)***	(-2.03)**	(-2.91)***	(-2.73)***	(-2.43)**
LnAssets	0.037	0.044	0.038	0.045	0.044	0.044
	(3.75)***	(4.90)***	(3.88)***	(4.93)***	(4.42)***	(4.33)***
LnAge	-0.005	-0.007	-0.005	-0.006	-0.006	-0.007
	(-0.38)	(-0.53)	(-0.37)	(-0.47)	(-0.48)	(-0.51)
Retention	-0.065	-0.049	-0.073	-0.085	-0.065	-0.060
	(-0.55)	(-0.41)	(-0.62)	(-0.72)	(-0.55)	(-0.51)
Expansion	-0.346	-0.341	-0.347	-0.344	-0.339	-0.342
	(-4.55)***	(-4.48)***	(-4.56)***	(-4.52)***	(-4.45)***	(-4.50)***
1/Midpoint	0.003	0.004	0.003	0.003	0.003	0.003
	(0.23)	(0.25)	(0.21)	(0.19)	(0.24)	(0.24)
VCDummy	-0.020	-0.022	-0.019	-0.015	-0.021	-0.020
	(-0.78)	(-0.86)	(-0.73)	(-0.59)	(-0.80)	(-0.75)
HiTechDummy	0.094	0.095	0.095	0.098	0.095	0.096
	(3.54)***	(3.55)***	(3.57)***	(3.69)***	(3.55)***	(3.58)***
Underpricing	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	(-0.98)	(-0.81)	(-1.00)	(-0.89)	(-0.86)	(-0.86)
QFTDAdj	0.001	0.002	0.001	0.002	0.002	0.002
	(0.38)	(0.56)	(0.38)	(0.52)	(0.52)	(0.55)
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.0343	0.0341	0.0343	0.0337	0.0335	0.0334
N	5,371	5,371	5,371	5,371	5,371	5,371

Table 10. Two-stage least squares regression analysis of the effect of a potentially exogenous change in lead IPO underwriter centrality on IPO characteristics

