WHY ARE INITIAL PUBLIC OFFERING (IPO) PRICES ONLY PARTIALLY ADJUSTED?

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I would like to dedicate this dissertation to my parents, Filiz and Metin İnce; my brother, Ufuk İnce; and Elise Chandon.

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Initial public offerings with upward offer price revisions leave disproportionately high amounts of money on the table. In this study, we investigate the factors that determine the efficiency of IPO offer price adjustment process. We conduct an efficiency analysis by comparing the magnitude of actual offer price revision to the hypothetical complete level of offer price revision for each IPO in our sample.

The analysis of 1,122 IPOs with upward price revisions during 1985-2003 indicates that on average only 42% of the change in firm value during the registration period was incorporated into offer prices, with this ratio dropping to 29% during the bubble period of 1999-2000. We document substantial variation in the efficiency of offer price adjustment across IPOs and over time, and test three hypotheses concerning the incorporation of information into offer prices.

Our findings do not support the dynamic information acquisition hypothesis of Benveniste and Spindt (1989). We find substantial inefficiencies in the incorporation of

market returns and information spillovers from recent IPOs into offer prices. More remarkably, the incorporation of private information is more efficient than the incorporation of public information. The cross-sectional analysis of the offer price adjustment efficiency reveals that the partial adjustment phenomenon is primarily due to agency problems between the issuing firms and the underwriters, and the magnitude of the offer price revision is strongly related to the relative bargaining powers of the two sides.

CHAPTER 1
INTRODUCTION

Beginning with Hanley (1993), various empirical studies have documented that when bookbuilding is used, the underpricing of IPOs is positively related to the offer price adjustment. Recent studies have shown that the magnitude of offer price adjustment is the single biggest predictor of IPO underpricing. This relationship is economically significant: During 1985-2003, average underpricing has exceeded 57% for issues with upward price adjustment, whereas it has been only 4.6% for issues with downward price adjustment.[1] During 1999-2000, this difference was even more dramatic: Average underpricing was 120% for IPOs with upward price adjustment versus 8% for those with downward price adjustment.

This positive relationship between offer price adjustment and underpricing is primarily due to the partial adjustment of offer prices to the change in the value of the issuing firm during its registration period. In our sample, IPOs with upward price adjustment have experienced first-day closing prices on average 113% higher than the midpoint of their initial filing range, while the average offer price increase for these IPOs has remained at a relatively small 29%. During 1985-2003, an aggregate of $113 billion

[1] In the rest of this article we use the term "upward price adjustment" for issues where the final offer price is above the maximum of the original filing price range, and "downward price adjustment" for issues where the final offer price is below the minimum of the original filing price range.

was left on the table due to underpricing.[2] Approximately 76% of the total money left on the table was from the 25% of IPOs whose offer prices were adjusted upward.

In this study we conduct a comprehensive investigation of the efficiency of the IPO offer price adjustment process. We start by estimating an efficiency ratio for each IPO with offer price adjustment by comparing the change in the firm value during the registration period with the revision in the offer price. This efficiency ratio captures actual offer price adjustment relative to the hypothetical complete level of offer price adjustment. The change in the firm value during the registration period is unobservable since the expected value of the firm at the time of the initial filing is unknown. In this study, we estimate the initial expected value of the IPO firm using the observed market price once it starts trading, the initial file price range, and the underpricing information provided by IPOs whose offer prices are not revised. The primary advantage of our methodology lies in its ability to identify the relation between the efficiency of the offer price adjustment process and various firm-, underwriter-, and offer-specific characteristics. Previous studies of IPO pricing efficiency have for the most part focused on underpricing, which is a combination of two components: the part that is independent from the offer price revision and common to all IPOs, for instance the initial return required by investors for investing in the shares of the issuing firm; and the additional underpricing due to the partial adjustment of offer prices. To the extent that the same factors are systematically related to both components, using underpricing as the measure of inefficiency leads to ambiguity in pinpointing the determinants of the IPO offer price adjustment efficiency. Our approach allows us to provide a comprehensive analysis of the

[2] Money left on the table is defined as the extra offer proceeds that would be attained by the issuing firm if the shares were sold at the first-day closing market price rather than at the offer price.

cross-sectional determinants of the offer price adjustment efficiency, and to test three hypotheses concerning the incorporation of information into the offer prices.

Our analysis reveals that from 1985 to 2003, on average only 42% of the increase in firm value during the registration period was incorporated into offer prices by means of an upward adjustment. In the bubble period of 1999 and 2000, this percentage dropped to 29%. Translated into dollars, conditional on an upward offer price adjustment, the average IPO firm in our sample with $100 million initial expected offer proceeds left $23.2 million on the table due to incomplete adjustment, equivalent to more than three times the initial expected commission payment to the underwriters.

Next, we relate the efficiency of offer price adjustment to various firm-, underwriter-, and offer-specific characteristics, and investigate which hypothesis of IPO pricing best explains the variation of efficiency across IPOs with upward price revision. Until recently the prevailing explanation for the partial adjustment of IPO offer prices was based on the Benveniste and Spindt (1989) model of IPO pricing. This dynamic information acquisition framework is based on the notion that potential investors have an information advantage over the issuers and the underwriters with respect to the market value of the issuing firms. Underwriters use underpricing as a reward to extract this private information from the investors. As a result, underpricing and offer proceeds for the issuers increase simultaneously, resulting in higher average underpricing for IPOs with upward offer price adjustment.

Our findings do not support the dynamic information acquisition hypothesis. We find that market returns and information spillovers from recent comparable IPOs (those in the same Fama-French (1997) industry) are only partially incorporated into the offer

prices. Issuing firms that go public following recent comparable IPOs with high levels of underpricing and during a period of high returns in the market experience less efficient offer price adjustments. Our results indicate that, even though upward offer price revisions in the IPO market are associated with higher market valuations for all comparable IPOs that soon follow, this information is incorporated into the offer prices efficiently only for offers taken public by the same underwriter. We interpret this finding as evidence that the underwriters that are associated with upward offer price revisions in the recent past are likely to adjust offer prices relatively more efficiently in their future IPOs. Notably, we find that the incorporation of private information is more efficient than the incorporation of public information. It appears that an offer price increase in excess of that driven by public information is due to the issuer's ability to efficiently extract a greater surplus from the underwriter and the investors, rather than due to exogenous and costly firm-specific information production by the investors.

This is not the first study to question the dynamic information acquisition explanation of the partial adjustment phenomenon. This explanation has recently come under criticism, primarily due to the positive relation documented between market returns during the registration period and the subsequent underpricing (e.g., Loughran and Ritter, 2002; Lowry and Schwert, 2004). In light of this finding, two new hypotheses of offer price adjustment have emerged.

The bargaining hypothesis is based on the notion that there are significant agency problems between the underwriter and the issuing firm, and suggests that the offer prices are determined as a result of negotiations between the two parties (Loughran and Ritter, 2002; Ljungqvist and Wilhelm, 2003). In the offer price adjustment context, an

unexpected positive shock to the valuation of the firm during the registration period results in a bigger aggregate surplus, which is then divided between the underwriter and the issuer according to their respective bargaining powers. This leads to a partial adjustment of IPO offer prices.

Our results are consistent with the bargaining hypothesis of IPO offer price adjustment. We find that the efficiency of offer price adjustment is better for IPO firms with attractive outside options and for those with bigger incentives to negotiate. On the other hand, efficiency is lower for issues underwritten by investment banks whose services are highly in demand at the time and by those that employ influential research analysts, indicating a positive relation between the bargaining powers of the underwriters and the efficiency of IPO pricing. Incorporation of market returns becomes less efficient towards the end of the registration period. We interpret this as evidence that the issuing firm's bargaining power weakens over time, reflecting the declining threat of withdrawal. In line with this argument, we find that the excess surplus created at the preliminary offer price, presumably the result of a price competition among potential underwriters during the bake-off process, erodes during the registration period. We also find evidence consistent with the existence of a negotiation process: Issues with longer registration periods and those with offer prices set at fractional dollars are associated with better offer price adjustments.

Our findings also have implications for the validity of the Edelen and Kadlec (2005) tradeoff hypothesis. According to the tradeoff hypothesis, the partial adjustment phenomenon is primarily due to the issuing firm's uncertainty over the offer's successful completion. Issuers maximize the expected surplus from going public by weighing the

probability of success against offer proceeds conditional on success. If the surplus increases during the registration period, issuers maximize the expected surplus by seeking a higher success probability, thereby demanding only a partial adjustment of offer prices. The bargaining and the tradeoff hypotheses differ in regard to the role of the underwriters in the offer price adjustment process. According to the bargaining hypothesis, partial adjustment occurs due to the underwriters' conflict of interests with the issuers and their ability to profit from underpricing. On the other hand, according to the tradeoff model underwriters do not play a role in the partial adjustment of offer prices. Our findings regarding the relation between underwriter characteristics, such as the level of demand for their services and the employment of influential research analysts, and the efficiency of the offer price adjustment contradict the predictions of the tradeoff hypothesis.

In addition, according to the tradeoff hypothesis, the underwriters and issuing firms have no incentive to engage in a nickel-and-diming strategy. Therefore, whether the final offer price is at an integer or a fraction of a dollar should not contain any information, and should not be significantly related to the efficiency of the offer price adjustment. This contradicts our finding that issues with offer prices set at integers experience less complete price adjustments. Taken together, the evidence in this study does not support the Edelen and Kadlec (2005) tradeoff model.

In sum, we document substantial inefficiencies in the IPO offer price adjustment process. The partial adjustment of IPO offer prices imposes substantial costs on the issuing firms and their pre-issue shareholders. The evidence suggests that the partial adjustment phenomenon is primarily due to agency problems between the issuers and the underwriters, and the variation of efficiency across IPOs is best explained by the

bargaining explanation of IPO offer price adjustment. Our findings indicate that the issuing firms can increase the efficiency of the IPO pricing process by improving their bargaining powers vis-à-vis the underwriters by taking proper actions prior to the IPO, for instance by securing alternative financing options.

The rest of this dissertation is organized as follows. Chapter 2 introduces the partial adjustment phenomenon, and discusses the hypotheses and empirical predictions. Chapter 3 describes the methodological approach. Chapter 4 describes the data and the variable construction. Chapter 5 discusses the empirical results. Chapter 6 presents various robustness checks and Chapter 7 provides a summary and conclusion.

CHAPTER 2
PARTIAL ADJUSTMENT PHENOMENON, HYPOTHESES, AND EMPIRICAL PREDICTIONS

The pricing process for an initial public offering (IPO) typically starts with the meetings between prospective underwriters and the issuing firm when underwriters present tentative valuations. After the formation of an underwriter syndicate, the first pricing information is provided to the public in the form of an offer price range either in the preliminary prospectus or an amended statement filed with the Securities and Exchange Commission (SEC). The anticipated offer price range may be adjusted upward or downward throughout the registration period depending on the level of investor demand for the offer. The final offer price is set by the issuing firm and the underwriters the day before the offering, and shares are allocated to investors at this offer price. Often the first-day closing market price is higher than the offer price, and the percentage premium over the offer price is termed underpricing.

Hanley (1993) was the first to document a strong positive relation between the offer price revision during the registration period and the subsequent underpricing. It appears that underwriters do not set the final offer prices up to the level that would be necessary to keep the underpricing constant in the face of strong demand from investors. In other words, the increase in the firm value during the registration period is only partially incorporated into the offer price.

Next, we introduce the three hypotheses of partial adjustment and their empirical predictions in the context of our analysis.

The Dynamic Information Acquisition Hypothesis

The first explanation of the partial adjustment phenomenon tested in this study is the dynamic information acquisition hypothesis of Benveniste and Spindt (1989). According to this hypothesis, investors possess valuable private information with regards to the fair market value of the IPO firm, and the underwriters and the issuing firm try to induce these investors to truthfully reveal their information in order to maximize the offer proceeds. Underpricing is used as a reward to satisfy the incentive compatibility constraint of the investors, creating a partial adjustment of offer prices.

