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Underpricing, stock allocation, ownership structure and post-listing liquidity of newly listed firms

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Abstract

This study investigates the relationship between underpricing, ownership structure and post-listing liquidity of initial public offerings (IPOs). It is argued that higher underpricing induces both broader investor participation and creates a more diffuse ownership structure. These two factors are in turn positively associated with the level of post-listing trading, and therefore offer an explanation of how underpricing can influence liquidity. Using a sample of Australian IPOs, we provide evidence of statistically significant relationship between underpricing and various proxies for shareholding distribution and liquidity. This result remains robust after controlling for a number of potential underlying factors that may drive both underpricing and ownership allocation decisions. Overall, our analysis suggests that liquidity is a partial but important benefit of underpricing an IPO.
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1. Introduction

The process of a firm's initial public offering (IPO) is characterised by the expansion of its ownership structure, previously concentrated in the hands of a few parties,

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to include a much larger number of outside investors. Consequently, this also leads to higher trading liquidity—a factor often considered to be one of the important objectives of any IPO. In particular, a higher level of liquidity reduces transaction costs in future equity raisings (Ibbotson and Ritter, 1995), increases firm value (Amihud and Mendelson, 1986), provides a better environment for managerial incentive schemes and improves market monitoring by encouraging information dissemination by speculators (Holmström and Tirole, 1993). In addition, promoting trading liquidity through ownership dispersion may engender an effective mechanism to impede future hostile takeovers (Shleifer and Vishny, 1986).

However, it has been argued that there are also certain drawbacks associated with higher trading liquidity. A concentrated shareholder distribution, which is associated with lower liquidity, may actually confer more value than a dispersed one, as large shareholders possess greater incentives to monitor their company's activities to minimise agency costs. [1] This is especially important for companies with a less pronounced degree of information asymmetries, as large shareholders are more likely to intervene because the consequence of their actions could be observed by the market (Kahn and Winton, 1998). Therefore, some companies may deliberately forfeit liquidity in order to adopt a concentrated ownership structure. Another drawback is the necessary cost incurred to achieve higher liquidity, because in order to create a broad and diverse shareholder base, small investors must be rewarded sufficiently to induce their participation. Our paper proposes that this reward is based on the extent to which IPOs are priced below their fair value (i.e. the level of underpricing); and hence there should be a strong connection between underpricing, post-allocation ownership structure and after-market liquidity.

While most of the research on IPOs has focused on explaining the underpricing phenomenon, few studies have investigated the determinants of after-market liquidity. [2] This factor among other issues was discussed briefly in Miller and Reilly (1987), Hanley (1993) and Schultz and Zaman (1994), who documented that underpriced IPOs on average exhibit higher after-market trading turnover than overpriced IPOs. However, they did not clearly provide an explanation regarding why this relationship arises. Reese (1998) also showed that there is a positive relationship between underpricing and post-listing trading turnover for up to three years after listing. He suggested the level of investor interest in each IPO, which is represented by the extent of financial media coverage, to be a possible explanation for this relationship.

Our study differs from the above-mentioned research in two primary ways. First, we present evidence that a higher level of underpricing will lead to not only increased trading turnover, but also lower bid–ask spread. It is believed that these two proxies are complementary and employing both provides a more complete representation of post-listing liquidity. Second, we also offer an explanation as to why this relationship arises. In contrast to Reese (1998), we argue that this relationship is formed through the mediation of ownership structure formed after the allocation process. Hence that

[1] See Jensen and Meckling (1976), Demsetz and Lehn (1985), Shleifer and Vishny (1986), Burkart et al. (1997) and Bolton and von Thadden (1998) among others.

[2] See Ibbotson and Ritter (1995) for an extensive review of the literature on IPO underpricing.

this explanation is more closely aligned to the existing theories on the determinants of trading liquidity (Demsetz, 1968; Amihud and Mendelson, 1986; Holmström and Tirole, 1993) and the "winners' curse" hypothesis of underpricing (Rock, 1986). However, the focus of our analysis is not in testing the winners' curse hypothesis, as in Michaely and Shaw (1994), but rather in the way this theory helps explain how an IPO could achieve its after-market liquidity objective.

