

**IPO MECHANISM SELECTION BY USING
CLASSIFICATION AND REGRESSION TREES (CART)**

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ABSTRACT

The Turkish IPO market gives issuers and underwriters a choice of three different IPO selling mechanisms. The current paper sheds new light on the determinants of these issue procedures within the context of the following methods (i) *book building mechanism*, (ii) *fixed price offer*, and (iii) *sale through the stock exchange*. Most of the empirical models in the IPO literature use binary probit and logit models to determine the factors behind the choice of one method over another and try to answer the question of “why is such a mechanism chosen”. To understand the reasons on issuers’ selection of IPO mechanism, we have conducted a Classification and Regression Trees (CART) methodology to represent decision rules in a form of binary trees. Our results indicate that, CART methodology predicts a firms’ IPO selling mechanism with 77.42% accuracy. The most important variable that determines the IPO selling mechanism is the Arrangement Type between the issuer and the underwriter as in the form of best effort and firm-commitment.

Key words: IPO selling mechanisms, Classification and Regression Trees

JEL Code: C14, C35, G10

1. Introduction

The efficiency of the IPO methods has been the subject of an academic research over a decade; both empirical studies and theoretical models have tried to explain the advantages of one method over another. The argument that is often made in favor of IPO methods is often empirical as well as theoretical. Researchers studying on the efficiency of the IPO methods try to answer the most challenging question, “Which one of the IPO mechanism is the most efficient¹, and why is such a mechanism chosen?”

Until now, the literature on IPOs, both theoretical and empirical, focuses on the efficiency of one method over another for pricing the shares and the factors behind the selection of IPO mechanisms. At the center of this literature, book building, auctions and fixed price offers differ mainly in price-discovery and share allocation process. Most of the empirical models in the literature use binary probit and logit models to determine the factors behind the choice of the following IPO mechanism over another;

(i) Book Building - in which the underwriters do road shows and take non-binding orders from investors before setting the issue price.

(ii) Auctions - in which the company sets a price range to be used as a non-restrictive guideline for investors, than accepts bids, each specifying a number of shares and a price the investor is willing to pay for them, finally, the market-clearing price set by the investors approximates the real price the shares will command in the market.

(iii) Fixed Price Offer - in which the issue price is set first and than orders are taken from investors who typically pay in advance for part or all of the shares that are ordered.

(iv) Sale through the Stock Exchange - in which the sale is initially conducted in the primary market of the stock exchange by a designated underwriter. Those investors who buy the shares in the primary market must wait until the shares trade in the secondary market in order to sell their shares. The price

¹ In terms of controlling the amount and volatility of underpricing, share allocation and pricing.

designated at the time of registration with the securities exchange commissions is set as the opening price.

(v) Hybrid Offerings - in which the underwriters combine the preceding IPO methods, and design auction/fixed price, auction/book building and book building/fixed price hybrids. For most hybrids, the most common combination is the book building/fixed price offer, where the underwriter uses the book building method to set the price and allocate shares to institutional and foreign investors, and retain the fixed price offer to the domestic retail investors who do not participate in the price-setting process.

Empirical models in the IPO literature determine the factors behind the choice of the above mentioned mechanisms over another. To understand the reasons on issuers' selection of IPO mechanism, we have conducted a Classification and Regression Trees (CART) methodology to represent decision rules in a form of binary trees.

Classification and Regression Trees is a special method of creating decision rules to distinguish between clusters of observations and determine the class of new observations. (Breiman, Friedman, Olshen, and Stone, 1984). A particular feature of CART is that decision rules are represented via binary trees, which is why it can be extremely easy to apply these rules in practice (Andriyashin, 2005).

CART is a non-parametric tool of discriminant analysis which is designed to represent decision rules in a form of so called binary trees. Binary trees split learning sample data imposing univariate linear restrictions and represent resulting data clusters hierarchically starting from root node for the whole learning sample itself and ending with relatively homogenous small groups of observations. For each terminal node class tag or forecasted value is assigned, hence resulting tree structure can be interpreted as a decision rule (Andriyashin, 2005).

Financial applications of CART methodology goes back to Flydman, Altman, and Kao (1985) to classify distressed firms, and Marais, Patell, and Wolfson (1985) to classify commercial loans. The CART methodology employed by Flydman, Altman, and Kao (1985) developed as an instrument for dealing with binary responses and as such it is suitable for use in credit scoring where the default and non-default responses are contained in data. It was later refined in subsequent editions of Breiman, Friedman, Olshen and Stone (1984).

This paper addresses the question of what kind of selling and underwriting procedure might be preferred by the issuers and/or underwriters in the Istanbul Stock Exchange (ISE). In this regard, we first compare the three IPO methods available in Turkey. One is very similar to the *book building mechanism* used in the U.S., another is the *fixed price offer*, and the third one is the *sale through the stock exchange* method. Then, we applied the Classification and Regression Trees (CART) methodology to predict and determine the factors that are expected to have an effect on the issuer's choice of IPO methods. Our results indicate that, CART methodology predicts a firms' IPO selling mechanism with 77.42% accuracy. The most important variable that determines the IPO selling mechanism is the Arrangement Type between the issuer and the underwriter as in the form of best effort and firm-commitment. If the offering is conducted through best effort, and natural logarithm of the IPO amount is smaller than 0.975, fixed price offer will be chosen by the issuer without looking at other variables. To the best of our knowledge, this is the first empirical study on the comparison between fixed price offer, sale through the stock exchange and book building methods in the IPO literature. The uniqueness of the data and the availability of the sale through the stock exchange method in the ISE make it possible to conduct a study on the comparison between these three methods.

The remaining part of this paper is organized in six sections. In the next section, we review the relevant literature and list the efficiency of one method over another. In section 3, we describe the three important Turkish IPO market selling procedures. In section 4, we describe the data set and the methodology we used in our empirical tests. In section 5, we document the results of the Classification and Regression Trees (CART) methodology and the last section concludes.

2. Comparison of the IPO methods in the literature: Theory and Evidence

The efficiency of the IPO methods has been the subject of an academic research over a decade; both empirical studies and theoretical models have tried to explain the advantages of one method over another. The argument that is often made in favor of IPO methods is often empirical as well as theoretical. The following studies presented on the table have focused on the relationship between initial market reactions and selling mechanism used in the IPO process. Researchers studying on the efficiency of the IPO methods try to answer the most challenging question, “Which one of the IPO mechanism is the most efficient?”. However, according to our comprehensive literature research, both empirical studies and theoretical models listed in Table 1 have some mixed answers.