Empirical evidence on the validity of the dynamic information acquisition hypothesis is mixed. A central prediction of the dynamic information acquisition hypothesis is that underpricing and offer proceeds for the issuers increase simultaneously, resulting in higher average underpricing among IPOs with upward offer price adjustment. Consistent with this prediction, Hanley (1993) documents a positive relationship between offer price adjustment and underpricing. Hanley also documents that lagged market returns predict underpricing, but she makes no attempt to explain this pattern. Loughran and Ritter (2002) revisit this finding and point out that it is inconsistent with the dynamic information acquisition hypothesis since investors need to be rewarded only for their private information, and the incorporation of public information should be costless to the issuer. Lowry and Schwert (2004) also find a statistically significant positive relationship between the market returns during the registration period and the subsequent underpricing of the offer, but argue that this relationship is economically small and conclude that the IPO pricing process is close to efficient. However, their analysis does not take into consideration the simultaneous effect of public information on the level of

offer price adjustment in addition to the underpricing, which may lead to a potential underestimation of the economic significance of the inefficiencies.[1]

Benveniste et al. (2002) extend the dynamic information acquisition framework to include potential indirect feedback from comparable IPOs. The authors argue that underwriters smooth the costs of information acquisition across IPOs related by a common factor to resolve potential coordination problems. According to the extended dynamic information acquisition framework, information produced in comparable IPOs should make the costs of price adjustment of an issue underwritten by the same investment bank cheaper, but not altogether free. On the other hand, there should be no cost to adjusting offer prices when information spillover originates from comparable IPOs taken public by other underwriters, since this is public information. Thus, the information revealed in the pricing of IPOs should be fully incorporated into the offer prices of subsequent IPOs that are in the same industry and taken public by other underwriters.

Ljungqvist and Wilhelm (2002) and Benveniste et al. (2003) examine the relationship between information spillovers and the level of offer price adjustment. Both studies find that information revealed in comparable IPOs affect subsequent IPO offer prices, consistent with the dynamic information acquisition hypothesis. However, they do not investigate the efficiency of this price adjustment. In this study, we analyze the efficiency of offer price adjustment associated with information spillovers. In addition,

[1] Edelen and Kadlec (2005) solve this problem econometrically by isolating the market returns from the offer price adjustment using orthogonalization and report a larger relationship between underpricing and market returns during the registration period. They do not discuss the implications of this finding on the significance of the costs associated with the partial adjustment of public information.

our analysis distinguishes between information spillovers among IPOs underwritten by the same investment bank and by others, and thereby provides a more comprehensive test of the dynamic information acquisition hypothesis.

The Bargaining Hypothesis

The second explanation of the partial adjustment phenomenon tested in this study is the bargaining hypothesis (Loughran and Ritter, 2002; Ljungqvist and Wilhelm, 2003). This hypothesis is based on the notion that the incentives of the underwriters and the issuing firm differ, and the offer price is set as a result of negotiations between the two parties. In the offer price adjustment context, positive information revealed during the registration period creates a surplus that is shared between the underwriter and the issuing firm according to their bargaining powers and incentives to bargain.

Despite the empirical and anecdotal evidence for the existence of significant conflicts of interest between underwriters and issuing firms, empirical investigations of the bargaining hypothesis have been limited in the IPO literature, with a few notable exceptions. Loughran and Ritter (2002) combine the bargaining hypothesis and prospect theory to explain the variation in IPO underpricing, and suggest that issuers bargain hard over the offer price in bad states of the world, whereas they are pushovers in bargaining in good states of the world. Ljungqvist and Wilhelm (2005) test the predictions of Loughran and Ritter (2002) by examining the decisions of issuing firms subsequent to the IPO and find evidence that managers of issuing firms that are satisfied with the IPO's outcome according to prospect theory are less likely to switch underwriters for their first seasoned equity offering. Ljungqvist and Wilhelm (2003) examine the relationship between the bargaining incentives of the issuing firms' decision makers and the level of underpricing, and find evidence consistent with bargaining in the U.S. in the second half

of the 1990s. Other studies of bargaining in the IPO context include Logue (1973), who examines the relationship between several bargaining proxies and underpricing; and Sternberg (1989) and Hoberg (2004) who use formal bargaining models to explain the partial adjustment phenomenon. In this study, we develop and test the predictions of the bargaining theory with respect to the efficiency of offer price adjustment, and provide a comprehensive analysis of the bargaining hypothesis in the context of IPO pricing.

In our analysis of the bargaining hypothesis, we first focus on the effect of outside options on the bargaining powers of the issuers and the underwriters. According to the bargaining theory, an attractive outside option leads to a higher bargaining power and a bigger share of the surplus. In the IPO pricing context, the existence of alternative financing options for the issuing firm should lead to a more complete offer price adjustment, due to the issuer's credible threat of withdrawal if necessary. For example, an IPO firm that is not satisfied with the terms offered by its underwriter would be more capable to prolong the negotiations or even withdraw and come back to the market after hiring another investment bank if it already has an established relationship with a bank or a private equity firm.[2] Following Dunbar and Foerster (2005), we use leverage and private equity investment in the firm prior to the IPO as proxies for alternative financing options of the IPO firms.

Next, we examine the underwriter's outside options. We argue that the underwriter's bargaining power is positively related to the overall demand for its services

[2] Consistent with this argument, Busaba et al. (2001) and Dunbar and Foerster (2005) find that IPO firms with greater access to alternative financing options are more likely to withdraw. In addition, Busaba et al. (2001) show that a higher probability of withdrawal by the issuing firm leads to lower underpricing although the authors suggest that a higher probability of withdrawal strengthens the issuer's bargaining power with respect to the investors, rather than the underwriters.

by other issuers. The rationale is that the opportunity cost of an issue's withdrawal to the underwriter is negatively related to the underwriter's expected revenues from other issues. In other words, a given offer is more valuable to the underwriter during a cold IPO market than during a hot one. On the other hand, the opportunity cost of withdrawal is positively related to the foregone revenues from the offer in case of a deal failure. Therefore, the bargaining hypothesis suggests that the ratio of expected fee income from the issue to the total expected fee income from issues completed or filed during the registration period should be negatively related to the underwriter's bargaining power, and consequently should be positively related to the efficiency of the offer price adjustment.

Prior studies have shown that research analyst reputation plays an important role in securing underwriting business. Dunbar (2000) and Clarke et al. (2003) report that the market share, and the change in the market share, of underwriters are positively related to the presence of an analyst who is a member of Institutional Investor's All-American Research Team. Furthermore, there is evidence that the presence of an all-star analyst affects the pricing of an initial offering. Cliff and Denis (2004) report that issues underwritten by investment banks with all-star analysts are more underpriced, and they interpret the higher underpricing as compensation for post-IPO coverage by highly ranked analysts. Loughran and Ritter (2004) attribute the higher underpricing observed in the 1990s to the increased importance of analyst coverage. To the extent that the existence of an all-star analyst leads to a higher demand for the services of the underwriter and to attractive outside options of revenue generation, investment banks

with all-star analysts should be associated with less complete price adjustments in their IPOs.

Ljungqvist and Wilhelm (2003) argue that issuers care more about underpricing and bargain harder when their stakes in the offer and thus their opportunity cost of underpricing are higher. Bradley and Jordan (2002) and Loughran and Ritter (2004) use share overhang, the ratio of retained shares to the public float, to examine the relationship between the opportunity cost of underpricing and first-day returns.[3] We include share overhang in the analysis as a proxy for the issuers' incentives to bargain. The bargaining hypothesis predicts a negative relationship between share overhang and the efficiency of the offer price adjustment.

The pricing of an IPO starts with the bake-off process, during which potential underwriters compete for the issuer's business and present their preliminary valuations. As a result, the initial file price range is determined in a highly competitive setting. On the other hand, the final offer price is set at a time when the issuer's probability of switching underwriters is very low (therefore, a threat to withdraw is not credible) due to the high levels of sunk costs incurred during a long registration period. Therefore, the bargaining hypothesis suggests that the bargaining power of the issuing firms decline during the registration period. Barondes (2005) argues that between the selection of an investment bank and the final IPO pricing, the negotiating advantage shifts in favor of the investment banks. Hall and Robbins-Roth (1992) state that "Pricing is a factor that caught

[3] An alternative interpretation of the relationship between underpricing and share overhang is provided by Loughran and Ritter's (2002) prospect theory model of offer price adjustment. Loughran and Ritter argue that issuers tend to sum the opportunity cost of underpricing with the wealth gain on retained shares as prices increase substantially in the aftermarket. As a result of this behavior, issuers do not bargain as hard as they should, especially when share overhang is high.

many managers by surprise. By the time the pricing meeting occurs, companies typically are not negotiating from a position of strength." Therefore, the bargaining hypothesis predicts less efficient price adjustment towards the end of the registration period than in the beginning. We test this prediction by investigating whether market returns are incorporated into the offer prices more completely in the beginning of the registration period compared to towards the end. We also examine whether the surplus created at the initial filing due to the high level of competition erodes away during the registration period by means of a less efficient offer price adjustment.

In the IPO pricing process, a potential offer price is proposed by underwriters after observing the demand for the offer by the investors, and the issuer has the option to accept the proposed price or negotiate for better terms. Stronger negotiations by the issuing firm results in a longer registration period due to the SEC regulations that require an amendment to be filed and the need to reconfirm investor demand at the new price (Barcaskey, 2005). Insistence of the issuing firm during the negotiations to increase the offer price should result in higher offer proceeds and a more efficient offer price adjustment. Therefore, the bargaining hypothesis predicts a positive relationship between the length of the registration period and the efficiency of the price adjustment.[4]

The bargaining hypothesis suggests that an increase in firm value during the registration period creates a surplus that is shared among the issuer, investors, and underwriters. A distinctive feature of the IPO pricing process is that the share of surplus that accrues to investors and underwriters is much less certain than the share that accrues

[4] Busaba et al. (2001) interpret the registration period length as an indicator of weaker investor interest. In unreported work we find that, conditional on upward offer price adjustment, longer registration periods are associated with higher offer price adjustments. This suggests that a longer pre-market does not indicate a weak demand for offers with upward offer price adjustment.

to the issuing firm. The reason for this asymmetry is that expected profits to investors depend on the price at which they sell their shares in the aftermarket, which is uncertain at the time the offer price is set, whereas offer proceeds for the issuing firm are known with certainty.

Harris's (1991) costly negotiation hypothesis suggests that the propensity to use a rounded set of prices rather than fractions is positively related to uncertainty about gains. Therefore, the costly negotiation hypothesis suggests that offer prices are more likely to be set at fractions as a result of stronger negotiations by issuing firms that face lower uncertainty relative to underwriters and investors, and predicts a lower efficiency of price adjustment for issues that are priced at integers. Consistent with this prediction, Bradley et al. (2004) find that average underpricing for IPOs with integer offer prices is significantly higher than those priced at a fraction. However, they do not examine the efficiency of the offer price adjustment process. Mola and Loughran (2004) find higher discounts at integer offer prices for seasoned offerings, and interpret this as evidence of investment bank pricing power.

The Tradeoff Hypothesis

The third explanation of the partial adjustment phenomenon tested in this study is the tradeoff hypothesis of Edelen and Kadlec (2005). In their model, issuers maximize the expected surplus from going public by weighing the probability of success against offer proceeds conditional on success. If the surplus increases during the registration period, issuers maximize expected surplus by seeking a higher success probability, thereby demanding only a partial adjustment of offer prices.

