Does information production attract more information producers?

TeWhan Hahn
Auburn University at Montgomery

Heather Rhodes
University of North Alabama

ABSTRACT

This study documents that information production in the pre-market attracts more potential information producers in the after-market for IPOs. The potential information producers examined were all-star analysts by the end of the first year after the IPO, number of analysts, and number of institutional investors by the end of immediate quarter after the IPO. The results show that information production in the pre-market, proxied by the absolute price update from the mid-file price to offer price, is positively and statistically significantly correlated with number of analysts and number of institutional investors in the after-market. All-star analyst coverage is not statistically significantly correlated with information production in the pre-market.

Keywords: price update, information production, initial public offerings

INTRODUCTION

Prior studies that examine Initial Public Offering (IPOs) suggest that underpricing of IPOs may increase information production by investors in the pre-market. For example, in the models of Ritter (1984) and Beatty and Ritter (1986), which build upon Rock's (1986) model explaining the persistence of IPO underpricing, greater uncertainty in the true value of an IPO gives outside investors incentives to produce private information because the value of private information increases with uncertainty. Specifically, the greater the risk, that is, the uncertainty the investor faces about the after-market value of the IPO, the greater the compensation (i.e., underpricing) to investors for producing information, or becoming informed about the true value of the offering. As a result, greater uncertainty in the value of an IPO can induce more investors to become informed through information production.

Empirical evidence supports this prediction (Megginson and Weiss 1991; Ritter 1984; Beatty and Ritter 1986; Ljungqvist and Wilhelm Jr 2005; Benveniste et al. 2003). For example, Megginson and Weiss (1991) demonstrate that venture capitalists (VCs) play a certification role that reduces uncertainty regarding the true value of an IPO and that VC-backed offerings have lower levels of underpricing than comparable non-VC-backed IPOs. Thus, because investors face less uncertainty, they produce less information in the pre-market and receive less compensation when an issue is VC-backed. In addition, Sherman and Titman (2002) build a model that predicts that greater underpricing is the reward to investors for the amount of information produced during the pre-market and that more investors participate in offerings when accurate pricing of shares is more important (i.e. when there is greater uncertainty about the value of the firm). Lowry, Officer, and Schwert (2010) produce empirical results consistent with such predictions; IPOs that are more difficult to value have higher average underpricing (see also, Muscarella and Vetsuypens 1989; Ritter 1991). The results of Beatty and Ritter (1986) and Booth and Chua (1996) suggest greater pre-market investor involvement in more underpriced offerings, as offerings with greater underpricing are more oversubscribed. Cornelli and Goldreich (2001 and 2003) provide evidence that underwriters reward investors who provide information in their bids with more favorable share allocations and that these bids are important in setting the offer price. Chemmanur (1993) also shows that a lower offer price in the form of a larger discount induces more outsiders to produce information to identify the quality of high-value firms. In general, prior studies suggest that more underpricing reflects more information production in the pre-market, and less information asymmetry in the after-market.

In other studies, information production in the after-market by particular types of informed investors such as analysts and institutional investors is one of the inevitable consequences of underpricing. For example, Rajan and Servaes (1997) and Aggarwal, Krigman, and Womack (2002) find that underpricing is positively related to analyst coverage of the new issues in the IPO after-market. Furthermore, Brennan and Subrahmanyam (1995) find that greater analyst following tends to reduce adverse selection costs. Li, McInish, and Wongchoti (2005) find that immediately after the IPO, asymmetric information is lower and initial underpricing significantly decreases asymmetric information.

These studies suggest that there is a potential link between pre-market and after-market information production in IPOs; offerings that are more difficult to value and those with greater investor involvement in the pre-market are more underpriced and more underpriced offerings tend to be associated with more information producers in the after-market. However, the existing literature has not investigated this link directly. The goal of this study is to test whether

information production of IPOs in the pre-market attracts more potential information producers in the immediate period after the IPO.

The next section sets up the empirical framework and elaborates on the potential link between pre-market and after-market information production. It also discusses the variables and data. The following section presents the empirical results and the last section concludes.

EMPIRICAL FRAMEWORK, VARIABLES, AND DATA

It is arguable that greater pre-market information production may spur increased interest by after-market information producers like institutional investors and analysts for at least four reasons. First, institutional investors are the key information producers during the IPO pre-market and the information they acquire may be profitable to them in the after-market. As Cornelli and Goldreich (2001) document, the managing underwriters of IPOs rely on institutional investors to provide indications of interest during the bookbuilding stage of the offering to aid in setting the final offer price. As a result of their information-producing activities in the pre-market, institutional investors have an informational advantage on the firms on whom they have expended greater effort to collect private information and may remain involved with such firms because they can trade profitably on the information they possess in the after-market (Kahn and Winton 2002).

Second, in instances in which they have already borne significant costs of acquiring private information, institutional investors may remain involved with IPO firms because their existing informational advantage makes them better monitors of firm managers and reduces the cost of producing information in the future. Low-cost monitoring is beneficial to both the investors and the IPO firm as it reduces informational asymmetries, which in turn reduce the likelihood of management misappropriation of shareholder wealth and the agency costs that other investors pass back to the firm (Jensen and Meckling 1976).[1] As a result, such investments may be highly valuable to the institutional investors. Likewise, low-cost monitoring makes it easier for the institutional investors to produce accurate information on the firm in the after-market.

Third, there may be greater institutional investment in the after-market in IPO firms upon which more information has been produced in the pre-market because said information reduces the uncertainty regarding the true value of the firm and its operations. That is, institutional investors are more likely to demand shares of stock in those firms in which they are more confident about the intrinsic value because they are less likely to lose money on their investments. In this case, they also face less risk in losing reputational capital based on any information they produce in the after-market (i.e., they can be more confident in any after-market information they produce). On the other hand, because the literature suggests that greater pre-market information production occurs in IPOs that tend to be riskier (i.e., there is greater up-front uncertainty regarding the true value of the firm), it is possible that institutional investors may be deterred from investing in and producing information on such firms for fear that their decisions are based on information that ultimately proves to be inaccurate.