Table 1. Comparison of the IPO methods in the literature: Empirical Studies and Theoretical Models

| | Empirical Studies and Theoretical Models presenting some evidence on the efficiency of | | |
|--|---|---------------------------|--|
| | Book Building Over | Fixed Price Offer Over | Auctions Over |
| Benveniste and Spindt, (1988), (1989) | Fixed Price Offer | | |
| Spatt and Srivastava, (1991) | Fixed Price Offer | | |
| Loughran, Ritter and Rydqvist, (1994) | Fixed Price Offer | | |
| Chowdhry and Sherman, (1996) | Fixed Price Offer | | |
| Benveniste and Busaba, (1997) | Fixed Price Offer | | |
| Ritter, (1998) | Fixed Price Offer | | Book Building and Fixed Price Offer |
| Sherman, (2000), (2002) | Fixed Price Offer and Auctions | | |
| Ljungqvist, Jenkinson and Wilhelm, (2000) | Fixed Price Offer | | |
| Aorsio, Giudici and Paleari, (2000) | Fixed Price Offer | | |
| Guidici and Paleari, (2001) | Fixed Price Offer | | |
| Biais and Faugeron-Crouzet, (2002) | Fixed Price Offer | | Fixed Price Offer |
| Chahine, (2002) | Fixed Price Offer and Auctions | | |
| Pandey, (2004) | Fixed Price Offer | | |
| Ma and Faff (2007) | Fixed Price Offer | | |
| Kutsuna and Smith, (2004) | Auctions | | |
| Anand, (2005) | Auctions | | |
| Jagannathan and Sherman, (2005) | Auctions | | |
| Pukthuanthong, Varaiya and Walker (2006) | Auctions | | |
| Chahine, (2007) | Auctions | | |
| Busaba and Cheng, (2002) | | Book Building | |
| Bierbaum and Grimm, (2003) | | Auctions | |
| Chemmanur and Liu, (2003) | | Auctions | |
| Hsu and Hung, (2005) | | Auctions | |
| Leleux and Paliard, (1995) | | | Fixed Price Offer |
| Beierlein, (2000) | | | Book Building |
| Bennouri and Falconieri, (2001) | | | Book Building |
| Draho, (2001) | | | Book Building |
| McDonald, (2001) | | | Book Building |
| Biais, Bossaert and Rochet, (2002) | | | Book Building and Fixed Price Offer |
| Kaneko and Pettway, (2003) | | | Book Building |
| Derrien and Womack, (2003) | | | Book Building |
| Vandemaele, (2003) | | | Fixed Price Offer |
| Pettway, Thosar and Walker (2006) | | | Book Building |

Almost half of the studies listed in Table 1, book building procedure turn out to be an efficient way of listing since it encourages investors to reveal their beliefs about the issue's market value, at a cost of initial underpricing. Book building mechanism result in more efficient pricing for sellers compared to fixed price offers and auctions. Another half of the IPO studies listed in Table 1 stresses the efficiency Auctions over Book Building and Fixed Price Offers, as the perceived benefits of collecting information about the state of demand through auctions are higher, firms are more opted to issue shares by auctions. Only a few provides some evidence on the efficiency of Fixed Price Offers over Auctions and Book Building, as the stock markets listing few IPOs each year, i.e. Istanbul Stock Exchange, fixed price offering remains to be the optimal methodology.

2.1. Different Methods of Sale in the Istanbul Stock Exchange (ISE)

Firms in Turkey may offer their shares to the public through book building, fixed price offer and sale through the stock exchange methods, however, they are mainly underwritten and sold using the fixed-price offering method; a method which is very common world wide is becoming much less common, particularly for more active markets. Accordingly, Turkish firms may offer their shares to the public through one of the following three methods of sale.

a. Fixed-Price Offering

In a fixed price offering method, a fixed price at which the securities are offered is known in advance by the investors. Investors fill in and sign the bid forms and submit them to the underwriter during the period designated in the prospectus. When the bid forms are submitted, investors must deposit the amount corresponding to the demanded shares to the underwriters' account. At the end of the bid collection period, the allocation of shares among investors is conducted through the pro-rata basis. Where the total amount of shares offered to the public is divided by the number of investors until the entire amount of shares has been allocated.

After the bid collection process, the underwriter submits to the issuer a list of the allocation of shares among investors within two business days after the end of the bid collection period. The issuer then approves the allocation list and returns it to the underwriter within two business days. The lists of bids that are not met are announced by the underwriter and the corresponding amounts are returned immediately to investors. Also, the shares pertaining to bids that have been met are released to investors.

b. Book Building Method

In a book building method, price at which securities will be offered is not known in advance to the investor. Only an indicative price range is known and bids above this minimum price are collected. As in the fixed price method, investors submit the bid forms and deposit the corresponding amount to the underwriters' account. At the end of the bid collection period, the allocation of shares is conducted as follows. Starting from the highest-price bid, the bids are transformed into a table showing cumulative bid amounts at each price level. The price level at which the cumulative amount exceeds the amount of shares offered is set as the selling price. All bids above that price are met.

After the bid collection process, the underwriter submits to the issuer a list of the allocation of shares among investors within two business days after the end of the bid collection period. The issuer then approves the allocation list and returns it to the underwriter within two business days. The lists of bids that are not met are announced by the underwriter and the corresponding amounts are returned immediately to investors. Also, the shares pertaining to bids that have been met are released to investors.

c. Sale through the Stock Exchange

The initial public offering of an issue using Sale through the Stock Exchange method can be carried out to the Istanbul Stock Exchange within the regulatory framework of the stock exchange after the approval of the Capital Markets Board of Turkey (CMBT). The sale is first conducted in the primary market of the ISE by a designated intermediary institution at a fixed price. Those investors who buy the shares in the primary market must wait until the shares trade in the secondary market in order to sell their shares. The sale can be made through the secondary market of the ISE after fulfilling all the required documentation at least 20 days prior to the offering. The price selected at the time of registration with the CMBT is set as the opening price. From then on, the price of the shares moves within the band determined by the daily limits set by the ISE.