Most empirical predictions of the tradeoff hypothesis are similar to those of the bargaining explanation of offer price adjustment. For example, both hypotheses contend

that public information is only partially incorporated into offer prices. In addition, the offer price that the issuing firm accepts is a function of the firm's opportunity cost of withdrawal. However, there are several predictions that distinguish the bargaining from the tradeoff hypothesis.

A central difference between the tradeoff and the bargaining hypotheses is related to the role of the underwriters in the pricing process. According to the bargaining hypothesis, partial adjustment occurs due to the underwriters' conflict of interests with the issuers, and their ability to profit from underpricing. On the other hand, underwriters do not play a role in partial adjustment in the tradeoff hypothesis since issuers demand partial adjustment of offer prices in order to maximize their expected surplus. Therefore, contrary to the predictions of the bargaining hypothesis, the level of demand for the underwriters' should not be related to the efficiency of the offer price adjustment. In addition, according to the Edelen and Kadlec (2005) model, underwriters and issuing firms have no incentives to engage in a nickel-and-diming strategy. Therefore, whether the final offer price is set at an integer or a fraction of a dollar should not contain any information, and should not be significantly related to the efficiency of offer price adjustment.

All three hypotheses may partly explain the pattern observed in IPO offer price adjustments, and one important goal of this study is to ascertain the relative importance of the three explanations.

CHAPTER 3
METHODOLOGY

Estimation of the Adjustment Ratio

In this study we examine the level and determinants of efficiency in the IPO offer price adjustment process. We define efficiency as the magnitude of the offer price adjustment relative to the hypothetical complete level of offer price adjustment. We posit that the complete level of offer price adjustment is equal to the change in the issuing firm's value during the registration period. In other words, if the underwriters revise the offer price as much as the change in the firm value, then the offer price adjustment is complete and the eventual underpricing is equal to the underpricing that would have been observed if the issuing firm's value had not changed.

We construct the Adjustment Ratio (AR), which is defined as the estimated percentage change in an IPO firm's share value divided by the percentage offer price revision during the registration period:[1]

$$AR_i = \frac{(MV_i - MV_i^0) / MV_i^0}{(OP_i - OP_i^0) / OP_i^0} \tag{3-1}$$

[1] There is no theoretical reason for using the ratio of the two as the efficiency measure. For example, using the difference between the percentage change in the firm value and the percentage offer price revision is theoretically valid. However, empirical evidence indicates that the frictions associated with the offer price adjustment process are multiplicative rather than additive. Additive frictions, such as a constant difference regardless of the level of offer price revision, would lead to a negative relation between the offer price revision and the underpricing which is not the case as documented in numerous studies. In addition, a valid efficiency measure should be free of scale effects. In other words, the efficiency should not be related to the magnitude of the offer price revision. In unreported results we find that the ratio measure is not related to the offer price revision ceteris paribus, whereas the difference measure is positively related to it. Therefore, we conclude that the ratio is a valid efficiency measure.

where OP_i is the offer price, OP_i^0 is the original expected offer price which is taken as the midpoint of the original file price range, MV_i is the first-day closing share price of the IPO firm, and MV_i^0 is the estimated market price of shares at the time of the original filing. AR is an inefficiency measure as higher values indicate a less efficient offer price adjustment process. A perhaps more intuitive measure of efficiency would be the reciprocal of the Adjustment Ratio. However, the change in the firm value measure has undesirable characteristics as the denominator since it takes values close to zero.

The expected market price of shares at the time of the original filing, MV_i^0, is required to calculate AR, but is not readily observable. Our methodology allows us to estimate MV_i^0 using the information provided by the pricing of IPOs without subsequent offer price revisions. We posit that MV_i^0 is the expected fair value of the shares that the underwriters and the issuers anticipate at the time of the initial filing, and the percentage difference between MV_i^0 and OP_i^0 is the underpricing that would have been observed if a substantial change in the firm value that requires an offer price revision had not occurred. Following this logic, we estimate the unobserved initial underpricing of IPOs with subsequent offer price revisions using the information provided in the pricing of IPOs without offer price revisions.

We first determine the relationship between the underpricing and firm-, underwriter-, and offer-specific characteristics for IPOs whose final offer price is set in the original file price range using the following first-stage regression model:

$$\frac{MV_i^0}{OP_i^0} - 1 = UP_i^0 = f\,(\textit{Firm-, Underwriter-, and Offer characteristics}) \qquad (3\text{-}2)$$

We use the coefficients from this OLS regression to estimate what the underpricing would have been for IPOs with eventual offer price revisions if the values of the issuing firms had not changed during the registration period and the offer prices were not adjusted. This analysis is essentially equivalent to decomposing the total underpricing of IPOs with offer price revisions into two: (i) initial expected underpricing common to all IPOs, independent of the offer price revision, and (ii) additional underpricing due to the partial offer price adjustment. Then, we use the estimated initial underpricing of IPOs with offer price revisions to calculate the expected market price of shares at the time of the original filing using

$$MV_i^0 = (\overline{UP_i^0} + 1)OP_i^0 \qquad (3\text{-}3)$$

where OPi0 is the midpoint of the original file price range, and is the estimated initial underpricing using the coefficients from the model in Equation (2). Then we plug-in MV_i^0 in Equation (1) to calculate AR for all IPOs with offer price revisions.

The Adjustment Ratio measures the inefficiency of IPO offer price adjustments. If offer prices are adjusted fully such that the percentage offer price revision is equal to the percentage change in the issuing firm's value during the registration period, then AR equals one. Otherwise, the higher the AR, the lower the adjustment of the offer price relative to the change in the market value, and hence the lower the efficiency.

After calculating ARi for all deals with offer price revisions using the methodology explained above, we investigate the determinants of variation in ARi across deals using the OLS regression

$$AR_i = f\,(\textit{Firm-, Underwriter-, Offer-specific characteristics, Public Information Proxies}) \qquad (3\text{-}4)$$

There are two primary concerns with regard to the validity of our efficiency measure that need to be addressed. First, are the variables that are used to calculate the efficiency ratio measured correctly? In particular, whether the midpoint of the initial file price range and the estimated initial share value can be regarded as unbiased estimates of their true values may be material to draw correct inferences from the analysis.

Lowry and Schwert (2004) find that the offer price revisions are predictably related to firm and offer characteristics and market returns leading up to the initial filing. They conclude that the file price ranges are low-balled by the underwriters and therefore are not unbiased estimates of the final offer price. This upward bias in the magnitude of the offer price revision can make the IPO pricing process seem more efficient than it really is if this bias is not accounted for in the change in the firm value measure.[2] However, our methodology captures the inefficiency associated with the low-balling of the initial file price range. Since we estimate the expected firm value at the time of the original filing using the midpoint of the file price range, a low-balled price range leads to a larger value for the change in the firm value measure as well and therefore results in a larger AR and lower efficiency. The validity of our efficiency measure also depends on the accuracy of the first-stage regression estimates of initial underpricing. We control for the stability of the first-stage regressions using alternative specifications in Section 6.

The second concern is whether a complete offer price adjustment (100% efficiency) is in fact attainable in an optimal IPO pricing process. A less than complete offer price

[2] It should be noted that even though the magnitude of the offer price revision may be biased upward, the final offer price should eventually be lower than what it otherwise would be for the underwriters to benefit from low-balling. This implies that the issuers give importance to the magnitude of the offer price revision independent from the level of the final offer price and proceeds. This is consistent with the prospect theory explanation of Loughran and Ritter (2002).

adjustment may be due to unavoidable frictions in addition to avoidable inefficiencies. For example, Booth and Smith (1986) argue that overpricing an IPO is undesirable to both the issuing firm and the underwriters. To the extent that the fair market value of the issuing firm is not known with certainty at the time of the offer, it may be in the best interest of risk-averse underwriters and issuers to underadjust the offer price, especially for issues with high valuation uncertainty and during volatile markets. We control for this possibility by including firm-specific and general market uncertainty measures and various control variables in the cross-sectional regressions. Another issue is the effect of investor sentiment on the market value of the firm. If the underwriters price IPOs with long-run value in mind, then the offerings with high investor overreaction in the aftermarket would seem to have less efficient offer price adjustments. This "leaning against the wind" hypothesis implies a negative relation between the post-IPO returns of the issuing firms and the efficiency of the offer price adjustment. We test the "leaning against the wind" hypothesis and examine whether investor sentiment plays a role in the efficiency of the offer price adjustment in Section 6.

Sample Selection Bias

In this study, we concentrate our efforts on analyzing the efficiency of upward offer price revisions primarily for two reasons. First, an overwhelming proportion of the aggregate money left on the table is associated with IPOs with upward price revisions. Therefore, an investigation of the factors that drive the efficiency of downward price revisions is not economically as interesting. Second, there is very little systematic variation in the pricing efficiency of IPOs when the offer prices are revised downward.[3] It

[3] Table II in Section 5.1 shows that the R square of the regression of underpricing on various firm-, offer-, and underwriter-specific characteristics is 4.2% for IPOs with downward price revisions, whereas it is

appears that the price setting of IPOs with downward offer price revisions is fundamentally different from the rest. In fact, there is evidence of widespread price stabilization by the underwriters when the offer prices are revised downward. The proportion of IPOs with exactly zero underpricing is 28.4% when the offer prices are revised downward, whereas it is only 1.45% when the offer prices are revised upward. This price stabilization renders the pricing of those IPOs uninformative for the purposes of this study.

However, regression analysis using a subsample of IPOs is complicated by a potential sample selection bias. If the selection criteria for the subsample is not random, ordinary least squares (OLS) regressions produce biased and inconsistent coefficient estimates. IPOs with upward price revisions do not constitute a random subsample of all IPOs since the direction of the offer price revision is systematically related to various factors and can be reliably predicted using information available prior to the offer date. Moreover, the same factors are likely to play a role in the efficiency of the offer price adjustment. For example, public information revealed during the registration period affects both the efficiency of the offer price adjustment process and the direction of the offer price revision. An upward offer price revision despite unfavorable market conditions and information spillovers is possibly due to a favorable private information revelation by the investors. Consequently, low market returns and information spillovers may be associated with high levels of private information production in the subsample, even if public and private information productions are completely orthogonal in the full sample of IPOs. This may contaminate the coefficient estimates of the public information

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41.1% for IPOs with upward price revisions. In addition, only industry affiliation and a time dummy are statistically significant.

proxies since the coefficients may capture additional information unrelated to publicly available information.

We control for this potential sample selection bias using the Heckman (1979) maximum likelihood estimation (MLE) procedure.[4] Heckman MLE procedure is the joint estimation of the following two econometric models:

$$I^{upward} = \alpha^{upward} X^{upward} + \varepsilon^{upward} \tag{3-5}$$

$$AR = \alpha^{AR} X^{AR} + \beta^{IMR} IMR + \varepsilon^{AR} \tag{3-6}$$

where I^{upward} is an indicator function for an upward offer price revision and is equal to one for IPOs with final offer prices higher than the maximum of the initial file price range and zero otherwise. X^{upward} includes the public information proxies and various control variables, and the model is estimated using the probit analysis. The correction for the sample selection bias is enabled by the inclusion of the inverse Mills ratio in the AR model. The inverse Mills ratio (IMR) is:

$$IMR = \frac{\varphi(\alpha^{upward} X^{upward})}{\Phi(\alpha^{upward} X^{upward})} \tag{3-7}$$

where $\alpha^{upward}X^{upward}$ are the predicted probabilities of inclusion in the upward offer price revision subsample from the probit regression of I^{upward} on X^{upward}, φ is the standard normal density function, and Φ is the standard normal distribution function. IMR is a monotonically decreasing function of the predicted probability of inclusion in the subsample.

[4] Heckman MLE is more efficient than the Heckman two-step procedure since the selection and the prediction models are estimated jointly in the MLE.