[1] The following studies are just a few that investigate the role and impact of institutional investors as monitors: Shleifer and Vishny (1986); Brickley et al. (1988); Pound (1988); McConnell and Servaes (1990); Coffee (1991); Barclay and Holderness (1991); Admati, et al (1994); Stoughton and Zechner (1998); Kahn and Winton (2002); Navissi and Naiker (2006); Cornett et al. (2007); Elyasiani and Jia (2010); Demiralp et al. (2011).

Fourth, the security analysts employed by institutional investors and brokers, who enjoy a comparative advantage in information production, may be more likely to follow a firm upon which more information has been previously generated because the existing information to which they are often privy reduces their costs of collecting information going forward. That is, the more they know about an IPO firm up front, the lower their cost of producing information in the future and the more likely they may be to follow the firm. However, the flip side of this is consistent with the alternative in the third point above; because firms upon which more information is produced in the pre-market tend to be riskier, analysts may prefer to avoid such firms for fear of losing reputational capital in the event that the information upon which they base their initial forecasts and recommendations proves to be inaccurate.

Previous studies have shown evidence that underpricing (the percentage change from the offer price to the closing price on the first day of trading) is greater on firms upon which more information is produced in the pre-market. Thus, underpricing is a potential proxy for pre-market information production. However, we intentionally avoid using underpricing as a proxy and choose instead to use the absolute value of the price update (the percentage change from the midpoint of the filing range to the offer price). There are at least four reasons why we use the price update as an information production proxy in the pre-market.

First, as the change from the midpoint of the filing range (the underwriter's initial estimate of the value of the firm based on its own analysis of the firm prior to soliciting information from institutional investors) to the final offer price (which reflects all information provided by investors during the bookbuilding phase), the price update is a direct measure of the amount of *new* information produced by investors in the pre-market (Benveniste and Spindt 1989; Hanley 1993). If investors provide information that the firm is more valuable than the underwriter initially believed, the offer price is revised upward from the midpoint of the filing range. On the other hand, if investors suggest that the IPO is worth less, then the offer price is revised downward. Since new information is provided in either case, it makes sense to evaluate the absolute value of the price update as a proxy of information production. Second, the price update has been used as an information production proxy in the existing IPO literature. Lowry and Schwert (2002) model initial returns using information that is known prior to the offering and use the price update as one measure of information produced during the registration period. They find that the average initial returns on other firms that go public during the same time period as a particular IPO do not impact the degree of underpricing on that issue; rather the extent of underpricing on an issue is related to information produced on similar IPO firms that are in registration around the same time as the issue itself. The current study conjectures that the information produced and revealed on similar IPO firms who share registration periods can be better captured by the price update on the IPO firm of interest. Consistent with this view, Corwin and Schultz (2005), in their study on the role of syndicates, found evidence of information production by syndicate members. The information production measures used were initial underpricing and the price update. Third, initial underpricing has been used as the key independent variable in other empirical studies with different focus (Cliff and Denis, 2004; and Zheng and Li, 2008[2]) to explain analyst coverage and institutional investor ownership, the same

[2] In these studies, while initial underpricing was used as the key independent variable, the focus was testing whether analysts' coverage and institutional ownership can be viewed as motives of initial underpricing. While in the reported results, the current study uses absolute price update as information production proxy in the pre-market, no material change in the results was found when initial return or total return (i.e., price update plus initial return) was used instead.

dependent variables in this study's empirical model. Thus, we avoid underpricing as an information production proxy so that our results are not confounded by other potential explanations. Fourth, arguably the price update will be a better information production proxy because initial underpricing could be caused in part by noise traders. Assuming noise traders would hinder the production of information rather than contribute to it, initial underpricing can be considered at best a noisier proxy for information production than the price update is. Consistent with this argument, Ritter (1991) provides evidence that in certain periods investors are overoptimistic and as a result, bid up secondary market prices, causing unusually high levels of IPO underpricing.

In formulating the empirical model, we regress the involvement of potential information producers in IPOs on information production in the pre-market after controlling for IPO characteristics, market and monetary policy environment, uncertainty measures, quality certification, and industry classification. As previously indicated, the independent variable of interest in this study is the absolute price update and the dependent variables are the involvement of potential information producers in IPOs, namely analysts and institutional investors in the after-market. Because they are possible predictors of the involvement of information producers in IPOs in the after-market, this study includes IPO characteristics, uncertainty measures, venture capital backing and underwriter certification measures, industry classification, and indicators of market and monetary policy environment. Following two sections define the dependent and independent variables and explain why these variables may have predictive power over the involvement of IPO after-market information producers.

Independent Variables

Absolute Price Update: This study uses the absolute price update as an information production proxy in the pre-market for IPOs. As previously discussed, analysts and institutional investors, as potential information producers in the after-market for IPOs, may condition their involvement[3] in IPOs on information already available about the IPOs. Again, as the change from the midpoint of the filing range (the underwriter's initial estimate of the value of the firm based on its own analysis of the firm prior to soliciting information from institutional investors) to the final offer price (which reflects all information provided by investors during the bookbuilding phase), the price update is a direct measure of the amount of *new* information produced by investors in the pre-market. When new positive information is revealed during the registration period, the final offer price is likely to be revised upward from the mid-file price and when negative information is revealed, it is likely to be revised downward. Therefore, if potential information producers prefer initiating their involvement with IPOs for which more information is available, a larger absolute price update is expected to be correlated with more analyst coverage and/or a greater number of institutional investors' ownership in IPOs.