3. Data and methodology

3.1. Data

The sample we analyze is the widest ever examined to carry out a research on IPOs in Turkey. We obtain firm data and issue data from the Istanbul Stock Exchange. Firm data includes sales revenue, net profit, firm age. Issue data include the number of shares issued, amount raised, offer price, first aftermarket price, and other offering details.

Our sample consists of 217 IPOs from January 1993 through October 2005. Panel A of Table 2 reports the number of IPOs and gross proceeds in Turkish market during this period. Of these 217 IPOs, 149 firms use Fixed Price Offers (69%), 39 firms use Sale through the Stock Exchange (18%), 29 firms use Book Building (13%) to distribute their shares. The number of IPOs during this period peaked in 2000 than hit the bottom in 2001. As a consequence of the 2001 crisis², the number of IPOs between 2001-2003 totaled only 7. Nevertheless, the book building mechanism which was often used in mid 90's has lost issuers interest in the most recent years, there were 25 total book building offerings in 1994-1995, but there have only been 4 since the beginning of 1996³.

² The Turkish economy has suffered from an acute liquidity crisis in 2001. The exchange rate as measured by Turkish Lira/USD depreciated by 50% in a short period of time.

³ Underwriters explain this disinterest as follows: Foreign investors are reluctant to participate in book building method, because they want to know the price in advance.

Table 2. Panel A – Initial Public Offerings Between 1993-2005**Distribution of IPOs**

| Year | Number of Companies | Fixed Price Offer | Sale through the Stock Exchange | Book Building | Nominal Value Thousand US\$ | Amount Sold Thousand US\$ |
|--------------|----------------------------|--------------------------|--|----------------------|------------------------------------|----------------------------------|
| 1993 | 16 | 1 | 15 | - | 18.130 | 152.447 |
| 1994 | 25 | 5 | 2 | 18 | 24.419 | 270.480 |
| 1995 | 29 | 16 | 6 | 7 | 44.440 | 246.783 |
| 1996 | 27 | 24 | 3 | - | 34.626 | 167.922 |
| 1997 | 29 | 28 | - | 1 | 66.091 | 420.377 |
| 1998 | 20 | 19 | 1 | - | 66.998 | 383.348 |
| 1999 | 10 | 8 | 2 | - | 52.391 | 87.413 |
| 2000 | 35 | 34 | 1 | - | 157.690 | 2.809.532 |
| 2001 | 1 | 1 | - | - | 231 | 243 |
| 2002 | 4 | 3 | 1 | - | 17.062 | 56.467 |
| 2003 | 2 | - | 2 | - | 1.958 | 11.252 |
| 2004 | 12 | 9 | 2 | 1 | 107.114 | 482.575 |
| 2005 | 7 | 1 | 4 | 2 | 18.436 | 472.107 |
| Total | 217 | 149 | 39 | 29 | 609.586 | 5.560.946 |

Our sample consists of 217 IPOs from January 1993 through October 2005. Of these 217 IPOs, 149 firms use fixed price offers (69%), 39 firms use Sale through the Stock Exchange (18%), 29 firms use book building (13%) to distribute their shares.

Panel B of Table 2 reports some descriptive statistics of Turkish IPOs from 1993 through 2005 on firms specific and market related characteristics. In line with the evidence on initial returns documented by Ozer (1999), Kiyamaz (2000) and Durukan (2002), IPOs in the sample also suffer from a significant underpricing on an average. The average initial returns computed on the basis of first trading day closing are positive and significant for all the three types of IPO methods, high levels of underpricing observed in sale through the stock exchange with a mean of 15.68%, low levels of underpricing observed in fixed price offers with a mean of 7.01%. The average initial returns computed on the basis of first month closing price are still positive for fixed price offers with a mean of 15.61% and sale through the stock exchange offers with a mean of 58.83%, however, book building offers lead their investors into a systematic under-performance at the same time period.

Table 2. Panel B – Descriptive statistics of Turkish IPOs from 1993 through 2005

IPO/Firm Characteristics

| | Fixed Price Offer | | | Sale through the Stock Exchange | | | Book Building | | |
|---|-------------------|--------------|--------------|---------------------------------|-------------|-------------|---------------|-------------|-------------|
| | Mean | Median | Std. Dev | Mean | Median | Std. Dev | Mean | Median | Std. Dev |
| IPO Amount (\$ Thousand) | \$29,873.40 | \$8,121.48 | \$147,300.88 | \$6,593.29 | \$3,141.03 | \$6,848.51 | \$12,177.25 | \$10,969.42 | \$9,009.70 |
| Fractions of Equity Sold | 25.66% | 20.00% | 16.37% | 35.32% | 20.00% | 30.98% | 24.28% | 16.67% | 16.78% |
| Days between pricing and first trade | 10.48 | 8.00 | 9.76 | 8.74 | 7.00 | 5.20 | 22.46 | 14.00 | 25.86 |
| Net Sales (\$ Thousand) | \$105,314.90 | \$275,416.00 | \$35,601.75 | \$54,464.50 | \$28,194.80 | \$68,297.10 | \$49,556.20 | \$30,864.70 | \$55,182.60 |
| Total Assets (\$ Thousand) | \$110,256.10 | \$29,454.50 | \$34,694.15 | \$50,311.60 | \$14,207.30 | \$72,297.20 | \$49,880.90 | \$31,384.80 | \$66,969.10 |
| Total Debt (\$ Thousand) | \$88,106.70 | \$13,515.80 | \$33,991.03 | \$36,108.00 | \$13,219.30 | \$50,667.60 | \$40,494.80 | \$17,538.90 | \$65,113.30 |
| Total Equity (\$ Thousand) | \$31,726.20 | \$13,642.70 | \$6,166.32 | \$19,845.50 | \$7,734.60 | \$37,226.10 | \$15,616.10 | \$12,119.90 | \$14,063.80 |
| Net Profit (\$ Thousand) | \$4,598.90 | \$2,643.70 | \$2,515.26 | \$7,202.90 | \$3,414.40 | \$10,755.30 | \$5,642.70 | \$3,213.70 | \$6,262.10 |
| Age of the Firm | 17.19 | 12.84 | 17.42 | 17.11 | 17.32 | 15.45 | 19.36 | 16.70 | 12.16 |
| 1st Day Return (underpricing) | 7.01% | 7.67% | 14.73% | 15.68% | 10.91% | 18.75% | 11.47% | 6.67% | 41.03% |
| 1st Day Adjusted Return (underpricing) | 7.47% | 7.22% | 14.86% | 15.88% | 12.15% | 18.21% | 11.85% | 7.32% | 41.34% |
| 1st Week Return | 9.59% | 0.96% | 31.77% | 42.58% | 25.94% | 55.96% | 17.37% | 5.87% | 59.67% |
| 1st Week Adjusted Return | 8.87% | 1.32% | 31.08% | 40.47% | 26.95% | 57.06% | 17.14% | 3.27% | 59.93% |
| 1st Month Return | 15.61% | -2.75% | 62.31% | 58.83% | 36.36% | 72.67% | -8.83% | -13.51% | 56.02% |
| 1st Month Adjusted Return | 12.14% | -3.97% | 59.79% | 43.23% | 36.20% | 64.98% | -13.02% | -12.40% | 54.69% |
| Market Return prior to IPO | 6.65% | 6.07% | 11.05% | 8.34% | 7.09% | 9.39% | 6.49% | 5.61% | 7.66% |
| Market Volatility prior to IPO | 15.40% | 14.80% | 4.77% | 13.58% | 13.93% | 3.49% | 15.64% | 13.76% | 6.24% |

