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IPO Pricing Mechanisms in Norway

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Abstract

In this paper, we have analysed 166 book-building and fixed-price IPOs listed on the Oslo Stock Exchange in 1993-2008 and compared the efficiency of two pricing mechanisms used in them (in terms of level and variability of underpricing, and the ability to fully incorporate market conditions in the pre-offering period into the final offer price). After having controlled for firm, issue characteristics and market conditions in the period prior to an IPO, we have found that the book-building mechanism is associated with 5.2% significantly lower underpricing. It has also been found that book-building is less sensitive to market conditions prior to an IPO. Yet, both pricing mechanisms have the similar variability of underpricing, i.e. accuracy of pricing. All things considered, we conclude that book-building (vs. fixed-price) is a more efficient pricing mechanism in the Norwegian IPO market, as it underprices less, and more effectively incorporates market conditions in the pre-offering period into the final offer price. Thus, after controlling for all the other possible objectives of an IPO, different from pricing issues (e.g. allocation), book-building is a more rational pricing mechanism choice for Norwegian firms going public.

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1. Introduction

The phenomenon of initial public offering underpricing has been extensively studied in academic literature. Loughran, Ritter, and Rydqvist (1994) present a first comprehensive research on IPOs in an international perspective. They document that underpricing is present in roughly all IPOs globally, priced by means of different mechanisms.

Loughran et al. (1994) argue that underpricing constitutes a cost to the issuer, and is not optimal since proceeds are "left on the table". On the contrary, Habib and Ljungqvist (2001) claim that some positive amount of underpricing may, in fact, benefit the issuer. Nonetheless, there seem to be no clear recommendation of what level of underpricing is optimal, academic IPO literature clearly suggests that excessive underpricing is detrimental to the issuer, who is predominantly concerned with maximization of its IPO proceeds. Yet again, Loughran et al. (1994) were first to draw attention to the fact that one should consider a pricing mechanism used in the IPO when evaluating its success, measured by gross proceeds that are exposed to underpricing.

The most noticeable research has been done in the strand of IPO literature that explains differences in IPO initial returns as a result of informational asymmetries that presumably exist amongst various parties involved in the IPO process. The way these informational asymmetries are handled by IPO pricing mechanisms, as we will see, is crucial.

As a general rule, parties involved in the IPO process include a firm going public (the issuer), a bank underwriting the issue (the underwriter) and investors. As there is obviously no secondary market so far for IPO shares, the issuer together with the underwriter need to determine the price of stocks to be issued. Three pricing mechanisms may be employed with the purpose of price determination. These mechanisms are book-building, fixed-price method, and auctions.

IPO pricing methods differ considerably with respect to whether the price discovery occurs before or after the final offer price is set (Busaba and Chang, 2010). For example, in the book-building process, which predominates in the United States and recently has spread to other parts of the world, noticeably Europe, the underwriter interacts with investors during the "road show", where investors bid their non-binding indications of interest. This process allows the underwriter to learn the demand for the issue, and subsequently set the appropriate

offer price. In contrast, the "true" price evolves only after an offer is made if the fixed-price method is used. Naturally, therefore, a dissimilar structure of various pricing mechanisms results in their different treatment of informational asymmetries present in IPOs. In turn, this affects the underpricing associated with the issue.

Growing theoretical literature on the topic gave rise to empirical tests of the superiority of one mechanism over another. The question is particularly interesting in countries, where more than one mechanism is available to price IPO shares, and thus they can be compared. Selected empirical evidence advocates for the superiority of auctions over book-building in terms of lower underpricing levels (Derrien and Womack (2003) for France; Kaneko and Pettway (2003) for Japan). Ljungqvist, Jenkinson and Wilhelm (2003) find that European book-built IPOs are more underpriced than fixed-price offerings, which contradicts most of the influential theoretical studies (Benveniste and Spindt (1989), Spatt and Srivastava (1991), Biais and Faugeron-Crouzet (2002) and other). In a nutshell, both theoretical and empirical findings are so far inconclusive about whether one or another pricing mechanism efficiently dominates in terms of lower underpricing, and higher proceeds to the issuer.

To our knowledge, the question is rather unexplored in the Norwegian IPO market, which provides the firms going public with two alternatives of the IPO pricing mechanisms – book-building and the fixed-price method. In our research, we compare their efficiency as measured by the level and variability of underpricing, as well as the ability to fully incorporate market conditions in the pre-offering period into the final offer price. Thus, our key research question is – what IPO pricing mechanism in Norway (book-building versus fixed-priced) is more efficient, i.e. underprices less, has higher accuracy of pricing, and is less sensitive to recent market conditions? In addition, we also explore what are the significant determinants of the pricing mechanism choice in Norwegian firms going public. To sum up, in our master thesis we attempt to bring so far inexistent empirical evidence on the question from Norway.

In our paper, we have found that, after controlling for differences in firm, issue characteristics and market conditions prior to an IPO, book-building is on average associated with 5.2% significantly lower underpricing, than the fixed-price mechanism. Secondly, both mechanisms have the very similar variability of underpricing, i.e. accuracy of pricing. Further, the analysis also suggests that the

book-building pricing mechanism effectively incorporates market conditions in the pre-offering period into the final offer price, while fixed-price mechanism is less effective, as market return in the period prior to an IPO has significant positive impact on both the level and variability of underpricing in fixed-price IPOs.

It has also been found that the choice of pricing mechanism in Norwegian IPOs is contingent on a number of firm and issue characteristics. Higher book-to-market and older firms, as well as the ones with higher fractions of shares to be created in an IPO, tend to choose the fixed-price method. In contrast, venture-capital backed firms are more likely to opt for book-building (apparently because Norwegian venture capitalists prefer book-building IPOs as an exit vehicle). Larger companies are as well more likely to choose book-building (presumably in order to attract foreign investors who dislike fixed-price IPOs in which they get no advantages in shares allocation). Lastly, firms, which IPOs are going to be underwritten by highly ranked underwriters, are more likely to use book-building as a pricing mechanism (since highly ranked underwriters in Norway are specialized in this procedure, as we infer).

All in all, we found empirical evidence in favour of a more efficient book-building pricing mechanism in Norwegian IPO market, as it underprices less and is less sensitive to market conditions prior to an IPO than the fixed-price mechanism. In fact, the difference in underpricing is even more pronounced in "hot" market conditions. Thus, after controlling for all the other possible objectives of an IPO, different from pricing issues (e.g. allocation), book-building should be rationally opted for by Norwegian firms going public in order to maximize IPO proceeds.

We will start with a review of the most relevant theoretical literature and selected empirical papers in the next section. Then, we will formulate testable hypotheses in section 3. The methodology used to investigate the issue will be outlined in section 4. Next, we will specify the data used, present the descriptive statistics and a cross-sectional analysis in section 5. Empirical evidence is presented in section 6. Lastly, we draw conclusions in section 7.

2. Literature Review

We begin with the review of previous studies that are of the highest relevance to our research question. We will make an emphasis on theoretical models discussed in the literature to answer the question *why* underpricing arises in different pricing mechanisms, and whether it should be different. Further, selected empirical evidence on the question from other countries will be presented. Also, throughout this literature review, we will mostly focus on contrasting the pricing mechanisms.

Rock (1986) presents one of the pioneering studies in the informational asymmetries and IPO underpricing literature. In his paper, Rock develops a model of a fixed-price method of IPO pricing, where he assumes the existence of a group of investors with pricing-relevant information, and the issuer is assumed to be unable to acquire this information before the offer price is set. There are no incentives for informed investors to reveal their information before the offer price is set and they can avoid participation in the overvalued IPOs. Conversely, uninformed investors cannot avoid participation in such IPOs, and as a result experience a winner‟s curse. He argues that underpricing is compensation to uninformed investors for experiencing the winner‟s curse, as informed investors crowd them out of the high quality offerings. He concludes that in order to guarantee that uninformed investors participate in the IPO, issued shares should be priced at a discount.

Benveniste and Spindt (1989) study the book-building pricing mechanism. Clearly, in contrast to Rock (1986), the underwriter is now assumed to be able to obtain information from informed investors before the offer price is set. In their model, underpricing is compensation to investors for the disclosure of positive information about the issue. Thus, the underwriter‟s role is to mitigate the informational asymmetry by using his discretion over pricing and allocation that motivates investors to reveal their information about the issue. Investors reveal their information to the underwriter by bidding their non-binding indications of interest. Among other, they conclude that the new issue will be associated with less underpricing and respectively more proceeds to the issuer, compared to a fixed-price offer.

Benveniste and Wilhelm (1990) essentially extend the model of Benveniste and Spindt (1989) by analysing the consequences of constraining the underwriters in their efforts to extract information from informed investors.

Underwriters maximize IPO proceeds by using a combination of price and allocation discrimination, given the opportunity to allocate shares among both regular (mostly informed institutional investors) and retail investors (mostly uniformed investors). Constraining underwriters in their efforts decreases the expected proceeds from the IPO by limiting the underwriter‟s ability to weaken the winner‟s curse. They argue that uniform-price restrictions increase the costs of gathering information from regular investors, and if they are combined with allocation restrictions, the underwriter appears to be no longer able to reduce the informational asymmetry because information gathering is impossible. At one extreme, when both uniform price and allocation restrictions are in place, the issuer may experience the consequences of the full winner‟s curse facing uninformed investors as in Rock (1986) and thus, book-building loses its advantages relative to the fixed-price mechanism. If not, they argue, book-building is an efficient pricing method and dominates the fixed-price mechanism.

Spatt and Srivastava‟s (1991) results are consistent with previous papers. They argue that the regular fixed-price procedure is inefficient since it does not utilize any information about investors‟ valuations. They further consider an augmented fixed-price mechanism by allowing informal communication between the underwriter and investors prior to the allocation of the issue. This communication, which resembles the book-building model in Benveniste and Spindt (1989), can transmit relevant information between the parties. They conclude that the fixed-priced mechanism with a non-binding premarket communication, that provides an underwriter with indications of interest, leads to the allocation and pricing that maximizes issuer‟s expected proceeds, given the informational constraints. Thus, they actually support the notion of the efficient book-building mechanism.

Welch (1992) focuses on the fixed-price mechanism and informational cascades. Under assumption that all investors possess equally valuable and correlated information, can observe each other‟s subscription decisions and their subscriptions are not simultaneously pro-rated, but instead served sequentially, he provides an explanation of IPO underpricing without a winner‟s curse (contrary to Rock, 1986). He argues that when an IPO is sold sequentially, later investors can learn from purchasing decisions of earlier investors, which can lead to informational cascades in which investors optimally ignore their private information and rely on and imitate the actions of earlier investors. Thus, in the

fixed-price mechanism underpricing is used to avoid information gathering and is needed in order to create a positive informational cascade. On the other hand, in the book-building procedure information about the demand is undisclosed by the underwriter to other investors. Therefore, informational cascades cannot develop, and less underpricing is required, ceteris paribus.

Hanley (1993) provides evidence that the book-building procedure may be exposed to the partial adjustment phenomenon. She claims that issues associated with the partial adjustment phenomenon – those that have positive offer price revisions – exhibit both an increase in underpricing and the number of offered shares. This result is consistent with Benveniste and Spindt (1989) who claim that the final offer price is only partially adjusted to the information gathered through book-building. She argues that issues with the final offer price exceeding the limits of the price range have greater underpricing, ceteris paribus. Moreover, issuers and underwriters tend to price in the initially set price range. For that reason, the final offer price may not be sufficiently increased to capture the excess demand, which results in excess underpricing.

Benveniste and Busaba (1997) theoretically compare fixed-price and book-building mechanisms under assumption that investors possess correlated information and can observe each other"s subscription decisions. They model fixed-priced mechanism similarly to Welch (1992). As a result, in their setting book-building no longer stochastically dominates the fixed-priced mechanism as in Spatt and Srivastava (1991). They argue that underpricing required under the fixed-price procedure in order to create a positive informational cascade is larger than underpricing needed to induce investors to reveal information in book-building. Therefore, book-building generates higher expected proceeds than the fixed-price method. However, it is as well associated with greater uncertainty. They conclude that it is the degree of price risk endogenous to the issue and risk-aversion of the issuer that are the determinants of the issuer"s choice of the pricing mechanism. They argue that the certainty of the proceeds is an advantage of the fixed-priced method, and for that reason, it may be attractive for more risk-averse issuers. Thus, they conclude that both the fixed-price and book-building may be optimal from the issuer"s point of view, contingent on his characteristics.

Biais and Faugeron-Crouzet (2002) develop a unified theoretical model in order to analyse and compare different pricing mechanisms. They provide evidence that the fixed-price mechanism leads to inefficient pricing of IPO shares

and a winner's curse (consistent with Rock, 1986), whereas auction mechanism can lead to inefficiencies due to implicit collusion among investors. Lastly, book-building leads to the optimal information revelation from investors about their valuation of stocks and an efficient price discovery (consistent with Benveniste and Spindt, 1989). Thus, both auction and book-building methods are superior to the fixed-price mechanism. And unless there are inefficiencies caused by collusion among investors, auction and book-building procedures are equally efficient.

Sherman and Titman (2002) further study the book-building mechanism of pricing IPO shares. They develop a model, in which an underwriter selects a group of targeted investors, pricing and allocation mechanisms that maximize the information generated during the IPO process subject to a minimum cost. In contrast to previously discussed papers (most notably Benveniste and Spindt, 1989), they argue that underpricing in book-building is needed so as to induce investors to produce information, rather than reveal it. Therefore, investors experience a cost of acquiring information, which should be compensated by corresponding underpricing. They conclude that when there is no need in accurate pricing, the expected gain from underpricing exactly offsets the costs of acquiring information by investors. However, when pricing accuracy is of high importance, the number of participating investors, as well as amount of underpricing increases, and on average underpricing will go above the information acquisition costs encountered by investors. Thus, the firms with a high need for pricing accuracy (e.g. riskier firms, smaller size firms with potentially less liquid shares, firms with significant future capital needs) are likely to be more underpriced.

Ljungqvist, Jenksinson and Wilhelm (2003) perform a cost-benefit analysis of the global integration of IPO markets and a followed-on adoption of the US-style book-building mechanism throughout 65 countries in 1990s, where the fixed-price method dominated until then. They find that on average, both pricing mechanisms are associated with the similar level of underpricing – around 20%. They argue that book-building on its own does not lead to lower underpricing. However, book-building leads to significantly lower underpricing relative to the fixed-price method, or book-building by domestic underwriters if only it is conducted by US underwriters or targeted at US investors. Even though it is twice as much expensive as the fixed price mechanism, gains associated with it – decreased underpricing – outweigh additional direct costs of hiring a US

underwriter or targeting at a US investor. They explain this due to longer book-building experience of US banks that seem to be better at rewarding investors for revealing information dynamically. What is more, they find that European book-built IPOs are more underpriced than fixed-price offerings. However, these results may be due to the fact that the issuer chooses the pricing mechanism endogenously, depending on her characteristics. Sectors with high degrees of informational asymmetry (e.g., IT and biotech) may benefit from either information production (as in Sherman and Titman, 2002) or revelation (as in Benveniste and Spindt, 1989) in the course of book-building.

In their paper, Derrien and Womack (2003) investigate empirically IPO pricing mechanisms and underpricing based on the French IPO market, where all the three pricing mechanisms, namely auctions, book-building and fixed-price offers are used. They focus their research not exclusively on the amount of underpricing, but also on the variability of underpricing, which are both related to previous market conditions, as they show. They argue that cross-sectional variance of underpricing is another important aspect of the efficiency of pricing mechanisms. They find that amongst all the mechanisms, the auction method is associated with lesser amount and variance of underpricing, thus it is superior to both book-building and fixed-price mechanisms. They argue that its auctions mechanism's ability to incorporate information on current and previous market conditions into the final offer price that is the reason for its superiority. Book-building appears to be the second-best alternative that may be opted for because of other objectives different from reduced underpricing, for example, a better-selected set of owners.

Kaneko and Pettway (2003) present a study of IPOs in Japan, which moved from an auction-priced to underwriter-priced IPOs using book-building mechanism in 1997. In line with Derrien and Womack (2003), they find evidence that initial returns of the book-built IPOs are significantly higher than those of the auctions, especially in "hot" market conditions. They relate higher underpricing of the book-built IPOs to the setting of the upper price limit by the underwriter too low at the stage of registering preliminary prospectus, and typical setting of the final offer price no higher than the upper bound of the price range by underwriters of the Japanese IPOs, despite the fact that the demand function learned through book-building suggests a higher appropriate price.