IPO Characteristics: A number of IPO characteristics may impact potential information producers' involvement with IPOs after the offering. The size of the firm may indicate the information available about the firm. Therefore, to control for the size effect, we include the natural logarithm of market capitalization (computed using the offer price) and the natural logarithm of the offering proceeds as proxies of firm size and offering size, respectively (Lowry

[3] For analysts, involvement means producing research reports about IPOs by research coverage. For institutional investors, involvement means producing research reports by their research teams and/or having equity ownership in the IPOs.

and Schwert, 2004). In addition, to control for a possible liquidity effect on information producers' involvement with IPOs after the offering, this study includes the percentage of primary (i.e., newly issued) shares as a proportion of total shares in the offering.

Uncertainty: Because there is variation in information availability and firm quality among IPOs, there is also variation in the ex-ante uncertainty regarding firm value. We use the following variables as ex-ante uncertainty measures: IPO firm's age (Habib and Ljungqvist 2001, Carter et al. 1998, Carter and Manaster 1990, Ritter, 1984), number of days following the IPO date over which insiders shares are prohibited from selling, sales in the year preceding the offering (Ritter 1984, Arugaslan et al. 2004), and EBIT in the year preceding the offering (Purnanandam and Swaminathan 2004). When insiders consent to retain shares for a longer period of time following the offering, they signal to outside investors firm quality, as the true value of the firm is more likely to be discovered the more time that passes before they are permitted to sell. Thus, insiders of high-quality firms are more willing to wait longer to sell shares than those of low-quality firms and the number of lockup days serves to reduce outsiders' ex ante uncertainty regarding the value of the firm. Such predictions flow naturally from the asymmetric information models developed by Leland and Pyle (1977), Kyle (1985), and Leland (1992). Ritter (1984) establishes that firm age and annual sales are potential proxies for the degree of ex ante uncertainty regarding firm value as young firms and those with little or no operating history clearly have limited available information upon which to judge firm value. Similar arguments can be made regarding firms with little or no EBIT data. A potentially limiting factor for the current study is that sales and EBIT data are missing for a number of observations in the dataset. In order to preserve observations with missing sales and EBIT data, we utilize two dummy variables to take the place of the sales and EBIT variables. If an IPO firm reports a positive number for sales in the year prior to the IPO, the Positive Sales Dummy equals one; it equals zero otherwise. Similarly, if an IPO firm reports a positive EBIT value in the year prior to the offering, the Positive EBIT Dummy equals one and zero otherwise. We include these variables because they may signal information availability or quality to potential information producers and therefore can predict their involvement with IPOs.

Quality Certification: Issuers who employ highly reputable underwriters or who are backed by venture capitalists are more likely to be targets of potential information producers' involvement since more prestigious underwriters (Carter et al. 1998, Gompers 1996, Carter and Manaster 1990) and venture capitalists (Loughran and Ritter 2004, Bradley and Jordan 2002, Aggarwal et al. 2002) have broader and deeper relationships with analysts and institutional investors and because they participate in the IPO market on a repeat basis and have reputational capital at stake, they are likely to endorse only the highest quality offerings. In addition, since they work with many IPO firms very closely, they would have more and better-quality information for different IPOs. We obtain data on underwriting ranking from Jay Ritter's website and code a venture capitalist (VC) backing dummy to equal one for issues with VC backing and zero for those without VC backing.

Market Conditions and Monetary Policy Environment: Stock market returns, number of IPOs (Cliff and Denis 2004) in the previous quarter, and the monetary policy environment can affect the attractiveness of involvement with IPOs and therefore can potentially predict information producers' involvement. As proxies for IPO market conditions, this study includes the natural logarithm of the number of IPOs in the previous quarter (the natural logarithm of IPO intensity), and a hot IPO market dummy, which equals one if an IPO firm goes public during a "hot" IPO market and equals zero otherwise. If the average initial return of IPOs in a particular

month is higher than that of all IPOs in the total sample, then that IPO market is deemed to be hot (Hahn, Ligon and Rhodes 2013). For the stock market condition variable, the CRSP value-weighted index return minus the yield on the 3-month T-bill (the preceding twekve month period market risk premium at the time of IPO), was used. In order to control for the impact of monetary policy on the interest rate environment, we consider utilizing four common interest rate variables; the 3-month Treasury rate relative to the long-term average, the term structure premium (computed as the difference between the yield on the 10-year Treasury and the yield on the 3-month Treasury), the default risk premium (computed as the difference between seasoned Baa-rated corporate bond yield and the 10-year Treasury rate), and a Fed dummy variable that equals one if the Fed funds rate one year after the offering is higher than it was on the offering date. However, these variables are strongly correlated and as a result, we run principal component analysis to reduce multicollinearity among the variables. From this analysis, we extract the first two principal components, Principal 1 and Principal 2, and use them in place of the 3-month Treasury rate, term structure premium, default risk premium and Fed dummy. We include these variables as controls in our analysis because they are used in asset pricing studies as risk factors and therefore may affect potential information producers' involvement with IPOs.

Industry Classification: Brigham and Daves (2014) recognize that the industry classification of a company can significantly affect its perceived business risk and as a result, industry classification can affect potential information producers' involvement with IPOs. This study specifically focuses on firms classified in the tech and internet industries. Data on tech and internet industry classification are obtained from Jay Ritter's website and this information was used to construct tech and internet industry dummy variables.

Dependent Variables

The dependent variables in this study capture the involvement of potential information producers in IPOs in the after-market. These variables are an all-star analyst dummy, number of analysts, and number of institutional investors. The all-star analyst dummy will have a value one if the IPO is covered by one of the top three all-star analysts by the end of the first year after the IPO. Number of analysts are the number of analysts covering the IPO by the end of the immediate quarter after the IPO. Number of institutional investors are the number of institutional investors having equity ownership in the IPO by the end of immediate quarter after the IPO.