IPO Amount, is the gross proceeds from the IPO stated in USD. *Fractions of Equity Sold*, is the portions of shares offered to the public. *Days between pricing and first trade*, is the number of calendar days between the day when the offering price is chosen and the IPO date. *Net Sales*, *Total Assets*, *Total Debt*, *Total Equity*, *Net Profit* are from the book values of the firm in the year preceding of an IPO. *Age of the Firm*, is the age of the issuing firm at the time of the IPO. *1st Day Return*, *1st Week Return*, *1st Month Return* of the IPO is defined as the percentage change of the stock price from its offering price to the first trading day, first trading week and first trading month's closing price. *1st Day Adjusted Return*, *1st Week Adjusted Return*, *1st Month Adjusted Return*, of the IPO is defined as the percentage change of the stock price from its offering price to the first trading day, first trading week and first trading month's closing price with adjustments to the market index returns. *Market Return prior to IPO*, is calculated as the weighted average of the returns of the market index for the 3 months before the IPO pricing date. The weights are 3 for the most recent month, 2 for the next month and 1 for the third month before the offering. *Market Volatility*, is the standard deviation of the 1 month return of the market index in the month before the IPO. In order to eliminate the inflation affect that may distort the results all figures are stated in USD.

Panel B also shows that the fractions of equity offered to the public is higher in the sale through the stock exchange method with a mean of 35.32%, than the fixed price offer (25.66%) and book building (24.28%) methods. Firm specific variables such as Net Sales, Total Assets, Total Equity, and Total Debt show that larger firms are more likely use the fixed price offers and smaller firms use sale through the stock exchange and book building methods.

The univariate results in Panel B of Table 2 indicate that firms have chosen an IPO method in accordance with the “issue related and issuing firm characteristics”. Likewise, CART analyses will help us relate these characteristics into three different IPO selling mechanisms.

We used various variables as indicators of different aspects of IPOs and grouped these independent variables that are predicted to have an influence on issue procedure choice; *Source of Equity Sold*, *Underwriting Arrangements*, *Fractions of Equity Sold*, and *IPO Amount* under “issue related characteristics”, and *Age of the Firm*, *Net Sales*, and *Net Profit* under “issuing firm characteristics”, and *Adjusted Daily Return*, *Adjusted Weekly Return*, *Adjusted Monthly Return*, and *Market Return*, under “market related characteristics”.

3.1.1. Issue Related Characteristics

Source of Equity Sold, *Underwriting Arrangements*, *Fractions of Equity Sold*, and *IPO Amount* have been used as indicators of “issue related characteristics”.

Source of Equity Sold, (*Source_equity*)

IPOs in the ISE are classified as either the offering of new issues where the equity that is offered to the public are from blocking of pre-emptive rights in a capital increase or the sales of previously issued outstanding shares where the equity that is offered to the public are from the existing shareholders. A dummy variable is employed and takes the value of 0 (zero) if the offering is the sale of the previously issued outstanding shares, and one (1) if it is the offering of new issues.

Underwriting Arrangements, (*Arrangement_type*)

There are two types of underwriting arrangements in the ISE; The firm-commitment and the best-effort method. In the firm-commitment method, the underwriter guarantees the proceeds of the issuing firm and bears the risk of under subscription. In the best-effort offerings, the underwriter attempts to sell as many of the new shares as possible at an agreed price per share, without purchasing any shares. A dummy variable is employed and takes the value of 0 (zero) if the offering is conducted through best-effort, and one (1) if the is the offering is conducted through firm commitment.

Fractions of Equity Sold, (*Fra_ipo*)

Portions of shares offered to the public.

IPO Amount, (*Amount_ipo*)

Gross proceeds from the IPO stated in USD. The natural logarithm of IPO amounts are used in the statistical tests.

3.1.2. Issuing Firm Characteristics

Age of the Firm, *Net Sales* and *Net Profit* have been used as indicators of “issuing firm characteristics”.

Age of the Firm, (*Firm_age*)

Is the age of the issuing firm at the time of the IPO. The natural logarithms of years are used in the statistical tests.

Net Sales, (Net_sales)

Is the book value of net sales of the firm in the year preceding of an IPO. In order to eliminate the inflation affect that may distort the results. All figures are stated in USD and the natural logarithms of amounts are used in the statistical tests.

Net Profit, (Net_profit)

Is the book value of net profit of the firm in the year preceding of an IPO. In order to eliminate the inflation affect that may distort the results. All figures are stated in USD and the natural logarithms of amounts are used in the statistical tests.

3.1.3. Market Related Characteristics

Adjusted Daily Return, Adjusted Weekly Return, Adjusted Monthly Return and Market Return have been used as indicators of “market related characteristics”.

Adjusted Daily Return, (AdjDaily_ret)

Adjusted daily return of the IPO is defined as the percentage change of the stock price from its offering price to the first trading day closing price with adjustments to the market index returns⁴.

Adjusted Weekly Return, (AdjWeekly_ret)

Adjusted weekly return of the IPO is defined as the percentage change of the stock price from its offering price to the first trading week closing price with adjustments to the market index returns.