Most of the previously reviewed studies assume that the "true" value of offered shares is established instantly after trading begins (e.g., Benveniste and Wilhelm, 1990; Spatt and Srivastava, 1991; Benveniste and Busaba, 1997; Biais and Faugeron-Crouzet, 2002). On the contrary, Busaba and Chang (2010) analyse book-building and fixed-price mechanisms allowing for strategic aftermarket trading by informed investors. They find that both methods require more underpricing when informed investors consider aftermarket trading. This is particularly true for the book-building procedure, which becomes especially costly since investors'' bidding behaviour is adversely affected by the potential for profits in aftermarket. Underpricing is thus required to offset the losses of uniformed investors who face trading with informed investors in aftermarket. They argue that dominance of the book-building procedure may be established if only the discretion to limit participation in the premarket is added to discretion to condition allocations (discussed in Benveniste and Wilhelm, 1990). Thus, in contrast to previous studies, that at large document the superiority of the book-building method, they argue that the fixed-price mechanism produces on average higher expected proceeds, unless the underwriter can target its book-building activity to a small subset of informed investors. Thus, they found an efficiency rationale of the common practice in book-built US IPOs to limit the book-building activity to a group of institutional informed investors.

In sum, theoretical studies suggests that the "nature" of underpricing in fixed-price and book-building IPOs is rather different. Underpricing in fixed-price offerings either serves as a compensation for winner''s curse, or is used to create informational cascades. On the contrary, in book-building IPOs, underpricing is used to induce investors to either reveal or produce information, to offset losses that investors face in the aftermarket trading, or arises as a result of only partial adjustment of the offer price. In turn, theory also predicts that underpricing due to, for instance, information revelation in book-building should be lower than underpricing in fixed-price offerings due to winner''s course or creation of informational cascades. In contrast, empirical studies suggest that European book-built IPOs are in fact more underpriced than fixed-price offerings. Price and/or allocation restrictions, or inability to limit participation in the premarket, are the possible reasons why book-building mechanism may lose its superiority over the fixed-price method.

3. Hypotheses

In this section, we postulate three sets of hypotheses that correspond to three characteristics of the efficient pricing mechanism, i.e. low underpricing, low variability of underpricing (i.e. higher pricing accuracy), and the ability to fully incorporate market conditions in the pre-offering period into the final offer price.

The traditional standpoint of IPO pricing mechanisms efficiency virtually supports the notion of the efficient book-building pricing mechanism. It origins from the most notable theoretical works of Benveniste and Spindt (1989), Benveniste and Wilhelm (1990), Spatt and Srivastava (1991), and it is supported by later studies of Benveniste and Busaba (1997), Biais and Faugeron-Crouzet (2002). For the most part, they all agree that book-building efficiently dominates the fixed-price method, as the underwriter during the course of it reduces informational asymmetries and weakens the winner"s course by utilizing the information disclosed by investors. Thus, book-building is associated with less underpricing, and respectively more proceeds to the issuer. Our central hypothesis is thus inspired by their works and is formulated in the following manner:

H1. On average, those IPOs that are priced using the book-building mechanism are associated with less underpricing, compared to fixed-priced offerings.

In contrast to a conventional viewpoint, Busaba and Chang (2010) argue that on average, the fixed-price mechanism produces higher expected proceeds, unless the underwriter can target its book-building activity to a small subset of informed investors. Also, Ljungqvist, Jenkinson and Wilhelm (2003) find empirically that European book-built IPOs are more underpriced than fixed-priced offerings (Norwegian IPOs are not included in their sample). Therefore, we formulate the competing hypothesis as follows:

H2. On average, those IPOs that are priced using the fixed-price mechanism are associated with less underpricing, compared to book-built offerings.

In their paper, Ljungqvist, Jenkinson and Wilhelm (2003) also find that on average in their sample (including European IPOs; Norway is not included), both

book-building and fixed-price mechanisms are associated with the similar level of underpricing – around 20%. Thus, we also consider the possibility that there may be no significant relation between the pricing mechanism used in an IPO and its consequent underpricing in the Norwegian IPO market. This is our null hypothesis.

As Derrien and Womack (2003) argue, low cross-sectional variance of underpricing is another important aspect of the pricing mechanism efficiency in addition to low underpricing since underwriters are also typically concerned about controlling the aftermarket price variation, particularly the downside potential. This matter was as well addressed by Busaba and Chang (1997), who suggest that the book-building mechanism is associated with greater aftermarket uncertainty. We therefore formulate the following two hypotheses to assess this aspect of the pricing efficiency:

H3. On average, those IPOs that are priced using the book-building mechanism are associated with a lower variance of underpricing, compared to fixed-price offerings.

H4. On average, those IPOs that are priced using the fixed-price mechanism are associated with a lower variance of underpricing, compared to book-built offerings.

Lastly, following Derrien and Womack (2003), we also hypothesise that recent market conditions prior to an IPO have a differential impact on the level and variability of underpricing in book-building and fixed-price IPOs. Therefore, we formulate:

H5. On average, book-building mechanism is more sensitive to market conditions in the pre-offering period, compared to the fixed-price pricing mechanism.

H4. On average, the fixed-price mechanism is more sensitive to market conditions in the pre-offering period, compared to the book-building pricing mechanism.

Having postulated the hypotheses, we describe the methodology in the next section.

4. Methodology

In this section, the methodology used in our research will be outlined. We start with the introduction of dependent variables of interest, as well as explanatory variables used. Next, the stages of the empirical research and corresponding models will be presented. We conclude this section with the discussion of statistical tests we employ in the models to check the reliability of obtained results.

4.1. Dependent variables

The central objective of the current research is to test empirically the efficiency of the book-building method versus fixed-price mechanism in Norwegian IPOs, measured by the level and variability of underpricing. We quantify the level of underpricing as the first-day return level. The variability of underpricing is measured by both the conditional and unconditional variances of the first-day return. The construction of the three dependent variables is presented in details below.

The level of underpricing is measured by the *first-day return*. Following the conventional definition, for each IPO in the sample, we compute the first-day return as a simple return, or a percentage difference, between the offer price and the closing price on the first day of trading.

The *Unconditional variance of the first-day return* is a measure of the variability of underpricing *without* controlling for differences in underpricing that might be introduced by dissimilarities in firm, issue characteristics and recent market conditions prior to an IPO. For each IPO in the sample, we compute the unconditional variance of underpricing as a squared deviation of the first-day return around mean underpricing in the cross-section of either book-building or fixed-price IPOs (depending on the pricing mechanism used in the IPO in question).

The *Conditional variance of the first-day return* is a measure of variability of underpricing *after* controlling for differences in underpricing introduced by dissimilarities in firm, issue characteristics and market conditions before an IPO. For each IPO in the sample, we construct the conditional variance of underpricing as squared residuals from the multivariate regression model with the *First-day return* as a dependent variable, and firm, issue characteristics and recent market conditions as independent covariates. In effect, the conditional variance of first-

day return is, for each observation, a squared difference between actual underpricing of the issue, and underpricing, predicted by the regression model, specified above.

4.2. Explanatory variables

Previous studies suggest that many firm and issue characteristics are inevitably linked with the ex-ante uncertainty associated with an IPO, and therefore, they should have a significant impact on underpricing (Kaneko and Pettway, 2003). In addition, market conditions prior to an IPO are also found to have a significant effect on the first-day return (Derrien and Womack, 2003). In this subsection we outline a comprehensive set of variables used in the current research, and that serves two purposes. Firstly, we study whether the relationships between firm, issue, market conditions variables and first-day returns, found in previous studies, are also present in Norwegian IPOs. Secondly (and more importantly), these variables are also used as control variables when first-day return levels, as well as variances of underpricing, are compared across book-building and fixed-price IPOs.

The company-specific variables in question are market capitalization, the book-to-market ratio, age, industry, venture capital investment. Issue characteristics are its size, underwriter reputation, and insider sales. Two moments of market conditions are market return and volatility prior to a listing date. The definitions of the variables, their construction, along with the underlying rationale of their link with first-day return, are presented below.

Company-specific variables

Market capitalization (or market value of equity) is a measure of the market size of the IPO firm. To avoid any mechanical relationships with underpricing, we calculate *initial* market capitalization (at the beginning of the first day of trading) as a total number of company shares (total post-issue shares) times the offer price. Companies with higher market size are usually exposed to higher analyst coverage during the IPO process, which leads to a decline in informational asymmetries. As these companies become less ex-ante uncertain, we expect a negative relationship between market capitalization and the first-day return level. For the regression analysis purpose, we take the natural logarithm of the variable to improve its distributional characteristics, in particular large positive skewness.

A *Book-to-market ratio* is also calculated at the IPO date as a ratio of book value of equity to initial market capitalization. Firms with lower book-to-market ratios are associated with higher informational asymmetries (Brav and Gompers, 2000), therefore we expect there to be an inverse relationship between the book-to-market ratio and underpricing. Logarithmic transformation has been applied to this variable as well.

Age of company is measured in a number of full years between a funding date and a listing date. Beatty and Ritter (1986) suggest that older companies are considered less ex-ante uncertain, and thus, there should be a negative relationship between firm"s age and first-day return. We will test whether this finding applies to Norwegian companies as well.

We construct a *high-tech dummy* variable to control for industry-specific effects. We classify a company as being high-tech if it belongs to either IT or the Telecommunications sector. High-tech firms are associated with higher levels of informational asymmetries, and more complicated pricing. Therefore, they should be on average more underpriced than non-high-tech companies. We also construct a *venture capital-backed dummy* variable encoded as 1 if a company at a listing date had venture capital investment and 0 otherwise. Baker and Gompers (1999) argue that venture capitalists reduce informational asymmetries in firms they invest. Hamao et al. (2000) also find that the presence of venture capital investment negatively affects the level of underpricing in Japan. We will investigate whether venture capitalist ownership also affects first-day returns in Norwegian IPOs.

Issue-specific variables

We define the *Issue size* as gross proceeds of the IPO, and calculate it as the final offer price times the number of shares sold in an IPO. Beatty and Ritter (1986) and Ibbotson et al. (1994) argue that there should be an inverse relationship between the issue size and level of first-day return as the larger issue size entails lower ex-ante uncertainty. We apply a logarithmic transformation to this variable to deal with high positive skewness.

We measure *Underwriter's reputation* based on capital levels, rather than on the number of IPOs as Derrien and Womack (2003)[1]. For each IPO in the

[1] In our sample, there are underwriters that were involved in a relatively small number of IPOs; however, the cumulative deal value of those IPOs is relatively high. If one measures the underwriter reputation based on the number of IPOs, these underwriters will be assigned an unreasonably low rank, which, we believe, does not truly represent their reputation level. Consequently, we use capital levels as a proxy for underwriter reputation.

sample, we determine the identity of the underwriter. Next, each underwriter is assigned a group of IPOs in which he was a lead underwriter. We then compute the cumulative IPO gross proceeds in each underwriter"s group, as well as total gross proceeds for all IPOs. Based on this data, we compute each underwriter"s market share[2]. For regression purposes, we calculate the underwriter"s reputation as follows:

$$\text{Underwiter's reputation} = \text{Ln}\,(1 + \text{Underwriter's market share})$$

Also, for the sake of easier interpretation, we assign each underwriter a rank, with 1 being the highest, based on his respective market share. Carter et al. (1998) argue that an underwriter"s reputation provides a credible ex-ante uncertainty signal to new investors about the quality of the issue and its embedded risk. Higher-ranked underwriters should therefore underwrite higher-quality issues with eventually lower underpricing levels[3].

Habib and Ljungqvist (2001) argue that company insiders selling their shares in an IPO implicitly provide an unfavourable signal to new investors, which increases ex-ante uncertainty of the IPO. Consequently, as they suggest, there should be an inverse relationship between insider sales and the first-day return. In our research, we would like to test two distinct features of the presence of insider sales in an IPO – whether the fact of insider sales alone provides such an unfavourable signal to investors, or the volume of insider sales is also important factor. For this reason, we construct *"No insider sales" dummy* encoded as 1 if no secondary shares were sold in an IPO and 0 otherwise. Then, for companies with non-zero insider sales (dummy variable equal to 0), we construct the *Volume of insider sales* variable as a percentage of secondary shares (shares previously owned by insiders and sold in an IPO) as of total primary and secondary shares sold in an IPO. We also logarithmically transform it[4].

[2] In our calculations we implicitly assume that underwriter"s market share has not changed during the period concerned. In general, this assumption holds in our sample: underwriters with high market share in the past also have a high market share in the future.

[3] Another explanation for decreased underpricing may arguably be that highly ranked underwriters are better skilled at pricing IPOs, and other things equal, are able to secure larger proceeds to firms

[4] In the pilot study, *Ln (Volume of insider sales)* was not a significant variable in both the single regression model, and multivariate regression model with firm, issue characteristics and market conditions as explanatory variables, and first-day return as a dependent variable. On the contrary, *"No insider sales" dummy* had significant explanatory power. We conclude that in Norwegian IPOs, the fact of insider sales alone constitutes an unfavourable signal and increases the first-day return, but the volume of insider sales seems to have no significant impact on underpricing. To make our regressions more parsimonious, we exclude *Ln (Volume of insider sales)* from the analysis hereafter.

Market conditions

Ritter (1984), Ibbotson et al. (1994), Benveniste et al. (2003) all find that recent market conditions prior to an IPO affect the level of underpricing associated with the issue. Further, Derrien and Womack (2003) in their study of French IPOs also find that recent market conditions significantly affect the variability of first-day return. To capture market conditions prior to a listing date, we construct market return and volatility variables.

In order to benchmark market conditions, we use price series of Oslo Stock Exchange All-share Index (OSEAX). It is a value-weighted market index that consists of all shares listed on Exchange and is adjusted for corporate actions (e.g. dividends) daily. We assume log-distribution of returns and continuous compounding, and compute daily log-returns for each trading day. By convention, we also assume 252 trading days in a year. Then, for each IPO in the sample, we use daily returns to construct *Market return* variable as three-month-weighted average buy-and-hold return prior to an IPO[5]. We hypothesize that investors take into account market return in three months prior to an IPO (or 21*3=63 trading days), but they care more about returns in more recent months. For this reason, we assign weight of 3 to the most recent month (or most recent 21 trading days), and weights of 2 and 1 to the second and third next months prior to an IPO, respectively. We then divide the computed weighted sum by 6 to obtain a measure of return in monthly terms. *Market volatility* variable is computed as a standard deviation of daily log-return over 21 trading days prior to a listing date[6].

Pricing mechanism dummy variable

For each IPO in the sample, this variable is coded 1 if book-building as a pricing mechanism was used in an IPO and 0 if the fixed-price method was employed. This variable is by far of the highest interest to us, since it is used to investigate whether underpricing or variance of underpricing across book-building and fixed-price IPOs differs significantly after controlling for all the covariates mentioned above.

After having discussed the variables used in the research, we continue with the description of its stages and corresponding models.

[5] In the pilot study, we also explored three other lengths of the pre-offering period, in which market conditions could possibly affect first-day returns (in particular, 1-week, 1-month, non-weighted 3-months). We chose to proceed with the one in which market conditions had the most significant impact on underpricing

[6] Since we are averse to underestimating market volatility, we calculate the corrected sample standard deviation (Bessel's correction).

4.3. Stages of the empirical research and models

Stage I. Investigation of differences between book-building and fixed-price IPOs

In order to study the differences between book-building and fixed-price IPO firms and their respective issues, we will examine and compare the descriptive statistics of the subsamples of fixed-price and book-building IPOs based on variables, outlined in the previous section. Among others, mean and median levels of first-day return, as well as its variability, in book-building and fixed-priced IPOs will be computed and statistically compared.

On this stage (and throughout the paper), we employ a number of statistical tests. To test whether the subsample means are different, we firstly perform Levene"s test for equality of variances. Then, depending on the test results, we perform either Two-tail t-test assuming equal variances (if we find that variances are equal) or Two-tail t-test assuming unequal variances otherwise. To compare medians across subsamples, we use Non-parametric median test. Finally, to compare proportions expressed as percentages, Chi-squared test is performed. Significances of corresponding tests will be indicated in the tables.

Stage II. Analysis of cross-sectional differences in the level and variability of underpricing in the subsamples of book-building and fixed-price IPOs

After having examined the differences between fixed-price and book-building IPOs, we further investigate whether there are any cross-sectional differences with respect to the level and variability of underpricing within the cross-sections of fixed-price and book-building IPOs individually. We will split the subsamples into subgroups based on pre-defined criteria (e.g., market capitalization >= median versus market capitalization < median, or high-tech versus non-high-tech firms). Each IPO in the subsample is next placed into one of these subgroups. Then, the mean first-day return and mean variance of first-day return in subgroups are computed and statistically compared.