The sample consists of IPOs conducted in 1980-2009. In first stage regressions GS takes values of zero, one, and two for IPOs conducted in 1980-1999, 2000-2004, and 2005-2009, respectively. In second stage regressions DegreeHat is the predicted value of Degree from first stage regressions. Degree is a measure of lead IPO underwriter centrality as described in Section 5.1. Underpricing is the percentage difference between the first trading day closing price and the IPO offer price. MktShare is the lead underwriter's share of total proceeds raised in the IPO market in the previous five years. xMktShare is the residuals from a regression of MktShare on six lead IPO underwriter centrality measures. LnOffer is the natural logarithm of the IPO issue offer size. xLnOffer is the residuals from a regression of LnOffer on six lead IPO underwriter centrality measures. LnAssets is the natural logarithm of the book value of total assets at the end of the fiscal year prior to the IPO. LnAge is the natural logarithm of one plus the number of years from IPO firm founding year to the IPO issue year. Retention is the ratio of the number of shares retained by IPO firm existing shareholders over the sum of the number of such retained shares and the number of secondary shares offered in the IPO by existing shareholders. Expansion is the ratio of the number of newly issued shares offered in the IPO over the sum of the number of such newly issued shares and the number of existing shares retained by IPO firm existing shareholders. 1/Midpoint is the reciprocal of the midpoint of the initial filing range. VCDummy is a dummy equal to one for VC-backed IPO firms. HiTechDummy is a dummy equal to one for hi-tech IPO firms. OIBD/AssetsAdj is the operating income before depreciation over the book value of assets at the end of the fiscal year prior to the IPO adjusted for the contemporaneous median OIBD/Assets of 2-digit SIC code industry peers. *t*-statistics of first stage regressions and *z*-statistics of second stage regressions are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Panel A: The effect of lead IPO underwriter centrality on absolute offer price revision, IPO and secondary market valuation, and IPO initial return
AbsRevision is the absolute percentage difference between the IPO offer price and the midpoint of initial filing range. QFTDAdj and QOPAdj are the industry-adjusted Tobin's Q ratios calculated using first trading day price and IPO offer price, respectively. PriorMktReturn is the return on the CRSP value-weighted index over the 30-day period prior to the IPO. AbsMktReturn is the absolute return on the CRSP value-weighted index between the filing date and the IPO issue date. FilingWidth20Dummy is a dummy equal to one for IPOs with filing width (the difference between the high filing price and the low filing price in the initial filing range divided by the high filing price) of 20% or more. PosRevDummy is a dummy equal to one for firms with positive price revision. AveUnderpricing is the average underpricing of all IPOs in the previous month.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent	I-stage	II-stage	I-stage	II-stage	I-stage	II-stage	I-stage	II-stage
variable	Degree	AbsRevision	Degree	QFTDAdj	Degree	QOPAdj	Degree	Underpricing
Intercept	-0.595	0.058	-0.600	15.386	-0.600	12.623	-0.548	-28.897
	(-15.28)***	(0.62)	(-31.65)***	(8.32)***	(-31.65)***	(11.00)***	(-14.68)***	(-1.35)
GS	0.049		0.047		0.047		0.048	
	(22.70)***		(21.44)***		(21.44)***		(23.59)***	
DegreeHat		0.295		7.115		5.720		-4.943
		(3.49)***		(3.05)***		(3.95)***		(-0.25)
xMktShare	0.076	0.221	0.102	11.665	0.102	2.865	0.074	92.125
	(1.56)	(2.36)**	(2.05)**	(4.71)***	(2.05)**	(1.86)*	(1.61)	(4.31)***
xLnOffer	-0.054	0.022	-0.056	1.076	-0.056	0.648	-0.068	-0.789
	(-34.81)***	(4.18)***	(-34.82)***	(7.01)***	(-34.82)***	(6.80)***	(-44.43)***	(-0.52)
LnAssets	0.038	-0.005	0.042	-0.837	0.042	-0.686	0.033	0.309
	(44.65)***	(-1.30)	(48.16)***	(-7.01)***	(48.16)***	(-9.26)***	(37.60)***	(0.37)
LnAge	-0.007	-0.010	-0.009	-0.266	-0.009	-0.038	-0.007	-3.052
	(-4.99)***	(-3.70)***	(-6.03)***	(-3.57)***	(-6.03)***	(-0.82)	(-5.05)***	(-4.87)***
Retention	-0.004	0.080	-0.011	1.586	-0.011	0.306	-0.021	19.054
	(-0.36)	(3.56)***	(-0.89)	(2.63)***	(-0.89)	(0.82)	(-1.91)*	(3.65)***
Expansion	-0.002	-0.085	-0.017	-5.300	-0.017	-2.789	0.011	-20.761
	(-0.27)	(-6.00)***	(-2.11)**	(-13.39)***	(-2.11)**	(-11.36)***	(1.55)	(-6.35)***
1/Midpoint	-0.005	-0.004	-0.004	0.057	-0.004	-0.010	-0.003	3.225
	(-3.43)***	(-1.71)*	(-2.48)**	(0.71)	(-2.48)**	(-0.20)	(-2.57)**	(5.07)***
VCDummy	0.024	0.043	0.023	0.422	0.023	0.032	0.020	4.329
	(9.19)***	(7.84)***	(8.63)***	(2.86)***	(8.63)***	(0.36)	(7.94)***	(3.45)***
HiTechDummy	0.024	0.028	0.032	0.210	0.032	-0.171	0.016	0.777
	(6.85)***	(3.97)***	(11.79)***	(1.27)	(11.79)***	(-1.67)*	(5.03)***	(0.49)
PosRevDummy							0.025	18.967
							(10.98)***	(15.76)***
PriorMktReturn							-0.026	62.962
							(-0.86)	(4.43)***
AbsMktReturn	0.025	0.152						
	(1.18)	(3.68)***						
FilingWidth20Dummy	-0.032	0.050						
	(-9.25)***	(6.98)***						
OIBD/AssetsAdj			-0.005	0.002	-0.005	0.000		
			(-7.13)***	(0.06)	(-7.13)***	(0.00)		
AveUnderpricing							0.001	0.701
							(17.28)***	(21.92)***
Ind. Dummies	Yes	Yes	No	No	No	No	Yes	Yes
Exch. Dummies	No	No	No	No	No	No	Yes	Yes
Centered R^2	5,486	5,486	0.4701	0.1442	0.4701	0.1109	0.5453	0.2897
N	0.4760	0.1318	5,087	5,087	5,087	5,087	5,450	5,450
F-statistic	515.16		459.83		459.83		556.44	
(*p*-value)	(0.000)		(0.000)		(0.000)		(0.000)	

Table 10. Two-stage least squares regression analysis of the effect of a potentially exogenous change in lead IPO underwriter centrality on IPO characteristics (continued)

Panel B: The effect of lead IPO underwriter centrality on the number of analysts following IPO firm, the number of institutional investors holding IPO firm shares, secondary market stock liquidity, and post-IPO stock return performance