Adjusted Monthly Return, (AdjMonthly_ret)

Adjusted monthly return of the IPO is defined as the percentage change of the stock price from its offering price to the first trading month closing price with adjustments to the market index returns.

Market Return, (Mkt_Ret)

Market return is calculated as the weighted average of the returns of the market index for the 3 months before the IPO pricing date. The weights are 3 for the most recent month, 2 for the next month and 1 for the third month before the offering. Hsu and Hung’s (2005) study in Taiwanese IPOs, shows that previous market returns prior to IPOs have significant impacts on the issuers’ choice of IPO method.

3.2. Methodology

The purpose of this section is to provide a brief description of the essential features of the Classification and Regression Trees (CART) method. We find it instructive to describe first the nature of the CART method, and next the rules in the construction of the model.

In this study Classification and Regression Trees (CART) method is used to predict IPO method. The (CART) method was first introduced by Breiman et. al (1984). It is an alternative method for classification that is used to split the observation into different classes by building binary decisions. CART is a widely used nonparametric technique for feature selection. The purpose of the technique is to determine a set of if-then else conditions to classify observations. In other words, it is a sequence of questions which can be answered as yes or no concerning whether the condition satisfied or not.

There are two types of trees; classification tree and regression tree. The classification tree is used when there is a need to classify the data into classes. The regression tree is used when the dependent variable is continuous. Since our goal is to predict the IPO method we have used the classification tree.

⁴ The raw returns have been adjusted for market movements through deducting the corresponding return of the market index from the raw return on a given event day t.

In classification tree, binary partitioning is used to construct the tree nodes by dividing the sample into two sub-samples for each node. The tree starts with the division of the sample into two sub samples. First, all observations of an independent variable are placed in the root node and it is assumed that each observation of that independent variable divide the sample into two sub samples. All observations of that independent variable are called splits. Suppose X_j is the j^{th} independent variable and x_{ij} is the i^{th} observation of the j^{th} independent variable. Then each observation, in other words each split, has been asked by a standard question, such as “is $X_j < x_{ij}$ ” and the observation of the variable with “yes” answer will be sent to the left child node and “no” answer will be sent to the right child node. Best split is determined by the splitting rule. This process repeated for each independent variable is to select the best split that minimizes the change in impurity. According to the terminating rule, each node is determined as terminal or non-terminal and for a terminal node a class is assigned with class assignment rule.

3.2.1. Splitting Rule

The splitting rule is used to split the data into smaller pieces with homogeneity. To determine the best split there are goodness of splitting criterion depending on the purity of nodes. To estimate the impurity function, first it is needed to estimate the probability of class j observation in node t ,

$$p(j|t) = \frac{N_j(t)}{N(t)}$$

Where,

$N_j(t)$ = number of observations in node t belonging to class j ,

$N(t)$ = number of observations in node t .

The impurity function has the following properties.

- 1) When $p(1|t) = p(2|t) = \dots = p(j|t) = \frac{1}{j}$ the impurity function $\phi(\frac{1}{j}, \dots, \frac{1}{j})$ takes its maximum value
- 2) In node t when there is only one majority of class, then the impurity function $\phi(p(1|t), p(2|t), \dots, p(j|t))$ takes its minimum.
- 3) ϕ is a symmetric function of probability of class j in node t

The impurity function is:

$$i(t) = \phi(p(1|t), p(2|t), \dots, p(j|t))$$

The best splitting rule is the rule that maximizes the change in impurity is defined as:

$$\Delta i(t) = i(t) - p_L i(t_L) - p_R i(t_R)$$

Where,

p_L is the proportion of observations in the left child node,

p_R is the proportion of observations in the right child node.

The most frequently used splitting rule is the Gini index:

$$i(t) = \sum_{i \neq j} p(j|t)p(i|t)$$

The change in impurity is:

$$\Delta i(t) = i(t) - p_L i(t_L) - p_R i(t_R)$$

The splitting rule problem is to select a rule that maximizes the change in impurity.

3.2.2. Terminating Rule

After determining the splitting rule the node's termination rule should be assessed to determine whether to terminate or continue to split. A splitting process stops when it is impossible to decrease the change in impurity.

3.2.3. Class Assignment Rule

For terminal nodes a class should be assigned. There are two ways to assign a class.

- 1) It is a rule of assigning a class to a node when the majority of observations are belonging to that class.
- 2) The second rule assigns a class to a node which maximizes the expected misclassification cost defined as:

$$r(t) = \sum_{j=1}^J c(i|j)p(j|t) \quad i \neq j$$

Where

$c(i|j)$ is the cost of assigning a class i to class j .

3.2.4. Determining the Right Sized Tree

First step of constructing the tree is to split the sample into homogeneous classes up to the last observation. This process is called determining the maximum sized tree. The maximum sized tree is too complex to interpret. Therefore, by taking into account the accuracy of results and complexity optimum sized tree should be found. To build right sized tree pruning process is used. For right sized tree we need the following cost and complexity measures.

$$R_\alpha(T) = R(T) + \alpha \tilde{T}$$

$$\alpha \geq 0 \quad T < T_{\max}$$

$R(T)$ is the misclassification cost of tree

α is the complexity parameter

\tilde{T} is the number of terminal nodes.

First, for each value of α sub trees are formed

$$T_{\max}, T_1, \dots, t_0$$

t_0 is the root node

Then cost complexity measures are estimated for each sub-tree. Finally, the tree with minimum-cost complexity measure is taken as the right-sized tree.

4. CART Results

In this section, what we expect from classification tree results is to help us relate issuers' choice of sale through stock exchange, fixed-price offer or book building method to "issue related characteristics" and/or "issuing firm characteristics" and/or "market related characteristics".

The right sized tree was obtained after 4 pruning with optimum cross-validation result. The CART applications are aimed to achieve the best predictive accuracy with minimum expected cost. In this study 77.4194 percentages of data is correctly classified.

In Figure 1, the decision tree with optimum cost and complexity is represented. The right-sized tree is built with *Arrangement_type*, *Source_equity*, *Fra_ipo*, *Firm_age*, *Amount_ipo*, *AdjDaily_ret*, and *AdjMonthly_ret*.