Stage III. Regression analysis

On this stage, we run a set of multivariate regression models. We firstly investigate and compare the relationships between underpricing, variability of underpricing and suggested firm, issue and market conditions variables, on the subsamples of book-building and fixed-price IPO separately. We run the following multivariate regression models:

(Set of models #1)

$$\text{First\_day\_return}_i = \beta_0 + \beta_1 \text{Ln(Market\_capitalization)}_i + \beta_2 \text{High\_tech\_dummy}_i + \beta_3 \text{Ln(Book\_to\_market\_ratio)}_i + \beta_4 \text{Venture\_capital\_backed\_dummy}_i + \beta_5 \text{Age} + \beta_6 \text{No\_insider\_sales\_dummy} + \beta_7 \text{Ln(Underwriter\_market\_share)}_i + \beta_8 \text{Ln(Issue\_size)}_i + \beta_9 \text{Market\_return}_i + \beta_{10} \text{Market\_volatility}_i + \epsilon_i$$

(Also, two more regressions with the same set of independent variables, but with *Unconditional variance of first-day return* and *Conditional variance of first-day return* as dependent variables)

Then, we proceed with by far the most important part of our research. In order to provide evidence whether the level and/or variability of underpricing differs between the fixed-price and book-building IPOs *after* controlling for the likely effects of the characteristics of the firm, the issue, and previous market conditions, we use a dummy variable approach. We run regressions on the *joint* sample of fixed-price and book-building IPOs with a pricing mechanism dummy and a set of controls as independent variables. The regression models are as follows:

(Set of models #2)

$$\text{First\_day\_return}_i = \beta_0 + \sum_{j=1}^{10} \beta_j (firm, issue, market\ conditions\ var.) + \beta_{11} \text{Pricing\_mechanism\_dummy}_i + \epsilon_i$$

(Also, two more regressions with the same set of independent variables, but with *Unconditional variance of first-day return* and *Conditional variance of first-day return* as dependent variables)

After having performed the main part of the analysis, we will then test whether there is a differential impact of market conditions on first-day return level and variability in book-building and fixed-price IPOs. We do it by splitting market return and volatility variables by the pricing procedure. As Derrien and Womack (2003), we multiply market return and volatility variables by corresponding procedure dummies to construct four new variables. The following regression models on the joint sample are constructed (*Book_building* = 1 for book-building and *Fixed_price* = 1 for fixed-price mechanism, and 0 otherwise):

(Set of models # 3)

$$\text{First\_day\_return}_i = \beta_0 + \sum_{j=1}^{8} \beta_j (firm, issue\ var.)$$
$$+\beta_9 \text{Pricing\_mechanism\_dummy}_i +$$
$$+\beta_{10} \text{Market\_return*Book\_building}_i + \beta_{11} \text{Market\_return*Fixed-price}_i$$
$$+\beta_{12} \text{Market\_volatility*Book\_building}_i + \beta_{13} \text{Market\_volatility*Fixed-price}_i + \epsilon_i$$

(Also, two more regressions with the same set of independent variables, but with *Unconditional variance of first-day return* and *Conditional variance of first-day return* as dependent variables)

Stage IV. Implementation of the pricing mechanism choice endogeneity

As Habib and Ljungqvist (2001) argue, the findings from regression analysis with a pricing mechanism dummy (in particular, the set of models #3 in our case) may be possibly biased if a pricing mechanism choice is endogenous. Thus, on this stage we will test and implement the endogeneity of the pricing mechanism choice, following the methodology of Jenkinson, Ljungqvist and Wilhelm (2001) and Derrien and Womack (2003).

We will employ the two-stage least squares procedure. On the first stage, we will use variables, exogenous with respect to underpricing (the ones that turned out to be insignificant determinants of underpricing in the set of models #3) as predictor variables in the multinomial logistic model with a pricing mechanism dummy as a dependent variable. We will then use the obtained logistic regression model coefficients to predict the probabilities of choosing book-building (versus fixed-price) for each IPO in the sample.

Next, in the second stage regressions, we substitute the pricing mechanism dummy variable in the set of models #3 with the predicted probabilities from first-stage logistic regression and run the same set of models. This will allow us to check whether our findings still hold after the implementation of endogenous pricing mechanism choice.

Having controlled for endogeneity, we additionally explore whether other firm or issue characteristics variables (not used on the first stage in the two-stage least squares model above) may also determine the choice of the procedure in Norwegian IPOs. We therefore run an extra multinomial logistic regression model

with the pricing mechanism dummy as a dependent variable, and these variables as predictor covariates.

Stage V. Analysis of first-day return differences in "hot" versus "cold" markets

Since the common variable that supposedly has an impact on first-day return in fixed-price and book-building IPOs is market return prior to a listing date, we will complete the empirical analysis with the study of first-day return differences in various market conditions, particularly "hot" versus "cold" markets.

For every trading day from January 1, 1993 through December 31, 2008, we compute a series of three-month-weighted buy-and-hold previous market returns, ending on this day, and rank it in an ascending order. Next, the obtained series is divided into quintiles of approximately the same number of market return observations. We then assign every IPO in the sample into one of the market "hotness" quintiles, with first being the "coldest" one, and fifth being the "hottest". The impact of "hot" versus "cold" markets is then analysed in terms of computed average first-day return levels and the number of IPOs in each quintile, also splitting by the pricing mechanism.

4.3. Testing the reliability of regression results

In the major part of the empirical research, the regression analysis is carried-out. To make sure that obtained results are reliable, we test whether assumptions of the OLS procedure are met. The key tests we perform will be briefly outlined here.

Each regression model is firstly tested for heteroskedasticity using White"s heteroskedasticity test. In the presence of heteroskedasticity, White"s algorithm is applied to obtain corrected standard errors, which results in more conservative hypothesis testing. However, as we have noticed, reporting heteroskedasticity-consistent standard errors and t-statistics has become a matter of routine in econometrics and finance. We therefore at all times report heteroskedasticity-consistent t-statistics throughout the paper.

Next, as we carry-out the regression analysis on the cross-sectional data without any time component, we perform no profound testing for serial correlation. Nevertheless, we are aware that autocorrelation may occur as a result of spatial ordering of observations in the sample.

We further examine bivariate correlations between independent variables to detect a possible multicollinearity issue in regressions. The Correlations matrix in Appendix 9.3 indicates that, as expected, high bivariate correlation of 0.736 exists between variables Ln (Issue size) and Ln (Market capitalization). In the pilot study, we ran regressions with either of them, and found that our results are neither qualitatively nor quantitatively affected. Further, we also computed variance inflation factors to assess the extent of possible multicollinearity. No severe multicollinearity has been found in regressions. Thus, in order to avoid the omitted variable bias, we include both of them in our models.

Finally, we perform Jarque-Bera normality test to assess the distribution of residuals. Even though we have applied logarithmic transformation to several variables in order to deal with large positive skewness, in the pilot study we had to reject the null hypothesis of normality at 5% level. Other data-mining techniques (e.g. excluding outliers in the sample) might only artificially improve the overall model fit. Therefore, we decide to proceed with our analysis by taking into account the fact that non-strict normality of residuals might have an effect on regression estimates.

Having described the methodology, we will present the data used in the next section.

5. Data

We begin this section with the presentation of sample selection process and the descriptive statistics of the subsamples of book-building and fixed-price IPOs, as well as the whole sample. Then, time trends in IPO activity and underpricing will be examined. Finally, we will explore the cross-sectional differences in underpricing and its variability in book-building and fixed-price IPOs.

5.1. Sample selection

For the purpose of the current research, we construct a sample of Norwegian fixed-price and book-building initial public offerings. Our primary sources of data are a dataset of equity offerings on Oslo Stock Exchange and corresponding prospectuses that contain information on firm and issue characteristics (both kindly provided by the Department of Financial Economics at BI Norwegian Business School). The database in question contains 587 equity offerings from January 1, 1993 to December 31, 2008. *Table 1* provides an overview of the sample selection process.

Table 1 Sample selection process

	No. of issues
Initial dataset	587
Excl. secondary, tertiary offerings etc.	163
Excl. employee offerings, mergers, private placements etc.	183
Excl. cross-listed, OTC traded offerings etc.	33
Excl. issues where pricing mechanism is unspecified	36
Excl. offerings that dropped	2
Excl. issues with missing and non-recoverable data	4
Final sample	**166**

From the initial dataset of 587 offerings, we firstly exclude issues that are not initial (e.g. secondary, tertiary offerings etc., 163 issues in total), and then issues that are not public offerings (e.g. employee offerings, mergers, private placements etc., 183 issues in total). We further eliminate IPOs that were priced by methods, other than the fixed-price mechanism or book-building (as well as cross-listed, OTC traded IPOs because these issues already have market valuation prior to an IPO; 33 issues in total). Then, 36 issues were excluded since the pricing method used in them was not specified. We also eliminate 2 offerings that

eventually dropped. And lastly, we exclude 4 issues for which data was significantly missing and could not be recovered due to missing prospectuses.

In effect, we will analyse 166 Norwegian equity offerings, initially listed on Oslo Stock Exchange during the period from January 1, 1993 to December 31, 2008, priced by means of the fixed-price mechanism (79 issues) and book-building (87 issues)[7].

From the IPO dataset and prospectuses, we collect the following information on company and issue characteristics: age of the company, industry, venture-capital backing, book value of equity, number of shares created in an IPO, number of secondary shares sold in an IPO, total number of outstanding shares, fraction of company sold, identity of the lead underwriter, offer price and closing price on the first day of trading etc., which we use to construct the variables, discussed in previous section. The market data (OSEAX index price series for the period from 1993 to 2008) is obtained from Thomson Reuters Datastream database.

5.2. Descriptive statistics

In order to summarize the data and compare a typical book-building and fixed-price IPO, we present the descriptive statistics of IPOs in our sample in *Table 2*. Columns 3 and 4 provide values for book-building and fixed-price IPOs, respectively, while column 5 indicates the significance level of statistical difference between them. One may notice that means are considerably higher than medians for some of the variables[8]. We will therefore mostly use median measures to describe a typical firm in the sample.

As *Table 2* shows, there are comparable numbers of book-building and fixed-price IPOs (87 and 79, respectively) in the sample. Our typical book-building IPO firm has larger market size than a fixed-price IPO firm. It has market capitalization at IPO date of roughly 1,071 million NOK, which is significantly higher (at 1% level) than the market size of the fixed-price IPO firm of 344

[7] Not surprisingly, the final sample size is smaller than the one used by Derrien and Womack (2003) in their study of *three* IPO pricing mechanisms in France (258 offerings). Nonetheless, we study *two* pricing methods and believe that our sample size is still sufficiently large to provide sound results.

[8] Means that are considerably higher than corresponding medians suggest a positively skewed distribution. For instance, mean market capitalization of the book-building IPO firm is ca. 5,072 million NOK, while median firm has market capitalization of only 1,071 million NOK. This difference comes from the fact that the sample contains several "outlier" firms with extremely high market size.

million NOK. Also, there are different fractions of high-tech firms across book-building and fixed-price IPOs. In the subsample of book-building IPOs, there are about 17% of high-tech firms, while in the fixed-price IPOs subsample there are only 13% of high-tech firms. Yet, these fractions are not significantly different from each other at any conventional significance level.

Table 2 Descriptive statistics of the sample of 166 Norwegian IPOs: 87 book-building, 79 fixed-price IPOs from January 1, 1993 to December 31, 2008

Measure		Book-building	Fixed-price	Diff. test p-value	All IPOs
No. of issues		87	79	n/a	166
Market capitalization (millions of NOK)	Mean	5,071.9	553.6	**0.025****	2,921.6
	Median	1,071.1	344.2	**0.000*****	623.3
% of high-tech firms		17.2%	12.7%	0.410	15.1%
Book-to-market ratio	Mean	0.45	0.99	**0.000*****	0.70
	Median	0.41	0.50	0.214	0.45
% of venture capital-backed firms		29.9%	6.3%	**0.000*****	18.7%
Age of firm at IPO date (years)	Mean	24	39	**0.035****	31
	Median	8	15	**0.032****	10
% of firms offering secondary shares		60.9%	44.3%	**0.032****	53.0%
% of secondary shares of total offered [a]	Mean	51.3%	67.4%	**0.024****	57.7%
	Median	50.0%	65.8%	0.384	51.6%
Rank of issuing firm's underwriter	Mean	5	9	**0.000*****	7
	Median	4	8	**0.000*****	5
Gross proceeds (millions of NOK)	Mean	1,108.0	187.8	**0.012****	670.1
	Median	288.1	95.0	**0.000*****	156.2
First-day return (underpricing)	Mean	3.36%	5.84%	0.278	4.54%
	Std Dev	12.15%	16.54%	**0.026****	14.45%
	Median	1.41%	1.25%	1.000	1.28%
	Max	60.94%	53.85%	n/a	60.94%
	Min	-30.00%	-34.21%	n/a	-34.21%
	Range	90.94%	88.06%	n/a	95.15%
	% positive	51.72%	53.16%	0.853	52.41%
Wealth lost by issuing firm (millions NOK)	Mean	45.4	6.2	0.140	26.7
	Median	0.3	0.5	1.000	0.4
Market return prior to IPO	Mean	1.57%	0.48%	**0.025****	1.05%
	Median	2.17%	0.91%	0.214	1.58%
Mean volatility prior to IPO	Mean	1.13%	0.96%	**0.010*****	1.05%
	Median	1.00%	0.90%	**0.030****	0.95%

*, **, *** indicate significance at 10%, 5%, and 1% level, respectively

[a] in the subsample of firms which sell a non-zero value of secondary shares in an IPO

We also observe from *Table 2* that a typical book-building and fixed-price IPO firms have comparable and not significantly different book-to-market ratios (0.41 and 0.50 for book-building and fixed-price IPOs, respectively). There is, however, significantly higher fraction of venture capital-backed firms in the subsample of book-building IPOs (29.9%) than in fixed-price IPOs (6.3%). The age of a company at IPO date clearly indicates that fixed-price IPO firms are significantly older than book-building IPO companies. Age of a typical firm at IPO date using book-building as a pricing method is 8 years, while typical firm going public and using fixed-price method is 15 years old.

In *Table 2* we also note that around 44% of fixed-price IPO firms offer secondary shares (shares that are owned by insiders and sold in an IPO), whereas almost 61% of firms offer secondary shares in book-building IPOs. Further, if a firm does offer secondary shares, it on average offers around 67% of them as of total shares offered in fixed-priced IPOs, and ca. 51% in book-building IPOs (significantly different at 5% level). Underwriter"s rank of a typical book-building IPO firm is 4 (1 being the highest rank), while the underwriter"s rank is significantly lower for a median firm using fixed-price method – 8. Median book-building IPO also has larger gross proceeds, or issue size, of around 288 million NOK than a typical fixed-price IPO with gross proceeds of only 95 million NOK.

Table 2 also shows that the average underpricing in the whole sample is around 4.5%. Average first-day return of 3.36% for book-building IPOs is lower than the one for fixed-price IPOs of 5.84%[9]. The median book-building IPO underpricing of 1.41% is, however, higher than a median underpricing across fixed-price IPOs of 1.25%. Even though these numbers are different in the sample, we found no statistical reasons to believe that they are different in population (corresponding difference tests are insignificant at any convention levels of significance). Also, both book-building and fixed-price IPOs have a very similar range of the first-day return of around 88-91%, and the percentage of positive first-day returns of ca. 52-53%. In contrast, we found that fixed-price IPOs are associated with a significantly higher (at 5% significance level) standard

[9] Average underpricing of Norwegian IPOs of 4.5%, as well as ca. 3.4% and 5.8% for book-building and fixed-price mechanisms separately, are lower numbers than the ones, provided in Loughran, Ritter and Rydqvist (1994), who find average levels of underpricing of 12% and 27%, for book-building and fixed-price IPOs, correspondingly. This may be due to the fact that our sample contains only book-building and fixed-price IPOs, that are on average less underpriced than other issues, a larger time-span of the sample, that includes periods of low overall market returns, or arguably lower underpricing in Norwegian IPO market in general

deviation of underpricing than book-building IPOs (16.54% versus 12.15%, for fixed-price and book-building IPOs, correspondingly).

Average wealth lost by an issuing firm measures loss of funds in NOK terms due to underpricing by taking into account the issue size or gross proceeds of the IPO. Typical fixed-priced IPO firm "left money on the table" amounting to 0.5 million NOK, while book-building IPO firm had lower median wealth loss of 0.3 million NOK. Yet, these numbers are not significantly different.

Lastly, as *Table 2* suggest, book-building and fixed-price IPO firms go public in significantly different market conditions. Average book-building IPO is associated with the higher three-month-weighted market return prior to an IPO date of 1.57% and higher volatility of daily market return in a month prior to a listing date of 1.13%. Fixed-price IPOs have mean return and volatility equal to 0.48% and 0.96%, correspondingly.

