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By investigating the entire IPO pricing process, beginning when the offering is filed, the paper contributes to the existing literature along four dimensions. First, price updates during the registration period are predictable based on firm and offer-specific characteristics known at the time the offer is filed. Second, price updates reflect market movements prior to the initial filing date as well as during the registration period. Third, positive and negative information learned during the registration period affect the offer price asymmetrically. Finally, public and private information learned during the registration period have different effects on the offer price. While a number of the biases that we uncover are consistent with one or more theories regarding IPOs, many remain a puzzle.

Key words: IPO, Underpricing, Private Information, Learning

JEL Classifications: G32, G24, G14

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1. Introduction

The pricing of Initial Public Offerings (IPOs) is one of the more puzzling phenomena in finance. Prior empirical evidence shows that underwriters do not fully incorporate all available information into the IPO offer price in an unbiased way. The first day returns of IPOs average approximately 15%, indicating that there is a systematic downward bias in the offer price compared with the price in the secondary trading market. Further, the size of these initial returns varies predictably across firms. Prior literature has found that initial returns are significantly related to certain firm- and offer-specific characteristics, to the price update between the expected offer price stated in the preliminary prospectus and the final offer price, and to market returns before the IPO.

The process of pricing an IPO generally begins months before the offer price is set. Yet with the exception of Benveniste and Spindt (1989), Hanley (1993), and more recently Loughran and Ritter (2000) and Benveniste, Wilhelm, and Yu (2000), the majority of the IPO pricing literature has only focused on price changes between the offer price and the secondary market price. The objective of this paper is to examine the entire IPO pricing process, beginning at the time the issue is filed. By including more of the information that potentially contributes to the pricing of new issues, we hope to increase our understanding of the apparent biases in IPO pricing. A number of theories have been advanced to explain the rationality of the predictability in initial returns, and we wish to discern the extent to which these theories can more broadly explain the dynamics of the entire IPO pricing process.

We focus on two of the more popular theories of IPO underpricing. First, Beatty and Ritter (1986), Rock (1986), and Baron (1982) assert that underpricing results from information asymmetry between the various parties involved in the IPO. Issues that are characterized by

greater uncertainty are more underpriced to compensate for the higher costs of learning about these firms' true values. Second, Benveniste and Spindt (1989) posit that underpricing is related to the information underwriters obtain from informed investors during the registration period. Underwriters compensate these investors for the information they provide by only partially incorporating it into the offer price, thus allowing the informed investors to earn especially high returns on the first day the IPO firm trades.

In examining the entire IPO pricing process, our empirical analysis builds on prior work along four dimensions. While some of our findings are understandable based on some of the existing theories, others remain a puzzle.

We begin our analysis of the IPO pricing process at the time the offering is filed. To file an IPO, the company must register with the SEC a preliminary prospectus containing basic information on the company and the proposed offering. Either in this preliminary prospectus or in an amended prospectus, the company provides a range of prices within which it expects to price the issue. The percent difference between the midpoint of this preliminary price range and the final offer price represents the price update. We find that the price update is significantly related to information that is publicly available when the IPO is filed, such as the underwriter rank, the industry of the IPO firm, and the exchange on which the stock will be listed. It seems that firm- and offer-specific characteristics can explain the price update in much the same way that they can explain the initial return. While the ability of such variables to explain the initial return has been generally interpreted as supporting the information asymmetry hypothesis, it is difficult to reconcile their ability to explain the price update with the same theory. In fact, this puzzling relation between the price update and firm- and offer-specific characteristics does not seem consistent with the existing theories of IPO pricing. Our findings suggest that

underwriters do not incorporate all available information when setting the range of expected offer prices.

Second, we examine the relation between the price update and general movements in market prices. For a sample of IPOs, we collect the date of the first prospectus containing the range of expected offer prices. Conceptually, the price update should be related to information that becomes available between the release of this prospectus and the setting of the final offer price, typically the day before the offering. Thus, we expect market returns over this period to be most strongly related to the price update. Consistent with Loughran and Ritter (2000), we find that companies and their underwriters do adjust the offer price in response to recent market movements. However, we find that market returns over fixed windows have higher explanatory power than those that are linked to the length of time between the initial revelation of the expected price range and the offer date. Specifically, our results show that market returns over the three months before the offer are reliably related to the price update. We note that this is a substantially longer period of time than the three weeks over which Loughran and Ritter measure market returns. Further, given that the registration period averages only two months, these findings raise further questions about how companies and their investment bankers set the range of expected offer prices that is stated in the preliminary or amended prospectus. The existing theories of IPO pricing do not seem to provide an adequate explanation for this phenomenon.

Third, we allow for the possibility that *positive* information learned during the registration period is not incorporated into the pricing of an IPO in the same manner as *negative* information. Benveniste and Spindt's (1989) partial updating theory asserts that underwriters only partially incorporate positive information they receive regarding firm value into the offer price, thus providing compensation (in the form of higher initial returns) to the investors who

provided them with this information. However, both underwriters and investors should want to avoid losses on overpriced issues, suggesting that negative information should be fully incorporated into the offer price. Consistent with this intuition, our empirical analysis shows significant differences in the effects of positive versus negative information on the pricing of IPOs. Investment bankers appear to incorporate negative information more fully into the offer price than positive information.

Finally, we compare the effects of *public* versus *private* information learned during the registration period on the pricing of an IPO. Loughran and Ritter note that under Benveniste and Spindt's partial updating theory, private information should be only partially incorporated into the offer price, but public information should be fully incorporated. Following Loughran and Ritter, we use market returns to proxy for public information. Consistent with Benveniste and Spindt's theory, we find that public information is fully incorporated into the offer price, but private information is only partially incorporated. As discussed in more detail later, this finding contrasts with the findings of Loughran and Ritter (2000) and to some extent those of Benveniste, Wilhelm and Yu (2000).

In summary, our results on the predictability of the price update, the asymmetry of positive versus negative information, and the extent to which public versus private information is incorporated into the offer price provide new evidence on the complexity of the IPO pricing process. While our results do not 'reject' any of the existing theories of IPO pricing, they show that no single existing theory comes close to explaining the numerous biases that exist.

Section 2 discusses the data that we use to examine the price updates and initial returns. Sections 3 and 4 investigate the predictability of the price update and the initial return,

respectively. In section 5 we conduct various robustness tests. Section 6 summarizes the results of the paper.

2. Data

To examine the biases in the pricing of IPOs, we obtain data on all firms that went public between 1985 and 1999 from the Securities Data Corporation (SDC). Unit IPOs, closed end funds, real estate investment trusts (REITs), and American Depositary Receipts (ADRs) are excluded. Section 2.1 defines our IPO pricing measures as well as the explanatory variables that we use in our empirical tests. Section 2.2 investigates the issue of sample selection, which potentially affects our empirical analysis.

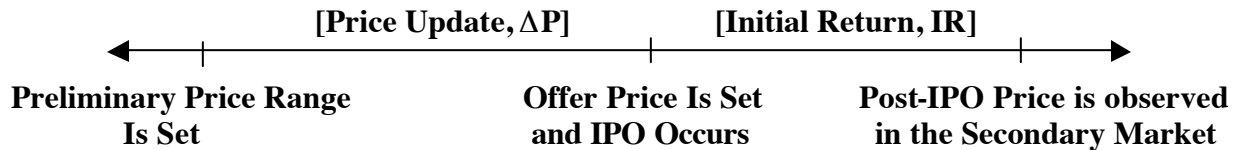


Fig. 1. Time-line for the IPO Pricing Process

2.1. SDC Data on Individual IPOs

The pricing of an IPO can be thought of as occurring in three stages, as illustrated in figure 1. First, the firm and its underwriters agree on a range of prices within which they expect to set the offer price. This price range is listed in a prospectus that is filed with the SEC. Some companies include this price range in the preliminary prospectus that is filed when the offering is

registered, while other companies set the price range in an amended registration statement that is filed between the initial registration date and the IPO date. Data on the original registration dates are available on SDC, but Loughran and Ritter (2000) emphasize that there are often amended filings after the original registration statement that do not appear in the SDC database. We investigate the exact timing of the first available pricing information using data from the S.E.C. Electronic Data Gathering, Analysis, and Retrieval system (EDGAR) in 1996-97. Second, typically the day before the offering, the company and its underwriters set the final offer price. This is the price at which the issue is offered to the public. Finally, when the issue starts trading we observe the market's assessment of the value of this firm.