Data

We obtain IPO data from Thomson Financial's SDC Global New Issues database. Our sample consists of firms completing IPOs for the period from 1998 to 2010. As is standard in the IPO literature, we exclude REITs (real estate investment trust funds), best efforts offerings, unit offerings and IPOs of closed end funds. We also exclude IPOs with non-positive equity book values; these firms may have different incentives for going public since many have suffered losses in the past. After applying these filters, we are left with 3,093 firm commitment offerings with complete data. As previously mentioned, many observations are missing sales and EBIT data. Thus, to preserve the sample size, we replace the sales and EBIT variables with two dummy variables capturing IPO firms with reported positive sales and EBIT values.

The dependent variables are the all-star analyst coverage dummy (indicating coverage by the end of the first year after the issue), the number of analysts covering the IPO firm, and the

number of institutional investors holding equity ownership in the IPO by the end of immediate quarter after the issue. All-star analyst coverage was obtained from Jay Ritter's IPO data web site. Number of analysts covering IPOs was obtained from the I.B.E.S. database and number of institutional investors for IPOs was obtained from 13F filings compiled by Thomson Reuters.

In the regressions, the effect of monetary policy environment around the IPO is controlled for through interest rate variables. We obtain data on interest rates from the St. Louis Federal Reserve Bank website. As previously mentioned, we attempt to include the default risk premium, term structure premium, 3-month Treasury yield and a Fed dummy in the analysis; however, due to multicollinearity issues among the four variables, we run principal component analysis and retain the first two principal components which have the largest eigenvalues (Principal 1 and Principal 2). These two principal components are supposed to be less severely correlated but retain most of the relevant information from the interest rate variables. Two other principal components are ignored due to significantly smaller eigenvalues they have. Principal 1, the first principal component, is positively correlated with the term structure premium and negatively correlated with the 3-month Treasury yield. This represents an interest rate environment with a normal (i.e. upward sloping) yield curve. Principal 2, the second principal component, is positively correlated with the Fed dummy and negatively correlated with the default risk premium. This represents restrictive monetary policy.

EMPIRICAL RESULTS

In Table 1 we report the means, standard deviations, minimum and maximum values for the variables utilized in our models. The average price update, percent of IPOs with all-star analyst coverage (all-star analyst dummy), average number of analysts covering the IPO, and average number of institutional investors for the IPO are 3.35%, 18.15%, 2.34 analysts, and 29.27 institutional investors, respectively. Based on the standard deviations and minimum and maximum values of the potential information producer variables, it is obvious that there is significant variation in the presence of these parties across our observations.

In Table 2, we report the correlations among the information producer variables and independent variables. Two variables, the natural logarithm of market cap and natural logarithm of proceeds are strongly correlated with each of the information producer variables. The results on natural logarithm of market cap and natural logarithm of proceeds are perhaps unsurprising; larger firms typically have larger offerings and more shares outstanding and as a result, there is greater opportunity for multiple institutions to invest in them. Likewise, larger firms tend to be more visible and less risky (from an informational uncertainty standpoint), and as a result, analysts may be more likely to follow them. Log of lock up days is negatively correlated with each of the information producer variables and this negative correlation is strongest with the all-star dummy and number of institutions. This initial observation is a bit surprising, given that longer lockup periods should theoretically be associated with IPO firms with less informational uncertainty given that insiders may be attempting to signal firm quality with the lockup period provision. The interest rate variables are highly and positively correlated with number of analysts only. It is interesting to find that the absolute price update shows a significantly higher correlation (0.1716) with number of institutional investors than with the all-star analyst dummy (0.0791) and number of analysts (0.0837). Underwriter rank is highly correlated with the all-star analyst dummy (0.2134) and with the number of institutions (0.2548) but the correlation is weaker with the number of analysts (0.0919).

In Table 3, we report the results of the regression analysis. A logistic regression model was run for the all-start analyst dummy model because the dependent variable, all-star analyst dummy,-has a binary outcome. Negative binomial regressions were run for the number of analysts and number of institutions because the dependent variables have countable outcomes.

Logistic regression results of all-star analyst coverage dummy

The results of the logistic regression on the all-star analyst dummy in the first two columns of Table 3 demonstrate that about 18.04% of the variation in this variable is captured by our model. The absolute price update is not significant in explaining the all-star analyst dummy and the coefficient is negative; this means that IPOs with larger absolute price updates exhibit lower probability of getting all-star analyst coverage.

Of the uncertainty and issue characteristic variables, only the natural logarithm of market capitalization, natural logarithm of lockup days, and natural logarithm of (1+ age) are statistically significant; the natural logarithm of market cap and natural logarithm of (1+ age) are positively and natural logarithm of lockup days is negatively correlated with the all-star analyst dummy. The results on the natural logarithm of market capitalization, natural logarithm of (1 + age) and natural logarithm of lockup days are consistent with what is observed among the univariate correlations reported in Table 2. As previously mentioned, because larger and older IPO firms are more visible, typically more established and less risky in terms of informational uncertainty, all-star analysts may be more inclined to follow them in the after-market. On the other hand, all-star analysts are significantly less likely to follow firms with longer lock-up periods, which suggests that perhaps all-star analysts do not value the signal insiders attempt to send about the value of the firm through this provision. The Positive Sales and Positive EBIT dummies were not strongly correlated with the all-star analyst dummy variable in the univariate correlations, so it is unsurprising that they are not significant predictors in the multivariate analysis.

Our two measures of certification, the underwriter rank and venture dummy, are statistically significant and have positive coefficients, consistent with the certification role that they play in reducing uncertainty regarding the value of the firm. All-star analysts prefer to follow firms whose values have been certified by other parties, as there is less uncertainty regarding the accuracy of value-relevant information provided in the pre-market.

Among the market and monetary policy environment variables, the natural logarithm of IPO intensity and the annual market risk premium are negatively and statistically significantly correlated with all-star analyst coverage. One potential explanation for the result on the natural logarithm of IPO intensity is that when more firms go public immediately prior to the IPO firm of interest, there is greater competition for all-star analyst coverage. These analysts have binding constraints on their time, and as such, when more firms go public, they are less likely to follow any one firm. Finally, neither the tech industry dummy nor the internet industry dummy is statistically significant in predicting all-star analyst coverage.