In sum, a typical book-building IPO firm, when compared to a fixed-price IPO firm, has larger market capitalization at IPO date, higher probability of being venture capital-backed, is younger, has a higher probability of being the one that offers secondary shares in an IPO, has an underwriter with a higher rank, larger issue size/gross proceeds of an IPO, and goes public in conditions with a higher market return and volatility prior to a listing date. Additionally, the book-building mechanism is also associated with the lower standard deviation of underpricing. In contrast, typical book-building and fixed-priced IPO firms are indifferent with respect to the probability of being a high-tech firm, fraction of secondary shares as of total offered in an IPO (conditional on offering secondary shares at all), or the unconditional level of underpricing and "money left on the table" as a result of it.

The important finding is, however, that even though unconditional underpricing of book-building and fixed-price IPOs is not statistically different, a lower mean and standard deviation of the first-day return of book-building IPOs are better distributional characteristics. This indicates that the book-building mechanism might be perceived to have a lower risk with respect to pricing than the fixed-price mechanism from issuing firm"s perspective.

5.3. Time trends in IPO activity and underpricing

Table 3 illustrates the distribution of IPOs and average underpricing by year. For the reference purposes, general market conditions are provided in columns 2 and 3. Market return is calculated as an annual buy-and-hold log-return

on the OSEAX daily stock price index, while market volatility is measured as the standard deviation of the daily log-return in the corresponding year.

Firstly, high IPO activity, as measured by the number of IPOs, seems to occur in years with a high market return. For instance, in the period from 2003 to 2007 when markets provided high returns, there were 78 IPOs, or ca. 47% of all IPOs in our sample. In contrast, in years with negative markets returns (i.e. 2001-2002, and 2008) there were only 5, 2 and 6 IPOs, respectively. This is consistent with the time-clustering of IPOs in Ritter (1984), and the fact that firms prefer going public in "hot" markets (Derrien and Womack, 2003). On the contrary, it seems that volatility in overall market is a less important factor in triggering decisions of going public. A logical explanation, suggested by Derrien and Womack (2003), is that while the higher market return entails higher attainable valuations for perspective IPOs, higher volatility is associated with a more risky environment for going public.

Table 3 Market conditions, number and initial return levels of Norwegian fixed-price and book-building IPOs from January 1, 1993 to December 31, 2008 by year

	Market conditions		All IPOs		Book-building IPOs		Fixed-price IPOs	
Year	Return	Volatility	#	Mean first-day return	#	Mean first-day return	#	Mean first-day return
1993	50.7%	1.0%	7	1.6%	1	6.7%	6	0.8%
1994	6.7%	0.8%	10	4.2%	0	n/a	10	4.2%
1995	10.4%	0.7%	10	4.6%	2	11.6%	8	2.9%
1996	23.5%	0.6%	6	21.9%	1	3.8%	5	25.6%
1997	25.6%	1.0%	15	20.1%	1	31.5%	14	19.3%
1998	-33.0%	1.6%	10	-2.0%	0	n/a	10	-2.0%
1999	41.3%	1.0%	4	18.7%	1	13.9%	3	20.3%
2000	0.9%	1.2%	11	4.3%	7	13.9%	4	-12.4%
2001	-14.0%	1.2%	5	-6.0%	4	-7.1%	1	-1.3%
2002	-29.1%	1.3%	2	-9.8%	1	-19.6%	1	0.0%
2003	39.2%	0.9%	2	-2.3%	2	-2.3%	0	n/a
2004	33.5%	0.9%	11	3.9%	9	3.8%	2	4.2%
2005	41.7%	1.1%	23	2.6%	23	2.6%	0	n/a
2006	28.5%	1.5%	17	3.6%	14	4.1%	3	1.4%
2007	12.6%	1.2%	27	1.6%	19	1.1%	8	2.9%
2008	-74.6%	2.9%	6	-5.8%	2	-1.5%	4	-8.1%
Total	**163.8%**	**1.3%**	**166**	**4.5%**	**87**	**3.4%**	**79**	**5.8%**

Also, as expected, average first-day return levels are positively associated with market "hotness". For example, in the period of 1996-1997, markets provided return of around 24-26% annually, and mean underpricing was around 20-22% – the highest in the sample. Investors in Norwegian IPOs seem to require more underpricing when the market as a whole provides higher returns (consistent with Derrien and Womack, 2003). Lastly, even though both methods were used during the whole period concerned, the fixed-price mechanism dominated book-building by the number of IPOs in 90s. From early 2000s, however, the number of book-building issues grows rapidly, and the fixed-price mechanism seems to lose its popularity. For instance, there were 60 fixed-price offerings from 1993 to 2000, or 76% of all fixed-price IPOs in our sample. In the same time period, only 13 firms used book-building as a pricing method. On the contrary, in the period of 2001-2008, there were 74 book-building IPOs (or 85% of all book-building IPOs in the sample), and only 19 fixed-price IPOs. Hypothetically, this might be explained by a trend towards use of the more efficient book-building pricing mechanism in IPOs. We will further examine whether book-building is actually more efficient.

5.4. Cross-sectional differences in the level and variability of underpricing

In this subsection, we analyse the cross-sectional differences in the level and variability of underpricing by splitting the subsamples of Norwegian book-building and fixed-price IPOs into different criteria-determined subgroups (listed in column 1 of *Tables 4 and 5*).

Fixed-price IPOs

Table 4 presents the cross-sectional differences in the subsample of fixed-price IPOs. Column 3 provides values of mean first-day return, while column 4 – variance of first-day return.

The average first-day return for fixed-price IPOs with above-median book-to-market ratio of 2.24% is significantly lower (at 5% level) than 9.53% first-day return for IPO firms with below-median book-to-market ratio. This is in line with the finding of Brav and Gompers (2000) that companies with lower book-to-market ratios are the ones with higher informational asymmetries, which results in higher underpricing levels.

Further, fixed-price IPO firms that offer secondary shares have significantly higher (at 1% level) mean underpricing of 12.14% than firms which

do not sell secondary shares (0.82%). This finding is consistent with Habib and Ljungqvist (2001). We infer that insider sales constitute a negative signal to investors in Norwegian fixed-price IPOs as well.

Table 4 Cross-sectional differences in the level and variability of underpricing in the subsample of Norwegian fixed-price IPOs

	N	Mean first-day return	Variance of first-day return
Market capitalization >= Median	40	4.25%	2.14%
Market capitalization < Median	39	7.46%	3.28%
p-value		0.394	0.316
High-tech	10	20.66%	10.64%
Non-high-tech	69	3.69%	1.55%
p-value		0.117	**0.011****
Book-to-market >= Median	40	2.24%	2.28%
Book-to-market < Median	39	9.53%	3.14%
p=value		**0.050****	0.453
Venture capital-backed	5	-0.76%	1.71%
Non-venture capital-backed	74	6.28%	2.77%
p-value		0.291	0.414
Age >= Median	41	7.74%	1.91%
Age < Median	38	3.78%	3.56%
p-value		0.297	0.158
Offering secondary shares	35	12.14%	3.68%
Not offering secondary shares	44	0.82%	1.93%
p-value		**0.003*****	0.152
% of secondary shares >= Median	18	12.21%	3.06%
% of secondary shares < Median	17	12.07%	4.32%
p-value		0.982	0.571
Underwriter rank >= Median	40	2.27%	2.63%
Underwriter rank < Median	39	9.50%	2.78%
p-value		**0.052***	0.899
Issue size >= Median	40	4.47%	2.12%
Issue size < Median	39	7.24%	3.30%
p-value		0.461	0.301
Market return prior IPO >= Median	40	11.10%	4.03%
Market return prior IPO < Median	39	0.44%	1.34%
p-value		**0.004*****	**0.017****
Market volatility prior IPO >= Median	40	2.91%	2.26%
Market volatility prior IPO < Median	39	8.84%	3.16%
p-value		0.112	0.427

*, **, *** indicate significance at 10%, 5%, and 1% level, respectively

Also, firms with an above-median underwriter rank have significantly lower initial return of 2.27% than those firms with the underwriter ranked below median (9.50%). We therefore conclude that Norwegian underwriters also provide a valuable ex-ante uncertainty signal, as Carter et al. (1998) find. We also note that higher-ranked underwriters may be better at pricing IPO shares, for instance, due to their superior experience or better skills.

Lastly, when a 3-month-weighted market return prior to an IPO is above median in the sample, fixed-price IPOs exhibit a significantly higher level of underpricing of 11.10%, compared to the firms that went public in conditions with a below-median market return prior to a listing date (mean first-day return of 0.44%). This finding is consistent with Derrien and Womack (2003), who argue that the previous market return has a large and positive impact on the level of the first-day return.

In contrast, no statistically significant cross-sectional differences in the first-day return were found between subgroups of fixed-price IPO firms with above and below median market capitalization, age, percentage of secondary shares offered, and the issue size. Likewise, the first-day return is not statistically different between high-tech and non-high-tech, venture capital-backed and non-venture capital-backed firms. In addition, splitting by the second measure of market conditions prior to an IPO – market volatility of daily return in a month prior to an IPO – does not provide evidence of different underpricing.

By examining the last column of *Table 4*, we find that high-tech firms have a significantly higher variance of underpricing of 10.64% while non-high-tech have the variance of only 1.55% (as a matter of fact, even though not statistically different, high-tech firms also have dramatically higher mean level of underpricing of approximately 21% than non-high-tech companies with mean first-day return of ca. 4%). This finding may be attributed to the fact that high-tech firms are much harder to price due to high levels of informational asymmetries, which in turn increases the "imprecision" of pricing (particularly using fixed-price method). Then, the variance of the first-day return is significantly higher in IPOs that occurred in conditions with above-median market return (4.03%), while below-median market-return IPOs have the variance of only 1.34% (consistent with finding of Derrien and Womack (2003) that market conditions not only have an impact on the level of underpricing, but as well on its variability). In contrast, no evidence has been found that the variance of

underpricing differs significantly when one splits the sample of fixed-price IPOs across other variables.

Having analysed the subsample of fixed-price IPOs, we conclude this section with the overview of cross-sectional differences in the level and variability of the first-day return in book-building IPOs, which is presented in *Table 5*.

Book-building IPOs

Table 5 Cross-sectional differences in the level and variability of underpricing in the subsample of Norwegian book-building IPOs

	N	Mean first-day return	Mean Squared Deviation of first-day return
Market capitalization >= Median	44	6.56%	1.65%
Market capitalization < Median	43	0.08%	1.30%
p-value		**0.012****	0.686
High-tech	15	0.99%	1.14%
Non-high-tech	72	3.85%	1.54%
p-value		0.372	0.542
Book-to-market >= Median	44	1.55%	1.31%
Book-to-market < Median	43	5.21%	1.64%
p-value		0.164	0.707
Venture capital-backed	26	4.06%	2.08%
Non-venture capital-backed	61	3.06%	1.22%
p-value		0.757	0.517
Age >= Median	45	4.14%	1.33%
Age < Median	42	2.52%	1.63%
p-value		0.542	0.740
Offering secondary shares	53	3.35%	1.51%
Not offering secondary shares	34	3.38%	1.42%
p-value		0.991	0.926
% of secondary shares >= Median	27	4.35%	1.36%
% of secondary shares < Median	26	2.31%	1.67%
p-value		0.556	0.683
Underwriter rank >= Median	57	3.24%	0.91%
Underwriter rank < Median	30	3.59%	2.54%
p-value		0.914	0.184
Issue size >= Median	44	5.71%	2.04%
Issue size < Median	43	0.95%	0.90%
p-value		**0.068***	0.192
Market return prior IPO >= Median	44	5.43%	2.17%
Market return prior IPO < Median	43	1.24%	0.76%
p-value		0.109	0.108
Market volatility prior IPO >= Median	44	2.74%	1.60%
Market volatility prior IPO < Median	43	4.00%	1.34%
p-value		0.633	0.769

*, **, *** indicate significance at 10%, 5%, and 1% level, respectively

The main findings from *Table 5* are that, firstly, first-day return of 6.56% is statistically higher in book-building IPOs with above-median market capitalization, than in IPOs with below-median market size of 0.08%. Further, offerings with above-median issue size also have statistically higher underpricing of 5.71%, while mean underpricing in below-median issue size offerings is only 0.95%. These findings are contradicting the studies of Beatty and Ritter (1986) and Ibbotson et al. (1994) who claim that a higher issue size entails lower ex-ante uncertainty, and subsequently lower underpricing. Additionally, as was noted before, companies with higher market capitalization gain higher analyst coverage during their IPOs, which should also decrease informational asymmetries, and consequently underpricing.

However, we take notice that these are unconditional differences. We believe that investigation of the impact of issue size on underpricing is more sensible when one controls for the market size first. Therefore, we expect the regression analysis in the next section to shed more light on these unexpected findings.

To conclude, no other cross-sectional differences in the level of first-day return are statistically significant. Likewise, no significant differences in the variance of first-day return in book-building IPOs have been found at this point. In sum, with the exception of market size and issue size in book-building IPOs, our findings in the cross-sectional analysis are consistent with previous studies.

We now proceed with a more formal empirical analysis in the next section.

6. Empirical evidence

In this section, the results of regression analyses will be presented and related to previous studies. We firstly investigate and compare the relationships between firm, issue characteristics, market conditions and underpricing in book-building and fixed-price IPOs. We will then use a pricing mechanism dummy variable approach in regressions to robustly compare the level and variability of underpricing across book-building and fixed-price mechanisms *after* controlling for the known effects of the above-mentioned variables. Next, the differential impact of market conditions on the level and variability of underpricing is analysed and endogeneity of the pricing mechanism choice is implemented. We conclude this section with the investigation of the pricing mechanism choice determinants, and analysis of underpricing in different market "hotness" conditions.

6.1. Analysis and comparison of factors explaining first-day return levels in book-building and fixed-price IPOs

In this subsection, individual company's first-day return levels are regressed upon a set of firm, issue, and market conditions variables, suggested by previous studies and outlined in section 4. *Table 6* presents the results of regression models with *First-day return* as a dependent variable, on the subsamples of book-building and fixed-price IPOs separately.

As *Table 6* suggest, rather different set of factors is significantly related to first-day returns in book-building and fixed-price IPOs. Other things equal, firms with larger market capitalization have significantly higher (at 1% level) underpricing in book-building IPOs. In contrast, market capitalization is not significantly related to underpricing in fixed-price IPOs. Seemingly, Norwegian book-building IPO firms with larger market capitalization are either not perceived to be less ex-ante uncertain, or there are other stronger forces that outweigh the decreased underpricing due to lower informational asymmetries common in large market size companies. One of the plausible explanations of positive relation between the market size and level of underpricing in book-building IPOs may be the fact that such firms attract a higher number of potential investors. In turn, investors, who have not been allocated shares during the course of book-building, actively trade in the aftermarket to satisfy their demand through acquiring shares. Subsequently, this may drive the prices up, and lead to higher first-day return

levels. Even though we cannot claim that this is an exhaustive reason behind a positive relationship between a market size and underpricing, we accept it as a reasonable explanation of this finding.

Table 6 Determinants of the first-day return level in Norwegian book-building and fixed-price IPOs from January, 1993 to December, 2008

Subsample	Book-building IPOs	Fixed-price IPOs
Dependent variable	First-day return	First-day return
Intercept	-0.663 **(-2.390)****	0.122 (0.398)
Ln (Market capitalization)	0.053 **(3.353)*****	0.015 (0.911)
High-tech dummy	-0.028 (-0.929)	0.148 **(2.026)****
Ln (Book-to-market ratio)	0.018 **(2.055)****	-0.026 **(-2.446)****
Venture capital-backed dummy	0.018 (0.508)	-0.123 (-1.493)
Age of firm	0.000 (-0.262)	0.001 **(3.090)*****
"No insider sales" dummy	-0.003 (-0.096)	-0.066 **(-2.229)****
Ln (Underwriter market share)	-0.158 (-1.247)	-0.331 **(-1.785)***
Ln (Issue size)	-0.022 **(-1.741)***	-0.019 (-1.429)
Market return (3-month-weighted monthly return)	1.416 **(2.248)****	0.913 (1.656)
Market volatility (monthly volatility of daily return)	3.300 (0.851)	-3.601 (-0.914)
N	87	79
Adjusted R Squared	**0.113**	**0.355**
F-value	2.094	5.293
p-value	0.035	0.000

White heteroskedasticity-consistent t-statistics are given in parentheses
*, **, *** indicate significance at 10%, 5%, and 1% level, respectively

As *Table 6* also suggests, while the high-tech dummy is insignificant in book-building regression, high-tech firms have significantly higher underpricing in fixed-price IPOs (dummy variable coefficient is significant at 5% level). Moreover, the economic significance is also extremely large: if a given firm is high-tech, it has on average 14.8% higher underpricing, ceteris paribus. We therefore infer that the book-building mechanism more efficiently deals with high

informational asymmetries, common in high-tech companies, by implementing them into the final offer price, than the fixed-price mechanism does.