For each IPO, the price update (ΔP) equals the percentage change between the midpoint of the filing range and the offer price. The initial return (IR) equals the percentage change between the offer price and the first closing price. To determine the first closing price of a particular issue, the first closing price from the Center for Research in Securities Prices (CRSP) is used if price data are available within 14 days of the offer date. If CRSP data are not available, we try to obtain the closing price on the first day of trading from SDC. If that is not available, the close on the second day or otherwise the end of the first week of trading is used.

We examine the predictability of both the firm-level price update and initial return, based on a number of firm- and deal-specific characteristics. For each firm, we identify the underwriter from SDC and assign an underwriter rank (RANK) based on the Carter, Dark, and Singh (1998) measures. The ranks range from 0 to 9, with higher numbers representing higher quality underwriters. Using the SDC classification system, we also assign each firm a technology dummy (TECH), equal to 1 if the firm is in a technology industry and 0 otherwise. To capture the effects of firm size, we collect data on total assets before the offering (TA) and

number of shares filed (SHRS) from SDC, both of which are transformed using logarithms to reduce the skewness in these data. In addition, TA is transformed into 1983-dollar values using the Consumer Price Index (CPI) to adjust for the effects of inflation. We form three exchange dummies, NYSE, NASDAQ, and AMEX, where each dummy equals 1 if the IPO was listed on that exchange and 0 otherwise.

Many researchers have noted that IPO pricing is affected by the risk of the issuing firm. This is not generally measurable at the time of the IPO, although investors and underwriters clearly form opinions about this important attribute when setting the IPO price. We follow the tradition in the literature of proxying for the ex ante risk of the IPO stock using volatility of the IPO stock return in the secondary trading market. VOL is the market-adjusted volatility of the IPO stock return, equal to the standard deviation of daily returns to the IPO stock in trading days 1 through 63 after the IPO (the first three months of secondary market trading) minus the standard deviation of daily returns to the CRSP equal-weighted market portfolio of NYSE, Amex, and Nasdaq stocks during the same period.

Loughran and Ritter (2000) analyze the reaction of the price update to public information that becomes available during the registration period as reflected in the return to the CRSP value-weighted portfolio over the 15 days before the IPO. Because IPO stocks tend to be small, we use the CRSP equal-weighted return to measure the public information that becomes available during the registration period. Also, we measure returns between the filing date and the IPO date. In section 3.2 we investigate several time intervals for market returns to see how current and past market movements affect IPO prices.

To investigate the possibility that positive and negative information learned during the registration period affect the offer price differently, we define two asymmetry measures. First,

ΔP^+ equals ΔP when the price update is positive, and zero otherwise. Similarly, MKT^+ equals MKT when the market returns during the registration period are positive, and zero otherwise. Thus, in our cross-sectional regression models, the coefficients on these variables measure the differences between the effects of positive versus negative information, if any.

We focus on data from 1985-97 in our tests because there is evidence that the IPOs in 1998 and 1999 had substantially different behavior. The effects of limiting our sample period in this manner are investigated in detail in section 5.

2.2. Sample Selection Bias

The goal of this analysis is to explain the IPO pricing process. How do IPO prices get updated between the initial prospectus and the final IPO, and how does the after-market price of the stock relate to the IPO offer price? The tests control for the characteristics of the IPO firms and of the transactions. The regression models, however, require full data on the explanatory variables. The data sources (SDC and CRSP) do not have complete information on all of the variables for many firms.

Table 1 shows a comparison of means between the sample with full data available for all of the variables listed above (referred to as the regression sample) in column (1) and the means of these variables for the observations that are omitted from the regression sample because they have data missing for at least one other variable (referred to as the incomplete data sample) in column (2). This shows the nature of the sample selection bias associated with the regression tests in tables 2, 6, 7, and 8. Column (3) of table 1 shows t-statistics that test whether the means are equal in the regression sample and in the incomplete data sample, based on heteroskedasticity-consistent standard errors, and column (4) shows the number of observations in the incomplete data sample.

We find that the characteristics of the regression sample firms differ significantly from the missing-data firms along several dimensions. For example, firms in the regression sample state in the prospectus that they plan to issue an average of 2.2 million ($= \exp(14.586)$) shares. In comparison, the average for firms that are not in the regression sample (because they are missing data for at least one of the other variables) is 2.4 million ($= \exp(14.680)$) shares. Thus, firms in the regression sample tend to file fewer shares (t-statistic = -2.93). Firms in the regression sample also have higher after-market volatility (t-statistic = 4.57), are less likely to issue on the NYSE (t-statistic = -6.10), more likely to issue on Nasdaq (t-statistic = 5.91), and have higher market returns in the registration period (t-statistics of 2.19 and 2.12 on MKT and MKT⁺), on average. Finally, the price update when it is positive, ΔP^+ , and the initial return are significantly larger for the regression sample (t-statistics of 2.88 and 2.03).

Columns (5) and (6) of table 1 show the percent of IPOs that occur in each year from 1985 through 1997 for each sample, and column (7) shows the heteroskedasticity-consistent t-statistics for the differences between the proportions in each sample by year. A large proportion (39%) of the regression sample occurs in the years 1995-97, and a large proportion (49%) of the incomplete data sample occurs in the years 1985-91. This likely reflects changes in the thoroughness with which SDC has collected data on IPOs over time. Some of the differences in characteristics in columns (1) and (2) are probably related to the calendar patterns seen in columns (5) and (6). For example, the greater proportion of technology firms in the regression sample is probably related to the fact that data from recent years are more likely to be in the regression sample, and there were a lot of technology-related IPOs from 1995-97.

The most important message to get from table 1 is that the firms with missing or incomplete data are not random. Thus, at a minimum, we must be cautious in interpreting our regression results to realize that they may not be representative of the firms with incomplete data.

3. Predictability of Price Updates

The pricing of an IPO begins at the time the IPO is filed, and thus we begin our analysis of the pricing process at this point. This section examines whether underwriters fully incorporate available information into the expected offer price.

3.1. Predictable Bias in the Price Update at the Filing Date

The first thing to note about the price update is that the average price update is negative (-2.796 in table 1) and the simple t-test for whether this is reliably different from 0 equals -9.16. Thus, on average the IPO price is about 2.8% below the mid-point of the initial filing range.

Table 2 examines the extent to which underwriters incorporate available information about the company at the time they set the initial filing range. Column (1) of table 2 contains estimates of a regression model that explains the price update that occurs between the date of the first prospectus with pricing information and the offer date, conditional on information that is publicly known at the time the offering is filed,

$$\begin{aligned} \Delta P_i = & \alpha + \beta_1 \text{RANK}_i + \beta_2 \text{TECH}_i + \beta_3 \text{TA}_i + \beta_4 \text{SHRS}_i + \beta_5 \text{NYSE}_i + \\ & \beta_6 \text{NASDAQ}_i + \beta_7 \text{AMEX}_i + \varepsilon_i, \end{aligned} \quad (1)$$

where the variables have been defined above.

We find that many of these predetermined variables predict the IPO price update. For example, IPOs underwritten by highly ranked investment bankers are likely to have larger price

updates (t-statistic of 4.57 in column (2)). Technology firms also tend to have larger price updates (t-statistic of 3.57). On the other hand, holding other things constant, firms that are larger are likely to have smaller price updates (t-statistic of -3.04 on total assets). Finally, the exchange the offering lists on is also significantly related to the price update. Specifically, firms that list on NYSE and NASDAQ tend to have larger price updates (t-statistics of 3.91 and 2.34), while firms that list on AMEX have smaller price updates on average (t-statistic of -2.90).

The regression in column (1) pools IPO price updates across the 1985-97 period, but to the extent that there are known cycles in the IPO market (see, for example, Ibbotson, Ritter, and Sindelar (1988, 1994) and Lowry and Schwert (2001)), it is likely that the regression errors for firms with IPOs close together in time are correlated. One simple way to check the severity of this problem is to use a bootstrap estimator similar to Fama and MacBeth (1973). Column (3) in table 2 shows the average of the estimates of the coefficients in (1) when they are estimated year-by-year from 1985-97. Each t-statistic in column (4) is based on the standard deviation of the time-series of estimates. The Fama-MacBeth estimates and tests in columns (3) and (4) generally support the regression estimates in columns (1) and (2). The estimate of the Nasdaq-listing variable changes sign, suggesting that this effect is not stable across the sample, but this is the only substantial difference between the pooled and Fama-MacBeth results.