A statistically significant coefficient for IMR indicates that the subsample is indeed not randomly chosen and the OLS coefficient estimates are biased. The sign of the coefficient estimate for IMR is also informative. The coefficient on IMR is given by:

$$\beta^{IMR} = \rho(\varepsilon^{upward}, \varepsilon^{AR})\ \sigma(\varepsilon^{AR}) \tag{3-8}$$

where ρ is the correlation between the two error terms and σ is the standard deviation of the error term from the AR regression. Therefore, the sign of the coefficient on IMR is the same as the sign of the correlation between the two error terms.

The error term in the probit regression captures the effect of information that is relevant to the valuation of the issuing firm and independent from the publicly available information when X^{upward} includes the public information proxies. According to the dynamic information acquisition hypothesis, this private information is only partially incorporated into the offer prices. Therefore, $\rho(\varepsilon^{upward}, \varepsilon^{AR})$ should be positive since high levels of private information should lead to a less complete offer price adjustment and a higher AR. On the other hand, a higher offer price revision than predicted by the public information measures may be due to the issuing firm's ability to demand and realize a better pricing in the IPO. In that case, issuing firms with high (low) bargaining powers will be associated with higher (lower) ε^{upward} and lower (higher) ε^{AR}, and $\rho(\varepsilon^{upward}, \varepsilon^{AR})$ will be negative. Therefore, a positive coefficient on IMR is consistent with the dynamic information acquisition hypothesis, whereas a negative coefficient is consistent with the bargaining hypothesis.

CHAPTER 4
DATA

Data Sources

The sample of IPOs comes from data provided by Jay Ritter. This database contains 8,042 IPOs between 1985 and 2003. Excluding ADRs (American Depository Receipts), closed-end funds, REITs (real estate investment trusts), banks and savings & loans, partnerships, unit offers, reverse leveraged buyouts, IPOs with an offer price below $5.00 per share, and IPOs with missing first-day close share price results in a sample of 5,285 firms.

This IPO database is supplemented with information from the new issues database of Securities Data Corporation (SDC). For each IPO, we collect information on the filing date, institutional investment prior to the issue, and the underwriting syndicate. We assign a ranking (RANK) to each lead manager using Loughran and Ritter's (2004) classification, which is based on Carter and Manaster (1990). Founding dates come from the Field-Ritter database (see Field and Karpoff (2002) and Loughran and Ritter (2004)). Total leverage prior to the offering is taken from Compustat (Leverage data are available for 86% of the final sample). Industry and individual firm returns are from the Center for Research in Securities Prices (CRSP).

Variable Construction

Variable names and their descriptions are listed in Table I.

[Insert Table I about here]

The two dependent variables in the analysis are underpricing, measured using the offer price and the first-day closing price, and the adjustment ratio. The first set of explanatory variables control for the riskiness of the issuing firm and the uncertainty in the market during the registration period. The second set includes proxies for public information revealed during the registration period, and the third set includes proxies for the bargaining powers of the underwriters and the issuers, and the proxies for their incentives to bargain.

The first risk proxy we use is the volatility of the issuing firm's stock price after the offering as a proxy for ex ante risk (Firm-specific uncertainty) (Ritter (1984, 1987). Asquith et al. (1998) report that price stabilization by underwriters continues until four weeks after the offering. In order to leave out the effects of price stabilization on stock return volatility, we use the standard deviation of returns over the first six months after the offering, excluding the first month after the offer date. In addition to firm-specific uncertainty, uncertainty in the market prior to the offering may affect the adjustment of offer prices. To capture the general uncertainty in the market we use the volatility of market returns during the registration period using an equally weighted index of firms in the same Fama-French industry as the issuing firm (Market uncertainty).[1] We also add technology (Tech Dummy) and internet (Net Dummy) dummies to capture the component of firm risk associated with those industries. To control for firm size, we use the twelve month trailing sales of the issuing firm prior to going public. Firms with zero

[1] Fama-French industry specifications are provided by Ken French at http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/Data_Library. We use the specifications updated in 2005 that form 49 industries using 4-digit SIC codes.

sales are assigned a value of $10,000. To adjust for inflation, we convert sales to 2003 dollars using the Consumer Price Index, and transform it using logarithms (Ln (Sales)).

To test the implications of the dynamic information acquisition hypothesis, we include in the regression the underpricing and the offer price adjustment of comparable firms taken public during the registration period by an IPO's own lead underwriter (UP (Same Underwriter), PrcAdj (Same Underwriter)), and by different underwriters (UP (Other Underwriters), PrcAdj (Other Underwriters)), as separate explanatory variables.[2] If an issuer has more than one lead underwriter we add up the offers of all lead underwriters when calculating the information spillover measures. To examine the relationship between market returns and the adjustment ratio, and the potential change in that relation over the duration of the registration period, we include in the analysis two market-return variables. First, we calculate the return on an equally weighted index of all publicly-traded firms in the same Fama-French industry as the IPO firm, for the duration of the registration period excluding the last 15 trading days, standardized to a 30-day return as in Busaba et al. (2001) (Industry Ret (Beginning)). Second, we measure the return on the same index during the last 15 trading days before the offering (Industry Ret (End)).

The third set of explanatory variables tests the bargaining hypothesis of offer price adjustment. The bargaining hypothesis suggests that the value of outside options is positively related to bargaining power. We use pre-issue leverage of IPO firms and the existence of institutional investment at the time of the offering as proxies for the issuing firm's alternative financing options. Information on leverage comes from COMPUSTAT.

[2] Following Ljungqvist and Wilhelm (2002), we set the spillover measures to zero if there are no comparable IPOs.

Following Busaba et al. (2001), firm leverage is defined as the ratio of total debt (short- and long-term as well as subordinated) to total assets in the most recent quarter prior to the issue. We use a dummy variable which equals one if the firm's leverage ratio is above the median leverage ratio of the sample (High Debt Dummy). We test the relationship between institutional investment in the IPO firm and the efficiency of the offer price adjustment by including a dummy variable that equals one if at least one venture capital or private equity firm owns a stake in the firm at the time of the offering (Institution Dummy). IPO firms with institutional investment are identified from SDC's New Issues Database.

As a proxy for the underwriter's outside options, we use the ratio of the underwriter's expected fee income from a particular offer to the total actual and expected fee income from all other IPOs completed or filed by the underwriter during the offer's registration period (UW Relative Income).[3] If an issuer has more than one lead underwriter we take the mean of UW Relative Income across the lead underwriters. Prior studies have shown that the quality of analyst coverage provided by the underwriters affects their market shares and the pricing of their IPOs (Dunbar (2000), Clarke et al. (2003), Cliff and Denis (2004)). To examine the relationship between analyst coverage and the efficiency of the price adjustment, we use a dummy variable (All-star Dummy) that equals one if the lead underwriter (or at least one lead if there are co-leads) has an all-star analyst in that year's survey of Institutional Investor (first-, second-, or third-team), and if the issuing firms is covered by that all-star analyst in the year after the offering. This information is from Jay Ritter's IPO database, and is available between

[3] Expected fee income from an IPO is calculated using the expected offer proceeds at the time of the initial filing and the gross spread as reported by the SDC.

1993 and 2003. In our sample, the all-star analyst dummy is equal to one for approximately 19% of the offers in that time period. To examine the link between underwriter prestige and the cost of offer price adjustment, we use the underwriter rankings of Loughran and Ritter (2002), which builds upon the Carter and Manaster (1990) and Carter, Dark, and Singh (1998) rankings (Underwriter Rank).

We include share overhang, the ratio of retained shares to the public float, in the analysis as a proxy for the issuers' incentives to bargain (Overhang).[4] To examine the relation between the initial surplus at the preliminary offer price and the subsequent efficiency of the offer price adjustment, we use the ratio of the issuer's price-to-sales ratio to the mean price-to-sales ratio of comparable firms in the market (Initial P/S Multiple). We calculate the issuing firm's initial price-to-sales ratio using the midpoint of the preliminary file price range and the total revenue in the twelve months prior to the offering. We calculate the mean price-to-sales ratio of comparable firms using the share price and the twelve month revenues of firms in the same Fama-French industry as the issuing firm, as of the latest fiscal year end prior to the offering. To examine the relationship between the strength of the negotiations and the efficiency of the price adjustment we include the natural logarithm of the length of the registration period (Registration Length). As an additional indicator of negotiation between the underwriter and issuer during the adjustment of offer prices, we include a dummy variable that equals one when the offer is priced at an integer (Integer OP).

[4] Loughran and Ritter (2004) question whether the percentage of shares offered (the measure used by Ljungqvist and Wilhelm (2003) and related to the reciprocal of overhang) is the correct measure of how much "skin in the game" management has, rather than the dollar value of the shares owned. Because valuations were much higher in 1999-2000 than previously, the patterns diverge when these alternative definitions are used.

Table 4-1. Definition of Variables.

Variable name	Variable Definition
Dependent Variables	
Underpricing	Equals MV / OP, where MV is the firm's first-day close share price, and OP is the offer price.
AR	Adjustment Ratio. Equals the ratio of the change in a firm's value per share during the registration period to the offer price adjustment.
Independent Variables	
Ln (1+Age)	The natural logarithm of one plus firm age, defined as the difference between the IPO calendar year and the founding year. Founding dates are from the Field-Ritter dataset available on Jay Ritter's website.
Ln (Assets)	The natural logarithm of total firm assets prior to the offering, in 2003 purchasing power.
Ln (Sales)	The natural logarithm of firm's trailing twelve month sales prior to going public, in 2003 purchasing power.
Tech Dummy	Equals 1 if the firm operates in a technology industry excluding internet firms, as identified in Loughran and Ritter (2004).
Net Dummy	Equals 1 if the firm operates in an internet-related industry, as identified in Loughran and Ritter (2004).
Firm-specific Uncertainty	Percentage daily standard deviation of the issuer's stock returns, for the five month period starting one month after the offer date.
Market uncertainty	Percentage daily standard deviation of stock returns for firms in the same Fama-French industry as the issuer, during the issuer's registration period.
Underwriter Rank	Lead underwriter prestige ranking, using Loughran and Ritter's (2002) classification, based on Carter and Manaster (1990). If there is more than one lead underwriter, we use the highest ranking.
UP (Same Underwriter)	The average underpricing of same-industry IPOs taken public by the same lead underwriter, completed during the registration period of the issue. If there are no same-industry IPOs in that time period, it is set to zero.
UP (Other Underwriters)	The average underpricing of same-industry IPOs taken public by a different lead underwriter, completed during the registration period of the issue. If there are no same-industry IPOs in that time period, it is set to zero.
PrcAdj (Same Underwriter)	The average offer price adjustment of same-industry IPOs taken public by the same lead underwriter, completed during the registration period of the issue. If there are no same-industry IPOs in that time period, it is set to zero.
PrcAdj (Other Underwriters)	The average offer price adjustment of same-industry IPOs taken public by a different lead underwriter, completed during the registration period of the issue. If there are no same-industry IPOs in that time period, it is set to zero.