The interpretation of the tree is so simple. There are different possible paths to move on to predict the IPO mechanism. The tree starts with the root node. This node's split is based on *Arrangement_type*. The variable in the root node is the most significant variable in IPO mechanism selection and all paths of the tree are started with the *Arrangement_type*.

As we move along the paths of the left side tree, *Arrangement_type* and *Firm_age* variables form the main branches of the CART. When a firm's initial public offering is conducted through underwriters' best effort and the natural logarithm of a firms' age is smaller than 0.975, fixed price offer will be chosen as an IPO mechanism.

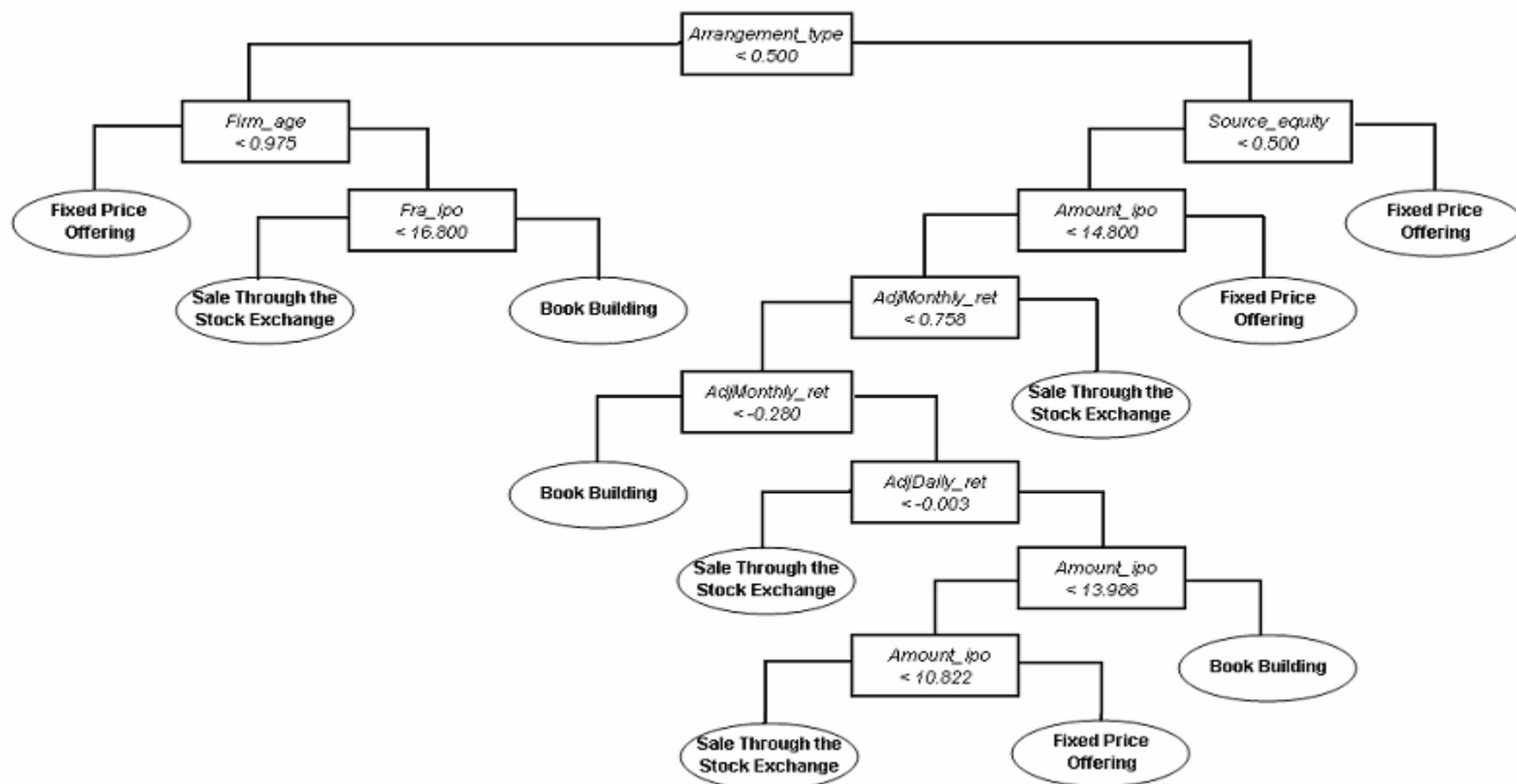
In the second path of the left side tree, in addition to *Arrangement_type* and *Firm_age*, if the natural logarithm of a firms' age is larger than 0.975, we need to check the fraction of the equity sold to the public. If the fraction of the equity sold to the public is less than 16.80%, it is predicted that the IPO mechanism will be the sale through the stock exchange method, contrary, if the fraction of the equity sold to the public is greater than 16.80%, the IPO mechanism is predicted to be the book building method.

The paths in the right side of the tree are more complex than the left side. There are more possibilities to check.

The first path of right side tree includes *Arrangement_type* and *Source_equity*. If the offering is conducted through firm commitment, and the offering is from the new issues, then the IPO mechanism is predicted to be the fixed price offer, however, if the offering is from the sale of the previously issued outstanding shares, we need to check the natural logarithm of the *Amount_ipo*. If the natural logarithm of the *Amount_ipo* is greater than 14.80, the IPO mechanism again will be predicted as fixed price offer. If the natural logarithm of *Amount_ipo* is smaller than 14.80, we need to move along the branches of a new path.

In the new path, an offering which is; (i) conducted through firm commitment, (ii) from the sale of the previously issued outstanding shares (iii) the natural logarithm of *Amount_ipo* is smaller than 14.800, *AdjMonthly_ret* variable should be checked for a new branch to another IPO choice. If *AdjMonthly_ret* is greater than 0.758, the IPO mechanism should be predicted as sale through the stock exchange method, if it is smaller than -0.280, then it should be predicted as book building method. In this new path, if the *AdjMonthly_ret* is smaller than 0.758 and greater than -0.280, we should check two more variables; *Amount_ipo* and *AdjDaily_ret*. If the expected adjusted daily return of an IPO is smaller than -0.003, the IPO mechanism will be selected as sale through the stock exchange by the issuer, however, if the adjusted daily return is greater than -0.003, and the natural logarithm of IPO amount is smaller than 10.822, the IPO mechanism will again be selected as sale through the stock exchange method. At last, if the *Amount_ipo* is smaller than 13.986 and greater than 10.822, the predicted IPO mechanism should be the fixed price offer, if it is greater than 13.986 the predicted IPO mechanism should be the book building method.