LnNumAn is the natural logarithm of the number of analysts following the firm at the end of the fiscal year of the IPO. LnInstN is the natural logarithm of the number of institutional investors holding IPO firm shares at the end of the first calendar quarter after the IPO. LnTurnover is the natural logarithm of the average monthly shares traded as a percentage of total shares outstanding over the one-year period after the IPO. 1YearHPRAdj is the IPO firms' one-year holding period return calculated by compounding daily returns over 252 trading days after the IPO (excluding the first trading day's return) adjusted for (minus) the holding period return of the NASDAQ value-weighted index over the same period. If an IPO firm is delisted before the end of the one-year period, returns of the IPO firm and NASDAQ value-weighted index are compounded until the delisting date.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent	I-stage	II-stage	I-stage	II-stage	I-stage	II-stage	I-stage	II-stage
variable	Degree	LnNumAn	Degree	LnInstN	Degree	LnTurnover	Degree	1YearHPRAdj
Intercept	-0.454	-0.232	-0.691	0.103	-0.696	3.078	-0.579	-0.549
	(-7.35)***	(-0.54)	(-15.22)***	(0.24)	(-15.62)***	(7.00)***	(-32.21)***	(-1.66)*
GS	0.046		0.045		0.045		0.049	
	(20.59)***		(20.43)***		(21.11)***		(23.56)***	
DegreeHat		2.767		4.329		0.826		0.166
		(9.05)***		(12.10)***		(2.30)**		(0.39)
xMktShare	0.129	0.227	0.053	-0.109	0.040	-0.613	0.013	0.299
	(2.61)***	(0.73)	(1.09)	(-0.31)	(0.83)	(-1.70)*	(0.27)	(0.62)
xLnOffer	-0.075	0.218	-0.065	0.545	-0.061	0.156	-0.056	-0.054
	(-43.59)***	(8.62)***	(-40.07)***	(20.89)***	(-39.27)***	(6.25)***	(-36.25)***	(-1.96)*
LnAssets	0.034	0.036	0.043	0.121	0.044	-0.044	0.040	0.043
	(29.04)***	(2.55)**	(45.05)***	(6.41)***	(49.51)***	(-2.32)**	(49.49)***	(2.08)**
LnAge	-0.005	0.000	-0.005	0.016	-0.005	-0.018	-0.006	-0.004
	(-3.13)***	(0.00)	(-3.52)***	(1.41)	(-3.47)***	(-1.68)*	(-4.71)***	(-0.26)
Retention	0.008	-0.015	-0.016	-0.575	-0.026	-0.686	-0.017	-0.168
	(0.65)	(-0.18)	(-1.31)	(-6.57)***	(-2.24)**	(-7.72)***	(-1.44)	(-1.44)
Expansion	0.026	-0.156	0.018	-0.115	0.013	1.090	0.018	-0.345
	(3.04)***	(-2.87)***	(2.18)**	(-1.92)*	(1.63)	(18.60)***	(2.45)**	(-4.60)***
1/Midpoint	-0.995	-0.609	-0.032	-0.208	-0.005	-0.037	-0.005	0.004
	(-18.99)***	(-1.37)	(-4.90)***	(-4.27)***	(-3.09)***	(-3.13)***	(-3.65)***	(0.27)
VCDummy	0.003	0.125	0.014	0.277	0.019	0.197	0.020	-0.017
	(0.92)	(6.67)***	(5.17)***	(13.24)***	(7.27)***	(9.36)***	(7.72)***	(-0.61)
HiTechDummy	0.020	0.077	0.022	0.103	0.021	0.148	0.027	0.070
	(4.93)***	(2.94)***	(6.04)***	(3.67)***	(6.26)***	(5.36)***	(10.13)***	(2.35)**
Underpricing	0.000	0.001	0.000	0.003	0.000	0.006	0.000	-0.001
	(9.18)***	(2.89)***	(8.84)***	(12.48)***	(10.04)***	(20.67)***	(11.00)***	(-1.94)*
QFTDAdj	0.002	0.003	0.003	-0.002	0.003	-0.016	0.002	0.001
	(6.17)***	(1.16)	(8.51)***	(-0.66)	(8.40)***	(-6.22)***	(7.94)***	(0.37)
OIBD/AssetsAdj	-0.003	0.007	-0.004	0.001	-0.004	0.000		
	(-5.23)***	(1.73)*	(-6.59)***	(0.24)	(-7.18)***	(0.05)		
Ind. Dummies	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Centered R^2	0.5384	0.3120	0.5143	0.6582	5,087	5,087	0.4850	0.0183
N	3,945	3,945	4,700	4,700	0.5266	0.3160	5,371	5,371
F-statistic	424.14		417.45		445.78		554.96	
(*p*-value)	(0.000)		(0.000)		(0.000)		(0.000)	

Table 11. Relationship between lead IPO underwriter centrality and pre-IPO media coverage of firms going public