In particular, it is proposed that an IPO company seeking a liquid secondary market for its shares must attract a large number of small shareholders to create a more dispersed ownership structure. However, being information-disadvantaged, small investors incur some adverse selection costs and therefore require a higher degree of underpricing to induce them to invest. Alternatively, an IPO may desire a concentrated ownership structure to promote the benefits of monitoring and reduce agency costs, but at the expense of liquidity. In this case, a smaller degree of underpricing is required to achieve complete participation, as large shareholders possess superior information about the company's true value and could even be prepared to pay a premium for the extent of control they receive. We document evidence in support of these arguments when investigating a sample of IPOs on the Australian Stock Exchange (ASX). Underpricing is found to influence the two dimensions of ownership structure (breadth and equality of shareholder distribution), which are in turn related to post-listing liquidity. This finding remains consistent across different proxies of ownership structure and liquidity, as well as various regression specifications employed.

Since our propositions rely upon the assumption that IPOs differ in their preference for liquidity or concentrated ownership, it is important that we attempt to identify what companies would be interested in underpricing to achieve more diverse shareholder distribution and higher liquidity. This is also useful to explore and control for the possible underlying firm characteristics that may simultaneously influence the three principal factors under investigation: underpricing, ownership structure and liquidity. [3] By utilising a probit model of underpricing decisions, we find that overpriced IPOs are likely to have less debt and higher market-to-book ratio. This result supports our previous arguments because firms with these features are often associated with higher agency costs (Jensen and Meckling, 1976; Gompers, 1995), and hence receive greater marginal benefits from future monitoring by large shareholders. As it is more desirable to create a concentrated ownership structure, these firms are less interested in underpricing their shares. In contrast, companies with more debt and lower market-to-book ratio would expect less future benefits from ownership concentration compared to higher liquidity, and hence are more prepared to underprice. This finding implies that the proposed link between underpricing, ownership structure and liquidity is consistent with the existing theory explaining an IPO as the first stage in the process of selling a company, in which the issuer actively makes pre-listing decisions to maximise the overall proceeds derived from current and future sell-offs (Zingales, 1995; Mello and Parsons, 1998; Pagano et al., 1998).

[3] We are grateful to the referees for directing our attention to this important issue.

The remainder of this paper is organised as follows. Section 2 presents detailed arguments of how IPO-underpricing, ownership structure and post-listing liquidity are inter-related and develops the hypotheses to be tested. The methodology to be employed in testing our hypotheses is discussed in Section 3. Section 4 contains sample selection procedures and descriptive statistics. Empirical results are presented in Section 5, and Section 6 concludes the study.

2. Development of hypotheses

2.1. Ownership structure and liquidity

Demsetz (1968) defines illiquidity as the absence of continuous trading, which is characterised by a degree of mismatch between available buyers and sellers at a given point in time, and this mismatch is dependent upon the number of shareholders. Consequently, a broader shareholder base is often thought to provide higher trading liquidity. In addition, Bhide (1993) and Holmström and Tirole (1993) argue that when there is a larger proportion of small shareholders or liquidity traders, the presence of asymmetric information is less substantial. This reduces adverse selection costs, encourages more trading activities and enhances secondary market liquidity.

However, according to Jensen and Meckling (1976) and Shleifer and Vishny (1986), dispersed shareholdings reduce the marginal benefits of monitoring, i.e. collecting information about the company's activities and correcting potential self-interest actions of managers. The spread of ownership creates a collective action problem, which prevents shareholders from effectively correcting management activities that are not in their best interests. Concentrated ownership also encourages active monitoring as lower liquidity raises the barrier to exit. In addition, Kahn and Winton (1998, p. 122) propose that concentration levels should be higher in relatively more "transparent" industries rather than the industries where information is harder to obtain and the effects of intervention may be more uncertain. Therefore, some IPO-companies may forfeit liquidity so that the benefits of control and monitoring are enhanced. [4]

The validity of the trade-off principle between liquidity and control is still under dispute. Holmström and Tirole (1993) argue that if a company is owned more predominantly by a small (uninformed) investors and hence enjoys higher liquidity, speculators may be induced to incur the cost of collecting information about the company, which they could profitably trade upon later. This still ensures private information will be manifested in the market through an unbiased price-discovery process and governance could then be improved through managerial incentive schemes. Holmström and Tirole also argue that this is superior to monitoring by large outside shareholders, who could be influenced by their own private benefits and possible collusion with managers.