The estimates in the right panel of table 2, columns (5) through (8), add the after-market volatility VOL to these regressions. Although this variable is not measurable by econometricians at the time of the IPO, it is likely that investors and investment bankers have at least an intuitive knowledge of this volatility when evaluating IPO pricing. The coefficient on volatility is reliably negative in both the pooled regression and in the Fama-MacBeth estimates, implying that price

updates are smaller or more negative for riskier firms. Coefficients on other variables are substantially unchanged.

These results imply that there is a predictable bias in the adjustment from the initial file range to the final IPO price. The explanatory power of these regressions is low (about 2%), because there is a lot of uncertainty about the IPO price at the time that the initial filing range is set. However, there are systematic patterns in price updates that are significantly related to the characteristics of the issuing firm, the offering, and the underwriter.

The literature on IPO pricing has often used variables such as those in table 2 to explain initial IPO returns as a test of theories about asymmetric information. However, it is not clear to us how these theories would predict any particular pattern in price updates. It seems that companies and their underwriters do not incorporate all available information when setting the range of expected offer prices. Consequently, certain types of IPOs tend to have larger price updates than others.

3.2. Price Updates and Market Returns

As noted earlier, Loughran and Ritter (2000) analyze the relation between price updates and the 15-day return to the CRSP value-weighted portfolio, and they find that the price update is significantly related to the market return. We examine this relation in more depth to better understand the way in which public information that becomes available prior to the IPO affects the final offer price.

To investigate the relation between price updates and contemporaneous market returns, we use several measures of market returns during the registration period, and in some cases before the initial registration date. The variable shown in table 1, MKT, is the CRSP equal-weighted return between the initial registration date and the day before the IPO. For 554 of the

firms that went public in 1996 and 1997, we obtained the date of the first prospectus that included the initial filing range of prices from EDGAR. In about 60% of the cases, the initial prospectus included the file range, while for the remaining 40% of cases the first pricing information was released in an amended prospectus. Across all cases, the average number of trading days between the first price range and the IPO was 44 days, or about 75% of the entire registration period. For these 554 firms, we measure the CRSP equal-weighted market return between the date of the first prospectus with pricing information and the day before the IPO, MKTMATCH.

Another approach to measuring the effect of market movements on IPO pricing is to measure market returns over a fraction of the entire registration period (file date to day before offer). In particular, we use intervals equal to 25%, 50%, and 75% of the registration period. Because these measures do not rely on the exact date on which the price range became available, they can be calculated for our entire sample. For each interval we measure market returns ending on the day before the IPO and moving backwards the requisite number of days to cover these proportions of the registration period, where our measure MKT covers 100% of the registration period. The measures MKT25%, MKT50%, and MKT75% should reflect information about market valuations that occur in the latter parts of the registration period, just before the IPO price is set.

Panel A of table 3 shows regressions of the price update (ΔP_i) on market returns over the period between the first pricing information and the setting of the IPO price (MKTMATCH). It also shows regressions of the price update on market returns over fractions of the entire registration period, MKT25%, MKT50%, MKT75%, and MKT. Interestingly, the estimates of β are similar across all measures of market return that are linked to the entire registration period,

MKT25% to MKT. The coefficient estimates on all of these variables are approximately 0.45. While the t -statistics and R^2 's increase as the intervals increase, this is somewhat mechanical. Note that the dependent variable is the same across all these regressions and the slope estimates are similar. Consequently, the larger variance of the longer period market returns yields larger t -statistics and R^2 measures.

Perhaps most surprising is that the market return that is matched to the period of the price update, MKTMATCH, has the lowest coefficient estimate (0.30, with a t -statistic of 2.08). Contrary to our intuition, market returns between the setting of the initial price range and the actual offer do not appear to be the most relevant. Rather, the importance of market returns seems to be independent of the exact time that the initial price range was set. It is also notable that although MKT incorporates returns prior to the release of the expected offer price for many firms, this coefficient is substantially larger and more significant than that on MKTMATCH. This suggests that price updates between the initial filing range and the IPO price react to market movements that precede the announcement of the initial filing range. Table 4 investigates this possibility in more depth.

Panel B of table 3 shows estimates of the sensitivity of the price update to market returns over fractions of the registration period, MKT25% to MKT, for the entire sample of SDC firms from 1985-97. As in Panel A, the estimates of β are similar for all of the measures of market return, although these estimates are smaller than in Panel A, around 0.15. Again, the larger variance of the longer period market returns yields larger t -statistics and R^2 measures.

Table 4 considers the general effects of recent market movements on IPO price setting, independent of the length of the registration period. We measure the equal-weighted CRSP return for periods of 5, 10, 15, 20, 25, 35, 40, 45, 50, 75, 100, 125, and 250 trading days before

the IPO (denoted MKT5 to MKT250) and measure the strength of the relation between price updates and these alternative measures of market returns.

Table 4 shows that the estimates of market sensitivity are highest in the week before the IPO, $\beta = 1.04$, with a t-statistic of 5.92. The estimates gradually decline to 0.11 for the 250 trading days (approximately one year) before the IPO. The largest t-statistic and R^2 are for the estimate including 50 trading days (about two months). Again, this reflects a trade-off between the increase in the variability of market returns measured over longer horizons versus the reduction in the slope estimate.

As discussed previously, the existence of cycles in the IPO market potentially causes regression errors for firms with IPOs close together in time to be correlated. It is possible that the OLS analysis overstates the importance of market returns in explaining price updates. The last two columns of table 4 show the Fama-MacBeth bootstrap estimates of the slope and the t-statistic. These t-statistics are much smaller, by a factor of about 3, reflecting the strong positive correlation in the errors of these regressions (unexpected price updates) that occur close together in time. It is interesting that these adjustments are much larger than those in table 2. This indicates that the relations between firm and offer characteristics and the price update are relatively stable over time, yet the extent to which companies and their underwriters incorporate recent market conditions varies much more substantially. Notably, while the significance is substantially attenuated in the Fama-MacBeth regressions, the finding that market returns up to one year contribute to the price update, with MKT50 being the most significant, remains.

As a final check on the relation between price updates and market movements, table 5 shows a multiple regression of the price update against 13 weeks or months of lagged market returns,

$$\Delta P_i = \alpha + \sum_{k=1}^{13} \beta_k XK_k + \varepsilon_i, \quad (2)$$

where XK_k is the weekly (WK_k) or monthly (MK_k) market return for the k^{th} week or month before the IPO. Each weekly return is measured as 5 trading day returns and each monthly return is measured as 20 trading day returns, using the CRSP equal-weighted portfolio of NYSE, Amex, and Nasdaq-listed stocks. As shown in the left panel, the coefficients for the 8 weeks before the IPO are similar in magnitude, between 0.441 and 0.894, with t-statistics between 2.37 and 4.63. The coefficients for weeks 9 through 13 are smaller and less significant, although still all positive. Consistent with the weekly results, the right panel shows that the coefficients for months 1 and 2 are similar and have large t-statistics (0.658 and 0.705, with t-statistics of 9.53 and 9.31). The coefficient for month 3 is 0.343, with a t-statistic of 5.40, and the remaining coefficients are small and not reliably different from zero.

Thus, the results in table 5 show that general market conditions for the two months prior to the IPO are strongly correlated with the price update, with a smaller effect in the third month. Together with the results in tables 3 and 4, this implies that while issuing firms and their underwriters do adjust the IPO price in response to recent market movements, this adjustment does not seem to be linked to the date on which the initial price range is first revealed. Further, since the registration period averages 2 months, our findings indicate that market returns prior to the setting of the initial price range contribute to the price update. This is puzzling because it implies that companies and their underwriters do not fully incorporate recent market returns into the expected price range that is declared in the preliminary or amended prospectus.

The results in tables 3, 4, and 5 also show that all of the coefficients on market returns are less than 1. This indicates that companies and their underwriters adjust the offer price less than one-for-one with overall movements in market values in the months before the IPO. Yet Ibbotson (1975), Clarkson and Thompson (1990) and Chan and Lakonishok (1992) find that the beta of IPOs shortly after going public is greater than 2. If IPO firms have similar risk levels prior to the actual offer, then the low β estimates in tables 3, 4, and 5 suggest that the price update represents only a partial adjustment to the public information reflected in market returns. Such a finding would be inconsistent with Benveniste and Spindt's model, as originally noted by Loughran and Ritter. However, because the market risk of private firms is by definition not quantifiable, we can make no definitive conclusion regarding this issue at this point. The extent to which public information is incorporated into market returns is examined further in section 4.3.