Negative binomial regression results of number of analysts

The results of the negative binomial regression on the number of analysts covering the IPO by the end of immediate quarter after the issue are reported in the second and third columns of Table 3. Based on the adjusted R-square, our model explains about 12.99% of the variation in

number of analysts covering the IPO. The coefficient on the absolute price update is positive and statistically significant at the 1% level, meaning that IPOs with larger absolute price updates experience more coverage in terms of the number of analysts in the after-market. This result is consistent with our conjecture that greater information production in the pre-market encourages information production in the after-market.

Of the IPO characteristic variables, the natural logarithm of market capitalization and natural logarithm of proceeds are statistically significant and both variables are positively correlated with number of analysts. Among the uncertainty variables, the natural logarithm of (1+age) is the only variable which is statistically significant and it is positively correlated with the number of analysts. As previously explained, these results suggest that analysts prefer to follow firms that are more established and for which there is less uncertainty regarding any information provided in the pre-market.

Two measures of certification, the underwriter rank and venture dummy, are statistically significant and have positive coefficients. This is again consistent with the view that analysts prefer to follow firms whose values have been certified by other parties because there is less uncertainty regarding the accuracy of value-relevant information provided in the pre-market.

Among the market and monetary policy environment variables, the coefficient on the hot IPO market dummy is negative and significant at the 5% significance level and the coefficient on Principal 2 is positive and significant at the 1% significance level. The result on the hot IPO market dummy implies that firms that go public during periods when IPOs are more underpriced on average tend to have fewer analysts following them. This is possibly explained as the result of competition among IPO firms for analyst attention; IPO firms that are more underpriced tend to garner more attention in general, analysts would likely prefer to focus on such firms but because they have limited time, they must choose which firms to cover, reducing the probability that any one IPO firm is followed by a large number of analysts. Finally, both industry membership variables are statistically significant and they are positively correlated with number of analysts, suggesting that firms operating in the tech and internet-based industries, relative to other industries, tend to have more analysts following them.

Negative Binomial regression results of number of institutions

The last two columns of Table 3 report the negative binomial regression results on the number of institutions. The model explains approximately 11.58% of the variation in number of institutional investors. Overall, the results are consistent with those on the number of analysts. The coefficient on the absolute price update is positive and statistically significant at the 5% level, meaning that issuers with more information produced in pre-market have more institutional investors among the firm's owners after the offering. As with the result on the number of analysts, this is consistent with our conjecture that greater information production in the pre-market attracts more information producers in the after-market.

All three IPO characteristic variables are statistically significant, although the natural logarithm of market cap and natural logarithm of proceeds are positively but the percent of primary shares is negatively correlated with number of institutions. Among the uncertainty measures, natural logarithm of (1+age) is the only statistically significant variable and its coefficient is positive. The results on the natural logarithm of market capitalization, natural logarithm of proceeds, and natural logarithm of (1+age) mimic those for the number of analysts; institutional investors are more likely to invest in and produce information on firms that are

larger, more established and for which there is generally less uncertainty regarding pre-market information production. While the coefficient on the percentage of primary shares offered was negative in the regression predicting the number of analysts, it was insignificant, but is negative and significant at the 1% level in the regression on the number of institutional investors. Because primary shares are newly offered or created shares (i.e., shares that were not outstanding prior to the offering), the greater the percentage of primary shares offered, the more diluted are the ownership positions of pre-offering owners (Habib and Ljungqvist 2001; Ljungqvist and Wilhelm 2003), and the greater the number of shares available for trading among new owners, assuming that pre-offering owners do not purchase the shares to maintain proportional ownership post-offering. When there are more shares available for potential new owners, the stock is more liquid. Thus, the sign on this variable could be easily positively or negatively related to the number of institutions investing in the IPO firm post-offering. If the liquidity effect trumps the dilution effect, we might expect the relationship to be positive; the more shares available for trading, the greater the opportunity for institutional investors to purchase stock. On the other hand, if institutional investors are significant pre-offering owners, they may be more likely to divest the greater their ownership stakes that are diluted as a result of the IPO, in which case the relationship could be negative, assuming that the liquidity effect does not trump the dilution effect. In the current study's results it seems that the dilution effect has a greater impact than the liquidity effect.

Both quality certification variables are statistically significant and they have positive coefficients, again consistent with the results on the number of analysts following the firm post-offering. Institutional investors are more likely to invest in and produce information on IPO firms about which there is less uncertainty due to the certification roles that venture capitalists and prestigious underwriters play in signaling the value of the firm to outsiders.

Among the market and monetary policy environment variables, the hot IPO market dummy is the only statistically significant variable and it has a positive coefficient. This relationship is the opposite of that between a hot IPO market and the number of analysts following an IPO firm post-offering. When IPO markets are "hot" during the time a firm goes public, there is greater underpricing in the IPO market as a whole and institutional investors are more likely to invest in and produce information on an IPO firm. While the hot issue dummy does not mean that a given IPO firm has significant underpricing, this is more likely to occur during a hot market (Hahn, Ligon and Rhodes 2013). If such is the case, institutional investors may be more attracted to IPO firms and more likely to participate in the offering itself (i.e., the initial issuance of the shares) because of the significant returns they can ultimately earn on underpriced shares. Finally, between the two industry membership variables, only the tech industry dummy is statistically significant; its coefficient is positive and significant at the 1% significance level, suggesting that IPO firms operating in high tech industries attract more institutional investors within a quarter of the offering.