Book-to-market ratio turns out to be a significant factor to explain the first-day return in both book-building and fixed-price IPOs, though the direction of its impact is different. Firms with higher book-to-market value tend to have on average lower underpricing if the fixed-price method is used to price IPO shares (consistent with the point of Brav and Gomper (2000) that the higher book-to-market value of equity is a proxy for the lower informational asymmetry). On the contrary, the higher book-to-market ratio is associated with higher underpricing if the book-building method is employed, other things equal.

The presence of venture capitalist does not significantly influence the level of underpricing in either book-building or fixed-price IPOs. Then, while age of a firm at IPO date does not have any significant impact on underpricing in book-building IPOs, older companies are more underpriced in fixed-price IPOs. However, in economic terms, the effect of the firm"s age is rather small: a 100 years increase in age increases underpricing by only 1%.

"No insider sales" dummy variable is insignificant in the book-building regression, while it enters significantly the fixed-price regression. The economic significance is rather large: those firms that do not offer secondary shares in the fixed-price IPO, have on average 6.6% lower first-day return, ceteris paribus. This finding provides evidence that insider sales do provide an unfavourable signal to investors (as Habib and Ljungqvist (2001) argue) in Norwegian fixed-price IPOs as well. By the same token, an underwriter"s reputation, as measured by his respective market share, does not significantly affect underpricing levels in book-building IPOs, whereas higher-ranked underwriters seem to be able to decrease the first-day return in fixed-price IPOs, which is consistent with argumentation of Carter et al. (1998) that higher-ranked underwriters should underwrite higher-quality issues with eventually lower underpricing levels.

As *Table 6* also indicates, issue size is not significantly related to underpricing in fixed-price IPOs, while it is significantly negatively associated with underpricing in book-building IPOs. We therefore find evidence that, for a given market size of the company, higher size issues are perceived to have lower ex-ante uncertainty from the perspective of investors in Norwegian book-building IPOs. This finding is in line with Beatty and Ritter (1986) and Ibbotson et al. (1994).

Lastly, market return prior to an IPO has a significant impact on underpricing in book-building IPOs. In economic terms, 1% increase in 3-month-weighted market return prior to an IPO increases the first-day return level on average by ca. 1.42%. In fixed-price IPOs, 1% increase in market return translates into 0.91% increase in underpricing (though only marginally significant at around 10% level). At this point, the book-building pricing mechanism appears to be more sensitive to previous market conditions than the fixed-price method. The second moment of market conditions – market volatility – does not have any significant impact on underpricing in either fixed-price or book-building IPOs subsamples. Yet, we will draw more robust conclusions about the differential impact of market conditions after carefully testing it at later stages of the analysis.

6.2. Analysis and comparison of factors explaining the unconditional variance of first-day return in book-building and fixed-price IPOs

Table 7 presents the results of regression models with *Squared deviation of first-day return* as a dependent variable, and a set of firm, issue characteristics and market conditions as explanatory variables, on the subsamples of book-building and fixed-price IPOs separately. *Squared deviation of first-day return* is a measure of unconditional variability of underpricing (without controlling for the likely effects of firm, issue characteristics and market conditions on underpricing).

As one may infer from *Table 7*, the explanatory power of book-building regression is rather small. As indicated by the insignificant F-test and near-zero Adjusted R-squared, independent variables do not jointly significantly explain the unconditional variability of underpricing in book-building IPOs. Nevertheless, two variables enter significantly the regression model. Book-building IPOs with a higher book-to-market ratio have on average a higher variability of first-day return. On the contrary, firms with higher-ranked underwriter exhibit a lower variability of underpricing, other things equal. This finding suggests that higher-ranked underwriters appear to be better skilled at pricing shares in book-building IPOs with higher precision.

The explanatory power of fixed-price regression (F-test significant at 1% level, and Adjusted R-squared equal to ca. 34%) is quite high (in contrast to book-building regression). This fact itself manifests that the unconditional variance of underpricing in fixed-price IPOs is more sensitive to our set of independent

variables. Thus, we assert that the fixed-price mechanism is less efficient in terms of pricing accuracy than the book-building mechanism.

Table 7 Determinants of the unconditional variability of first-day return in Norwegian book-building and fixed-price IPOs from January, 1993 to December, 2008

Subsample	Book-building IPOs	Fixed-price IPOs
Dependent variable	Squared deviation of first-day return	Squared deviation of first-day return
Intercept	-0.092 (-0.718)	0.048 (0.619)
Ln (Market capitalization)	0.005 (0.960)	0.001 (0.251)
High-tech dummy	-0.006 (-0.626)	0.092 **(3.157)*** **
Ln (Book-to-market ratio)	0.005 **(1.802)***	0.001 (0.429)
Venture capital-backed dummy	0.009 (0.574)	-0.037 **(-1.856)***
Age of firm	0.000 (-1.278)	0.000 (0.385)
"No insider sales" dummy	0.002 (0.127)	-0.006 (-0.686)
Ln (Underwriter market share)	-0.094 **(-1.831)***	0.045 (1.212)
Ln (Issue size)	0.001 (0.367)	-0.003 (-0.705)
Market return (3-month-weighted monthly return)	0.003 (0.014)	0.172 (1.027)
Market volatility (monthly volatility of daily return)	-0.431 (-0.392)	0.143 (0.122)
N	87	79
Adjusted R Square	**-0.028**	**0.344**
F-value	0.770	5.088
p-value	0.657	0.000

White heteroskedasticity-consistent t-statistics are given in parentheses
*, **, *** indicate significance at 10%, 5%, and 1% level, respectively

As can be seen from *Table 7*, fixed-price regression"s explanatory power is fully driven by two variables. Firstly, high-tech firms have a significantly higher unconditional variance of first-day return, which provides evidence if favour of little ability of the fixed-price mechanism to price shares of companies with high levels of informational asymmetries accurately. In contrast, venture capital-backed firms have a significantly lower unconditional variability of first-day

return. As expected, venture capitalists help to overcome informational asymmetries when the fixed-price method is used to price IPO shares, which translates into a lower variance of first-day return, or higher pricing precision of venture-capital backed fixed-price IPOs.

6.3. Analysis and comparison of factors explaining the conditional variance of first-day return in book-building and fixed-price IPOs

Table 8 Determinants of the conditional variability of first-day return in Norwegian book-building and fixed-price IPOs from January, 1993 to December, 2008

Subsample	Book-building IPOs	Fixed-price IPOs
Dependent variable	Squared residuals of first-day return	Squared residuals of first-day return
Intercept	-0.062 (-0.706)	-0.021 (-0.449)
Ln (Market capitalization)	0.003 (0.936)	0.000 (-0.143)
High-tech dummy	-0.006 (-0.863)	0.032 **(1.943)***
Ln (Book-to-market ratio)	0.004 **(2.180)****	0.001 (0.823)
Venture capital-backed dummy	0.009 (0.774)	0.006 (0.349)
Age of firm	0.000 (-1.280)	0.000 (0.820)
"No insider sales" dummy	0.005 (0.504)	0.005 (0.764)
Ln (Underwriter market share)	-0.061 **(-1.751)***	0.069 (1.261)
Ln (Issue size)	0.001 (0.330)	0.001 (0.460)
Market return	0.007 (0.067)	0.155 (1.304)
Market volatility	-0.377 (-0.596)	0.197 (0.326)
N	87	79
Adjusted R Square	**-0.014**	**0.095**
F-value	0.885	1.815
p-value	0.551	0.074

White heteroskedasticity-consistent t-statistics are given in parentheses
*, **, *** indicate significance at 10%, 5%, and 1% level, respectively

Table 8 presents the result of regression models with *Squared residuals of first-day return* as a dependent variable, and a set of firm, issue characteristics, and market conditions as explanatory variables, on the subsamples of book-building and fixed-price IPOs separately.

Squared residuals of first-day return is a measure of conditional variability of underpricing, after controlling for effects of firm, issue characteristics and pre-offering market conditions on underpricing. For each observation, it is constructed as a squared difference between actual observed level of first-day return, and the first-day return level predicted using the coefficients of regression in *Table 5* (with *First-day return* as a dependent variable).

The main finding from *Table 7* is that our result for variability of underpricing of book-building IPOs still holds. Variability of underpricing is still positively associated with the book-to-market ratio, and negatively with the underwriter rank. From the fixed-price regression we infer, however, that variability of underpricing, after controlling for other explanatory variables, is no longer significantly related to the presence of venture capitalist. Nevertheless, high-tech firms still exhibit a higher variability of underpricing in fixed-price IPOs.

6.4. Analysis of differences in the level and variability of first-day return in book-building and fixed-price IPOs using a dummy variable approach

In *Table 2* we found that average underpricing of book-building IPOs is 3.36%, while average underpricing associated with fixed-price IPOs is 5.84%. However, after having performed the Two-tail t-test, we found that this difference is not statistically significant. In the same table we also found that book-building IPOs are associated with a significantly lower variability of underpricing (standard deviation of 12.15%) than fixed-price IPOs (standard deviation of 16.54%). However, these are *unconditional* mean level and variability of first-day return, i.e. *without* controlling for firm, issue and market conditions effects. In this subsection, we use the dummy variable approach as a more robust procedure to test the differences in the level and variability of underpricing *after* controlling for firm, issue and market conditions variables.

Table 9 presents the results of regression models with *First-day return, Unconditional variance of first-day return* and *Conditional variance of first-day return* as dependent variables, a set of firm, issue, and market conditions as

independent control variables, and a pricing mechanism dummy variable (encoded as 1 for book-building, and 0 for fixed-price), on the whole sample of 166 IPOs.

Table 9 Pricing mechanism dummy variable regressions on the whole sample of 166 Norwegian IPOs from January, 1993 to December, 2008

Dependent variable	First-day return	Unconditional variance of first-day return	Conditional variance of first-day return
Intercept	-0.176	-0.001	-0.019
	(-0.967)	(-0.015)	(-0.258)
Ln (Market capitalization)	0.026	0.002	0.000
	(2.365)**	(0.426)	(0.052)
High-tech dummy	0.051	0.035	0.020
	(1.291)	**(2.352)****	**(1.903)***
Ln (Book-to-market ratio)	-0.010	0.000	0.000
	(-1.172)	(0.103)	(0.092)
Venture capital-backed dummy	-0.020	-0.008	0.006
	(-0.597)	(-0.534)	(0.451)
Age of firm	0.001	0.000	0.000
	(3.225)***	(-0.654)	(-0.314)
"No insider sales" dummy	-0.056	-0.007	0.002
	(-2.435)**	(-0.741)	(0.297)
Ln (Underwriter market share)	-0.262	-0.005	-0.014
	(-2.363)**	(-0.137)	(-0.425)
Ln (Issue size)	-0.015	0.000	0.002
	(-1.703)*	(-0.071)	(0.774)
Market return	1.304	0.198	0.132
	(3.071)***	(1.471)	(1.331)
Market volatility	0.299	0.117	-0.057
	(0.115)	(0.139)	(-0.101)
Pricing mechanism dummy (1:book-building)	-0.052	-0.018	-0.009
	(-1.953)*	**(-2.143)****	(-1.280)
N	166	166	166
Adjusted R Square	0.178	0.056	-0.003
F-value	4.248	1.898	0.953
p-value	0.000	0.043	0.491

White heteroskedasticity-consistent t-statistics are given in parentheses
*, **, *** indicate significance at 10%, 5%, and 1% level, respectively

Our main finding from *Table 9* is that pricing mechanism dummy variable enters significantly regressions with *First-day return* and *Unconditional variance of first-day return* as dependent variables (at 10% and 5% levels of significance, respectively).

Economically, this implies that after controlling for firm and issue characteristics and market conditions prior to an IPO, **book-building IPOs on average are associated with 5.2% lower underpricing than fixed-price IPOs**, ceteris paribus. Likewise, **book-building IPOs on average are associated with 1.8% lower unconditional variance of first-day return**, when compared to fixed-price IPOs. Although not statistically significant, pricing mechanism dummy variable in the last-column regression also has a sign that is in accordance with our expectations: it implies that book-building IPOs on average have 0.9% lower *conditional* variance of underpricing in our sample. Yet, statistically, we cannot claim whether conditional variances of first-day return of book-building and fixed-price IPOs differ in population.

All in all, after using robust dummy variable approach regressions, and controlling for firm, issue and market conditions variables, we conclude that book-building mechanism is more efficient than the fixed-price method, as it underprices significantly less and has higher accuracy of pricing (partial evidence supported by the significantly lower unconditional variance of first-day return). Keeping all variables constant, if a firm moves from using book-building mechanism to the fixed-price method, it will suffer a decline in IPO gross proceeds, while potential investors in an IPO will gain. Another implication is that investors in fixed-price IPOs on average realize significantly higher returns than investors in book-building IPOs.

Lastly, *Table 9* also indicates that increase in 3-month-weighted market return prior to an IPO of 1% is associated with approximately 1.3% significant increase in the average level of underpricing. Therefore, in the next subsection we will study whether there is a differential impact of market conditions in book-building and fixed-price IPOs.

6.5. Differential impact of market conditions on the level and variability of first-day return in book-building and fixed-price IPOs

Table 10 presents the results of regression models with *First-day return, Unconditional variance of first-day return* and *Conditional variance of first-day return* as dependent variables, and firm, issue characteristics, and pricing mechanism dummy variable (encoded as 1 for book-building, and 0 for fixed-price) as control variables, and *Market return* and *Market Volatility*, split by procedure, as explanatory variables of interest, on the whole sample of IPOs.

After splitting market conditions variables by procedure, we firstly infer from *Table 10* that *Market Volatility*Book-building* and *Market Volatility*Fixed-price* does not have any significant impact on the level or variability of underpricing.

Table 10 Differential impact of market conditions on the level and variability of underpricing in the sample of Norwegian IPOs from January, 1993 to December, 2008 (market conditions variables split by procedure)

Dependent variable	First-day return	Squared deviation of first-day return	Squared residuals of first-day return
Intercept	-0.123 (-0.655)	0.003 (0.042)	-0.026 (-0.364)
Ln (Market capitalization)	0.027 **(2.435)****	0.001 (0.359)	0.000 (-0.074)
High-tech dummy	0.050 (1.264)	0.034 **(2.296)****	0.018 **(1.748)***
Ln (Book-to-market ratio)	-0.009 (-1.081)	0.000 (0.145)	0.000 (-0.006)
Venture capital-backed dummy	-0.026 (-0.776)	-0.006 (-0.442)	0.008 (0.557)
Age of firm	0.001 **(3.106)*****	0.000 (-0.703)	0.000 (-0.321)
"No insider sales" dummy	-0.052 **(-2.264)****	-0.007 (-0.733)	0.002 (0.266)
Ln (Underwriter market share)	-0.261 **(-2.309)****	-0.003 (-0.085)	-0.014 (-0.393)
Ln (Issue size)	-0.017 **(-1.892)***	0.000 (-0.060)	0.002 (1.017)
Pricing mechanism dummy (1:book-building)	-0.137 **(-2.002)****	-0.013 (-0.604)	0.005 (0.370)
Market return*Book-building	1.604 **(2.682)*****	0.089 (0.452)	0.004 (0.030)
Market return*Fixed-price	1.170 **(1.959)***	0.282 (1.599)	0.200 (1.562)
Market volatility*Book-building	4.134 (1.107)	-0.164 (-0.142)	-0.667 (-0.886)
Market volatility*Fixed-price	-3.839 (-0.970)	0.072 (0.058)	0.495 (0.613)
N	166	166	166
Adjusted R Square F-value p-value	0.177 3.729 0.000	0.047 1.633 0.082	-0.018 0.777 0.684

White heteroskedasticity-consistent t-statistics are given in parentheses
*, **, *** indicate significance at 10%, 5%, and 1% level, respectively

We therefore conclude that, even after testing the differential impact of market volatility on the joint sample of book-building and fixed-price IPOs, and controlling for firm, issue characteristics and pricing mechanism-specific differences, the level and variability of underpricing is still unaffected by the volatility in the general market prior to a listing date in either book-building or fixed-price IPOs. This finding is consistent with our previous results from regressions on fixed-price and book-building IPOs subsamples separately in *Tables 5, 7, and 8*.