3.2. Predictable Bias in the Price Update at the IPO Date

Table 6 combines the tests in table 2, showing the relation between price updates and information that is available in the preliminary prospectus, with the market returns for the 50 trading days before the IPO,

$$\Delta P_i = \alpha + \beta_1 \text{RANK}_i + \beta_2 \text{TECH}_i + \beta_3 \text{TA}_i + \beta_4 \text{SHRS}_i + \beta_5 \text{NYSE}_i + \beta_6 \text{NASDAQ}_i + \beta_7 \text{AMEX}_i + \beta_8 \text{VOL}_i + \beta_9 \text{MKT50}_i + \beta_{10} \text{MKT50}_i^+ + \varepsilon_i. \quad (3)$$

Market returns (MKT50) are measured using the CRSP equal-weighted return for the 50 trading days before the IPO. MKT50^+ equals MKT50 when the market return is positive and zero otherwise. We include both MKT50 and MKT50^+ to allow for an asymmetric response of the price update to the market return. As discussed earlier, it is plausible that investment bankers

may not treat positive and negative information equally. For example, if they are risk averse, they will tend to incorporate negative information more fully into the offer price than positive information. This enables them to share gains on underpriced issues but avoid losses on overpriced issues.

Column (1) in table 6 shows estimates of equation (3) without the asymmetric market effect. The coefficients and t-statistics on most of the firm and deal variables are similar to those in table 2, and the coefficient on MKT50 in column (1) (0.664 with a t-statistic of 15.14) is similar to the coefficient in the univariate regression in table 4 (0.589 with a t-statistic of 16.76). The main difference from table 2 is that the coefficient on after-market volatility, VOL, is smaller and not reliably different from zero. This difference is potentially driven by the interaction between MKT50 and after-market volatility. French, Schwert, and Stambaugh (1987) find that increases in stock prices tend to be followed by decreases in market-wide volatility, and Schwert and Seguin (1990) show that there is a strong market factor in the time-varying volatility of individual firms.¹ Thus, it is possible that the significant coefficient on volatility in table 2 was driven by correlated omitted variables. After controlling for market returns prior to the offering, firm volatility after the offering does not seem to be significantly related to the price update.

Columns (3) and (5) in table 6 allow for the asymmetry of market returns. In column (3), the coefficient on MKT is 1.152 (t-statistic of 5.34), implying that market returns of -10% result in price updates that are 11.5% lower. In contrast, the coefficient on MKT⁺ is -0.562 (t-statistic of -2.31), implying that market returns of 10% result in price updates that are only 5.9% higher ($1.152 - 0.562$). This much smaller price update when market values rise implies an under-adjustment to positive new information that becomes available before the IPO. However, the Fama-MacBeth bootstrap estimates

¹ Although our volatility measure nets out the volatility of the equally weighted index, is it unlikely that we have perfectly excluded market effects.

shown in column (5) cast doubt on this conclusion. The estimate of the coefficient on MKT^+ is 0.192 and insignificant at conventional levels (t-statistic of 0.31). This contrast between the OLS results and the Fama-MacBeth results implies that the asymmetric effect of market returns is not stable across the sample period. Fama-MacBeth coefficient estimates on the other variables and their associated t-statistics are similar to those in columns (3) and (4), indicating that the other relations are stable over time.

4. Predictability of Initial Returns

The process of updating the price of the issuing firm's stock takes another large step when the IPO occurs. It is well known that the percent change between the offer price and the secondary market price (the initial return) is large on average, but also highly variable across firms. Section 4.1 examines the predictability of initial returns based on firm and offer-specific characteristics that are known at the time the issue is filed. In section 4.2, we investigate the extent to which information learned during the registration period is incorporated into the offer price. Intuitively, if such information is entirely incorporated into the offer price, then it should have no significant power to explain initial returns. Finally, section 4.3 attempts to differentiate between the effects of private versus public information learned during the registration period. Benveniste and Spindt's (1986) model provides a rational explanation for why private information should only be partially incorporated into the offer price. However, Loughran and Ritter's (2000) findings suggest that both public and private information are only partially incorporated into the offer price, which is inconsistent with Benveniste and Spindt's model.

4.1 The Effects of Firm- and Offer-specific Characteristics

The information asymmetry theories of Beatty and Ritter (1986), Rock (1986), and Baron (1982) suggest that issues characterized by greater uncertainty will tend to be more underpriced to compensate investors for learning the true value of these issues. Prior work, including Beatty

and Ritter (1986), Megginson and Weiss (1991), and Koh and Walter (1989), has found support for these information asymmetry theories in cross-sectional analyses. Table 7 re-examines this issue, employing both pooled cross-sectional regressions and Fama-MacBeth regressions. In controlling for the possible correlation of regression errors of IPOs close together in time, the Fama-MacBeth regressions examine the robustness of prior findings.

As a starting point for our initial return analysis, we focus on information that is available at the time the offer is filed. Specifically, column (1) of table 7 estimates the following regression,

$$\begin{aligned} IR_i = & \alpha + \beta_1 RANK_i + \beta_2 TECH_i + \beta_3 TA_i + \beta_4 SHRS_i + \beta_5 NYSE_i + \\ & \beta_6 NASDAQ_i + \beta_7 AMEX_i + \varepsilon_i, \end{aligned} \quad (4)$$

where the variables were described in section 2. The regression in column (3) adds volatility as an unbiased estimator of information that is known to the market, but not to econometricians, at the time the offer is filed.

Our results are generally consistent with the findings of prior literature in that offerings subject to greater information asymmetry tend to be underpriced by a greater amount. Specifically, we find that technology firms, smaller firms, and riskier firms tend to have higher initial returns (t-statistics of 4.22, -5.04, and 4.98 in column (4)). We also find that firms that list on Amex are less underpriced on average (t-statistic of -3.27).

Columns (5) and (6) in table 7 show the Fama-MacBeth bootstrap estimates of the regression in column (3) and the associated t-statistics. Most of the estimates and their t-statistics are similar to those in columns (3) and (4), indicating that these relations are stable over time.

4.2. The Effects of Information Learned During the Registration Period

When the IPO firm and its underwriters go on the road show prior to the offering, they presumably have two main objectives. They wish to market the issue to potential investors, and they seek to obtain more information on the true value of the firm. To the extent that this new information gets incorporated into the offer price, it contributes to a more accurate pricing of the new issue. Note that if such information were entirely incorporated into the offer price, then it would not be significantly related to the initial return. Table 8 examines whether two measures of information learned during the registration period, market returns and the price update, are significantly related to the initial return.

Column (1) of table 8 includes all of the independent variables from table 7, plus two measures of the information that becomes available during the registration period, MKT50 and ΔP . Assuming underwriters employ both public and private information learned during the registration price to arrive at the ultimate offer price, the price update (ΔP) should incorporate both types of information. In contrast, MKT50 should only reflect public information. Because we include both of these variables in one regression, to the extent that MKT50 captures the effects of public information on the initial return, the coefficient on ΔP should isolate the effects of private information.

As shown in tables 3, 4, and 5, market returns over different intervals appear to have varying effects on the offer price, and thus potentially on the initial return. For purposes of comparison with the results in earlier tables, we report results using MKT50. Because the initial price range is generally set within 50 trading days of the IPO, market-wide returns over this period (MKT50) should provide a reasonable measure of public information that potentially

affects the pricing of the IPO. However, we also examine the sensitivity of our results to using market returns over other intervals.

As shown in table 8, we find that both information measures are significantly positive (t-statistics of 3.60 and 18.76 for MKT50 and ΔP , respectively). Consistent with the prior findings of Loughran and Ritter (2000), this suggests that underwriters only partially incorporate both the public and the private information that they learn during the registration period into the offer price. Consequently, such information contributes significantly to the initial return.

The price update regressions in section 3 suggested that underwriters incorporate negative information more fully into the offer price than positive information. Column (3) allows for a similar asymmetric effect in the initial return regressions. Specifically, we add both $MKT50^+$ and ΔP^+ to the regression. We find that the effect of price update on initial returns is strongly asymmetric. A 10% increase in the price update corresponds to an 8.83% ($0.190 + 0.693$) increase in the initial return, while a 10% decrease in the price update corresponds to a smaller 1.90% decrease in the initial return. Thus, the magnitude of the initial return tends to be lower after negative price updates than after positive price updates. As with the results in table 6, investment bankers and issuing firms adjust to negative information more fully than to positive information. This is consistent with underwriters trying to avoid losses on overpriced issues while allowing informed investors to share the gains on underpriced issues.