CONCLUSION

This study provides evidence that information production in the pre-market, as proxied by the absolute value of the price update, is positively and statistically significantly correlated with the number of analysts following and the number of institutions holding equity ownership in an IPO by the end of immediate quarter after the issue. Specifically, when the absolute price update is larger, more new information has been generated between the time the underwriter set

the initial IPO price range and the time that the final offer price is determined, and this leads to greater involvement of after-market information producers. Among the control variables, the two quality certification variables, underwriter rank and the venture capitalist backing dummy, are the most consistently significant explanatory variables of involvement of the potential after-market information producers. Both are positively correlated with all the potential information producer variables: all-star analyst coverage, number of analysts, and number of institutional investors. While the current study does not explicitly consider the presence of venture capitalists and prestigious underwriters as proxies of pre-market information production, they do signal to outsiders the quality of the IPO firm during the pre-market, which is itself valuable information. Thus, the finding of more involvement of post-issuance information producers in IPO firms with venture capitalist backing and more prestigious underwriters is consistent with the notion that pre-market information production leads to more after-market information producers. The evidence in this study is consistent with the results of Corwin and Schultz (2005) who find that information production is correlated with more syndicate members, who are presumably connecting IPO issuers with their institutional client base to distribute the shares allotted to them.

Among the issue characteristic variables, the log of market cap is significantly and positively correlated with all three potential information producer variables, while the log of proceeds is significantly and positively correlated with number of analysts and number of institutions. Among the uncertainty variables, it is also shown that log of (1+age) is significantly and positively correlated with all three potential information producer variables. These results imply that after-market information producers are more attracted to IPO firms that tend to be less risky from an informational standpoint as larger and older firms are more established with longer operating histories upon which to judge firm value.

Among the market and monetary policy environment variables, the hot IPO market dummy is statistically significantly correlated with number of analysts and number of institutions, although it is negatively correlated with number of analysts but positively correlated with number of institutions. This study proposes that hot IPO markets result in less analyst coverage for an individual IPO firm because significantly underpriced IPOs tend to garner more attention and analysts prefer to follow such firms as a result of this increased attention, but because they have binding time constraints and there is competition among hot IPOs for attention, an individual IPO is less likely to have as many analysts following them when markets are hot. On the other hand, hot IPO markets increase institutional investment in IPO firms measured a quarter after the offering because significant underpricing may encourage institutional investor participation in the offering itself due to the large potential for future returns. Finally, both of our industry classification variables, the tech and internet dummies, are significant predictors of the number of analysts only.

Overall, the results suggest that information production in the IPO after-market happens through analysts and institutional investors who are incentivized to engage with IPO firms about which more information is produced in the pre-market. While this study does not attempt to pinpoint their specific incentives for engaging with these firms, the current study proposes four distinct reasons they may. First, as the key information producers in the IPO pre-market, institutional investors acquire information that may be profitable to them in the after-market, as their informational advantage would likely allow them to trade profitably with uninformed investors. Second, the private information that institutional investors produce in the pre-market makes them better and lower-cost monitors of firm managers in the after-market. Because low-cost monitoring is beneficial to both the investors and the firm itself as it reduces agency costs

and increases firm value, institutional investors likely stay involved with the IPO firm because the investment is a valuable one. Likewise, low-cost monitoring makes it easier for the institutional investor to produce accurate information on the firm in the after-market. Third, greater information production in the pre-market reduces uncertainty of the true value of the firm and its operations. As such, institutional investors are more likely to invest in firms upon which more information has been produced because they are less likely to lose money on their investments and they can be more confident in any information they produce in the after-market. Fourth and finally, analysts employed by institutional investors and brokers may be more likely to follow an IPO firm with greater pre-market information production because they are often privy to the information produced during the pre-market, lowering their costs of producing information in the after-market. Like the argument in the third point, greater pre-market information production may reduce uncertainty regarding firm value which makes analysts more likely to follow a firm because they can be more confident in the information they produce in the future and less likely to lose reputational capital. Whatever the incentive, our results suggest that greater pre-market information production increases the involvement of information producers in IPO firms in the after-market.

REFERENCES

Admati, A.R., P. Pfleiderer, and J. Zechner, 1994, Large shareholder activism, risk sharing and financial market equilibrium, *Journal of Political Economy* 102, 1097-1130.

Aggrawal, R.K., L. Krigman, and K.L. Womack, 2002, Strategic IPO underpricing, information momentum, and lockup expiration selling, *Journal of Financial Economics* 66, 105-137.

Arugaslan, O., D.O. Cook, and R. Kieschnick, 2004, Monitoring as a motivation for IPO underpricing, *Journal of Finance* 59, 2403-2420.

Barclay, M., and C. Holderness, 1991, Negotiated block trades and corporate control, *Journal of Finance* 46, 861-878.

Beatty, R. P., and Ritter, J. R., 1986, Investment banking, reputation, and the underpricing of initial public offerings, *Journal of Financial Economics* 15, 213-232.

Benveniste., L.M., A.P. Ljungqvist, W. J. Wilhelm and X. Yu, 2003, Evidence of information spillovers in the production of investment banking services, *Journal of Finance* 58, 577-608.

Benveniste, L.M., and P.A. Spindt, 1989, How investment bankers determine the offer price and allocation of new issues, *Journal of Financial Economics* 24, 343-361.

Booth, J.R. and L. Chua, 1996, Ownership dispersion, costly information and IPO underpricing, *Journal of Financial Economics* 41, 291-310.

Bradley, D. J. and B.D. Jordan, 2002, Partial adjustment to public information and IPO underpricing, *Journal of Financial and Quantitative Analysis* 37, 595-616.

Brennan, M. J., and A. Subrahmanyam, 1995, Investment analysis and price formation in securities markets, *Journal of Financial Economics* 38, 361-381.

Brickley, J., R.C. Lease, and C.W. Smith, Jr., 1988, Ownership structure and voting on antitakeover amendments, *Journal of Financial Economics* 20, 267-291.

Brigham, E. F., and P.R. Daves, 2014, *Intermediate Financial Management*. Cengage Learning.

Carter, R.B. and S. Manaster, 1990, Initial public offerings and underwriter reputation, *Journal of Finance* 53, 285-311.

Carter, R.B., F.H. Dark, and A.K. Singh, 1998, Underwriter reputation, initial returns, and the long-run performance of IPO stocks, *Journal of Finance* 53, 285-311.