The most important finding from column 2 of *Table 10* is that *Market return*Book-building* and *Market return*Fixed-price* variables are significant at 1% and 10% levels, respectively. Economically, this implies that the book-building pricing mechanism is more sensitive to market return prior to an IPO than the fixed-price method. 1% increase in 3-month weighted market return prior to an IPO is associated with ca. 1.6% increase of underpricing if book-building was used in IPO, and 1.1% increase in case of the fixed-price mechanism, other things equal. As market return has a larger impact on underpricing in book-building IPOs, the fixed-price mechanism seems to be more efficient in terms of controlling for the recent market return impact on first-day return. However, we also take into account the fact that failure to implement endogeneity of the pricing mechanism choice into regression analysis can potentially bias the obtained results, as Jenkinson, Ljungqvist and Wilhelm (2001) argue. Therefore, next subsection is devoted to this potential endogeneity problem.

6.6. Implementing the endogeneity of the pricing mechanism choice

In this subsection, the endogeneity of the pricing mechanism choice is implemented into regressions in *Table 10*. We use a two-stage least-squares procedure. On the first stage, we use variables that are exogenous with respect to underpricing as predictors in a multinomial logistic model with a pricing mechanism dummy as a dependent variable. We then use logistic regression model coefficients to predict the probability of choosing book-building (versus fixed-price) for every IPO in the sample. Next, we substitute our pricing mechanism dummy variable with these predicted probabilities and run the same regressions as in *Table 10* (with an exception of independent variables that we use as instruments in logistic regression).

Most of the variables we have used so far are endogenous with respect to underpricing. Only three variables are exogenous, i.e. they are insignificant predictors of level of first-day return (please see column 2 in *Table 10)*. These variables are *High-tech dummy*, *Ln (Book-to-market ratio)*, and *Venture capital-backed dummy*. For the sake of completeness, we construct two more variables that might possibly influence the choice of the procedure. First one is *Percentage of shares created*, constructed as a ratio of shares created in an IPO to existing shares before IPO[10]. We also add *Ln (Total assets)* as predictor variable in the first stage logistic regression, which is a proxy for economic size of a firm. In unreported regressions, first-day return was regressed upon these two new variables to make sure they are not significant predictors, and can be used as instruments in the first-stage logistic regression[11].

Table below presents the results of the first-stage logistic regression.

Table 10 First-stage logistic regression

Dependent variable	Pricing mechanism dummy (1:book-building)
Intercept	-5.325 **(-2.303)****
High-tech dummy	-0.191 (-0.364)
Ln (Book-to-market ratio)	-0.451 **(-1.907)***
Venture capital-backed dummy	1.948 **(3.475)*****
Ln (Total Assets)	0.252 **(2.349)****
Percentage of shares created	-0.343 **(-1.758)***
N	166
McFadden Pseudo-R Squared	**0.177**

*, **, *** indicate significance at 10%, 5%, and 1% level, respectively

As *Table 10* indicates, the higher the book-to-market ratio and percentage of shares created, the lower is the probability of choosing book-building (versus

[10] We winsorized this variable at 5%-95% tails since it contained several observations with extremely high percentages of shares created.

[11] Both single regression models showed that neither variable has significant impact (at any conventional significance level) on underpricing. Thus, we can assume them to be exogenous with respect to underpricing.

fixed-price) as a pricing method. On the contrary, in the presence of a venture capitalist, the probability of choosing the book-building mechanism is higher. This indicates that venture capitalists in Norway prefer book-building IPOs to fixed-price IPOs as an exit vehicle.

Also, companies with a larger economic size, as measured by total assets, have a higher probability of choosing book-building. Derrien and Womack (2003) suggest that larger firms typically are the ones that want to attract foreign investors, who in turn may be unwilling to participate in fixed-price IPO since it gives them no advantages in terms of shares allocation. In effect, larger companies tend to select book-building as a pricing procedure.

Although four out of five variables used are significant predictors of the pricing mechanisms choice, the overall model predictive ability is rather small as indicated by the McFadden pseudo R-squared of 0.177.

Table 11 presents the results of the second-stage regressions. Our main finding from it is that, after controlling for endogeneity of the pricing mechanism choice, the book-building pricing mechanism turns out to be able to efficiently incorporate market conditions in the pre-offering period into the final offer price, as indicated by the insignificant coefficients of *Market return*Book-building* and *Market volatility*Book-building* variables in the *First-day return* regression. Likewise, neither *Unconditional variance of first-day return,* nor *Conditional variance of first-day return* variable is significantly sensitive to previous market conditions in book-building IPOs.

In contrast, the fixed-price mechanism is less efficient in terms of controlling for previous market conditions, as *Market return*Fixed-price* IPO has a significant impact on both the level of first-day return and the variability of first-day return (both conditional and unconditional). In economic terms, 1% increase in the 3-month-weighted market return in the pre-offering period increases underpricing associated with fixed-price IPOs by around 1.5%. Likewise, 1% increase in market return increases unconditional variance of underpricing by 0.36% and conditional variance by 0.28%, respectively. Therefore, the fixed-price mechanism has little ability to incorporate market conditions in the period prior to an IPO into the final offer price. This inefficiency translates into higher underpricing and lower accuracy of pricing.

Table 11 Second-stage regressions

Dependent variable	First-day return	Squared deviation of first-day return	Squared residuals of first-day return
Intercept	-0.105 (-0.596)	0.024 (0.372)	0.010 (0.179)
Ln (Market capitalization)	0.033 **(2.896)*** **	0.003 (0.699)	0.000 (-0.023)
Age of firm	0.001 **(2.803)*** **	0.000 (-1.117)	0.000 (-0.914)
"No insider sales" dummy	-0.065 **(-2.339)** **	-0.010 (-0.881)	-0.001 (-0.133)
Ln (Underwriter market share)	-0.259 **(-2.364)** **	0.004 (0.116)	-0.017 (-0.495)
Ln (Issue size)	-0.024 **(-2.216)** **	-0.002 (-0.454)	0.001 (0.143)
Predicted probability of choosing book-building	-0.034 (-0.535)	-0.013 (-0.554)	0.003 (0.110)
Market return*Book-building	0.785 (1.621)	-0.005 (-0.042)	0.021 (0.180)
Market return*Fixed-price	1.503 **(2.444)** **	0.358 **(1.906)** *	0.279 **(1.854)** *
Market volatility*Book-building	-2.260 (-0.901)	-0.919 (-1.320)	-0.350 (-0.581)
Market volatility*Fixed-price	-0.138 (-0.040)	0.043 (0.039)	0.235 (0.272)
N	166	166	166
Adjusted R Square	**0.159**	**0.002**	**-0.028**
F-value	4.127	1.039	0.544
p-value	0.000	0.413	0.857

White heteroskedasticity-consistent t-statistics are given in parentheses
*, **, *** indicate significance at 10%, 5%, and 1% level, respectively

Even though not statistically significant, the negative sign and magnitude of the coefficient of *Predicted probability of choosing book-building* variable (column 2 in *Table 11*) is in accordance with our expectations: it is negative, and equal to -3.4%. Thus, after implementing the endogeneity of the pricing mechanism choice, book-building IPOs still exhibit lower *First-day return* in our sample. We believe that its insignificance may be explained by the small explanatory power of the variables used in the first-stage logistic regression.

We would also like to refer here to the paper of Ljungqvist et al. (2003), who carefully explored the endogeneity of the pricing mechanism choice issue. In section 3.2 of their paper they say "… OLS estimates for the coefficients of

endogenous choice dummies are likely to be inconsistent and serious bias will lead to *understatement* of the effects on underpricing of book building, choice of U.S. bank, and marketing to U.S. investors". Thus, the endogeneity bias actually leads to *understatement* of the effect of the endogenous choice dummy variable. Therefore, if there is any bias in our regressions, we would expect the underpricing of fixed-price IPOs (as well as unconditional variability of underpricing) to be actually even higher, than reported in *Table 9*.

6.7. Determinants of the pricing mechanism choice

On the first stage of the two-stage least squares regression in the previous subsection, we have already found four significant determinants of the pricing mechanism choice. In this subsection, we run an extra logistic regression model (presented in *Table 12*) aimed at testing whether other independent variables from *Table 9* potentially influence the choice of the procedure.

Table 12 Determinants of the pricing mechanism choice in Norwegian IPOs

Dependent variable	Pricing mechanism dummy (1:book-building)
Intercept	-22.425 **(-5.237)***
Ln (Market capitalization)	1.063 **(4.174)***
Age of firm	-0.009 **(-1.671)***
"No insider sales" dummy	-0.583 (-1.541)
Ln (Underwriter market share)	3.118 **(1.725)***
Ln (Issue size)	0.063 (0.348)
N	166
McFadden Pseudo-R Squared	**0.244**

*, **, *** indicate significance at 10%, 5%, and 1% level, respectively

As can be seen from *Table 12*, the larger the expected market size, the higher the probability of choosing book-building. The explanation is the same as for economic size variable in Table 10: larger companies are usually willing to

attract foreign investors, who dislike fixed-price IPOs due to the inability to have advantages with respect to shares allocation in them.

Table 12 also indicates that older companies have a higher probability of choosing the fixed-price method. Lastly, the higher the underwriter rank, the higher is the probability of choosing book-building. We believe that this is due to the fact that highest-ranked underwriters in our sample are specialized in this procedure.

6.8. Analysis of underpricing during "cold" and "hot" markets

We conclude the empirical part of the research with the brief analysis of first-day return differences in various market conditions. *Table 13* presents the breakdown of IPOs in our sample by market "hotness" quintiles, with quintile 5 being the "hottest". The number of IPOs in each quintile and first-day return levels, also split by the pricing mechanism, are presented below.

Table 13 Distribution of Norwegian book-building and fixed-price IPOs by market hotness quintiles

Market "hotness" quintile	Measure	Book-building IPOs	Difference in first-day-return	Fixed-price IPOs	All IPOs
1	No. of IPOs	12		19	31
	Mean first-day return	-3.40%	3.29%	-0.10%	-1.38%
			(0.462)		
2	No. of IPOs	21		20	41
	Mean first-day return	3.36%	-2.41%	0.95%	2.18%
			(0.288)		
3	No. of IPOs	16		17	33
	Mean first-day return	3.28%	-0.30%	2.98%	3.12%
			(0.950)		
4	No. of IPOs	24		16	40
	Mean first-day return	4.20%	18.08%	22.28%	11.43%
			(0.003)* **		
5	No. of IPOs	14		7	21
	Mean first-day return	7.81%	-2.52%	5.29%	6.97%
			(0.748)		

*** indicates significance at 1% level

As can be noted from *Table 13,* in the "coldest" quintile, average underpricing is negative for both book-building and fixed-price IPOs (-3.40% and -0.10%, respectively). When one moves from bearish quintiles to more bullish quintiles, there is evidence of a roughly monotonic increase in average

underpricing levels (with an exception of underpricing in quintile 5 for fixed-price IPOs).

The key finding from *Table 13* is however that the differences in underpricing between fixed-price and book-building IPOs are not statistically significant in relatively "cold" quintiles 1, 2, 3. But in the fourth "hotness" quintile, fixed-price mechanism has underpricing of around 22%, while average underpricing for book-building is only 4%. The difference in first-day return levels of 18% is highly statistically significant at 1% level. Thus, as markets get hotter, the fixed-price mechanism tends to underprice even more than book-building. This finding further supports our previous regression results that the fixed-price mechanism is less efficient than book-building in terms of ability to properly incorporate market "hotness" into the final offer price, as has been found in *Table 11*.

Having presented the empirical analysis, we draw conclusions in the last section.

7. Conclusion

In our research, we have analysed and compared the efficiency of initial public offering pricing mechanisms. The efficient pricing mechanism has been defined as the one that is associated with a lower level of underpricing, lower variability of underpricing (i.e., higher accuracy of pricing), and the one that more completely incorporates recent market conditions in the pre-offering period into the final offer price (i.e., which underpricing level and variability are less sensitive to market conditions in the pre-offering period). The question is particularly interesting in the Norwegian IPO market, where firms going public mainly choose among two alternatives – book-building and the fixed-price method, and thus, their efficiency can be robustly compared. Thus, in our master thesis paper we have made an attempt to bring so far inexistent empirical evidence from Norway on which pricing mechanism (book-building versus fixed-price) is more efficient, i.e. underprices less, has higher accuracy of pricing, and is less sensitive to market conditions prior to an IPO.

We have analysed 166 Norwegian equity offerings, initially listed on Oslo Stock Exchange, during the period from January 1, 1993 to December 31, 2008, priced by book-building and the fixed-price mechanism. After using a robust set of models, and controlling for differences in firm, issue and market conditions prior to an IPO, we have found that, on average, the book-building mechanism is associated with significant 5.2% lower underpricing, than the fixed-price mechanism. Further, some partial evidence has been found that book-building has also lower variability of underpricing (significant 1.8% lower *unconditional* variance of underpricing). Yet, 0.9% lower *conditional* variance of underpricing in our sample is not statistically significant in population. Therefore, we accept the fact that we cannot claim that variability of underpricing between book-building and fixed-price mechanisms is different[12]

Our analysis also suggests that book-building pricing mechanism effectively incorporates market conditions in the pre-offering period into the final offer price. Neither the level of underpricing, nor the variability of underpricing is significantly sensitive to either market return or volatility in the period prior to an IPO. On the contrary, the fixed-price mechanism is less effective with respect to

[12] We believe that the inability to reject the null of no difference between conditional variability of underpricing in book-building and fixed-price IPOs is mainly due to the limitation imposed by a relatively small sample size. It is highly likely that an increase in number of observations could provide enough statistical power to reject this null hypothesis.

controlling for previous market conditions, as market return in the pre-offering period has a significant positive impact on both the level and variability of underpricing (1% increase in 3-month-weighted market return in the pre-offering period translates into 1.5% increase in the level of underpricing, and 0.36% and 0.28% increases in unconditional and conditional variability of underpricing, respectively).

It has also been found that the choice of the pricing mechanism in Norwegian IPOs is contingent on several firm and issue characteristics. For instance, firms with the higher book-to-market value of equity, larger number of shares to be created in an IPO, and older firms (all the three variables are proxies for lower ex-ante uncertainty) are more likely to choose the fixed-price method. On the contrary, firms with venture capital investment are more likely to choose book-building (presumably because Norwegian venture capitalists prefer book-building IPOs to fixed-price IPOs as an exit vehicle). Larger size companies (both in economic and market terms) are also more likely to choose book-building (apparently in attempt to attract foreign investors who are reluctant to fixed-price IPOs in which they get no preferences with respect to shares allocation). Also, firms with higher-ranked underwriters are more likely to use book-building as a pricing mechanism (apparently because highly ranked underwriters in Norway are specialized in this procedure).

All things considered, we conclude that book-building is a more efficient pricing mechanism in Norwegian IPO market, as it underprices less and is less sensitive to the market conditions prior to an IPO, than the fixed-price method. The key implications of our findings for the issuer are as follows. Keeping everything else constant, if a given firm moves from using book-building in its IPO to the fixed-price mechanism, it will suffer a decline in IPO gross proceeds. Furthermore, the decline in gross proceeds will be even more substantial (and more variable) in "hot" markets. Therefore, *after controlling for all the other possible objectives of an IPO, different from pricing issues*, book-building is a more rational pricing mechanism choice. The implication for potential investors is that investors in fixed-price IPOs on average realize higher returns than investors in book-building IPOs. The "hotter" the market is, the larger (and more variable) the difference between realized returns is.

As a matter of fact, it has been also found that the fixed-price mechanism dominated book-building by the number of IPOs in 90s, however, from early

2000s and forward, the number of book-building issues grows, while the fixed-price method seems to lose its previous popularity. In light of our findings, this may arguably represent a time trend towards use of a more efficient book-building pricing mechanism in Norwegian IPOs.

As a concluding remark, while the rationale behind using book-building as a pricing mechanism is fairly understandable (more efficient pricing, better set of owners etc.), it is less clear what features of the fixed-price method make it still attractive for firms going public in the Norwegian IPO market. We believe that lower direct costs of issuance might be a possible explanation. Therefore, formal implementation of direct costs into the models might be a fruitful area for further research.