Figure 1. Classification and Regression Tree



5. Conclusion

The Turkish IPO market gives issuers and underwriters a choice of three different IPO selling mechanisms. The current paper sheds new light on the determinants of these issue procedures within the context of the following methods (i) *book building*, (ii) *fixed price offer*, and (iii) *sale through the stock exchange*. Understanding the reasons issuers' select one method over another is important. If for each firm, the total benefit one method is higher, then this method will definitely dominates as a favorable way of going public. Issuers select IPO mechanisms on the basis of their private benefits. However, as we discuss above, some of the benefits are redistributive across issuers. In a regime where all three methods are available, every issuer may select fixed price offering even though, collectively, they would prefer book building or sale through the stock exchange.

Most of the empirical models in the IPO literature use binary probit and logit models to determine the factors behind the choice of one method over another and try to answer the question of "why is such a mechanism chosen". To understand the reasons on issuers' selection of IPO mechanism, we have conducted a Classification and Regression Trees (CART) methodology to represent decision rules in a form of binary trees. Our results indicate that, CART methodology predicts a firms' IPO selling mechanism with 77.42% accuracy. The most important variable that determines the IPO selling mechanism is the Arrangement Type between the issuer and the underwriter as in the form of best effort and firm-commitment.

The main conclusion of this work is that decision trees can be used to select IPO mechanisms, even in high-dimensional space. We have explored the qualities of the CART methodology applied to the selection of the IPO methods in Turkey. Answering the question of which method to choose is not straightforward and depends mainly on the issuer's and/or underwriters preferences. Although, the literature on the efficiency of the IPO methods suggests that, fixed price offering seems to be the less favorable method comparing to book building and auction methods across many countries around the world. Fixed price offering method still used as a favorable method in the ISE. And this fact can also be supported by Sherman's study on Global Trends in IPO methods (2002), where stock markets listing few IPOs each year, i.e. Istanbul Stock Exchange, fixed price offering is still be the optimal method.

REFERENCES

- Allen, F., and G. Faulhaber, 1989, "Signaling by Underpricing In the IPO Market," *Journal of Financial Economics*, 23, pp.303-323.
- Anand, A.I., 2005, "Is the Dutch Auction IPO a Good Idea?", *Expresso Preprint Series*, Paper, 672.
- Andriyashin, A., March 2005, "Financial Applications of Classification and Regression Trees." Master's thesis, Humboldt University, Berlin.
- Aorsio, R., G. Giudici, and S. Paleari., 2000, "Underpricing and Money "Left on the Table" in Italian IPOs", Working Paper, Politecnico di Milano - Dipartimento di Economia e Produzione
- Beierlein, J., 2000, "The Efficiency of IPO Mechanisms: A Comparison of Book-Building", Discriminatory Price Auctions and Uniform Price Auctions, Unpublished paper, University of Utah.
- Bennouri, M. and S. Falconieri, 2001, "Price vs. Quantity Discrimination in Optimal IPOs", Tinbergen Institute Discussion Papers.
- Benveniste, L. and P. Spindt, 1988, "Bringing New Issues to Market: A Theory of Underwriting." Unpublished Manuscript.
- Benveniste, L., and P. Spindt, 1989, "How investment bankers determine the offer price and allocation of new issues", *Journal of Financial Economics*, 24, pp.343-361.
- Benveniste, L., and W. Busaba, 1997 "Bookbuilding versus Fixed Price: An Analysis of Competing Strategies for Marketing IPOs", *Journal of Financial and Quantitative Analysis*, 32, pp.383-403.
- Biais, B., P. Bossaert, and J.C. Rochet, 2002, "An optimal IPO mechanism", *Review of Economic Studies*, 69, pp.117-146.
- Biais, B., and A.M. Faugeron-Crouzet, 2002, "IPO Auctions: English, Dutch,...French and Internet", *Journal of Financial Intermediation* , 11, pp.9-36.
- Bierbaum, J., and V. Grimm, 2003, "Selling Shares to Retail Investors: Auction vs. Fixed Price", Humboldt-Universität Berlin, Working Paper.
- Breiman, L., Friedman, J. H., Olshen, R. A. and Stone, C. J., 1984, "Classification and Regression Trees". Pacific Grove, CA: Wadsworth.
- Chalk A.J., and J.W. Peavy, 1987, "Initial public offerings and underwriter reputation", *Journal of Finance*, Vol. 45, No. 4, pp. 1045-1067.
- Chahine, S., 2002, "Mispricing in IPO Methods and the Predictive Ability of Investors' Interest for New Issues", University of Audencia-Nantes, Working Paper.
- Chahine, S., 2007, "Investor interest, trading volume, and the choice of IPO mechanism in France", *International Review of Financial Analysis* 16 (2007) 116– 135
- Chemmanur, T., and H. M. Liu, 2003, "How should a firm go public? A dynamic model of the choice between fixed-price offerings and auctions in IPOs and privatizations", Unpublished paper, Boston College.

Chowdhry, B., and A. Sherman, 1996, "International differences in oversubscription and underpricing of IPOs", *Journal of Corporate Finance*, Vol. 2, Issue 4, pp.359-381.

Cornelli, F., and D. Goldreich, 2001, "Book Building and Strategic Allocation", *Journal of Finance*, Vol. 56, Number 6, pp.2337-2369.

Cornelli, F., and D. Goldreich, 2003, "Bookbuilding: How Informative Is the Order Book", *Journal of Finance*, Vol. 58, Number 4, pp.1415-1443.

Derrien, F. and K. Womack, 2003, "Auction vs Bookbuilding and the Control for Underpricing in the Hot IPO Markets", *Review of Financial Studies*, Vol. 16, Number 1, pp.31-61.

Draho, J., 2001, "The Effect of Uncertainty on the Underpricing of IPOs", mimeo, Yale University.

Durukan, M.B., 2002, "The relationship between IPO returns and factors influencing IPO performance: case of the Istanbul Stock Exchange", *Managerial Finance*, Vol. 28, pp.18-38.