[4] Wruck (1989) documents that for private equity sales, which are often followed by an increased ownership concentration, the share values of the selling companies increased by an average of 4.5%.

Given the preceding arguments, issuers may differ in their desire to seek after-market liquidity. They also need to consider the possible costs associated with achieving their objectives. Since small shareholders are often informationally disadvantaged when investing in IPOs, improving liquidity through creating a broader and more evenly distributed shareholder base requires costs to be incurred to induce their participation. This paper proposes that underpricing can be used as such a compensation mechanism.

2.2. Underpricing and ownership structure

Several explanations of IPO underpricing rely upon the theoretical foundation of information asymmetries, which exist between different participants in the offer. In particular, Rock's (1986) winners' curse argument implies that the purpose of underpricing is to attract uninformed investors, who otherwise would have withdrawn from the IPO market due to their informational disadvantage. This theoretical argument is supported by the findings in Michaely and Shaw (1994) who demonstrate that where investors do not face information asymmetries, underpricing is significantly reduced. However, a shortcoming of Rock's model is that it does not explain why it is necessary and beneficial for the issuer to induce uninformed investor participation. A number of studies clarify this issue by asserting that it is crucial to the issue's success to attract a certain proportion of small, less informed investors for liquidity reason. [5] Also, regulations in many countries require a significant degree of spread of ownership in any float to reduce the disadvantages to retail investors. However, Bhide (1993) acknowledges that this could differ from country to country. Policies in the US, UK and Australia aim more at promoting liquidity than those in Germany and Japan, where the benefits of monitoring through concentrated ownership structure are favoured.

Another reason why underpricing could influence the dispersion of shareholder distribution is proposed by Booth and Chua (1996). They argue that in managing a float, the investment banker cannot market all the information regarding the firm's true value to all potential investors, but only to its most regular institutional customers. Other investors must incur some additional costs to collect information and therefore will not be induced to participate unless a higher degree of underpricing is offered. In support of this argument, Michaely and Shaw (1994) find higher underpricing for IPOs with more diverse shareholder base. Brennan and Franks (1997) develop an alternative argument in that underpricing is used to ensure over-subscription of shares. This allows the owners to have discretion in the allocation process, where large applicants are likely to be discriminated against for the purpose of protecting company insiders against potential hostile change of control. Similarly, Chowdhry and Sherman (1996) and Mello and Parsons (1998) also argue that the optimal allocation strategy should favour small investors.

[5] See Koh and Walter (1989), Ibbotson and Ritter (1995) and Brennan and Franks (1997).

In contrast, there exist other theoretical models that argue that the allocation process will usually discriminate against small investors. Stoughton and Zechner (1998) argue that as small investors can "free-ride" the monitoring efforts of large shareholders, the latter will not participate unless they are compensated by being favoured in the allocation process. Similarly, Benveniste and Spindt (1989) propose that as the issuer needs to induce the most informed investors to reveal their information, indication of interest and valuation of the firm, distributional priority is more likely to be given to large applicants.

2.3. Hypotheses

This paper does not attempt to resolve the disagreement in the above-mentioned studies regarding whether large or small shareholders are favoured in the allocation process. In fact, we believe that allocation priority should differ from one IPO to another. In particular, in companies with higher needs for further equity raisings, where owners are reluctant to relinquish control or where barriers exist to prevent effective monitoring activities by large shareholders, there should be more interest in aiming for greater ownership dispersion and liquidity. For these companies, we argue that underpricing decisions can result in attaining liquidity objectives in two ways. First, higher underpricing induces participation from a larger number of new investors, i.e. wider breadth. Second, underpricing is likely to result in over-subscription, which allows the issuer to discriminate against larger applicants in order to ensure that equity holdings of new investors are more evenly distributed. Subsequently, both breadth and greater diffusion will eventually promote more active trading in the secondary market.