Table 4-1. Continued

Variable name	
Independent Variables	
Industry Ret (Beginning)	Average market return of firms in the same Fama-French industry as the issuer, during the issuer's registration period, excluding the last 15 trading days before the offering. We standardize Industry Ret (Beginning) to a 30-day equivalent.
Industry Ret (End)	Average market return of firms in the same Fama-French industry as the issuer, during the last 15 trading days of the issuer's registration period.
High Debt Dummy	Equals 1 if the issuer's ratio of total debt to total assets prior to the offer is larger than 15% (median of the sample).
UW Relative Income	Natural logarithm of the ratio of expected spread income from the offer to the lead underwriter's expected spread income from all offers completed or filed during the issue's registration period. If there is more than one lead underwriter, we take the average across underwriters before taking the natural logarithm.
Overhang	Ratio of retained shares to public float.
Initial P/S Multiple	The ratio of the issuer's price-to-sales ratio to the mean price-to-sales ratio of all firms in the same Fama-French industry as the issuer. The issuer's price-to-sales ratio is calculated using the midpoint of the preliminary file price range and the twelve month trailing revenues prior to the IPO. The mean price-to-sales ratio of comparable firms is calculated using the share price and the twelve month trailing revenues as of the latest fiscal year end prior to the offering.
Registration Length	The natural logarithm of the duration of the registration period.
Institution Dummy	Equals 1 if a venture capital or private equity firm owns shares of the IPO firm at the time of the offering.
Integer OP	Equals 1 if the offer price is set at an integer dollar.
All-star Dummy	Equals 1 if the lead underwriter has an all-star analyst covering the firm in the one year following the offering.
Nineties Dummy	Equals 1 if the offer year is between 1990 and 1998.
Bubble Dummy	Equals 1 if the offer year is 1999 or 2000.
Post Dummy	Equals 1 if the offer year is between 2001 and 2003.

CHAPTER 5
EMPIRICAL ANALYSIS

In this section we investigate the level and determinants of efficiency in IPO offer price adjustments. We first calculate the adjustment ratio for IPOs as described in Section 3. Second, we test the predictions of the dynamic information acquisition hypothesis (Benveniste and Spindt (1989), Benveniste et al. (2002)) by comparing the effect of public information revealed during the registration period on the offer price adjustment and the change in firm value. Third, we investigate the determinants of the variation in the adjustment ratio across IPOs and through time.

Estimation of the Adjustment Ratio

In this sub-section, we estimate the initial underpricing of IPOs with subsequent offer price revisions. In order to estimate the initial underpricing, we first investigate the determinants of underpricing for IPOs with no subsequent offer price revisions. In this analysis we use explanatory variables that are commonly used in other IPO underpricing studies. In order to prevent a look-ahead bias we only use information that is available at the time of the initial filing.

Table II presents the ordinary least squares regression results. The coefficients from the underpricing regression of IPOs with a final offer price inside the original file price range are used to estimate the adjustment ratio in the next step of the analysis. In addition, Table II reports the regression results separately for all IPOs, IPOs with negative price adjustments, and IPOs with upward price adjustments.

[Insert Table II about here]

The regression results from Table II suggest that the level and variation of underpricing depend significantly on offer price adjustment. Notably, for IPOs with negative price adjustment only the technology industry dummy and a dummy variable for IPOs from 1990-1998 are significantly related to underpricing. In addition, the adjusted R square of 4.2% reveals that the explanatory power of the model is low. On the other hand, the determinants of IPO pricing for issues with upward price adjustment show considerable differences compared to other issues. The last row in Table II shows that underwriter rank, share overhang, total assets, and firm age have substantially more impact on underpricing when the offer price is adjusted upward.[1] Internet firm IPOs are underpriced an additional 23% compared to other IPOs when offer prices are adjusted upward, but this relationship does not exist in offers with no upward price adjustment. The regression results also reveal that the extreme underpricing in the bubble period of 1999 and 2000 can be attributed for the most part to IPOs with upward price adjustment. The bubble dummy for IPOs with upward price adjustment is 68% whereas it is 17% for those with no price adjustment and an insignificant 2% for those with negative price adjustment.

Next, we estimate the initial underpricing of IPOs with subsequent offer price revisions using the following model from Table II:

[1] Habib and Ljungqvist (2001) and Fernando et al. (2004) argue that the underwriter rank variable is endogenous in underpricing regression. Loughran and Ritter (2004) control for endogeneity using an instrumental variable regression and find no difference in the underwriter rank coefficient in the instrumental variable regression compared to an OLS regression. We conduct a similar analysis in Section 6 to control for potential endogeneity between the underwriter prestige and the efficiency of the offer price adjustment process.

$$\overline{UP_i^0} = 8.68 - 0.32 * Rank + 1.66 * Overhang - 1.63 * Ln(Assets) + 0.53 * Ln(Sales) - 0.73 * Ln(1 + Age) + 2.39 * Tech\ Dummy + 3.17 * Net\ Dummy + 1.01 * Inst\ Dummy + 6.80 * Nineties\ Dummy + 16.74 * Bubble\ Dummy + 5.65 * Post\ Dummy \quad (5\text{-}1)$$

Using the estimated initial underpricing from Equation (9) we calculate the adjustment ratio, the ratio of the percentage change in firm value during the registration period to the percentage offer price adjustment, as described in Section 3. The adjustment ratio is:

$$AR_i = \frac{(MV_i - (\overline{UP_i^0} + 1)OP_i^0) / (\overline{UP_i^0} + 1)OP_i^0}{(OP_i - OP_i^0) / OP_i^0} \quad (5\text{-}2)$$

where MVi is the first-day closing share price of the IPO firm , OPi is the offer price, OPi0 is the midpoint of the file price range used as a proxy for the original expected offer price, and is the initial underpricing estimated using Equation (9).

Table III presents descriptive statistics for the adjustment ratio, categorized by the direction of the offer price adjustment and by offer price adjustment quartile. Panel A shows the descriptive statistics for IPOs with downward offer price revisions. The mean AR is 1.26, suggesting that on average 79% ([1/1.26]*100) of the decrease in the firm value during the registration period is incorporated into the offer prices. This partial downward adjustment is surprising in that it appears as if the underwriters are setting the final offer prices too high after revising the preliminary expected offer prices downward. There are several reasons why we may observe only partial adjustment of offer prices in IPOs with downward offer price revisions. First, the costs to the underwriter of slightly overpricing an IPO may be smaller than the costs of withdrawing the offer altogether if the expected final offer price at full adjustment is below the reservation price of the

issuing firm. Second, the initial underpricing before the downward offer price revision may be too high and therefore the final offer price may be at a fair value after the partial adjustment. This is consistent with the findings of Lowry and Schwert (2004) who suggest that the initial file price ranges are low-balled by the underwriters. Third, the partial adjustment finding may be due to a truncation bias in that we only observe IPOs that successfully go public. The adjustment may be full on average, but less than full conditional on offer completion if IPOs with more complete adjustments are more likely to withdraw. On the other hand, the downward adjustment may be even more partial than suggested by the results in Table III. The underwriters appear to engage in price stabilization especially for IPOs with downward offer price revisions. The proportion of IPOs with exactly zero underpricing is 28.4% when the offer prices are revised downward, whereas it is only 1.45% when the offer prices are revised upward. If the underwriters support the share price of the issuing firm in the aftermarket so that it does not fall below the final offer price, then AR is upward biased and the downward offer price revision is even less complete.

[Insert Table III about here]

Panel B presents the descriptive statistics for IPOs with upward offer price revisions. The mean AR is 2.36 suggesting that on average only 42% ([1/2.36]*100) of the increase in the firm value during the registration period is incorporated into the offer prices. This partial adjustment is highly costly for the issuers and their pre-issue shareholders. As an example, a firm with $100 million in expected filing proceeds and a

40% increase in the expected market value during the registration period increases its final offer proceeds by only $16.8 million ([40%] * 0.42 * $100 million = $16.8 m.), and leaves an additional $23.2 million ($40 million - $16.8 million) on the table due to the partial adjustment of its offer price. Given that the median underwriter spread is 7%, the indirect costs due to the partial offer price adjustment for this issuing firm is more than three times the initial expected direct costs of going public.

We also observe a negative relation between the efficiency of the upward offer price adjustment and the magnitude of the offer price revision. The mean AR for IPOs in the first quartile (offer price revision below 15.2%) is 1.90, whereas it is 3.06 for IPOs in the fourth quartile (offer price revision above 35%). However, in Section 6 we show that this relation is spurious: IPOs in the upward offer price adjustment sample and with higher valuation uncertainty tend to have higher offer price revisions, but such issues also experience less complete offer price adjustments.

Figure 1 depicts the mean and median adjustment ratio for IPOs with upward offer price adjustments by year. As illustrated in the figure, the efficiency of offer price adjustment exhibits substantial variation over time, reaching a maximum of 3.53 in 1999. The cost of upward offer price adjustment is clearly larger in the bubble period of 1999-2000. The average AR during 1999 and 2000 is 3.46, which is equivalent to incorporating only 28.9% of the change in the firm value into the offer prices. For the firm in the example above, this means increasing the offer proceeds by only $11.6 million and leaving an additional $28.4 million on the table.

[Insert Figure 1 about here]

The costs associated with the partial adjustment of IPO offer prices are very high and point to substantial inefficiencies in the IPO pricing process. In the next section, we examine the relationship between the adjustment ratio of IPOs with upward offer price revisions and firm-, underwriter-, and offer-specific characteristics, as well as IPO market conditions, and we investigate the determinants of the inefficiencies in the IPO offer price adjustment process.

Regression Analysis

The Impact of Public Information on the Value and Pricing of IPO Firms

We first examine how our public information proxies are related to the offer price adjustment and the change in firm value during the registration period. This analysis allows us to verify that our proxies indeed capture publicly available information relevant to the pricing the IPO firms, and to examine whether the information revealed during the registration period affect the offer prices and the value of the IPO firms differently. The results are presented in Table IV.

The dependent variable in the first column is the percentage offer price adjustment, measured as the ratio of the final offer price to the midpoint of the original filing price range. The dependent variable in the second column is the estimated percentage change in firm value during the registration period. The independent variables include measures of information spillovers from recent comparable IPOs, and the market returns of comparable public firms during the registration period. Information spillovers from recent comparable IPOs underwritten by the same investment bank and from those underwritten by other investment banks are examined separately following Benveniste et al. (2002). The market returns in the beginning and towards the end of the registration

period are also examined separately in order to capture any change in the incorporation of information during the registration period.

It is well documented that the underpricing of IPOs is strongly related to their offer price revisions and both the underpricing and the offer price revisions are strongly related to contemporaneous market returns. Therefore our information spillover measures are highly correlated with each other and with the market return variables. In order to isolate the influence of each public information measure, we orthogonalize the average underpricing of recent comparable IPOs variables with respect to the average offer price adjustment and market return variables, and the average offer price adjustment of recent comparable IPOs variables with respect to the market return variables. White's heteroskedasticity-consistent standard errors are provided in parentheses below the coefficients.

[Insert Table IV around here]

The results from Table IV demonstrate that both the offer price adjustment and the change in the value of the IPO firm during the registration period are strongly and positively related to information spillovers from recent comparable IPOs and market returns of comparable public firms. More specifically, higher average underpricing and higher average offer price adjustment in the IPO market lead to higher final offer prices and total valuation for comparable IPO firms that are going through the IPO pricing process. In addition, higher market returns lead to higher offer prices and valuation for

IPO firms that recently filed for an IPO and also for those that are about to complete their offerings.

On the other hand, the findings suggest that public information revealed during the registration period has a bigger impact on the value of the firm than on the magnitude of the offer price adjustment. The coefficients of the regressors on column (2) are larger than the respective coefficiencts on column (1), and the differences are statistically highly significant. This finding suggests that information revealed in recent comparable IPOs, both from those underwritten by the same investment bank and by others, and the market returns during the registration period are only partially incorporated into IPO offer prices. Therefore, offer price adjustment in response to public information revealed during the registration period is inefficient and costly to the issuer. The evidence from this analysis is contrary to the predictions of the dynamic information acquisition hypothesis, but consistent with both the bargaining and tradeoff hypotheses.

Multivariate Analysis of the Efficiency of the Offer Price Adjustment Process

Having shown that the public information proxies used in this study indeed influence the valuation of the issuing firm and the pricing of the offer, we next conduct a comprehensive analysis of the efficiency of the IPO offer price adjustment process. In particular, we investigate the factors that lead to a more efficient offer price adjustment process and we determine which hypothesis of IPO offer price adjustment best explains the pattern.