The sample consists of IPOs conducted in 1980-2009. Degree, Indegree, Outdegree, Betweenness, Eigenvector, and 2-StepReach are measures of lead IPO underwriter centrality as described in Section 5.1. Headline is the number of times major English language publications in the U.S. have mentioned the IPO firm name in article headlines in the two months prior to IPO. Article is the number of times major English language publications in the U.S. have mentioned the IPO firm name in full articles in the two months prior to IPO. SpecialReports is the number of special reports aired on ABC, CBS, and NBC in the past two months prior to IPO. MktShare is the lead underwriter's share of total proceeds raised in the IPO market in the previous five years. xMktShare is the residuals from a regression of MktShare on six lead IPO underwriter centrality measures. LnAssets is the natural logarithm of the book value of total assets at the end of the fiscal year prior to the IPO. LnAge is the natural logarithm of one plus the number of years from IPO firm founding year to the IPO issue year. VCDummy is a dummy equal to one for VC-backed IPOs. HiTechDummy is a dummy equal to one for hi-tech IPOs. All regressions are negative binomial maximum-likelihood estimations. All regressions include 2-digit SIC industry code and trading exchange dummies. *z*-statistics are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Headline	Headline	Headline	Headline	Headline	Headline	Article	Article	Article	Article	Article	Article
Constant	-3.353	-4.034	-3.283	-3.903	-4.186	-3.523	-1.634	-2.298	-1.539	-2.146	-2.406	-1.882
	(-3.44)***	(-4.12)***	(-3.37)***	(-3.98)***	(-4.25)***	(-3.63)***	(-2.51)**	(-3.48)***	(-2.36)**	(-3.22)***	(-3.59)***	(-2.90)***
Degree	1.767						2.333					
	(7.95)***						(11.33)***					
Indegree		3.317						5.100				
		(3.61)***						(6.15)***				
Outdegree			1.821						2.433			
			(8.37)***						(11.99)***			
Betweenness				2.297						2.707		
				(3.66)***						(4.35)***		
Eigenvector					-0.179						-0.323	
					(-0.55)						(-1.06)	
2-StepReach						0.732						0.870
						(8.91)***						(12.20)***
SpecialReports	-0.029	-0.030	-0.029	-0.030	-0.030	-0.029	-0.034	-0.033	-0.034	-0.034	-0.034	-0.032
	(-12.77)***	(-12.78)***	(-12.75)***	(-12.93)***	(-12.93)***	(-12.34)***	(-17.17)***	(-16.77)***	(-17.23)***	(-17.16)***	(-17.02)***	(-16.64)***
xMktShare	-0.619	-0.345	-0.616	-0.567	-0.290	-0.243	-0.843	-0.151	-0.862	-0.503	-0.056	0.021
	(-0.67)	(-0.39)	(-0.66)	(-0.63)	(-0.33)	(-0.27)	(-0.97)	(-0.19)	(-0.99)	(-0.61)	(-0.07)	(0.03)
LnAssets	0.160	0.203	0.156	0.194	0.214	0.160	0.219	0.264	0.214	0.257	0.277	0.220
	(8.08)***	(10.59)***	(7.89)***	(9.95)***	(10.85)***	(8.12)***	(13.01)***	(15.92)***	(12.73)***	(15.16)***	(16.18)***	(12.95)***
LnAge	-0.092	-0.114	-0.087	-0.106	-0.117	-0.097	-0.117	-0.145	-0.111	-0.137	-0.149	-0.126
	(-2.91)***	(-3.60)***	(-2.77)***	(-3.34)***	(-3.67)***	(-3.09)***	(-4.11)***	(-5.00)***	(-3.91)***	(-4.68)***	(-5.07)***	(-4.39)***
VCDummy	0.320	0.337	0.318	0.342	0.343	0.312	0.260	0.289	0.255	0.290	0.299	0.267
	(5.71)***	(5.93)***	(5.68)***	(6.05)***	(6.04)***	(5.54)***	(5.19)***	(5.63)***	(5.11)***	(5.67)***	(5.81)***	(5.29)***
HiTechDummy	0.530	0.560	0.530	0.574	0.593	0.517	0.441	0.456	0.442	0.483	0.490	0.408
	(7.54)***	(7.84)***	(7.56)***	(8.13)***	(8.31)***	(7.31)***	(7.19)***	(7.27)***	(7.22)***	(7.72)***	(7.77)***	(6.61)***
Ind. Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exch. Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.0662	0.0633	0.0666	0.0634	0.0626	0.0668	0.0615	0.0583	0.0621	0.0577	0.0570	0.0617
N	3,439	3,439	3,439	3,439	3,439	3,439	3,439	3,439	3,439	3,439	3,439	3,439