Degeorge, F., Derrien, F., and K.L. Womack, 2005, "Quid Pro Quo in IPOs: Why Book-Building Is Dominating Auctions, RICAFA Working Paper, No. 011

Flydman, H., Altman, E.I., and Kao, D., 1985, "Introducing Recursive Partitioning for Financial Classification: The Case of Financial Distress". *The Journal of Finance*. Vol. 40. No.1. pp.269-291.

Guidici, G., and S. Paleari., 2001, "What drives the initial market performance of Italian IPOs? An empirical investigation on underpricing and price support", Working Paper, Università degli Studi di Bergamo, Italy.

Grinblatt, M., and C. Hwang, 1989, "Signalling and the Pricing of New Issues," *Journal of Finance*, 44, pp.393-420.

Hsu, Y., and H. Chung-Wen, 2005, "Why Have IPO Auctions Lost Market Share to Fixed-price Offers? Evidence from Taiwan" Working Paper, National Chengchi University, Taipei, Taiwan, Southern Taiwan University of Technology, Tainan, Taiwan.

Ibbotson, R., 1975, "Price performance of common stock new issues", *Journal of Financial Economics*, September, pp.235-272.

Jagannathan, R., and A. Sherman, 2005, "Reforming the Bookbuilding Process for IPOs", *Journal of Applied Corporate Finance*, Vol. 17, Number 1, pp.67-72

Jenkinson, T., and H. Jones, 2004, "Bids and Allocations in European IPO Bookbuilding", *Journal of Finance*, 59, 5, pp.2309-2338.

Kandel, S., Sarig O., and A. Wohl, 1999, "The Demand for Stocks: An Analysis of IPO Auctions", *The Review of Financial Studies*, 12, pp.227-48.

Kaneko, T. and R. H. Pettway, 2003, "Auctions versus book building of Japanese IPOs", *Pacific-Basin Finance Journal*, 11, (September), pp.439-462.

Kiyamaz, H., 2000, "The initial and aftermarket performance of IPOs in an emerging market: evidence from Istanbul Stock Exchange", *Journal of Multinational Financial Management*, Vol. 10, pp.213-227.

Kutsuna, K., and R. Smith, 2004, "Issue cost and method of IPO under-pricing: Japan's change from auction method pricing to book-building", *The Review of Financial Studies*, 17, 4, pp.1129-1166.

- Liu, Y., J. Wei, and G. Liaw, 2003, "On the demand elasticity of initial public offerings: An analysis of discriminatory auctions", *International Review of Finance*, 2, pp.151-178.
- Ljungqvist, A.P., 2005, "IPO Underpricing", Forthcoming in B. Espen Eckbo (ed.), *Handbook of Corporate Finance: Empirical Corporate Finance (Handbooks in Finance Series, Elsevier/North Holland)*, Chapter 12.
- Ljungqvist, A.P., Jenkinson, T., Wilhelm, W.J., 2000, "Has the introduction of bookbuilding increased the efficiency of international IPOs?" Working Paper, Stern School of Business, New York University.
- Logue, D., 1973, "On the pricing of unseasoned equity issues:1965-1969", *Journal of Financial and Quantitative Analysis*, January, pp.91-103.
- Loughran, T., Ritter, J.R., and K. Rydqvist, 1994, "Initial public offerings: international insights", *Pacific-Basin Journal*, Vol. 2, pp.165-199.
- Ma, S., and Faff, R., 2007, "Market conditions and the optimal IPO allocation mechanism in China." *Pacific-Basin Finance Journal* 15 (2007) 121-139
- Marais, M.L., Patell, J.M., and Wolfson, M.A. "The experimental design of classification tests: the case of commercial bank loan classifications." *Journal of accounting research* 22 (1984), Supplement, March-April 1985.
- McDonald, S., 2001, "Internet IPO Auctions: Will they eliminate traditional underwriting inefficiencies?" University of Lausanne, Masters Thesis.
- Miller, R., and F. Reilly, 1987, "An Examination of Mispricing, Returns and Uncertainty of IPOs", *Financial Management*, Summer, pp.33-38.
- Ozer, B., 1999, "Price Performance of Initial Public Offerings in Turkey", *Capital Markets Board of Turkey*, Publication No. 128, Ankara, Turkey.
- Pettway, R. H., Thosar, S., and Walker, S., 2006, "Auctions versus book-built IPOs: Further evidence" 2006 FMA Annual Meeting, Salt Lake City, Utah.
- Pettway, R. H., and T. Kaneko, 1996, "The effects of removing price limits and introducing auctions upon short-term IPO returns: The case of Japanese IPOs", *Pacific-Basin Finance Journal*, 4, pp.241-258.
- Pukthuanthong, K., Varaiya, N.P., and Walker, T.J., 2006, "Book Building versus Auction Selling Methods: A Study of U.S. IPOs" 2006 FMA Annual Meeting, Salt Lake City, Utah.
- Ritter, J.R., 1984, "The 'Hot Issue' Market of 1980," *Journal of Business* 57, pp.215-240.
- Ritter, J.R., 1998, "Initial Public Offerings", *Contemporary Finance Digest* 2, pp.5-30.
- Ritter, J.R., and I. Welch, 2002, "A Review of IPO Activity, Pricing, and Allocations", *Yale ICF Working Paper* No. 02-01.
- Ritter, J.R., 2003, "Differences between European and American IPO Markets", *European Financial Management*, Vol. 9, Number 4, pp.421-434.
- Rock, K., 1986, "Why New Issues Are Underpriced," *Journal of Financial Econometrics* 15, pp.187-212.

Sherman, A., 2000, "IPOs and Long Term Relationships: An Advantage of Book Building", *Review of Financial Studies* 13, pp.697-714.

Sherman, A., 2002, "Global Trends in IPO Methods: Book Building vs. Auctions", Working Paper, University of Notre Dame.

Spatt, C., and S. Srivastava, 1991, "Preplay Communication, Participation Restrictions, and Efficiency in Initial Public Offerings", *Review of Financial Studies*, 4, pp.709-726.

Vandemaele, S., 2003, "Choice of selling mechanism at the IPO: the case of the French Second Market", *European Financial Management*, 9, 4, pp.435-455.

Welch, I., 1989; "Seasoned Offerings, Imitation Costs, and the Underpricing of Initial Public Offerings," *Journal of Finance*, 44, pp.421-449.

Welch, I., 1992, "Sequential Sales, Learning, and Cascades", *Journal of Finance*, 47, pp.695-732.