Table V presents the regression results. The dependent variable, the adjustment ratio, is defined as the ratio of the change in firm value during the registration period to the offer price adjustment. Therefore, the dependent variable is a measure of inefficiency and a positive coefficient in the regression analysis means that the factor is negatively

related to the efficiency of offer price adjustment. Model (1) presents the base ordinary least squares regression results and includes valuation uncertainty measures, proxies for public information revealed during the registration period, bargaining hypothesis proxies, and various control variables as the explanatory variables. Model (2) includes the all-star analyst dummy, which is available between 1993 and 2003.

[Insert Table V around here]

The findings suggest that IPOs that are harder to value experience less complete offer price adjustments: The coefficient on the volatility of issuing firm post-IPO returns, Firm-specific uncertainty, is positive and significant. It appears that underwriters are risk-averse and they tend to underadjust the offer prices when there is a relatively high probability of valuation reversal. This finding is consistent with Booth and Smith (1986) who argue that underwriters use their reputation to certify that an issue is not overpriced. In addition, Nanda and Yun (1997) find that overpriced offerings are associated with a decrease in the lead underwriter's market value and Dunbar (2000) finds that investment banks lose market share if they are associated with overpriced IPOs. Even though the aversion to overprice leads to lower offer proceeds, the issuers may also benefit from it. The market may take overpricing as a negative signal with respect to the ability and the incentives of the firm's managers, which may especially be damaging to issuers that plan to come back to the market for a seasoned equity offering and to insiders that are planning to sell their shares in the near future. On the other hand, the volatility of the comparable public firm returns during the registration period, Market uncertainty, is not

significantly related to the efficiency of the offer price adjustment. Underwriters do not seem to be concerned about the uncertainty in the market when they are setting the IPO offer prices.

Next, we test the predictions of the dynamic information acquisition hypothesis by investigating the relationship between the measures of public information revealed during the registration period and the adjustment ratio. According to the extended dynamic information hypothesis of Benveniste and Spindt (1989) and Benveniste et al. (2003), all public information measures should be negatively related to the adjustment ratio (hence positively related to the efficiency of offer price adjustment) and the coefficients on the measures of information spillover from recent IPOs taken public by the same underwriter should be less negative than those taken public by different underwriters. The relation between information spillovers from recent IPOs and the offer price adjustment have been documented in previous studies.[2] However, this is the first study to examine how efficiently this information is incorporated into offer prices.[3] In addition, ours is the first study to differentiate the source of the information spillover with regards to the identity of the lead underwriters as suggested by Benveniste et al. (2003).

According to the regression results in model (1), incorporation of information revealed in recent comparable IPOs taken public by other underwriters is inefficient: the coefficients on UP (Other Underwriters) and PrcAdj (Other Underwriters) are positive and statistically significant. In other words, IPO markets with high average underpricing

[2] See Ljungqvist and Wilhelm (2002), Ljungqvist and Wilhelm (2003), Benveniste et al. (2003), and Edelen and Kadlec (2005).

[3] Edelen and Kadlec (2005) document a positive relationship between information spillover measures and subsequent underpricing. However, they do not discuss the implications of this result.

and high average offer price revisions are followed by IPOs that experience less efficient offer price adjustments. This finding is inconsistent with the dynamic information acquisition hypothesis since the information regarding the pricing of recent IPOs is publicly available and should be completely incorporated into the offer prices. On the other hand, incorporation of information revealed in recent comparable IPOs taken public by the same underwriter is more efficient: the coefficient PrcAdj (Same Underwriter) is negative and significant. Taken together with the finding that the average offer price revision of recent comparable IPOs of other underwriters do not lead to a more efficient offer price adjustment, this result suggests that the efficiency of the offer price adjustment process is not related to the type of information that is revealed, but rather to the identity of the underwriters. More specifically, underwriters with a history of upward offer price revisions tend to adjust offer prices in future IPOs more efficiently. Together, these results are inconsistent with the extended dynamic information acquisition hypothesis. The regression results also suggest that the efficiency of the offer price adjustment is negatively related to the average market return of comparable public firms during the registration period. This inefficiency is especially prevalent towards the end of the registration period: Industry Ret (End) is positive and highly significant, while Industry Ret (Beginning) is negative but insignificant. This inefficiency associated with the incorporation of public information is similar to the findings of Loughran and Ritter (2002), and consistent with both the bargaining and tradeoff hypotheses, but not the dynamic information acquisition hypothesis.

Next, we examine the relation between the bargaining hypothesis proxies and the efficiency of the offer price adjustment. Coefficient estimates for all eight bargaining

proxies have the predicted sign and are highly significant. The coefficient on High Debt Dummy is negative and significant, indicating that issuers with higher leverage at the time of the offering experience more complete offer price adjustments. This relation is consistent with Helwege and Packer (2004) who argue that firms with high levels of leverage are more concerned over the pricing of their equity. Additionally, Busaba et al. (2001) show that firms with higher leverage are more likely to withdraw under undesirable circumstances, and attribute this finding to a better access to alternative sources of financing for such firms. Similarly, the coefficient on Institution Dummy is negative and significant, suggesting that issuers that have an established relationship with institutional investors (venture capitalists and private equity funds) prior to their IPOs experience more efficient offer price adjustments. Taken together, we interpret these results as evidence that issuing firms with access to alternative financing sources during the IPO pricing process have higher bargaining powers in their negotiations with the underwriters as a result of a more credible threat to withdraw, which leads to more complete offer price adjustments. Overhang is positively related to the adjustment ratio, consistent with a lower opportunity cost of money left on the table associated with smaller offerings. In other words, issuers that have lower incentives to bargain for higher offer prices experience less efficient offer price adjustments.

The bargaining hypothesis is based on the notion that potential conflicts of interest between the issuers and underwriters play a significant role in the setting of the IPO offer prices. More specifically, the efficiency of the offer price adjustment process is related to not only the bargaining power of the issuers but also to that of the underwriters. In particular, according to the bargaining hypothesis, underwriters whose services are highly

in demand by other issuing firms at the time should be associated with less efficient offer price adjustments since the potential withdrawal of a single IPO is financially less costly. The regression results support this argument. The coefficient on UW Relative Income is negative, which implies that when the expected fee income from an individual IPO is relatively small compared to the fee income from recently completed offers and from offers expected to be completed in the near future, the efficiency of the offer price adjustment for that particular IPO is lower.[4] Model (2) includes the All-star analyst dummy, which equals one if the lead underwriter employs an all-star analyst that is specialized in the industry of the IPO firm and provides coverage for the IPO firm within a year of the offer date. Dunbar (2000) and Clarke et al. (2003) find that the demand for the services of an underwriter is positively related to the presence of an analyst who is a member of Institutional Investor's All-American Research Team. As predicted by the bargaining hypothesis, the coefficient on the All-star analyst dummy is positive and highly significant. In other words, there is less adjustment of the offer price when the lead underwriter employs an all-star analyst who subsequently covers the company going public. Overall, the negative relation between the efficiency of the offer price adjustment process and the demand for the underwriter's services is consistent with the bargaining hypothesis. On the other hand, this result is inconsistent with the dynamic information acquisition and the tradeoff hypotheses.

[4] The same argument could be made for underwriters with high prestige. In fact, the prestige of the lead underwriter, as measured by its Carter-Manaster rank, is negatively and statistically significantly related to the offer price adjustment efficiency when *UW Relative Income* is excluded from the regressions. The fact that the influence of the underwriter prestige disappears after controlling *UW Relative Income* suggests that it is the short-term demand that determines the underwriter's bargaining power in its deals at the time rather than its long-term prestige, as should be expected.

The initial pricing in the beginning of the registration period influences the efficiency of subsequent offer price adjustment: the coefficient on Initial P/S Multiple is positive and statistically significant. Therefore, issuers with relatively high initial offer prices experience less efficient offer price adjustments. It appears that the initial surplus created as a result of competition among potential underwriters during the bake-off process erodes away during the registration period. Taken together with the finding that the efficiency of the incorporation of the market returns worsens towards the end of the registration period, this result supports the idea that the bargaining powers of the issuers decline during the IPO pricing process.

The coefficient on Integer OP is positive and significant, suggesting that the issues priced at fractional dollars experience more complete price adjustments. We interpret this as evidence that price setting by the issuer instead of the underwriter, which indicates a higher bargaining power, results in a more efficient offer price adjustment. This finding is inconsistent with the tradeoff hypothesis since in the Edelen and Kadlec (2005) framework issuing firms set the offer prices that maximize the unconditional expected offer proceeds and consequently the efficiency of offer price adjustment should not be related to whether the final offer price is set at the fractions of a dollar or at an integer. The coefficient on the length of the registration period, Registration Length, is negative and significant, suggesting that longer negotiations result in more complete adjustments.[5]

The ordinary least squares analysis in models (1) and (2) assumes that the sub-sample of IPOs with upward price revisions is representative of all IPOs. However, this

[5] The distribution of *Length* is skewed towards right due to a group of IPOs with uncharacteristically long registration periods. In order to ensure that our results are not driven by outliers, we repeat the analysis after truncating *Length* to 180 days. The results are qualitatively and quantitatively identical.

assumption is not valid if the selection criteria for the sub-sample of IPOs is not random, and OLS regressions may produce biased coefficient estimates and may lead to incorrect inferences. We correct for this potential sample-selection bias using the Heckman (1979) MLE procedure. The MLE procedure consists of the joint estimation of two econometric systems. The first system is a probit model of inclusion in the sub-sample using the full sample of IPOs, where the dependent variable equals one if an IPO experiences upward price revision and zero otherwise. The second system is the main specification that parallels the OLS regressions in models (1) and (2), with the addition of the inverse Mills ratio (IMR) which is derived using the predicted probabilities of inclusion in the sub-sample estimated in the first-step probit regression.

Model (3) presents the first-step probit regression of inclusion in the sub-sample. The independent variables include proxies for valuation uncertainty, information spillover measures and market returns during the registration period, firm size as proxied by Ln (Sales), industry affiliation, and two instrumental variables, Ln (Expected Proceeds) and Pure Primary Dummy, to ensure good identification.[6]

Not surprisingly, more positive information revealed during the registration period leads to a higher probability of upward offer price revision: the coefficients on five of the six public information measures are positive and statistically significant. The exception is the UP (Same Underwriter) variable which has a positive but insignificant coefficient. The probit regression results also suggest that IPOs are less likely to experience upward offer price revision during volatile markets. On the other hand, firm-specific valuation

[6] In unreported results, we find that *Ln (Expected Proceeds)* and *Pure Primary Dummy* are not significantly related to the efficiency of the offer price adjustment. Therefore, they satisfy the required criteria of valid instruments.

uncertainty is not significantly related to the likelihood of upward offer price revision, perhaps because offer prices of issuers that are harder to value are equally likely to be revised downward or upward.

Models (4) and (5) report the Heckman MLE results from the joint estimation of the two econometric systems. The coefficient estimate for the inverse Mills ratio (IMR) is statistically significant and thus indicates the presence of a sample selection bias. The biggest differences between the OLS and the Heckman MLE results are associated with the public information proxies. The coefficient on PrcAdj (Other Underwriters) remains large and positive but turns insignificant after correcting for the sample selection bias. In addition, the coefficient on Industry Ret (Beginning) becomes weakly significant, which leads to a more apparent reversal in the efficiency of the offer price adjustment over the duration of the registration period. Overall, the inferences drawn from the OLS regression results remain largely unchanged after correcting for the sample selection bias.

The sign of the coefficient on the inverse Mills ratio is especially interesting and informative. The statistically significant negative coefficient estimate on AR indicates that the correlation between the error terms of the probit regression and the inefficiency regression is also negative. In other words, issues with upward offer price revisions that are driven primarily by private information production are associated with more complete offer price adjustments. This finding is inconsistent with the dynamic information acquisition hypothesis which predicts that private information production leads to less complete offer price revisions. On the other hand, it is consistent with the bargaining hypothesis. It appears that issuing firms that achieve higher offer prices than suggested by publicly available information are associated with more complete offer price adjustments,

which is consistent with the predicted relationship between the bargaining power of the issuers and the efficiency of the offer price adjustment process.