On the other hand, for companies who place a higher value on the benefits of having large shareholders, a lower level of underpricing is required to achieve full allocation, because these investors are generally more informed. This does not imply that large shareholders are stuck with less attractive IPOs because lower underpricing is compensated by receiving a higher proportion of the issue. In addition, as large shareholders may derive additional private benefits of control (Bolton and von Thadden, 1998) or believe that their superior monitoring practices may produce long-term returns, they are more likely to participate in the less underpriced or even overpriced IPOs. Therefore, companies that place a lower value on the benefits of liquidity than those of a concentrated ownerships structure would tend to be less underpriced. In summary, our arguments can be formally stated in the following hypotheses:

Hypothesis 1. Underpricing is positively related to the breadth of shareholder base, and negatively related to the inequality of shareholder distribution amongst new investors.

Hypothesis 2. Post-listing liquidity is positively influenced by the breadth of shareholder base, and negatively influenced by the inequality of shareholder distribution amongst new investors.

Hypothesis 3. A positive relationship exists between underpricing and post-listing liquidity.

3. Research methodology

3.1. Measures of underpricing

Consistent with previous studies, such as Ibbotson and Ritter (1995), market adjusted returns are calculated using the following formula:

$$\mathrm{MAR} = \frac{P_1 - \mathrm{OP}}{\mathrm{OP}} - \frac{M_1 - M_0}{M_0}, \tag{1}$$

where MAR is the market-adjusted return of each IPO at the end of the listing date, P_1 is the closing price on the first trading day, OP is the offer price provided by the prospectus. M_1 and M_0 are the closing values of a selected market index on the listing date and the day prior to listing, respectively. [6] The All Industrials Accumulation Index is used to adjust for market movements, as all IPOs in the sample are industrial companies.

3.2. Measures of ownership structure

The difficulty that confronts studies of ownership structure is the lack of a single, agreed measure of the degree of shareholders' concentration. This ambiguity is the result of the fact that the ownership structure of a company consists of a distribution of the size of investor shareholdings. Using a single measure in the form of an average or proportion may not be sufficient to describe distributions with varying shapes. Therefore, we propose that a firm's ownership structure should be described by reference to two distinct dimensions simultaneously. These are the breadth and equality of shareholder distribution. [7]

Breadth of shareholder distribution reflects the size and diversity of the outside investor base of an IPO after allocation. To adjust for size differences, the breadth of shareholder distribution (BREADTH) is calculated by dividing the total number of new investors by the dollar amount of issued shares. However, using the breadth of shareholder distribution may not adequately describe some of the forms of variation in the ownership structure of the new investors. For example, let consider two IPOs A and B. For each of the IPOs, \$1,000,000 worth of shares is issued to 1000 shareholders. Even though the breadth of shareholder distribution is identical. The level of ownership concentration could be different. Company A might have 10 shareholders with \$900,000 worth of shares, while the other 990 shareholders

[6] How and Low (1993) found insignificant differences in market adjusted returns after adjustment was made using either closing date for subscriptions or the date prior to listing.

[7] All variables used to measure ownership structure do not include the proportion retained by the original owners in their calculation, as we are only interested in the holding distribution of outsiders.

possess only $100,000. In contrast, company B could have an equal distribution of shares amongst its owners so each of them would hold $1000 worth of shares. Therefore, to capture any disproportion in distribution, we propose another measurement dimension—the equality of shareholder distribution, which refers to the difference in the proportions of ownership possessed by outside investors. [8]