Chemmanur, T. J., 1993, The pricing of initial public offerings: A dynamic model with information production, *Journal of Finance* 48, 285-304.

Cliff, M. T., and Denis, D. J., 2004, Do initial public offering firms purchase analyst coverage with underpricing?, *Journal of Finance* 59, 2871-2901.

Coffee, J.C., 1991, Liquidity versus control: The institutional investor as corporate monitor, *Columbia Law Review* 91, 1277-1368.

Cornelli, F. and D. Goldreich, 2001, Bookbuilding and strategic allocation, *Journal of Finance* 56, 2337-2370.

Cornelli, F. and D. Goldreich, 2003, Bookbuilding: How informative is the order book? *Journal of Finance* 58, 1415-1443.

Cornett, M.M., A.J. Marcus, A. Saunders, and H. Tehranian, 2007, The impact of institutional ownership on corporate operating performance, *Journal of Banking and Finance* 31, 1771-1794.

Corwin, S. A., and Schultz, P., 2005, The role of IPO underwriting syndicates: Pricing, information production, and underwriter competition, *The Journal of Finance 60*, 443-486.

Demiralp, I., R. D'Mello, F.P. Schlingemann, and V. Subramaniam, 2011, Are there monitoring benefits to institutional ownership? Evidence from seasoned equity offerings, *Journal of Corporate Finance* 17, 1340-1359.

Elyasiani, E., and J. Jia, 2010, Distribution of institutional ownership and corporate firm performance, *Journal of Banking and Finance* 34, 606-620.

Gompers, P. A. , 1996, Grandstanding in the venture capital industry, *Journal of Financial Economics 42*, 133-156.

Habib, M. A. and A. P. Ljungqvist, 2001, Underpricing and entrepreneurial wealth losses in IPOs: Theory and evidence, *Review of Financial Studies* 14, 433-458.

Hahn, T., J.A. Ligon, and H. Rhodes, 2013, Liquidity and initial public offering underpricing, *Journal of Banking and Finance* 37, 4973-4988.

Hanley, K.W., 1993, The underpricing of initial public offerings and the partial adjustment phenomenon, *Journal of Financial Economics* 34, 231-250.

Jensen, M.C., and W.H. Meckling, 1976, Theory of the firm: Managerial behavior, agency costs, and ownership structure, *Journal of Financial Economics* 3, 305-360.

Kahn, C., and A. Winton, 2002, Ownership structure, speculation, and shareholder intervention, *Journal of Finance* 53, 99-129.

Kyle, A., 1985, Continuous auctions and insider trading, *Econometrica* 53, 1315-1335.

Li, M., T. H. McInish, and U. Wongchoti, 2005, Asymmetric information in the IPO aftermarket, *Financial Review* 40, 131-153.

Leland, H.E., 1992, Insider trading: Should it be prohibited? *Journal of Political Economy* 100, 859-887.

Leland, H.E., and D.H. Pyle, 1977, Informational asymmetries, financial structure, and financial intermediation, *Journal of Finance* 32, 371-387.

Loughran, T. and J.R. Ritter, 2004, Why has IPO underpricing changed over time? *Financial Management* 33, 5-38.

Ljungqvist, A., and W. J. Wilhelm Jr., 2003, IPO pricing in the dot-com bubble, *Journal of Finance* 58, 723-752.

Ljungqvist, A., and W. J. Wilhelm Jr., 2005, Does prospect theory explain IPO market behavior? *Journal of Finance* 60, 1759-1790.

Lowry, M., M. S. Officer, and W. Schwert, 2010, The variability of IPO initial returns, *Journal of Finance* 65, 425-465.

Lowry, M., and W. Schwert, 2002, IPO market cycles: Bubbles or sequential learning? *Journal of Finance* 57, 1171-1200.

Lowry, M., and W. Schwert, 2004, Is the IPO pricing process efficient? *Journal of Financial Economics* 71, 3-26.

McConnell, J.J., and H. Servaes, 1990, Additional evidence on equity ownership and corporate value, *Journal of Financial Economics* 27, 595-612.

Megginson, W. and Weiss, K., 1991, Venture capitalist certification in initial public offerings, *Journal of Finance* 46, 879-904.

Muscarella, C. J., and M. R. Vetsuypens, 1989, Initial public offerings and information asymmetry, Working paper (Penn State University, University Park, PA; Southern Methodist University, Dallas, TX).

Navissi, F., and V. Naiker, 2006, Institutional ownership and corporate value, *Managerial Finance* 32, 247-256.

Pound, J., 1988, Proxy contests and the efficiency of shareholder oversight, *Journal of Financial Economics* 20, 237-265.
Purnanandam, A. K. and B. Swaminathan, 2004, Are IPOs really underpriced? *Review of Financial Studies* 17, 811-848.
Rajan, R., and H. Servaes, 1997, Analyst following of initial public offerings, *Journal of Finance* 52, 507-529.
Ritter, J.R., 1991, The long-run performance of initial public offerings, *Journal of Finance* 46, 3-27.
Ritter, J.R., 1984, The 'hot issue' market of 1980, *Journal of Business* 57, 215-240.
Rock, K.R., 1986, Why new issues are underpriced, *Journal of Financial Economics* 15, 187-212.
Sherman, A. E., and S. Titman, 2002, Building the IPO order book: underpricing and participation limits with costly information, *Journal of Financial Economics* 65, 3-29.
Shleifer, A., and R. Vishny, 1986, Large shareholders and corporate control, *Journal of Political Economy* 94, 461-488.
Stoughton, N. M., and J. Zechner, 1998, IPO-mechanisms, monitoring and ownership structure, *Journal of Financial Economics* 49, 45-77.
Zheng, S. X., and Li, M., 2008, Underpricing, ownership dispersion, and aftermarket liquidity of IPO stocks, *Journal of Empirical Finance 15*, 436-454.