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9. Appendices

9.1. List of IPOs in the sample and pricing mechanisms used

Listing date	Company name	Pricing mechanism
19930705	Smedvig Tankships Ltd.	Fixed price
19931112	First Olsen Tankers	Fixed price
19931117	Nordic American Shipping	Fixed price
19931210	Western Bulk Shipping	Fixed price
19931213	Kongsberg Gruppen (Senere Norsk Forsvarsteknologi)	Fixed price
19931217	Bona Shipholding	Fixed price
19931220	Christiania Bank og Kreditkasse	Book-building
19940110	Braathens SAFE	Fixed price
19940113	Rica Hotell- og Restaurantkjede	Fixed price
19940502	Sparebanken Rogaland (Gr.f.bevis)	Fixed price
19940502	Sparebanken Midt-Norge (Gr.f.bevis)	Fixed price
19940502	Gresvig	Fixed price
19940502	Sparebanken Nord-Norge (Gr.f.bevis)	Fixed price
19940705	Steen & StrÃ¸m	Fixed price
19940715	JÃ¸tul	Fixed price
19940729	EEG-Henriksen Gruppen	Fixed price
19940919	Atlantic Container Line	Fixed price
19950104	Sparebanken Vest (Gr.f.bevis)	Fixed price
19950406	Kongsberg Automotive	Fixed price
19950406	Ekornes	Fixed price
19950621	Fesil (Ila and Lilleby Smelteverker AS)	Fixed price
19950731	Legra	Fixed price
19951016	Fokus Bank	Book-building
19951025	Santech Micro Group	Book-building
19951026	Selmer	Fixed price
19951027	Sandnes Sparebank	Fixed price
19951218	Toten sparebank (Gr.f.bevis)	Fixed price
19960503	NetCom	Book-building
19960604	Narvesen	Fixed price
19960613	Ringerike Sparebank	Fixed price
19960617	PC-Systemer Norge	Fixed price
19960807	Medi-Cult	Fixed price
19961101	P4 Radio Hele Norge	Fixed price
19970120	Indre Sogn Sparebank	Fixed price
19970317	ContextVision	Fixed price
19970317	Seateam Technology	Fixed price
19970421	Kitron	Fixed price
19970502	Choice Hotels Scandinavia	Fixed price

19970604	Procon Offshore	Fixed price
19970627	EDB - Elektronisk Databehandling	Fixed price
19971001	Iterated Systems	Fixed price
19971009	Ulstein Holding	Fixed price
19971015	Fred. Olsen Energy	Book-building
19971027	Solstad Offshore	Fixed price
19971119	Aktiv Kapital (Aktiv Inkasso)	Fixed price
19971121	Int. Gold Exploration IGE	Fixed price
19971215	Norcool Holding	Fixed price
19971218	Fredrik Lindegaard	Fixed price
19980114	Team Shipping	Fixed price
19980226	Tecmar Technologies Int. (TTI Holding)	Fixed price
19980515	Luxo	Fixed price
19980602	Stavdal Maskinutleie	Fixed price
19980603	Havila Supply	Fixed price
19980618	Norema	Fixed price
19980706	SynnÃ¸ve Finden	Fixed price
19980708	Eltek	Fixed price
19980812	Aurskog Sparebank	Fixed price
19981019	Nes Prestegjelds Sparebank	Fixed price
19990701	Industrifinans Forvaltning	Fixed price
19990713	Infostream	Fixed price
19990713	Enitel	Book-building
19990817	HÃ¸land Sparebank	Fixed price
20000203	Helgeland Sparebank	Fixed price
20000314	Stepstone	Book-building
20000414	Expert Eilag	Book-building
20000505	Nutri Pharma	Book-building
20000519	Flora - Bremanger Sparebank	Fixed price
20000529	PhotoCure	Book-building
20000607	Scandinavia Online AB	Book-building
20000619	Customax	Fixed price
20000619	Webcenter Solutions	Fixed price
20000718	Sait Sento	Book-building
20001204	Telenor	Book-building
20010613	Consorte Group	Book-building
20010618	Statoil	Book-building
20010629	Domstein	Book-building
20010716	Acta Holding	Book-building
20010717	Odim Hitec	Fixed price
20020403	Q-Free	Book-building
20020603	LerÃ¸y Seafood Group	Fixed price
20031218	Norwegian Air Shuttle	Book-building

20031219	NextGenTel Holding	Book-building
20040311	Opera	Book-building
20040325	Yara International	Book-building
20040329	Catch Communications	Book-building
20040402	Aker KvÃ¦rner	Book-building
20040510	Mamut ASA	Book-building
20040525	Findexa Limited	Book-building
20040528	Medi-Stim	Fixed price
20040624	Conseptor	Book-building
20040628	Camillo Eitzen & Co	Book-building
20041112	Active 24	Book-building
20041217	BjÃ¸rge	Fixed price
20050223	Petrojack ASA	Book-building
20050309	Exploration Resources (Polar seismikk)	Book-building
20050317	Wilson ASA	Book-building
20050318	APL ASA	Book-building
20050426	Polimoon	Book-building
20050503	Oslo Areal ASA	Book-building
20050513	Aker Seafood	Book-building
20050607	Norway Energy & Marine Insurance	Book-building
20050609	Via Travel Group	Book-building
20050624	Kongsberg Automotive Holding	Book-building
20050627	Revus Energy	Book-building
20050708	Artumas Group Inc.	Book-building
20050923	Media & Research Group	Book-building
20051013	Bluewater Insurance	Book-building
20051024	Cermaq	Book-building
20051024	Powel	Book-building
20051025	Bergesen Worldwide Gas	Book-building
20051104	Biotec Pharmacon	Book-building
20051116	Norgani Hotels	Book-building
20051118	Odim	Book-building
20051212	Grenland Group	Book-building
20051213	Funcom	Book-building
20051214	NorDiag	Book-building
20060208	Petrobank Energy and Resources Ltd	Book-building
20060317	Block Watne Gruppen ASA	Book-building
20060411	SeaBird Exploration Ltd	Book-building
20060509	Renewable Energy Corporation ASA	Book-building
20060630	Petrojarl	Book-building
20060703	Ability Group	Book-building
20060705	Trolltech	Book-building
20060707	Clavis Pharma	Fixed price

20061019	Codfarmers	Book-building
20061023	Northland Resources	Fixed price
20061102	Eitzen Chemical	Book-building
20061110	AKVA Group	Book-building
20061110	Pertra	Book-building
20061115	Norwegian Property	Book-building
20061208	Faktor Eiendom	Book-building
20061212	Spits	Book-building
20061221	Crew Minerals	Fixed price
20070323	NEAS ASA	Book-building
20070327	Algeta ASA	Book-building
20070330	ElectroMagnetic GeoServices ASA	Book-building
20070330	Nexus Floating Production Ltd	Book-building
20070503	Klepp Sparebank	Fixed price
20070508	SalMar ASA	Fixed price
20070510	ScanArc ASA	Book-building
20070511	Fred.Olsen Production ASA	Book-building
20070515	Bouvet ASA	Book-building
20070525	Protector Insurance ASA	Book-building
20070530	Arrow Seismic ASA	Book-building
20070606	InvivoSense ASA	Fixed price
20070611	RomReal Ltd.	Book-building
20070612	Badger Explorer ASA	Book-building
20071003	EOC Limited	Book-building
20071008	SeaJacks International Limited	Fixed price
20071009	London Mining	Book-building
20071011	ETMA International ASA	Fixed price
20071011	Pronova Biopharma ASA	Book-building
20071015	Abillity Drilling	Book-building
20071029	NÃ¸tterÃ¸ Sparebank	Fixed price
20071030	Eastern Echo Holding Plc	Book-building
20071122	Scandinavian Clinical Nutrition	Fixed price
20071205	Hafslund Infratek ASA	Book-building
20071217	Aker Exploration ASA	Fixed price
20071217	Aker Philadelphia Shipyard	Book-building
20071221	IGE Nordic AB	Book-building
20080110	Aqua Bio Technology ASA	Fixed price
20080130	NattoPharma ASA	Book-building
20080618	PCI Biotech Holding	Fixed price
20080624	Norway Pelagic	Fixed price
20080627	Remedial Offshore PCL	Book-building
20080630	Bergen Group	Fixed price

9.2. List of underwriters, their market shares and ranking

Underwriter	Market Share	Rank
DnB	0.40422	1
Carnegie	0.12347	2
Sundal Collier	0.11381	3
Enskilda	0.09289	4
Pareto	0.04691	5
Goldman Sachs	0.04448	6
Fondsfinans	0.03498	7
Fearnley	0.03114	8
Alfred Berg	0.03078	9
Morgan Stanley	0.01611	10
Orkla	0.01468	11
First	0.00857	12
Natwest	0.00742	13
SG. Warburg	0.00660	14
Terra	0.00406	15
Deutsche Bank	0.00358	16
CS First Boston	0.00328	17
Christiania	0.00267	18
CAR	0.00233	19
KBC	0.00219	20
Handelsbanken	0.00196	21
Elcon	0.00189	22
Orion	0.00123	23
Finanshuset	0.00045	24
SPN Fonds	0.00027	25
Karl Johan	0.00004	26

9.3. Correlations matrix

	First-day return	Squared deviation of first-day return	Ln (Market capitalization)	High-tech dummy	Ln (Book-to-market ratio)	Venture capital-backed dummy	Age of company	"No insider sales" dummy	Ln (Underwriter's market share)	Ln (Issue size)	Market return	Market volatility	Pricing mechanism dummy
First-day return	1.000												
Squared deviation of first-day return	0.483	1.000											
Ln (Market capitalization)	0.043	-0.048	1.000										
High-tech dummy	0.126	0.266	-0.029	1.000									
Ln (Book-to-market ratio)	-0.056	-0.009	-0.247	-0.087	1.000								
Venture capital-backed dummy	-0.042	-0.004	0.087	0.274	-0.099	1.000							
Age of company	0.146	-0.045	-0.135	-0.123	0.471	-0.201	1.000						
"No insider sales" dummy	-0.170	-0.073	-0.138	-0.093	0.145	-0.141	0.099	1.000					
Ln (Underwriter's market share)	-0.211	-0.029	0.099	0.033	0.056	0.034	0.008	-0.050	1.000				
Ln (Issue size)	-0.028	-0.061	0.736	-0.098	0.173	0.117	0.067	-0.193	0.107	1.000			
Market return	0.267	0.121	0.025	0.101	0.037	0.168	-0.034	-0.073	-0.079	0.038	1.000		
Market volatility	-0.213	-0.120	0.046	-0.069	-0.118	0.073	-0.094	0.058	0.100	-0.004	-0.510	1.000	
Pricing mechanism dummy	-0.086	-0.134	0.485	0.064	-0.215	0.302	-0.165	-0.166	0.122	0.368	0.174	0.199	1.000

9.4. Preliminary Thesis Report

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Preliminary Thesis Report

IPO Pricing Mechanisms in Norway

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Supervisor:
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Content

Introduction

The phenomenon of initial public offering underpricing has been extensively studied in academic literature. Loughran, Ritter, and Rydqvist (1994) present a first comprehensive research on IPOs in an international perspective. They document that underpricing is present in roughly all IPOs globally, priced by means of different mechanisms.

Loughran et al. (1994) argue that underpricing constitutes a cost to the issuer, and is not optimal since proceeds are "left on the table". On the contrary, Habib and Ljungqvist (2001) claim that some positive amount of underpricing may, in fact, benefit the issuer. Nonetheless, there seem to be no clear recommendation of what level of underpricing is optimal, academic IPO literature clearly suggests that excessive underpricing is detrimental to the issuer, who is predominantly concerned with maximization of its IPO proceeds. Yet again, Loughran et al. (1994) were first to draw attention to the fact that one should consider a pricing mechanism used in the IPO when evaluating its success, measured by gross proceeds that are exposed to underpricing.

The most noticeable research has been done in the strand of IPO literature that explains differences in IPO initial returns as a result of informational asymmetries that presumably exist amongst various parties involved in the IPO process. The way these informational asymmetries are handled by IPO pricing mechanisms, as we will see, is crucial.

As a general rule, parties involved in the IPO process include a firm going public (the issuer), a bank underwriting the issue (the underwriter) and investors. As there is obviously no secondary market so far for IPO shares, the issuer together with the underwriter need to determine the price of stocks to be issued. Three pricing mechanisms may be employed with the purpose of price determination. These mechanisms are bookbuilding, fixed-price method, and auctions.

IPO pricing methods differ considerably with respect to whether the price discovery occurs before or after the final offer price is set (Busaba and Chang, 2010). For example, in the bookbuilding process, which predominates in the United States and recently has spread to other parts of the world, noticeably Europe, the underwriter interacts with investors during the "road show", where investors bid their non-binding indications of interest. This process allows the underwriter to learn the demand for the issue, and subsequently set the appropriate

offer price. In contrast, the "true" price evolves only after an offer is made if the fixed-price method is used. Naturally, therefore, a dissimilar structure of various pricing mechanisms results in their different treatment of informational asymmetries present in IPOs. In turn, this affects the underpricing associated with the issue.

Growing theoretical literature on the topic gave rise to empirical tests of the superiority of one mechanism over another. The question is particularly interesting in countries, where more than one mechanism is available to price IPO shares, and thus they can be compared. Selected empirical evidence advocates for the superiority of auctions over bookbuilding (Derrien and Womack (2003) for France; Kaneko and Pettway (2003) for Japan). Ljungqvist, Jenkinson and Wilhelm (2003) find that European bookbuilt IPOs are more underpriced than fixed-price offerings, which contradicts most of the influential theoretical studies (Benveniste and Spindt (1989), Spatt and Srivastava (1991), Biais and Faugeron-Crouzet (2002) and other). In a nutshell, both theoretical and empirical findings are so far inconclusive.

To our knowledge, the question is rather unexplored in the Norwegian IPO market, which provides the firms going public with two alternatives of the IPO pricing mechanisms – bookbuilding and the fixed-price method. In our research, we will compare their efficiency as measured by both the level of underpricing and variance of underpricing. If we find that one method is associated with lesser underpricing, we will then try to answer the puzzling question why not all the firms choose this superior method. For this reason, in our research we will also test empirically what are the significant determinants of the pricing mechanism choice in Norwegian firms going public. To sum up, in our master thesis we are eager to bring so far inexistent empirical evidence on the question from Norway.

We will start with the review of the most relevant theoretical literature and selected empirical papers. Then, based on the key findings, we will formulate testable hypotheses and possible extensions. Next, the methodology used to investigate the issue will be outlined. Lastly, we will specify the data needed.

Literature Review

Rock (1986) presents one of the pioneering studies in the informational asymmetries and IPO underpricing literature. In his paper, Rock develops a model of a fixed-price method of IPO pricing, where he assumes the existence of a group of investors with pricing-relevant information, and the issuer is assumed to be unable to acquire this information before the offer price is set. There are no incentives for informed investors to reveal their information before the offer price is set and they can avoid participation in the overvalued IPOs. Conversely, uninformed investors cannot avoid participation in such IPOs, and as a result experience a winner‟s curse. He argues that underpricing is compensation to uninformed investors for experiencing the winner‟s curse, as informed investors crowd them out of the high quality offerings. He concludes that in order to guarantee that uninformed investors participate in the IPO, issued shares should be priced at a discount.

Benveniste and Spindt (1989) study the bookbuilding pricing mechanism. Clearly, in contrast to Rock (1986), the underwriter is now assumed to be able to obtain information from informed investors before the offer price is set. In their model, underpricing is compensation to investors for the disclosure of positive information about the issue. Thus, the underwriter‟s role is to mitigate the informational asymmetry by using her discretion over pricing and allocation that motivates investors to reveal their information about the issue. Investors reveal their information to the underwriter by bidding their non-binding indications of interest. Among other, they conclude that the new issue will be associated with less underpricing and respectively more proceeds to the issuer, compared to a fixed-price offer.

Benveniste and Wilhelm (1990) essentially extend the model of Benveniste and Spindt (1989) by analysing the consequences of constraining the underwriters in their efforts to extract information from informed investors. Underwriters maximize IPO proceeds by using a combination of price and allocation discrimination, given the opportunity to allocate shares among both regular (mostly informed institutional investors) and retail investors (mostly uniformed investors). Constraining underwriters in their efforts decreases the expected proceeds from the IPO by limiting the underwriter‟s ability to weaken the winner‟s curse. They argue that uniform-price restrictions increase the costs of gathering information from regular investors, and if they are combined with

allocation restrictions, the underwriter appears to be no longer able to reduce the informational asymmetry because information gathering is impossible. At one extreme, when both uniform price and allocation restrictions are in place, the issuer may experience the consequences of the full winner‟s curse facing uninformed investors as in Rock (1986) and thus, bookbuilding loses its advantages relative to the fixed-price mechanism. If not, they argue, bookbuilding is an efficient pricing method and dominates the fixed-price mechanism.

Spatt and Srivastava‟s (1991) results are consistent with previous papers. They argue that the regular fixed-price procedure is inefficient since it does not utilize any information about investors‟ valuations. They further consider an augmented fixed-price mechanism by allowing informal communication between the underwriter and investors prior to the allocation of the issue. This communication, which resembles the bookbuilding model in Benveniste and Spindt (1989), can transmit relevant information between the parties. They conclude that the fixed-priced mechanism with a non-binding premarket communication, that provides an underwriter with indications of interest, leads to the allocation and pricing that maximizes issuers expected proceeds, given the informational constraints. Thus, they actually support the notion of the efficient bookbuilding mechanism.