Prior research in this area has attempted to measure this difference by using various methods of categorising shareholders. However, the criteria that distinguish large to small shareholders are often arbitrary. Therefore, to improve the robustness of our results, we need to employ many different ways of categorisation that are available in our data set. In reporting their ownership structure, Australian companies follow a standardised approach by dividing their shareholdings into five categories according to the absolute number of shares held by each individual investor. [9] Based on this division, we select the top category, in which each investor has more than 100,000 shares, to represent the large shareholders; and derive our first proxy for the equality of shareholder distribution (LARGE):

$$\text{LARGE} = \frac{\sum_{k=1}^{n} \text{TOPCATEGORY}_k - \text{RETAIN}}{\text{OFFERSIZE}}, \tag{2}$$

where TOPCATEGORY_k is the holding amount of investor k who has at least 100,000 shares of company i; n is the total number of these investors; OFFERSIZE is the total number of share on issue. RETAIN is the total number of shares retained by the original owners of company i, which is subtracted from the numerator because our focus is in measuring outsider interest.

A different way of categorisation, this time according to relative shareholding size, is used in Wruck (1989), who defines block shareholders as those who hold more than 5% of a company's issued capital. We follow the same definition to calculate the variable BLOCK, which represents outside block holders:

$$\text{BLOCK} = \frac{\sum_{k=1}^{m} \text{BLOCKSIZE}_k - \text{RETAIN}}{\text{OFFERSIZE}}, \tag{3}$$

where BLOCKSIZE_k is the number of shares held by investor k who has at least 5% equity ownership, and m is the total number of such investors. In addition, the ASX requires every listed company to disclose its ownership structure by providing shareholding details of its 20 largest shareholders. We use this aggregate figure as another proxy for the inequality of shareholder distribution:

$$\text{TOP20} = \frac{\sum_{k=1}^{20} \text{TOP20SIZE}_k - \text{RETAIN}}{\text{OFFERSIZE}}, \tag{4}$$

where TOP20SIZE_k is the number of shares held by investor k in the top-20 group.

Another measure frequently employed in ownership structure research is the Herfindahl index of concentration (HERFINDAHL), which is defined as the sum of the squared holding proportions of n largest shareholders (Cubbin and Leech, 1983). Al-

[8] The original owner retention is excluded in calculating this variable for the reasons mentioned earlier.

[9] The categories are: 0–999; 1000–4999; 5000–9999; 10,000–99,999 and over 100,000 shares.

though the choice of n is arbitrary, we follow Sabherwal and Smith (1999), who set $n = 5$. The reason is that the holding proportion substantially reduces with each incremental shareholder; hence the Herfindahl index, being the sum of the squared proportions, converges very quickly as the choice of n increases. In addition, the descriptive statistics of the Herfindahl index show extreme level of non-normality (Table 2). We rectify this problem by taking the square-root transformation of the original Herfindahl index.

A limitation of the above measures lies in choosing the cut-off values. Moreover, they are sensitive to changes in the upper tail of the shareholder distribution, but to a large extent ignore potential variations in the remainder of the distribution. Therefore, to further improve the robustness of our results, we employ another measure of shareholder inequality, namely the Gini coefficient (Gini, 1912). Applied to ownership structure, the Gini coefficient shows the expected difference between the values of equity holdings of any two individual investors drawn independently from the shareholder distribution, divided by the mean value of shareholding. Compared to the other proxies proposed above that focus on the upper tail of ownership distribution, the Gini coefficient can give a different perspective because it is more sensitive to variations in the middle quantiles. We do not posit that the Gini coefficient is superior to the other proxies, but the different focus of this measure serve to balance the account and improve the robustness of our results. More details of Gini-coefficient approximation can be found in Appendix A.