APPENDIX

Table 1
Summary Statistics

Variable	N	Mean	STD	Min	Max
Information Producers:					
Allstar Analyst Dummy	3,093	0.1815	0.3855	0.0000	1.0000
Number of Analysts	2,167	2.3409	2.0526	0.0000	29.0000
Number of Institutions	2,826	29.2713	24.2114	1.0000	273.0000
IPO Characteristic:					
Log (Market Capitalization)	3,093	12.2515	1.3329	7.6295	17.8092
Log (Proceeds)	3,093	17.7387	1.0814	14.9141	22.7142
Offer Price	3,093	13.2927	5.8578	3.5000	97.0000
Percent of Primary Shares	3,093	0.9115	0.1685	0.0284	1.0000
Uncertainty Measures:					
Log (Lockup Days)	3,093	4.0304	2.2504	0.0000	7.5099
Log (1+ age)	3,093	1.9407	1.1488	0.0000	5.1120
Positive Sales Dummy	3,093	0.2856	0.4518	0.0000	1.0000
Positive EBIT Dummy	3,093	0.1565	0.3634	0.0000	1.0000
Quality Certification:					
Venture Dummy	3,093	0.4290	0.4950	0.0000	1.0000
Underwriter Rank	3,093	7.1935	2.4398	0.0000	9.0010
Market & Monetary Policy Environment:					
Log (IPO Intensity)	3,093	4.6665	0.6981	0.0000	5.5134
Hot IPO Market Dummy	3,093	0.5268	0.4994	0.0000	1.0000
Market Risk Premium	3,093	1.2358	3.7482	-16.2000	8.0000
Principal 1	3,093	26.4680	3.1841	22.7380	34.9252
Principal 2	3,093	144.6218	13.3341	128.4718	179.9050
Industry Membership:					
Internet Industry Dummy	3,093	0.1385	0.3454	0.0000	1.0000
Tech Industry Dummy	3,093	0.3275	0.4694	0.0000	1.0000
Price Update	3,093	0.0335	0.3078	-0.9842	8.0521

Table 2
Correlation between potential information producers and explanatory variables

	All-star Analyst Dummy	Number of Analysts	Number of Institutions
All-star Analyst Dummy	1		
Number of Analysts	0.1626	1	
Number of Institutions	0.2576	0.5021	1
Log (Market Capitalization)	0.3074	0.4056	0.6740
Log (Proceeds)	0.2255	0.4878	0.6971
Percent of Primary Shares	0.0050	-0.0653	-0.1046
Log (Lockup Days)	-0.2391	-0.0415	-0.2557
Log (1+ age)	0.1040	0.1193	0.1480
Positive Sales Dummy	0.0288	0.1734	0.1344
Positive EBIT Dummy	0.0220	0.1419	0.1207
Venture Dummy	0.0470	0.0357	-0.0013
Underwriter Rank	0.2134	0.0919	0.2548
Log (IPO Intensity)	-0.0468	-0.2932	-0.1978
Hot IPO Market Dummy	0.0888	-0.0849	0.0970
Market Risk Premium	-0.0202	-0.0166	0.0387
Principal 1	0.0075	0.3299	0.1880
Principal 2	0.0007	0.3749	0.1905
Internet Industry Dummy	0.0781	0.0687	0.0937
Tech Industry Dummy	0.0262	0.0193	0.0409
Absolute Price Update	0.0791	0.0837	0.1716

Table 3
Potential Information Producers as a function of absolute price update

	All-star Analyst Dummy		Number of Analysts		Number of Institutions	
	Coeff	Std Err	Coeff	Std Err	Coeff	Std Err
IPO Characteristic:						
Log (Market Capitalization)	0.5014***	0.0745	0.0540**	0.0217	0.1860***	0.0133
Log (Proceeds)	0.0704	0.0967	0.3146***	0.0263	0.4287***	0.0179
Percent of Primary Shares	0.2251	0.3100	-0.0628	0.0847	-0.2412***	0.0586
Uncertainty Measures:						
Log (Lockup Days)	-0.0694***	0.0240	0.0123	0.0079	0.0021	0.0047
Log (1+ age)	0.2663***	0.0508	0.0462***	0.0145	0.0264***	0.0091
Positive Sales Dummy	-0.1615	0.1524	0.0595	0.0422	0.0186	0.0288
Positive EBIT Dummy	0.1701	0.1947	-0.0180	0.0514	0.0197	0.0363
Quality Certification:						
Venture Dummy	0.2010*	0.1176	0.1886***	0.0339	0.1306***	0.0205
Underwriter Rank	0.3483***	0.0544	0.0226***	0.0077	0.0457***	0.0053
Market & Monetary Policy Environment:						
Log (IPO Intensity)	-0.2216*	0.1195	0.0249	0.0387	-0.0153	0.0224
Hot IPO Market Dummy	0.1307	0.1247	-0.0781**	0.0367	0.0755***	0.0218
Market Risk Premium	-0.0240*	0.0131	-0.0022	0.0042	0.0038	0.0025
Principal 1	-0.0149	0.0365	-0.0036	0.0099	0.0002	0.0068
Principal 2	-0.0112	0.0082	0.0114***	0.0020	-0.0021	0.0015
Industry Membership:						
Internet Industry Dummy	0.0729	0.1525	0.0777*	0.0437	-0.0427	0.0291
Tech Industry Dummy	-0.1655	0.1206	0.0785**	0.0346	0.0744***	0.0215
Absolute Price Update	-0.1109	0.2643	0.2286***	0.0712	0.1168**	0.0507
Constant	-9.3898***	1.7587	-7.7045***	0.4997	-6.7319***	0.3194
N	3,093		2,167		2,826	
Adj. R-Square (Pseudo R-Square)	18.04%		12.99%		11.58%	

* indicates statistical significance at 10% level. ** indicates statistical significance at 5% level. *** indicates statistical significance at 1% level.