Welch (1992) focuses on the fixed-price mechanism and informational cascades. Under assumption that all investors possess equally valuable and correlated information, can observe each other‟s subscription decisions and their subscriptions are not simultaneously pro-rated, but instead served sequentially, he provides an explanation of IPO underpricing without a winner‟s curse (contrary to Rock, 1986). He argues that when an IPO is sold sequentially, later investors can learn from purchasing decisions of earlier investors, which can lead to informational cascades in which investors optimally ignore their private information and rely on and imitate the actions of earlier investors. Thus, in the fixed-price mechanism underpricing is used to avoid information gathering and is needed in order to create a positive informational cascade. On the other hand, in the bookbuilding procedure information about the demand is undisclosed by the underwriter to other investors. Therefore, informational cascades cannot develop, and less underpricing is required, ceteris paribus.

Hanley (1993) provides evidence that the bookbuilding procedure may be exposed to the partial adjustment phenomenon. She claims that issues associated

with the partial adjustment phenomenon – those that have positive offer price revisions – exhibit both an increase in underpricing and the number of offered shares. This result is consistent with Benveniste and Spindt (1989) who claim that the final offer price is only partially adjusted to the information gathered through bookbuilding. She argues that issues with the final offer price exceeding the limits of the price range have greater underpricing, ceteris paribus. Moreover, issuers and underwriters tend to price in the initially set price range. For that reason, the final offer price may not be sufficiently increased to capture the excess demand, which results in excess underpricing.

Benveniste and Busaba (1997) theoretically compare fixed-price and bookbuilding mechanisms under assumption that investors possess correlated information and can observe each other‟s subscription decisions. They model fixed-priced mechanism similarly to Welch (1992). As a result, in their setting bookbuilding no longer stochastically dominates the fixed-priced mechanism as in Spatt and Srivastava (1991). They argue that underpricing required under the fixed-price procedure in order to create a positive informational cascade is larger than underpricing needed to induce investors to reveal information in bookbuilding. Therefore, bookbuilding generates higher expected proceeds than the fixed-price method. However, it is as well associated with greater uncertainty. They conclude that it is the degree of price risk endogenous to the issue and risk-aversion of the issuer that are the determinants of the issuer‟s choice of the pricing mechanism. They argue that the certainty of the proceeds is an advantage of the fixed-priced method, and for that reason, it may be attractive for more risk-averse issuers. Thus, they conclude that both the fixed-price and bookbuilding may be optimal from the issuer‟s point of view, contingent on her characteristics.

Biais and Faugeron-Crouzet (2002) develop a unified theoretical model in order to analyse and compare different pricing mechanisms. They provide evidence that the fixed-price mechanism leads to inefficient pricing of IPO shares and a winner‟s curse (consistent with Rock, 1986), whereas auction mechanism can lead to inefficiencies due to implicit collusion among investors. Lastly, bookbuilding leads to the optimal information revelation from investors about their valuation of stocks and an efficient price discovery (consistent with Benveniste and Spindt, 1989). Thus, both auction and bookbuilding methods are superior to the fixed-price mechanism. And unless there are inefficiencies caused

by collusion among investors, auction and bookbuilding procedures are equally efficient.

Sherman and Titman (2002) further study the bookbuilding mechanism of pricing IPO shares. They develop a model, in which an underwriter selects a group of targeted investors, pricing and allocation mechanisms that maximize the information generated during the IPO process subject to a minimum cost. In contrast to previously discussed papers (most notably Benveniste and Spindt, 1989), they argue that underpricing in bookbuilding is needed so as to induce investors to produce information, rather than reveal it. Therefore, investors experience a cost of acquiring information, which should be compensated by corresponding underpricing. They conclude that when there is no need in accurate pricing, the expected gain from underpricing exactly offsets the costs of acquiring information by investors. However, when pricing accuracy is of high importance, the number of participating investors, as well as amount of underpricing increases, and on average underpricing will go above the information acquisition costs encountered by investors. Thus, the firms with a high need for pricing accuracy (e.g. riskier firms, smaller size firms with potentially less liquid shares, firms with significant future capital needs) are likely to be more underpriced.

Ljungqvist, Jenksinson and Wilhelm (2003) perform a cost-benefit analysis of the global integration of IPO markets and a followed-on adoption of the US-style bookbuilding mechanism throughout 65 countries in 1990s, where the fixed-price method dominated until then. They find that on average, both pricing mechanisms are associated with the similar level of underpricing – around 20%. They argue that bookbuilding on its own does not lead to lower underpricing. However, bookbuilding leads to significantly lower underpricing relative to the fixed-price method, or bookbuilding by domestic underwriters if only it is conducted by US underwriters or targeted at US investors. Even though it is twice as much expensive as the fixed price mechanism, gains associated with it – decreased underpricing – outweigh additional direct costs of hiring a US underwriter or targeting at a US investor. They explain this due to longer bookbuilding experience of US banks that seem to be better at rewarding investors for revealing information dynamically. What is more, they find that European bookbuilt IPOs are more underpriced than fixed-price offerings. However, these results may be due to the fact that the issuer chooses the pricing mechanism endogenously, depending on her characteristics. Sectors with high degrees of

informational asymmetry (e.g., IT and biotech) may benefit from either production (as in Sherman and Titman, 2002) or revelation (as in Benveniste and Spindt, 1989) in the course of bookbuilding.

In their paper, Derrien and Womack (2003) investigate empirically IPO pricing mechanisms and underpricing based on the French IPO market, where all the three pricing mechanisms, namely auctions, bookbuilding and fixed-price offers are used. They focus their research not exclusively on the amount of underpricing, but also on the variability of underpricing that is related to previous market conditions, as they show. They argue that cross-sectional variance of underpricing is another important aspect of the efficiency of pricing mechanisms. They find that amongst all the mechanisms, the auction method is associated with lesser amount and variance of underpricing, thus it is superior to both bookbuilding and fixed-price mechanisms. They argue that its auctions mechanism"s ability to incorporate information on current and previous market conditions into the final offer price that is the reason for its superiority. Bookbuilding appears to be the second-best alternative that may be opted for because of other objectives different from reduced underpricing, for example, a better-selected set of owners.

Kaneko and Pettway (2003) present a study of IPOs in Japan, which moved from an auction-priced to underwriter-priced IPOs using bookbuilding mechanism in 1997. In line with Derrien and Womack (2003), they find evidence that initial returns of the bookbuilt IPOs are significantly higher than those of the auctions, especially in hot market conditions. They relate higher underpricing of the bookbuilt IPOs to the setting of the upper price limit by the underwriter too low at the stage of registering preliminary prospectus, and typical setting of the final offer price no higher than the upper bound of the price range by underwriters of the Japanese IPOs, despite the fact that the demand function learned through bookbuilding suggests a higher appropriate price.

Most of the previously reviewed studies assume that the "true" value of offered shares is established instantly after trading begins (e.g., Benveniste and Wilhelm, 1990; Spatt and Srivastava, 1991; Benveniste and Busaba, 1997; Biais and Faugeron-Crouzet, 2002). On the contrary, Busaba and Chang (2010) analyse bookbuilding and fixed-price mechanisms allowing for strategic aftermarket trading by informed investors. They find that both methods require more underpricing when informed investors consider aftermarket trading. This is

particularly true for the bookbuilding procedure, which becomes especially costly since investors‟ bidding behaviour is adversely affected by the potential for profits in aftermarket. Underpricing is thus required to offset the losses of uniformed investors who face trading with informed investors in aftermarket. They argue that dominance of the bookbuilding procedure may be established if only the discretion to limit participation in the premarket is added to discretion to condition allocations (discussed in Benveniste and Wilhelm, 1990). Thus, in contrast to previous studies, that at large document the superiority of the bookbuilding method, they argue that the fixed-price mechanism produces on average higher expected proceeds, unless the underwriter can target its bookbuilding activity to a small subset of informed investors. Thus, they found an efficiency rationale of the common practice in bookbuilt US IPOs to limit the bookbuilding activity to a group of institutional informed investors.

Hypotheses

The traditional standpoint of IPO pricing mechanisms efficiency virtually supports the notion of the efficient bookbuilding pricing mechanism. It origins from the most notable theoretical works of Benveniste and Spindt (1989), Benveniste and Wilhelm (1990), Spatt and Srivastava (1991), and it is supported by later studies of Benveniste and Busaba (1997), Biais and Faugeron-Crouzet (2002). For the most part, they all agree that bookbuilding efficiently dominates the fixed-price method as it is associated with less underpricing, and respectively more proceeds to the issuer. Our central hypothesis is thus inspired by their works and is formulated in the following manner:

On average, those IPOs that are priced using the bookbuilding mechanism are associated with less underpricing, compared to fixed-priced offerings.

In contrast to a conventional viewpoint, Busaba and Chang (2010) argue that on average, the fixed-price mechanism produces higher expected proceeds, unless the underwriter can target its bookbuilding activity to a small subset of informed investors. Also, Ljungqvist, Jenkinson and Wilhelm (2003) find empirically that European bookbuilt IPOs are more underpriced than fixed-priced offerings (Norwegian IPOs are not included in their sample). Therefore, we formulate the competing hypothesis as follows:

On average, those IPOs that are priced using the fixed-price mechanism are associated with less underpricing, compared to bookbuilt offerings.

In their paper, Ljungqvist, Jenkinson and Wilhelm (2003) also find that on average in their sample (including European IPOs; Norway is not included), both bookbuilding and fixed-price mechanisms are associated with the similar level of underpricing – around 20%. Thus, we also consider the possibility that there may be no significant relation between the pricing mechanism used in an IPO and its consequent underpricing in the Norwegian IPO market. This is our null hypothesis.

There are several extensions of the research question we are eager to test.

Derrien and Womack (2003) argue that there is another important feature of the pricing mechanism efficiency in addition to low underpricing. They suggest that underwriters are also typically concerned about controlling the aftermarket price variation, particularly the downside potential. Therefore, they claim, low cross-sectional variance of underpricing is another important aspect of the pricing mechanism efficiency. This matter was as well addressed by Busaba and Chang (1997), who suggest that the bookbuilding mechanism is associated with greater aftermarket uncertainty. Therefore, in our master thesis we will also assess this aspect of the pricing efficiency of bookbuilding versus the fixed-price mechanism.

Finally, there are theoretical and empirical studies that clearly suggest superiority of one pricing mechanism over another with respect to underpricing. For instance, Derrien and Womack (2003) and Kaneko and Pettway (2003) provide empirical evidence that the auction pricing mechanism is associated with less underpricing than bookbuilding. Probably, the most puzzling question is then why not all firms going public opt for the same superior pricing mechanism that maximizes the IPO proceeds. With respect to this matter, Benveniste and Busaba (1997) were first to point out that both bookbuilding and fixed-price mechanisms may be optimal from an issuer‟s perspective, conditional on her characteristics. Later, Ljungqvist, Jenkinson and Wilhelm (2003) also argue that the issuer selects the pricing mechanism endogenously, and this choice is contingent on her characteristics. Lastly, Derrien and Womack (2003) emphasise that the issuer‟s choice of a pricing mechanism may as well be driven by other determinants, different from lesser underpricing (for example, preference for controlling the aftermarket price variability discussed above). Therefore, in our research we will also investigate what are the significant determinants of the choice of a pricing mechanism in Norwegian firms going public, if any.

Methodology

The central objective of the current research is to test empirically the efficiency of bookbuilding versus the fixed-price mechanism, measured by the amount and variance of underpricing. We will follow the conventional definition of underpricing, or initial return, calculated as the difference between the closing price on the first day of trading and the offer price. The variance of underpricing will be proxied by either cross-sectional squared deviations of the initial return around the means in the subsamples of bookbuilt and fixed-priced IPOs, or obtained as squared residuals from the initial multivariate regression model with the initial return as dependent variable, as showed below. In most parts, our methodology will be consistent with Derrien and Womack (2003) and Kaneko and Pettway (2003).

In order to grasp the initial idea of the pricing mechanisms‟ efficiency, we will examine the statistical moments of distributions across different dimensions and then compare the average levels and variances of underpricing associated with bookbuilt and fixed-priced IPOs by performing t-tests of differences in means. We will then proceed with controlling for the likely effects of the characteristics of the firm (industry, age, book-to-market ratio), the issue (size, fraction of shares issued, goal of the IPO, rank of the underwriter), and previous market conditions (market return and volatility) on the initial return.

We will construct the market return variables for several periods, such as 1-week, 1-month, and 3-month prior the IPO date, for every IPO in a sample. Stock market index, such as the OBX, will be used to calculate the market return as a buy-and-hold return over a corresponding period. We will then normalize these returns to obtain average monthly returns over each period. In the same manner, we will compute market volatility variables as the standard deviation of daily returns of the OBX index over corresponding periods.

We will use a set of industry dummy variables, and alternatively, dummy variables like high-tech versus non-high-tech firm, depending on the sample. Age (in years) and the book-to-market value of equity of a firm will be measured at the IPO date. We will measure the size of the issue by the initial market capitalization at an IPO date, calculated as the offer price times the number of shares offered. The fraction of shares issued will be calculated as the ratio of shares issued in the IPO to all existing shares. Depending on the information in the prospectuses, we might also categorize the announced goals of the IPOs. The rank of the

underwriter will be determined by the number of IPOs in the sample in which it was a lead underwriter. Finally, in order to control for time variation in underpricing, we might consider including year dummy variables.

We will use a pricing mechanism dummy variable (encoded as "1" for bookbuilding, and "0" for the fixed-price mechanism) to examine its effect on the amount and variance of underpricing after controlling for the effects of other variables discussed above. We may consider including both level variables, as well as natural logarithms of variables in order to allow for non-linarites in relations. Therefore, the following multivariate regression models will be estimated:

$$Underpricing_i = \beta_0 + \beta_1 Pricing\ mech._i + control\ var. + \epsilon_i$$

$$Variance\ of\ underpricing_i = \beta_0 + \beta_1 Pricing\ mech._i + control\ var. + \epsilon_i$$

(As was pointed out before, we might consider constructing the variance of underpricing variable as squared residuals from the first regression model)

Then, we will proceed with two logit models to estimate the probabilities of the selection of bookbuilding and fixed-price procedure, depending on the variables discussed above. This will allow us to learn the determinants of the pricing mechanism choice in Norwegian IPOs.

As Habib and Ljungqvist (2001) argue, OLS estimates may not be BLUE if a pricing mechanism choice is in fact endogenous. Thus, at this stage we will allow for endogeneity of the pricing mechanism choice. We will use exogenous variables (the ones that turned out to be insignificant in explaining underpricing efficiency) from previous multivariate regressions, and use them to construct corresponding logit models for bookbuilding and fixed-price. We will use logit regression coefficients to predict probabilities of the pricing mechanism choice for each IPO in the sample. We will then use these predicted probabilities in order to replace the dummy variables in the previous multivariate models. This will allow us to implement the endogeneity of the pricing mechanism choice, and check the robustness of our results.

If we have enough evidence to reject the null hypothesis of no significant link between the pricing mechanisms and underpricing after controlling for other variables, we will then study how a particular pricing mechanism performs with respect to controlling the amount and variability of underpricing, using a cross-section of bookbuilt and fixed-priced IPOs independently. This will also allow us to test the relationships between the characteristics of the issuer, the issue, market

conditions and underpricing. To implement this, multivariate regression models, constructed in a similar manner as the initial ones (though obviously without a pricing mechanism dummy), will be analysed.

If we find a statistically significant impact of the market return and volatility on underpricing, we will extend the analysis of the pricing mechanisms‟ efficiency to various market conditions, particularly “hot” versus “cold” markets. Most likely, we will sort the dataset into several market “hotness” quintiles and perform corresponding regression analyses in each of them. Lastly, to confirm the robustness of the results in our research, we might want to consider the initial returns over a longer period, for instance 10 days.

Data

For the purpose of the current research, we will need a dataset on IPOs, listed on the Oslo Stock Exchange. To construct the dataset, we will gather the information about characteristics of the firms going public (industry, age, book-to-market ratio), and characteristics of the issue (offer price, number of shares issued, number of existing shares, goal of the IPO, identity of the underwriter, pricing mechanism used).

Most of these data we intend to obtain from the IPO prospectuses and IPO database, provided by the Department of Financial Economics at BI Norwegian Business School. We are aware that there might be a need to update this database by including recent IPOs, which we intend to do.

We will also need the market data, such as stock prices time series and stock market indexes (particularly OBX), which we will obtain from the Oslo Stock Exchange. We also consider using comprehensive databases, such as Thomson Reuters DataStream, and reliable sources of information, such as companies‟ websites, if there will be a need to verify the dataset.

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