3.3. Measures of liquidity

We measure liquidity using two proxies, trading turnover and the bid–ask spread. Trading turnover is calculated by scaling daily trading volume—a variable frequently used to proxy liquidity (Roll, 1981; Amihud and Mendelson, 1986)—for the total number of that company's issued shares. Note that there is a potential pitfall in using a trading turnover figure, as it can be excessively high during the first few days of trading as a result of informed trading activities that continue until share price reaches the "fair value" as perceived by the market. Moreover, there is also substantial evidence of traders "flip" in IPOs (i.e. selling an initial share allocation by an investor immediately on listing) in order to capture instantaneous profits from IPO underpricing (Krigman et al., 1999). This also results in abnormally higher trading volumes on the listing day compared to those over the long run. [10]

To overcome this problem, the trading turnover figures for the first four days are excluded from the analysis. The decision is based on the results obtained from sequential t-test for mean differences in the daily average turnover of all IPOs for the initial 30 days of trading. Consistent with Miller and Reilly (1987) and Aggarwal and Rivoli (1990), our results indicate that volumes in the first four days are significantly higher than those on subsequent days, during which trading turnover

[10] Krigman et al. (1999) and Miller and Reilly (1987) find first-day mean trading turnover to be 33% and 22%, respectively; and the initial trading frenzy dissipates after 5–10 days.

stabilises. Hence, trading turnover is calculated as the average of the remaining 26 days: [11]

$$\text{TURNOVER} = \frac{\sum_{t=5}^{30} \text{VOLUME}_t}{26 \times \text{ISSUEDCAPITAL}}, \tag{5}$$

where t is the number of days after listing for each IPO, VOLUME_t is the number of shares that are traded during day t, ISSUEDCAPITAL is the total number of listed shares that are tradeable. [12]

Alternatively, another more extensively used measure of liquidity is the bid–ask spread (Demsetz, 1968; Amihud and Mendelson, 1986). In contrast to trading turnover, which is quite volatile, this proxy tends to be "sticky" as traders do not adjust their estimation of the spread as quickly as the market changes (Reese, 1998). It is perceived that bid–ask spread and trading turnover should be used complementarily since none provides an exact and universally accepted measure of liquidity. For the purpose of consistency, we employ the same time horizon used in calculating trading turnover to derive the average bid–ask spread from the daily closing bid and ask quotes as follows:

$$\text{BIDASK} = \frac{1}{26} \sum_{t=5}^{30} \frac{\text{ASK}_t - \text{BID}_t}{(\text{ASK}_t + \text{BID}_t)/2}. \tag{6}$$

3.4. Regression analyses

We begin the empirical analysis by splitting the sample two groups of underpriced (i.e. MAR more than or equal to zero) and overpriced IPOs (i.e. MAR less than zero) and employ one-sided t-tests for mean differences to determine whether the underpriced IPOs have on average wider breadth of shareholder base, more equal distribution of shares amongst outside investors, and finally, higher liquidity. [13] However, this procedure could be potentially biased since differences between underpriced and overpriced IPOs might be caused by some underlying firm characteristics that simultaneously affect both underpricing and ownership structure decisions. For example, it has been argued that the lack of transparency, asset tangibility and industry differences affect the effectiveness of monitoring activities by outside shareholders (Gompers, 1995; Kahn and Winton, 1998). Similarly, higher agency costs have been associated with firms that possess higher leverage (Jensen and Meckling, 1976), smaller size and higher risk level (Demsetz and Lehn, 1985; Leech and Leahy, 1991) and more growth potential (Gompers, 1995; McConnell and Servaes, 1995). Therefore, ownership structure of a firm is likely to be influenced by these factors. Given the

[11] Lack of data on the number of outstanding shares prevents us from selecting a longer time period. Following Aggarwal and Rivoli (1990), we assume that the average trading turnover during this selected period does not differ substantially if a longer time horizon is used in the calculation.

[12] This figure excludes shares that are under escrow agreements, which cannot be traded.