Once we allow for this asymmetry, neither of the MKT50 measures is reliably related to initial returns. To the extent that these market returns capture public information learned during the registration period, this finding is consistent with Benveniste and Spindt and suggests that underwriters fully incorporate *public* information, while they only partially incorporate *private* information. This finding is reassuring in the sense that Benveniste and Spindt provide a rational

incentive-based explanation for underwriters only partially incorporating private information, but similar theories do not hold for public information.

However, we must be cautious in drawing such a conclusion. It seems plausible that some of the public information that is learned during the registration period may not be incorporated in a market-wide index. For example, events in the issuing firm's industry may have ramifications for the firm's value. Such industry effects may include an overall increase in demand for the industry's products, circumstances related to a competitor, or changes in a supplier relationship, among other things. Such dynamics would be extremely hard to measure directly. At a minimum, public information that affects the overall market does appear to be fully incorporated into the offer price, and thus does not contribute to the initial return.

Our finding that public information learned during the registration period is entirely incorporated into the offer price contrasts with the conclusions of Loughran and Ritter (2000) and to some extent those of Benveniste, Wilhelm, and Yu (2000). We thus briefly discuss the differences between the studies that led to these opposite conclusions. Loughran and Ritter run univariate regressions of the initial return on value-weighted market returns during the 15 days prior to the IPO, and they find that initial returns are significantly related to these market returns. Our results indicate that this relation becomes insignificant after controlling for the effect of the price update on initial returns and for the asymmetric manner in which investment bankers incorporate positive versus negative information. Benveniste, Wilhelm, and Yu find that public information, measured as S&P500 returns during the registration period, is significantly related to initial returns for mature industry firms but not for immature industry firms. They conclude that their results are consistent with Loughran and Ritter, but that the differences between mature and immature industry firms suggest an alternative interpretation. Specifically, if some of the

information embedded in S&P500 returns first became available through the bookbuilding process in the primary equity market, then underwriters may consider it to be private information and only partially incorporate it into the offer price. Because the S&P500 represents mature industry firms, it is more likely that such information originated during the bookbuilding periods of similar firms, resulting in a significant relation between the initial returns of mature industry firms and S&P500 returns.

Several other findings emerge from the table 8 regressions. For example, the coefficients on investment banker rank have opposite signs between tables 6 and 8. Rank is positively related to the price update, but negatively related to the initial return. This suggests a systematic conservative bias in IPO pricing by high quality investment banks at the preliminary prospectus state of the process, but less conservatism when setting the actual IPO price.

Columns (5) and (6) in table 8 show the Fama-MacBeth bootstrap estimates of the regression in column (3) and the associated tstatistics. Most of the estimates and their t statistics are similar to those in columns (3) and (4), indicating that the relations are stable over time.

We also ran the regressions in Table 8 using market returns over the entire registration period instead of MKT50. Results are qualitatively similar using this alternative measure. Specifically, once we account for asymmetric effects, market returns do not contribute significantly to the initial return. Again, this suggests that public information as represented by market-wide returns is fully incorporated into the offer price.

5. Robustness Checks

The tests above use data from 1985-97. We have also estimated similar tests extending the sample through 1999, but the extreme conditions in the IPO market in 1998-99 result in some unusual estimates when these additional years are included.

Figure 2 shows the time series of estimates of the regression in column (5) of table 7, estimated year-by-year from 1985-99. It is obvious from figure 2 that the estimates of many of the coefficients in 1998 and 1999 are extreme outliers compared with the 1985-97 sample, so including these data could skew the conclusions for the entire sample.

The dispersion of initial returns across different IPOs was much higher in 1998 and 1999, so any type of least squares (OLS) procedure, such as those used in tables 2 through 8, would give inordinate weight to the data from the last two years. As one check on this conjecture, we used weighted least squares (WLS) to create Fama-MacBeth estimates for tables 2, 6, and 7. The weights used for each year are the cross-sectional standard error estimates for the regression coefficients. Using this WLS Fama-MacBeth procedure, the estimates from 1985-99 are similar to the OLS estimates for the 1985-97 period. Thus, after controlling for the heteroskedasticity of the data, adding 1998 and 1999 does not change the conclusions we draw from the 1985-97 sample.

We chose to report and focus on the results from 1985-97 because it was not necessary to use complicated WLS procedures in our tests. The data are sufficiently stable within this period to use standard least squares procedures.

6. Conclusion

This paper examines the entire IPO pricing process to study the apparent biases in the pricing of new offerings. While some of our findings provide added support for one or more of the existing theories of IPO pricing, others cannot be explained with these theories.

We begin our analysis with the firm's revelation of the expected range of offer prices, which is announced at the time the offer is filed or in an amended prospectus. We find that there are significant biases in these expected offer prices. Specifically, the price update, defined as the percent difference between the midpoint of this file range and the final offer price, is predictably related to publicly known firm- and offer-specific characteristics. Apparently, companies and their investment bankers do not incorporate all available information when setting this price range. While significant relations between such characteristics and the initial return have been interpreted as supportive of information asymmetry theory, it is difficult to similarly explain the predictability of the price update.

We then investigate how information that becomes available during the book-building period is incorporated into the offer price. Our results show that companies and their underwriters update the offer price in response to recent market returns. However, this adjustment process does not seem to be directly related to the date on which the initial price range is first revealed. Underwriters appear to consider the past three months of market returns when they update the offer price, irrespective of when the initial price range was first revealed. This finding provides additional evidence that all available information is not incorporated into the initial price range.

We also find that the response of the final offer price to information is asymmetric, with negative information being more fully incorporated than positive information. This is consistent

with investment bankers trying to avoid losses on overpriced issues, but sharing the gains on underpriced issues.

Finally, the predictability of initial returns shows that underwriters only partially incorporate private information that is learned during the filing period into the final offer price, while public information is fully incorporated. This finding is consistent with Benveniste and Spindt's partial updating theory.

In summary, our results show that the IPO pricing process is a complicated function of many factors. Some of the dynamics are explainable under the information asymmetry theory or the partial updating theory, but other patterns remain puzzles.

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Table 1**Sample Selection Bias Based on Availability of SDC and CRSP Data, 1985-97**

Column (1) shows the means for the variables used to estimate regression models in subsequent tables. IR is the initial return to IPO investors using SDC data from 1985-97, the percent difference between the IPO price and the secondary market price. ΔP is the price update between the middle of the range of prices in the initial registration statement and the offer price. ΔP^+ is the price update when ΔP is positive, and zero otherwise. RANK is the underwriter rank, from Carter, Dark, and Singh (1998). TECH equals one if the firm is in a high tech industry [biotech, computer equipment, electronics, communications, and general technology (as defined by SDC)], and zero otherwise. TA equals the logarithm of real total assets (1983 dollars) before the IPO. SHRS is the logarithm of millions of shares filed in the IPO. VOL is the market-adjusted volatility of the IPO stock return, the standard deviation of daily returns to the IPO stock in the first 63 trading days after the IPO minus the standard deviation of daily returns to the CRSP equal-weighted market index during the same period. NYSE equals one if the IPO firm will be listed on the New York Stock Exchange, and zero otherwise. NASDAQ equals one if the IPO firm will be listed on the Nasdaq National Market System, and zero otherwise. AMEX equals one if the IPO firm will be listed on the American Stock Exchange, and zero otherwise. MKT is the return to the CRSP equal-weighted portfolio of NYSE, Amex, and Nasdaq-listed stocks for the period between the filing date and the offering date for the IPO. MKT^+ is the return to the market MKT when it is positive, and zero otherwise. The estimates in column (1) are based on the common regression sample of 3,595 firms with complete data. Columns (2) and (3) show estimates of the means in the sample of cases where data are missing for some other variable so they are not included in the regression analysis, with a t-statistic testing whether the difference from the regression sample is reliably different from zero using White's (1980) heteroskedasticity-consistent standard errors. Column (4) shows the size of the incomplete data sample. Column (5) shows the proportion of observations for each year from 1985-97 for the cases in the regression sample. Column (6) shows the proportion of observations for each year from 1985-97 where data are missing for some other variable so they are not included in the regression analysis, with a t-statistic testing whether the difference from the regression sample is reliably different from zero.