Table 5-1. Regressions of First-Day Returns on IPOs Categorized by Price Adjustment*

	Intercept	Underwriter Rank	Overhang	Ln (Assets)	Ln (Sales)	Ln (1+Age)	Tech Dummy	Net Dummy	Institution Dummy	Nineties Dummy	Bubble Dummy	Post Dummy	R^2_{adj}
All	-4.46**	1.39***	4.21***	-2.94***	0.61	-1.99***	6.80***	32.04***	0.03	9.72***	33.74***	5.57***	0.277
N = 4,825	(2.00)	(0.29)	(0.51)	(0.53)	(0.41)	(0.53)	(1.43)	(4.85)	(1.48)	(0.75)	(2.98)	(1.69)	
OP < LO	5.06***	-0.30	0.04	0.02	-0.59	0.03	3.87**	17.95	-2.61	3.39***	1.66	3.39	0.042
N = 1,151	(1.99)	(0.45)	(0.34)	(0.47)	(0.51)	(0.39)	(1.97)	(13.66)	(2.30)	(0.66)	(4.12)	(2.38)	
LO < OP < HI	8.68***	-0.32	1.66***	-1.63***	0.53*	-0.73	2.39***	3.17	1.01	6.80***	16.74***	5.65***	0.099
N = 2,471	(1.85)	(0.24)	(0.43)	(0.35)	(0.31)	(0.47)	(0.93)	(4.20)	(0.93)	(0.72)	(2.48)	(1.47)	
HI < OP	-9.51	4.94***	7.33***	-8.01***	0.54	-3.87**	4.72	23.43***	-0.60	17.18***	68.80***	12.45**	0.411
N = 1,203	(10.48)	(1.28)	(0.94)	(1.56)	(1.25)	(1.75)	(3.72)	(7.30)	(4.03)	(3.01)	(6.48)	(5.50)	

*The sample includes 4,825 US operating firm IPOs over 1985-2003. Unit offers, REITs, closed-end funds, banks and S&Ls, ADRs, reverse LBOs, and IPOs with minimum of the price range below $8.00 are excluded. OP is the final offer price. LO is the minimum of the initial filing price range. HI is the maximum of the initial filing price range. Underwriter Rank is the updated Carter-Manaster prestige measure of the lead underwriter. Overhang is the ratio of retained shares to public float (the number of shares issued). Ln (Assets) is the natural logarithm of the pre-issue book value of assets, expressed in millions of dollars of 2003 purchasing power using the CPI. Ln (Sales) is the natural logarithm of the total pre-issue revenues during the prior twelve months, expressed in millions of dollars of 2003 purchasing power using the CPI. Ln (1+Age) is the natural logarithm of one plus the number of years since the firm's founding date as of the IPO. Tech Dummy takes a value of one (zero otherwise) if the firm is in the technology business, and Net Dummy is similarly defined for internet firms. Institution Dummy takes a value of one (zero otherwise) if a venture capital or private equity firm owns shares of the IPO firm at the time of the offering. Nineties Dummy takes a value of one (zero otherwise) if the IPO occurred during 1990-1998. Bubble Dummy takes a value of one (zero otherwise) if the IPO occurred during 1999-2000. Post Dummy takes a value of one (zero otherwise) if the IPO occurred during 2001-2003. White's heteroskedasticity consistent standard errors are in parentheses. ***, **, and * denote significance at the 1, 5, and 10 percent level, respectively.

Table 5-2. Descriptive Statistics for the Adjustment Ratio*

Panel A: IPOs with downward offer price adjustment

Offer price adjustment quartile	N	Mean (Median) offer price adjustment	Mean (Median) change in the firm value	Mean (Median) PAR
1 (low)	245	-38.8% (-36.8%)	-43.5% (-42.9%)	1.12 (1.13)
2	264	-26.2% (-25.9%)	-31.1% (-32.5%)	1.19 (1.24)
3	230	-20.1% (-20.0%)	-26.2% (-26.1%)	1.31 (1.30)
4 (high)	261	-13.8% (-14.3%)	-19.7% (-20.4%)	1.43 (1.45)
All	1000	-24.6% (-23.1%)	-30.0% (-29.8%)	1.26 (1.24)

Panel B: IPOs with upward price adjustment

Offer price adjustment quartile	N	Mean (Median) offer price adjustment	Mean (Median) change in firm value	Mean (Median) PAR
1 (low)	254	12.6% (13.0%)	24.1% (19.3%)	1.90 (1.54)
2	293	18.2% (18.2%)	38.8% (32.8%)	2.14 (1.75)
3	285	27.6% (27.3%)	65.7% (52.9%)	2.34 (2.01)
4 (high)	287	59.8% (50.0%)	190.2% (138.0%)	3.06 (2.55)
All	1119	29.7% (22.2%)	80.9% (42.6%)	2.36 (1.94)

*The sample includes 2119 US operating firm IPOs with either upward or downward offer price revisions during 1985-2003. Unit offers, REITs, closed-end funds, banks and S&Ls, ADRs, reverse LBOs, and IPOs with minimum of the price range below $8.00 are excluded. Offer price revision is the offer price minus the midpoint of the initial filing range, divided by the midpoint of the initial filing range. Change in the firm value is the first-day close share price minus the original expected market price, divided by the original expected market price. Adjustment ratio (AR) is defined as the ratio of the percentage change in a firm's share value during the registration period to the percentage offer price adjustment.

Table 5-3. Regressions of Percentage Offer Price Revision and Percentage Change in Firm Value during the Registration Period on Public Information Measures*

	Dependent Variable:		Test: Coefficients are equal across the two models (p value)
	(1) Percentage Offer Price Revision	(2) Percentage Change in Firm Value	
Intercept	-0.01	0.06***	
	(0.00)	(0.01)	
UP (Same Underwriter)	0.04***	0.19***	< 0.001
	(0.01)	(0.04)	
UP (Other Underwriters)	0.08***	0.56***	< 0.001
	(0.01)	(0.04)	
PrcAdj (Same Underwriter)	0.28***	0.82***	< 0.001
	(0.03)	(0.09)	
PrcAdj (Other	0.31***	1.04***	< 0.001
	(0.03)	(0.08)	
Industry Ret (Beginning)	1.70***	3.69***	< 0.001
	(0.08)	(0.27)	
Industry Ret (End)	1.04***	3.39***	< 0.001
	(0.06)	(0.18)	
Adjusted R^2	0.233	0.243	
Test: All coefficients = 0 (p value)	< 0.001	< 0.001	
Number of Observations	4300	3997	

*The sample includes 4300 US operating firm IPOs during 1985-2003. Unit offers, REITs, closed-end funds, banks and S&Ls, ADRs, reverse LBOs, and IPOs with minimum of the price range below $8.00 are excluded. Offer price revision is the offer price minus the midpoint of the initial filing range, divided by the midpoint of the initial filing range. Change in firm value is the first-day close share price minus the original expected market price, divided by the original expected market price. White's heteroskedasticity consistent standard errors are in parentheses. ***, **, and * denote significance at the 1, 5, and 10 percent level, respectively.

Table 5-4. System Estimation

Column:	(1)	(2)	(3)	(4)	(5)
Dependent Variable:	AR	AR (1993-2003)	Dummy =1 if OP > HI	AR	AR (1993-2003)
Estimation Method:	OLS	OLS	Selection Model	Heckman ML	Heckman ML
Valuation Uncertainty					
Firm-specific uncertainty	0.09**	0.10**	0.01	0.09**	0.09**
	(0.04)	(0.04)	(0.01)	(0.04)	(0.04)
Market uncertainty	0.05	0.11	-0.10**	0.10	0.16
	(0.17)	(0.19)	(0.05)	(0.17)	(0.18)
Public Information Proxies					
UP (Same Underwriter)	-0.01	-0.02	0.06	-0.02	-0.04
	(0.14)	(0.14)	(0.07)	(0.14)	(0.14)
UP (Other Underwriters)	0.92***	0.89***	0.27***	0.86***	0.83***
	(0.24)	(0.26)	(0.08)	(0.24)	(0.26)
PrcAdj (Same Underwriter)	-0.66*	-0.71*	0.37*	-0.79**	-0.83**
	(0.38)	(0.39)	(0.21)	(0.38)	(0.39)
PrcAdj (Other Underwriters)	1.02**	1.00*	0.37**	0.73	0.75
	(0.52)	(0.55)	(0.19)	(0.53)	(0.56)
Industry Ret (Beginning)	-0.27	-0.18	4.72***	-2.48*	-2.10
	(1.36)	(1.48)	(0.56)	(1.42)	(1.54)
Industry Ret (End)	4.50***	5.03***	4.27***	2.88***	3.55***
	(1.02)	(1.21)	(0.34)	(1.11)	(1.27)
Bargaining Proxies					
High Debt Dummy	-0.24**	-0.28**		-0.24**	-0.29**
	(0.11)	(0.12)		(0.11)	(0.12)
Institution Dummy	-0.31**	-0.33**		-0.31**	-0.32**
	(0.14)	(0.15)		(0.14)	(0.15)
UW Relative Income	-0.23***	-0.20***		-0.24***	-0.21***
	(0.06)	(0.07)		(0.06)	(0.07)
Overhang	0.06**	0.05*		0.06**	0.05*
	(0.03)	(0.03)		(0.03)	(0.03)
Registration Length	-0.39***	-0.47***		-0.39***	-0.47***
	(0.12)	(0.13)		(0.12)	(0.13)
Initial P/S Multiple	0.09**	0.09**		0.08**	0.08**
	(0.04)	(0.04)		(0.04)	(0.04)
Integer OP	0.58***	0.70***		0.57***	0.69***
	(0.10)	(0.13)		(0.10)	(0.13)
All-star Dummy		0.37**			0.37**
		(0.16)			(0.15)

Table 5-4. Continued

Column:	(1)	(2)	(3)	(4)	(5)
Dependent Variable:	AR	AR (1993-2003)	Dummy =1 if OP > HI	AR	AR (1993-2003)
Estimation Method:	OLS	OLS	Selection Model	Heckman ML	Heckman ML
Control Variables					
Ln (Sales)	-0.00	-0.01	0.04***	-0.03	-0.04
	(0.04)	(0.05)	(0.01)	(0.04)	(0.05)
Tech Dummy	-0.01	-0.07	0.30***	-0.16	-0.21
	(0.12)	(0.14)	(0.05)	(0.14)	(0.16)
Net Dummy	0.28	0.28	0.55***	0.09	0.11
	(0.21)	(0.21)	(0.07)	(0.21)	(0.22)
Underwriter Rank	-0.09	-0.10		-0.10	-0.11
	(0.07)	(0.08)		(0.07)	(0.07)
Bubble Dummy	0.49*	0.37		0.49*	0.36
	(0.26)	(0.26)		(0.26)	(0.26)
Instrumental Variables					
Ln (Expected Proceeds)			0.14***		
			(0.03)		
Pure Primary Dummy			-0.21***		
			(0.04)		
Intercept	4.43***	4.77***	-1.52***	5.49***	5.75***
	(0.87)	(0.96)	(0.11)	(0.93)	(1.02)
Inverse Mills Ratio				-0.58***	-0.55***
				(0.20)	(0.23)
Adjusted R^2 / Pseudo R^2	0.277	0.271	0.138	--	--
All coefficients = 0 (p-value)	<0.001	<0.001	<0.001	<0.001	<0.001
Number of Observations	902	777	3100	902	777

* The sample includes 902 US operating firm IPOs with upward offer price adjustment over 1985-2003. Unit offers, REITs, closed-end funds, banks and S&Ls, ADRs, reverse LBOs, and IPOs with minimum of the price range below $8.00 are excluded. Adjustment ratio (AR) is defined as the ratio of the change in a firm's share value during the registration period to the offer price adjustment. The definition of independent variables is as in the Appendix. Columns (1) and (2) are estimated using OLS. Column (4) and (5) are estimated using Heckman Maximum Likelihood methodology, with Column (3) as the selection model. Column (2) and Column (5) include the All-star Dummy,which is available for the period 1993-2003. Underpricing spillover variables are orthogonalized with respect to the price adjustment spillover variables and the market return variables. Price adjustment spillover variables are orthogonalized with respect to the market return variables. White's heteroskedasticity consistent standard errors are in parentheses. ***, **, and * denote significance at the 1, 5, and 10 percent level, respectively.