[13] This procedure is similar to Miller and Reilly (1987), Schultz and Zaman (1994) and Hanley (1993), who compared differences in only trading turnover between underpriced and overpriced IPOs.

popular explanation that underpricing based on information asymmetries and the past empirical evidence on IPOs such as Lee et al. (1996), Keloharju and Kulp (1996) and Pagano et al. (1998) among others, it is possible that these factors also affect the issuer's decision of whether to underprice the shares on offer. This implies the possibility of some type of selection bias in the relationship between underpricing and ownership structure, as there may be systematic differences between the underpriced and overpriced groups. To control for this problem in later analysis, it is necessary to answer first the important question of what firm characteristics among those mentioned above might influence the decision to underprice by running the following probit regression:

$$\begin{aligned}\text{UNDPROB} = {} & \alpha + \beta_1 \text{SIZE} + \beta_2 \text{RISK} + \beta_3 \text{MB} + \beta_4 \text{DEBT} + \beta_5 \text{INTA} \\ & + \beta_6 \text{RD} + \beta_7 \text{FIN} + \beta_8 \text{TECH} + \varepsilon \end{aligned} \tag{7}$$

in which the dependent variable UNDPROB is used to proxy the underpricing decision of an IPO and takes value of 1 if it is underpriced and 0 otherwise. SIZE is the natural logarithm of firm size, measured by the market capitalisation after listing. The level of risk (RISK) is proxied by the standard deviation of daily share returns during the first trading month, excluding the first five days. [14] Growth potential is proxied by the natural logarithm of the market-to-book ratio (MB). DEBT is measured by book value of debt divided by total assets. The ratios of intangible assets to total assets (INTA) and research and development expenditures to total assets (RD) are included to account for the degree of transparency and information asymmetries (Gompers, 1995). We also include dummy variables for financial institutions and service providers (FIN) and high technology and Internet companies (TECH). [15] The first variable is suggested by Demsetz and Lehn (1985) because the finance industry is more severely regulated, while the latter is included because of the uncertain and fast-evolving nature of high-tech and Internet-related industries, which makes them harder to be valued and monitored. [16] Therefore, levels of agency costs and transparency of these firms might be different to the other parts of the economy.

Results from the probit regression above may further clarify the issue of what companies are interested in underpricing their shares. This issue is as important as providing evidence in support of the proposed relationship between underpricing, ownership and liquidity, because the assumption underlying such relationship is that issuers differ in their preference for either greater liquidity or more concentrated ownership, and hence their underpricing decisions would reflect this accordingly. Therefore, if it could be identified that this difference between underpriced and overpriced IPOs does exist, the implication would be that liquidity is not just a collateral

[14] This is consistent with the period selected for calculating trading volume and bid–ask spread.

[15] To construct these variables, we rely on industry classification by the ASX. Because there is no official industry group for Internet companies, they are grouped together with high-tech firms.

[16] Demsetz and Lehn (1985) also propose a dummy for utility firms, but none is present in our sample.

benefit of underpricing an IPO, but rather an objective towards which its pre-listing strategies are designed.

Using standard OLS regression, we can test the relationship between underpricing and ownership structure (Hypothesis 1). As ownership structure could also be determined by other firm characteristics such as size, risk, growth, leverage, industry differences and operation transparency, the regression needs to incorporate these factors as shown below:

$$\begin{aligned}\text{OWNERSHIP} = {} & \alpha + \beta_1 \text{MAR} + \beta_2 \text{SIZE} + \beta_3 \text{RISK} + \beta_4 \text{MB} \\ & + \beta_5 \text{DEBT} + \beta_6 \text{INTA} + \beta_7 \text{RD} + \beta_8 \text{FIN} + \beta_9 \text{TECH} + \varepsilon. \end{aligned} \tag{8}$$

In this regression, the dependent variable OWNERSHIP is consecutively measured by different proxies, including the breadth of shareholder base (BREADTH), holding proportion of top-20 investors (TOP20), proportion of block holders (BLOCK), proportion of investors holding more than 100,000 shares (LARGE), the Gini coefficient (GINI) and the square root of Herfindahl index (HERFINDAHL).