| Variable | (1) | (2) | (3) | (4) | Year | (5) | (6) | (7) |
|--------------|-------------------------------------|--------------------------------|----------------------------|--------------------------------|------|--|---|----------------------------|
| | Regression Sample (N=3,595) Mean | Incomplete Data Sample Mean | t-statistic for Difference | Incomplete Data Sample Size, N | | Regression Sample (N=3,595) Percent | Incomplete Data Sample (N=1,361) Percent | t-statistic for Difference |
| IR | 13.172 | 11.571 | 2.03 | 1,235 | 1985 | 0.053 | 0.059 | -0.76 |
| ΔP | -2.796 | -2.417 | -0.70 | 1,331 | 1986 | 0.110 | 0.124 | -1.38 |
| ΔP^+ | 4.982 | 4.190 | 2.88 | 1,331 | 1987 | 0.071 | 0.107 | -3.80 |
| RANK | 6.242 | 6.123 | 1.05 | 1,361 | 1988 | 0.030 | 0.043 | -2.08 |
| TECH | 0.340 | 0.317 | 1.53 | 1,361 | 1989 | 0.024 | 0.039 | -2.53 |
| TA | 16.784 | 16.853 | -0.56 | 514 | 1990 | 0.025 | 0.035 | -1.75 |
| SHRS | 14.586 | 14.680 | -2.93 | 1,030 | 1991 | 0.054 | 0.081 | -3.27 |
| VOL | 1.927 | 1.839 | 4.57 | 1,071 | 1992 | 0.085 | 0.079 | 0.70 |
| NYSE | 0.099 | 0.168 | -6.10 | 1,361 | 1993 | 0.102 | 0.110 | -0.85 |
| NASDAQ | 0.525 | 0.432 | 5.91 | 1,361 | 1994 | 0.060 | 0.069 | -1.17 |
| AMEX | 0.042 | 0.032 | 1.75 | 1,361 | 1995 | 0.102 | 0.087 | 1.65 |
| MKT | 6.426 | 5.665 | 2.19 | 1,330 | 1996 | 0.167 | 0.097 | 6.94 |
| MKT^+ | 6.984 | 6.144 | 2.12 | 1,330 | 1997 | 0.117 | 0.071 | 5.28 |

Table 2

**Firm and Deal Characteristics That Predict
Price Updates Between the Initial Filing and the IPO, 1985-97**

Regression models for the percentage change between middle of the range of prices in the initial registration statement and the offer price, ΔP , using SDC data from 1985-97. RANK is the underwriter rank, from Carter, Dark, and Singh (1998). TECH equals one if the firm is in a high tech industry [biotech, computer equipment, electronics, communications, and general technology (as defined by SDC)], and zero otherwise. TA equals the logarithm of real total assets (1983 dollars) before the IPO. SHRS is the logarithm of millions of shares filed in the IPO. NYSE equals one if the IPO firm will be listed on the New York Stock Exchange, and zero otherwise. NASDAQ equals one if the IPO firm will be listed on the Nasdaq National Market System, and zero otherwise. AMEX equals one if the IPO firm will be listed on the American Stock Exchange, and zero otherwise. VOL is the market-adjusted volatility of the IPO stock return, the standard deviation of daily returns to the IPO stock in the first 63 trading days after the IPO minus the standard deviation of daily returns to the CRSP equal-weighted market index during the same period. The t-statistics use White's (1980) heteroskedasticity consistent standard errors. R^2 is the coefficient of determination, adjusted for degrees of freedom. S(u) is the standard error of the regression. The sample size is 3,595 observations. Fama-MacBeth estimates are an average of the year-by-year regression coefficients and the t-statistics are based on the standard deviation of the time-series of coefficient estimates.

| | Pooled | | Fama-MacBeth | | Pooled | | Fama-MacBeth | |
|----------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|
| | (1) Coefficient | (2) t-statistic | (3) Coefficient | (4) t-statistic | (5) Coefficient | (6) t-statistic | (7) Coefficient | (8) t-statistic |
| Constant | 12.821 | 1.91 | 22.224 | 2.15 | 16.238 | 2.39 | 31.153 | 2.68 |
| RANK | 0.462 | 4.57 | 0.388 | 2.66 | 0.449 | 4.43 | 0.383 | 2.81 |
| TECH | 2.599 | 3.57 | 1.867 | 1.92 | 2.768 | 3.80 | 2.397 | 2.35 |
| TA | -0.584 | -3.04 | -0.739 | -2.16 | -0.703 | -3.65 | -0.823 | -2.45 |
| SHRS | -0.731 | -1.48 | -1.020 | -2.06 | -0.608 | -1.23 | -1.203 | -1.88 |
| NYSE | 4.748 | 3.91 | 2.720 | 1.33 | 4.623 | 3.80 | 2.365 | 0.99 |
| NASDAQ | 1.612 | 2.34 | -3.075 | -3.16 | 1.960 | 2.83 | -2.988 | -2.63 |
| AMEX | -5.493 | -2.90 | -9.206 | -3.15 | -5.687 | -3.02 | -8.996 | -3.06 |
| VOL | | | | | -1.745 | -2.87 | -2.559 | -2.06 |
| R^2 | 0.020 | | | | 0.022 | | | |
| S(u) | 18.116 | | | | 18.101 | | | |

Table 3**Relation of Price Updates to Public Information:
Market Returns During the Registration Period, 1985-97**

Regression models for the percentage change between middle of the range of prices in the initial registration statement and the offer price, ΔP_i , using SDC data from 1985-97.

$$\Delta P_i = \alpha + \beta \text{MKT}_i + \varepsilon_i$$

MKT is the return to the CRSP equal-weighted portfolio of NYSE, Amex, and Nasdaq-listed stocks for the period between the filing date and the offering date for the IPO. MKT25%, MKT50%, and MKT75% are market returns for the last 25%, 50%, and 75% of the filing period, ending the day before the IPO.

The sample in Panel A includes the 554 firms for which the exact date of the filing containing the initial price range could be determined from EDGAR during 1996-97. MKTMATCH is the market return from the day that the initial pricing range is revealed to the day before the IPO. The sample in Panel B includes the 4,919 firms with price update information available from SDC from 1985-97.

The t-statistics use White's (1980) heteroskedasticity-consistent standard errors. R^2 is the coefficient of determination, adjusted for degrees of freedom.

**A. 554 Firms from EDGAR, 1996-97
with Dates for Initial Filing Range**

| | MKT25% | MKT50% | MKT75% | MKT | MKTMATCH |
|-----------------------------|--------|--------|--------|-------|----------|
| β | 0.455 | 0.421 | 0.416 | 0.470 | 0.302 |
| t-statistic ($\beta = 0$) | 1.42 | 2.34 | 3.55 | 5.06 | 2.08 |
| R^2 | 0.005 | 0.014 | 0.028 | 0.049 | 0.010 |

B. 4,919 Firms from SDC, 1985-97

| | MKT25% | MKT50% | MKT75% | MKT |
|-----------------------------|--------|--------|--------|-------|
| β | 0.116 | 0.127 | 0.121 | 0.145 |
| t-statistic ($\beta = 0$) | 1.30 | 2.53 | 3.26 | 4.41 |
| R^2 | 0.000 | 0.002 | 0.004 | 0.007 |

Table 4**Relation of Price Updates to Public Information:
Market Returns for K Trading Days Before the IPO, 1985-97**

Regression models for the percentage change between the middle of the range of prices in the initial registration statement and the offer price, ΔP , using SDC data from 1985-97.

$$\Delta P_i = \alpha + \beta \text{MKTK}_i + \varepsilon_i$$

MKTK is the return to the CRSP equal-weighted portfolio of NYSE, Amex, and Nasdaq-listed stocks for K trading days before the IPO. The sample includes the 4,919 firms with price update information available from SDC from 1985-97. The t-statistics use White's (1980) heteroskedasticity-consistent standard errors. R^2 is the coefficient of determination, adjusted for degrees of freedom. Fama-MacBeth estimates are an average of the year-by-year regression coefficients and the t-statistics are based on the standard deviation of the time-series of coefficient estimates.