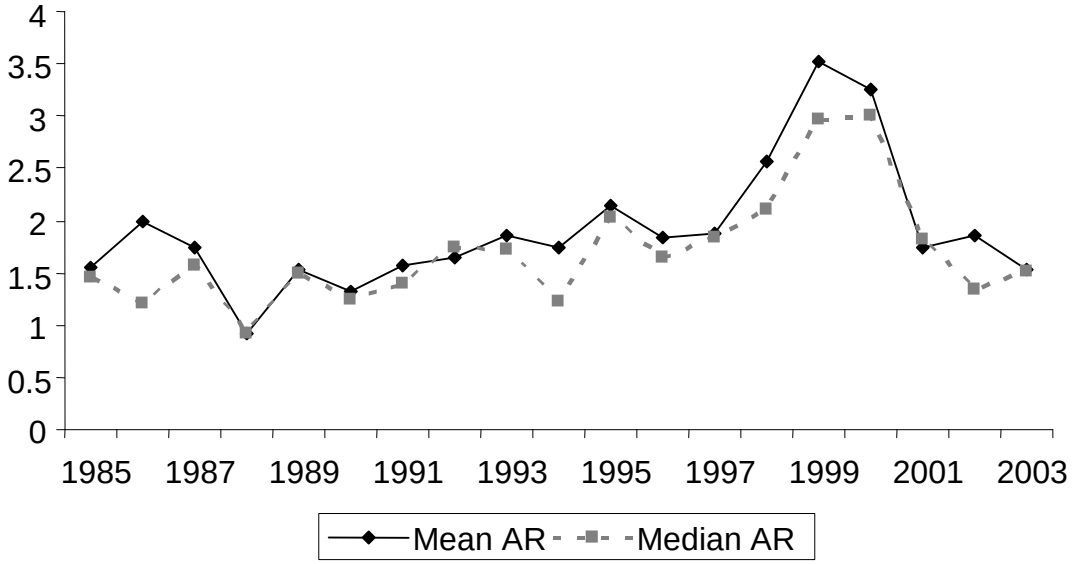

Figure 5-1. Mean and Median Adjustment Ratio by Cohort Year. Adjustment Ratio (AR) is the ratio of the change in a firm's share value during the registration period to the offer price adjustment. The sample is composed of 1,119 IPOs from 1985 to 2003 with upward price adjustment, excluding unit offers, REITs, closed-end funds, banks and S&Ls, ADRs, reverse LBOs, and IPOs with the minimum of the price range below $8.

CHAPTER 6
ROBUSTNESS

In this section we conduct various experiments to ensure that our findings are robust.

Endogeneity of Underwriter Selection

Habib and Ljungqvist (2001) and Fernando et al. (2004) argue that the reputation ranking of the lead underwriter is endogeneous in underpricing regressions. A similar endogeneity bias may affect the analysis in this study if issuers choose underwriters based on the bargaining powers of the two sides. We test this possibility using the Durbin-Wu-Hausman test. We include in the AR regression the residual from a first-stage regression of the underwriter prestige on various firm- and offer-specific characteristics. A significant coefficient estimate on the residual indicates an endogeneity bias. In our test, we cannot reject the null hypothsis that the underwriter prestige is exogeneous (p=17.3%).

Stability of the First-Stage Regression

The adjustment ratio is a function of initial underpricing, which is estimated using a first-stage regression of underpricing on a set of variables. To test the stability of this analysis, we repeat the estimation of initial underpricing by adding other explanatory variables to the first-stage regression. More specifically, in unreported work we include the firm-specific volatility, high-leverage dummy, integer offer price dummy, the natural logarithm of expected proceeds, and the pure primary dummy to the first-stage estimation. The results remain the same and our conclusions remain unchanged.

Forward-Looking Bias

The estimation of the initial underpricing is done in the first-stage regression of IPOs with no offer price revisions that went public throughout the whole sample period of 1985 to 2003. Therefore, AR for IPOs earlier in the sample period is calculated using information provided in future IPOs. Even though the time dummies in the first-stage regression capture this time effect in the intercept, a forward-looking bias could affect the results if the coefficients differ significantly over time. We repeat the analysis using rolling-window regressions in the first-stage estimation. More specifically, we estimate the initial underpricing for each IPO with upward offer price revision using only the information provided in the pricing of IPOs that went public in the last three years. The results are qualitatively identical.

Scale Effect on Efficiency

Table III demonstrates a potential scale effect on the efficiency of the offer price adjustment: higher offer price revisions (output) seem to be achieved only at lower efficiencies. It is important to ensure that the explanatory variables in the main regression analysis are not in fact capturing this scale effect. For instance, IPOs with integer offer prices experience on average higher offer price revisions. Therefore, it is possible that the inefficiency associated with the pricing of IPOs with integer offer prices is in fact due to this scale effect. In unreported results we investigate the relation between the efficiency and the magnitude of the offer price revision in more detail. We find that the positive relation between the revision and AR disappears after controlling for other factors. In particular, in a regression of AR on the offer price revision and firm-specific uncertainty, the coefficient estimate of the offer price revision becomes insignificant and remains insignificant after other factors are included. It appears that the relation between the offer

price revision and the efficiency of offer price adjustment is spurious: IPOs with a higher valuation uncertainty tend to have higher offer price revisions conditional on having an upward offer price adjustment, but at the same time their offer price revisions are less complete. As an additional test, we include the magnitude of the offer price revision in our regressions. The coefficient estimate is insignificant and the other coefficients remain the same. Therefore, we conclude that the findings are not driven by a scale effect.

Investor Sentiment

Investment banks sometimes claim that they have long-run value in mind when they set IPO offer prices. Therefore, if they believe the market to be overoptimistic in regards to the valuation of an IPO they may not increase the offer price up to the market clearing level. Loughran and Ritter (2002) call this the “leaning against the wind” theory. We test whether the inefficiencies we document in this study are in part due to the cautious behavior of the underwriters when setting the offer prices. Leaning against the wind theory predicts a positive relation between the efficiency of the offer price adjustment and long-run post-IPO returns of the issuing firm: overreaction by the market results in a seemingly inefficient offer price adjustment process and low returns in the aftermarket. In unreported tests, we include the returns of the issuing firm during the one year period following the IPO in our main regression. We find that the coefficient estimate is insignificant and the other coefficients do not change materially. We conclude that the partial adjustment phenomenon is not driven by the cautious price setting of the underwriters in response to the investor sentiment.

CHAPTER 7
CONCLUSION

How efficiently do the underwriters adjust offer prices in response to the change in the expected market valuations of the IPO firms? How does this efficiency vary across IPOs? Which hypothesis of IPO offer price adjustment best explains the pattern?

In this study we examine the level and determinants of the efficiency of the IPO offer price adjustment process. More specifically, we compare the magnitude of the offer price adjustment relative to the change in the firm value during the registration period of IPOs with upward price adjustment. We document that between 1985 and 2003 only 42.0 % of the increase in firm value prior to the IPO was incorporated into offer prices. In the bubble period, the level of price adjustment relative to the change in firm value dropped to 28.9%. Inefficiency of offer price adjustment at these levels points to significant costs and inefficiencies in the IPO pricing process.

We evaluate three hypotheses related to the offer price adjustment process. Under the extended dynamic information acquisition hypothesis (Benveniste and Spindt (1989), Benveniste et al. (2002)), underwriters use their discretion to extract information from investors, thereby reducing the average level of underpricing. This hypothesis implies that the change in the firm value due to publicly observable industry returns and information spillovers from comparable IPOs in the same industry should be fully incorporated into offer prices.

Our results indicate that IPOs whose upward offer price revisions are primarily driven by private information production rather than publicly available information

experience more efficient offer price adjustments. This finding is inconsistent with the central implication of the dynamic information acquisition hypothesis that the partial adjustment phenomenon is due to the partial incorporation of private information. We find that market returns during the registration period and information spillovers from recent comparable IPOs are only partially incorporated into the offer prices. Issuing firms that go public following recent comparable IPOs with high levels of underpricing and during a period of high returns in the market experience less efficient offer price adjustments. In addition, the information provided through the offer price adjustment of recent IPOs is incorporated into the offer prices inefficiently, except when the source of the information is from the underwriter's own offerings. Overall, our findings do not support the dynamic information acquisition hypothesis as the explanation of the partial adjustment phenomenon.

We next test the predictions of the bargaining hypothesis (Loughran and Ritter (2002), Ljungqvist and Wilhelm (2003)). The bargaining hypothesis suggests that the offer prices are determined as a result of a bargaining process between underwriters and issuers. In the offer price adjustment context, positive information revealed during the registration period creates a surplus that is divided between the underwriter and the issuing firm according to their bargaining powers and incentives to bargain.

We show that the efficiency of offer price adjustment is higher for IPO firms with alternative financing options and with high opportunity cost of underpricing, as suggested by the bargaining hypothesis. On the other hand, efficiency is lower for issues underwritten by investment banks with high demand for their services in the short-term and by those that employ influential research analysts, indicating that attractive outside

options increase the bargaining powers of the underwriters vis-à-vis the issuing firms. We document a decline in the efficiency of the offer price adjustment over the duration of the registration period. In addition, a bigger surplus for the issuing firm created at the preliminary offer price at the beginning of the registration period is taken back through a subsequent less efficient offer price adjustment. These findings are consistent with a decline in the bargaining powers of the issuing firms during their IPO pricing processes, presumably reflecting their lack of options towards the end. We also find that issues with longer registration periods and those with offer prices set at fractional dollars are associated with better offer price adjustments, which we interpret as an evidence for the existence of a negotiation process in the setting of the IPO offer prices.

Our findings do not support the Edelen and Kadlec (2005) tradeoff hypothesis as a full explanation of the partial adjustment phenomenon. According to the tradeoff hypothesis partial adjustment is demanded by issuers, and consequently the efficiency of the price adjustment is independent from the actions and the characteristics of underwriters. However the evidence on the negative relationship between the demand for the underwriters' services and the efficiency of the offer price adjustment suggests significant conflicts of interest between the underwriters and the issuing firms. In addition, according to the tradeoff hypothesis, the underwriters and issuing firms have no incentives to engage in a nickel-and-diming strategy. Therefore, whether the final offer price is set at an integer or a fraction of a dollar should not contain any information, and should not be significantly related to the efficiency of offer price adjustment. Contrary to this prediction, we find that issues with offer prices set at integers experience less

complete price adjustments, suggesting the existence of a negotiation process between the underwriters and the issuers.

Overall, our analysis reveals significant inefficiencies in the IPO offer price adjustment process and we document a systematic variation in this inefficiency across IPOs and over time. Our findings do not support the distinct implications of the dynamic information acquisition hypothesis or the tradeoff hypothesis. The evidence in this study is consistent with the hypothesis that offer prices are determined as a result of a bargaining process between underwriters and issuers, as hypothesized by Loughran and Ritter (2002) and Ljungqvist and Wilhelm (2003).

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