| Market Return for K Trading Days Before IPO, MKTK | β | t($\beta=0$) | R^2 | Fama-MacBeth β | Fama-MacBeth t($\beta=0$) |
|---|---------|----------------|-------|----------------------|-----------------------------|
| MKT5 | 1.040 | 5.92 | 0.007 | 0.967 | 2.20 |
| MKT10 | 0.829 | 7.08 | 0.011 | 0.791 | 3.12 |
| MKT15 | 0.845 | 9.74 | 0.020 | 0.748 | 4.19 |
| MKT20 | 0.808 | 12.22 | 0.030 | 0.761 | 4.43 |
| MKT25 | 0.757 | 13.66 | 0.038 | 0.756 | 4.85 |
| MKT30 | 0.704 | 14.36 | 0.042 | 0.727 | 5.22 |
| MKT35 | 0.678 | 14.82 | 0.048 | 0.722 | 5.31 |
| MKT40 | 0.659 | 16.00 | 0.055 | 0.713 | 5.54 |
| MKT45 | 0.621 | 16.41 | 0.057 | 0.708 | 5.72 |
| MKT50 | 0.589 | 16.76 | 0.057 | 0.692 | 5.68 |
| MKT75 | 0.413 | 16.10 | 0.047 | 0.556 | 5.42 |
| MKT100 | 0.278 | 12.80 | 0.032 | 0.393 | 5.40 |
| MKT125 | 0.205 | 11.08 | 0.022 | 0.322 | 4.69 |
| MKT250 | 0.112 | 9.01 | 0.015 | 0.209 | 2.49 |

Table 5**Relation of Price Updates to Public Information:
Market Returns for K Trading Days Before the IPO, 1985-97**

Regression models for the percentage change between the middle of the range of prices in the initial registration statement and the offer price, ΔP , using SDC data from 1985-97.

$$\Delta P_i = \alpha + \sum_{k=1}^{13} \beta_k XK_i + \varepsilon_i$$

XK_i is the weekly (WK_i) or monthly (MK_i) market return for the k^{th} week or month before the IPO. Each weekly return is measured as 5 trading day returns and each monthly return is measured as 20 trading day returns, using the CRSP equal-weighted portfolio of NYSE, Amex, and Nasdaq-listed stocks. The sample includes the 4,919 firms with price update information available from SDC from 1985-97. The t -statistics use White's (1980) heteroskedasticity-consistent standard errors. R^2 is the coefficient of determination, adjusted for degrees of freedom. $S(u)$ is the standard error of the regression.

| Weekly Lags | | | Monthly Lags | | |
|-------------|-------------|-------------|--------------|-------------|-------------|
| Variable | Coefficient | t-statistic | Variable | Coefficient | t-statistic |
| Constant | -6.954 | -19.49 | Constant | -7.294 | -12.74 |
| W1 | 0.552 | 3.08 | M1 | 0.658 | 9.53 |
| W2 | 0.447 | 2.45 | M2 | 0.705 | 9.31 |
| W3 | 0.894 | 4.79 | M3 | 0.343 | 5.40 |
| W4 | 0.724 | 4.12 | M4 | 0.083 | 1.27 |
| W5 | 0.790 | 4.63 | M5 | 0.002 | 0.02 |
| W6 | 0.441 | 2.37 | M6 | -0.011 | -0.18 |
| W7 | 0.707 | 3.40 | M7 | -0.009 | -0.14 |
| W8 | 0.799 | 4.47 | M8 | -0.057 | -0.95 |
| W9 | 0.328 | 1.87 | M9 | 0.101 | 1.71 |
| W10 | 0.304 | 1.66 | M10 | 0.068 | 1.17 |
| W11 | 0.053 | 0.30 | M11 | 0.058 | 1.00 |
| W12 | 0.446 | 2.51 | M12 | 0.042 | 0.59 |
| W13 | 0.244 | 1.48 | M13 | -0.221 | -3.50 |
| R^2 | 0.059 | | R^2 | 0.061 | |
| $S(u)$ | 17.207 | | $S(u)$ | 17.191 | |

Table 6**Firm and Deal Characteristics and Market Conditions That Predict Price Updates Between the Initial Filing and the IPO, 1985-97**

Regression models for the percentage change between the middle of the range of prices in the initial registration statement and the offer price, ΔP , using SDC data from 1985-97. RANK is the underwriter rank, from Carter, Dark, and Singh (1998). TECH equals one if the firm is in a high tech industry [biotech, computer equipment, electronics, communications, and general technology (as defined by SDC)], and zero otherwise. TA equals the logarithm of real total assets (1983 dollars) before the IPO. SHRS is the logarithm of millions of shares filed in the IPO. NYSE equals one if the IPO firm will be listed on the New York Stock Exchange, and zero otherwise. NASDAQ equals one if the IPO firm will be listed on the Nasdaq National Market System, and zero otherwise. AMEX equals one if the IPO firm will be listed on the American Stock Exchange, and zero otherwise. VOL is the market-adjusted volatility of the IPO stock return, the standard deviation of daily returns to the IPO stock in the first 63 trading days after the IPO minus the standard deviation of daily returns to the CRSP equal-weighted market index during the same period. MKT50 is the return to the CRSP equal-weighted portfolio of NYSE, Amex, and Nasdaq-listed stocks for 50 trading days before the IPO. MKT50⁺ is the return to the market MKT50 when it is positive, and zero otherwise. The t-statistics use White's (1980) heteroskedasticity consistent standard errors. R² is the coefficient of determination, adjusted for degrees of freedom. S(u) is the standard error of the regression. The sample size is 3,595 observations. Fama-MacBeth estimates are an average of the year-by-year regression coefficients and the t-statistics are based on the standard deviation of the time-series of coefficient estimates.

| | (1) Coefficient | (2) t-statistic | (3) Coefficient | (4) t-statistic | Fama-MacBeth | |
|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|
| | | | | | (5) Coefficient | (6) t-statistic |
| Constant | 13.152 | 1.99 | 13.824 | 2.08 | 16.665 | 1.46 |
| RANK | 0.469 | 4.81 | 0.471 | 4.83 | 0.362 | 2.82 |
| TECH | 2.382 | 3.38 | 2.387 | 3.39 | 1.932 | 1.81 |
| TA | -0.475 | -2.53 | -0.475 | -2.52 | -0.742 | -1.97 |
| SHRS | -0.989 | -2.05 | -0.977 | -2.03 | -0.833 | -1.30 |
| NYSE | 2.949 | 2.53 | 2.949 | 2.53 | 2.299 | 1.07 |
| NASDAQ | 0.040 | 0.06 | 0.025 | 0.04 | -2.814 | -2.60 |
| AMEX | -6.017 | -3.31 | -5.950 | -3.29 | -9.118 | -3.14 |
| VOL | -0.965 | -1.62 | -0.980 | -1.65 | -0.767 | -1.29 |
| MKT50 | 0.664 | 15.14 | 1.152 | 5.34 | 0.740 | 1.68 |
| MKT50 ⁺ | | | -0.562 | -2.31 | 0.192 | 0.31 |
| R ² | 0.084 | | 0.086 | | | |
| S(u) | 17.515 | | 17.503 | | | |

Table 7**Firm and Deal Characteristics That Predict Initial Returns to IPO Investors, 1985-97**

Regression models for the percentage change between the offer price and the secondary market trading price, IR, using SDC data from 1985-97. RANK is the underwriter rank, from Carter, Dark, and Singh (1998). TECH equals one if the firm is in a high tech industry [biotech, computer equipment, electronics, communications, and general technology (as defined by SDC)], and zero otherwise. TA equals the logarithm of real total assets (1983 dollars) before the IPO. SHRS is the logarithm of millions of shares filed in the IPO. NYSE equals one if the IPO firm will be listed on the New York Stock Exchange, and zero otherwise. NASDAQ equals one if the IPO firm will be listed on the Nasdaq National Market System, and zero otherwise. AMEX equals one if the IPO firm will be listed on the American Stock Exchange, and zero otherwise. VOL is the market-adjusted volatility of the IPO stock return, the standard deviation of daily returns to the IPO stock in the first 63 trading days after the IPO minus the standard deviation of daily returns to the CRSP equal-weighted market index during the same period. The t-statistics use White's (1980) heteroskedasticity consistent standard errors. R^2 is the coefficient of determination, adjusted for degrees of freedom. S(u) is the standard error of the regression. The sample size is 3,595 observations. Fama-MacBeth estimates are an average of the year-by-year regression coefficients and the t-statistics are based on the standard deviation of the time-series of coefficient estimates.

| | (1) Coefficient | (2) t-statistic | (3) Coefficient | (4) t-statistic | Fama-MacBeth | |
|----------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|
| | | | | | (5) Coefficient | (6) t-statistic |
| Constant | 17.597 | 1.83 | 9.590 | 1.00 | 33.130 | 2.69 |
| RANK | -0.082 | -0.67 | -0.052 | -0.44 | -0.045 | -0.27 |
| TECH | 3.952 | 4.54 | 3.557 | 4.22 | 2.281 | 2.18 |
| TA | -1.630 | -6.28 | -1.352 | -5.04 | -0.884 | -3.24 |
| SHRS | 1.489 | 2.00 | 1.200 | 1.60 | -0.591 | -0.67 |
| NYSE | -0.164 | -0.09 | 0.129 | 0.07 | -3.012 | -1.08 |
| NASDAQ | 1.241 | 1.15 | 0.427 | 0.38 | -4.797 | -3.74 |
| AMEX | -6.012 | -3.52 | -5.559 | -3.27 | -8.429 | -4.05 |
| VOL | | | 4.089 | 4.98 | 2.942 | 2.47 |
| R^2 | 0.036 | | 0.043 | | | |
| S(u) | 21.551 | | 21.470 | | | |

Table 8**Effects of Information Learned During the Registration Period on Initial Returns to IPO Investors, 1985-97**

Regression models for the percentage change between the offer price and the secondary market trading price, IR, using SDC data from 1985-97. RANK is the underwriter rank, from Carter, Dark, and Singh (1998). TECH equals one if the firm is in a high tech industry [biotech, computer equipment, electronics, communications, and general technology (as defined by SDC)], and zero otherwise. TA equals the logarithm of real total assets (1983 dollars) before the IPO. SHRS is the logarithm of millions of shares filed in the IPO. NYSE equals one if the IPO firm will be listed on the New York Stock Exchange, and zero otherwise. NASDAQ equals one if the IPO firm will be listed on the Nasdaq National Market System, and zero otherwise. AMEX equals one if the IPO firm will be listed on the American Stock Exchange, and zero otherwise. VOL is the market-adjusted volatility of the IPO stock return, the standard deviation of daily returns to the IPO stock in the first 63 trading days after the IPO minus the standard deviation of daily returns to the CRSP equal-weighted market index during the same period. MKT50 is the return to the CRSP equal-weighted portfolio of NYSE, Amex, and Nasdaq-listed stocks for 50 trading days before the IPO. MKT50⁺ is the return to the market, MKT50, when it is positive, and zero otherwise. ΔP is the price update between the middle of the range of prices in the initial registration statement and the offer price. ΔP^+ is the price update when ΔP is positive, and zero otherwise. The t-statistics use White's (1980) heteroskedasticity consistent standard errors. R² is the coefficient of determination, adjusted for degrees of freedom. S(u) is the standard error of the regression. The sample size is 3,595 observations. Fama-MacBeth estimates are an average of the year-by-year regression coefficients and the t-statistics are based on the standard deviation of the time-series of coefficient estimates.

| | (1) Coefficient | (2) t-statistic | (3) Coefficient | (4) t-statistic | Fama-MacBeth | |
|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|
| | | | | | (5) Coefficient | (6) t-statistic |
| Constant | 1.640 | 0.18 | 8.195 | 0.89 | 20.501 | 1.74 |
| RANK | -0.246 | -2.22 | -0.427 | -3.87 | -0.366 | -2.48 |
| TECH | 2.238 | 2.94 | 0.998 | 1.34 | 0.170 | 0.23 |
| TA | -0.984 | -3.87 | -0.963 | -3.75 | -0.619 | -2.32 |
| SHRS | 1.372 | 1.90 | 0.907 | 1.23 | -0.136 | -0.14 |
| NYSE | -2.335 | -1.32 | -2.278 | -1.29 | -4.203 | -1.68 |
| NASDAQ | -0.924 | -0.87 | -2.346 | -2.23 | -3.925 | -2.26 |
| AMEX | -3.132 | -1.81 | -4.515 | -2.74 | -6.732 | -3.54 |
| VOL | 5.057 | 6.67 | 4.148 | 5.64 | 3.804 | 3.95 |
| MKT50 | 0.168 | 3.60 | 0.172 | 0.79 | -0.335 | -0.35 |
| MKT50 ⁺ | | | -0.027 | -0.11 | 0.725 | 0.64 |
| ΔP | 0.441 | 18.76 | 0.190 | 8.63 | 0.196 | 10.70 |
| ΔP^+ | | | 0.693 | 8.71 | 0.509 | 3.24 |
| R ² | 0.188 | | 0.222 | | | |
| S(u) | 19.781 | | 19.356 | | | |

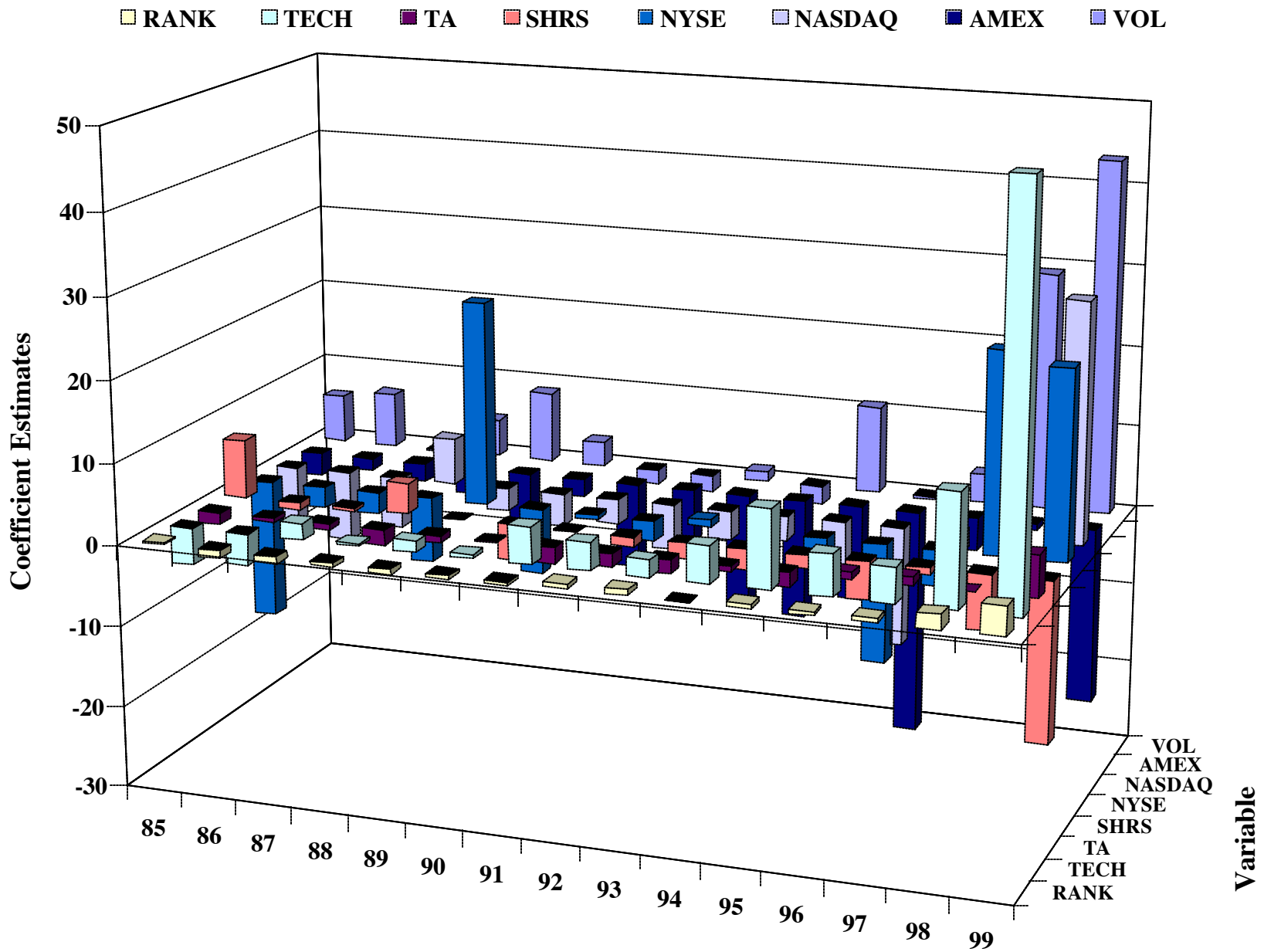


Figure 2. Time series plot of year-by-year estimates of the regression of initial returns to IPO investors on firm and deal characteristics (table 8), 1985-99.