There is one further complication. The pre-listing ownership allocation decision by the issuer may be biased by his or her decision of whether to underprice (or overprice), which is itself an endogenous outcome of the underlying firm characteristics listed above. This possibility of a systematic difference between underpriced and overpriced IPOs makes simple OLS regression estimates of the underpricing–ownership link less convincing. To deal with this type of selection biases, we retest Hypothesis 1 using another specification in which the regression explaining ownership structure (Eq. (8)) is augmented with the dummy variable indicating whether an IPO is underpriced (UNDPROB), which is itself dependent upon other firm characteristics as shown in the earlier probit model (Eq. (7)). These two equations are then estimated jointly as a system, and a significant coefficient for UNDPROB in the first equation would indicate the presence of the above-mentioned selection problem. This specification is a special case of Heckman's (1978) simultaneous equation models that contain both continuous and dummy endogenous variables. [17]

However, as our main focus here is on testing the underpricing–ownership relationship, the result section will only report the coefficients and test statistics for the earlier equation.

We search for evidence in support of Hypothesis 2 by regressing one of the proxies for liquidity (i.e. trading turnover and the bid–ask spread) against each proxy for

[17] Heckman derives a two-stage estimation procedure for the general model, which can be applied to our special case as follows. In the first step, the reduced form equation with the indicator variable UNDPROB being the dependent variable is estimated against all exogenous variables of the system using standard probit estimation procedure. The results then allow us to generate the estimated probability ($\widehat{P}$) of UNDPROB being equal to 1 (i.e. an IPO is underpriced) conditional on the exogenous variables. In the second step, the ownership structure equation is estimated using $\widehat{P}$ as an instrumental variable for UNDPROB. Here, consistent estimators for the coefficients are produced using standard OLS procedure but the asymptotic variance–covariance matrix of the coefficients is estimated by using standard instrumental variable formula as given in Heckman (1978, p. 946).

ownership structure. As past evidence has revealed that these measures of liquidity could be further influenced by firm size (Roll, 1981) and trading volatility (Karpoff, 1987; Stoll, 1978), we also control for these variables in testing Hypothesis 2. Because the liquidity of a firm could be either overstated or understated as a result of the seasonality in company reporting cycle, an additional control variable (ANN) that proxies the extent of information disclosure is included and defined as the natural logarithm of the number of company announcements made first month of trading (excluding the initial four days).

Although trading turnover and the bid–ask spread are viewed as alternative proxies for liquidity, their cross-sectional variations are not driven by the same set of factors. In particular, when trading turnover is used to proxy liquidity, it is necessary to control for the proportion of original owner retention (RETAIN), because in Australia the owners often retain their shares for a minimum period of 12 months in the form of restricted securities (Lee et al., 1996) and are also less likely to commit to secondary market trading during the initial period. Thus, scaling the trading volume by the total number of issued shares could show companies with higher retained ownership as having low liquidity, while in fact their shares are actively traded among new investors. Thus, if trading turnover is used to proxy liquidity, we test Hypothesis 2 using the following regression:

$$\begin{aligned}\text{TURNOVER} = {} & \alpha + \beta_1 \text{OWNERSHIP} + \beta_2 \text{RISK} + \beta_3 \text{ANN} + \beta_4 \text{SIZE} \\ & + \beta_5 \text{RETAIN} + \varepsilon. \end{aligned} \tag{9}$$

As for the case of the bid–ask spread, Stoll (1978) suggests that another control variable should be the inverse of stock price (INVPRICE), for two separate reasons. First, because of the 1/8 minimum tick rule (Stoll, 1978), percentage bid–ask spreads on US exchanges were 'artificially' larger for lower share price levels (these rules have been recently changed to decimal equivalence). Since price variation rules on the ASX are analogous to its US counterparts, the same relationship is applied in Australia. Second, spreads may also cover part of dealers' order processing costs. These are fixed costs that can be spread out over greater trade values of higher priced shares, hence reducing their proportionate spreads. Therefore, if the bid–ask spread is the dependent variable, we run the following regression:

$$\begin{aligned}\text{BIDASK} = {} & \alpha + \beta_1 \text{OWNERSHIP} + \beta_2 \text{RISK} + \beta_3 \text{ANN} + \beta_4 \text{SIZE} \\ & + \beta_5 \text{INVPRICE} + \varepsilon. \end{aligned} \tag{10}$$

If the results support the first two hypotheses, we can proceed to test the final hypothesis, which directly relates underpricing to liquidity. In addition, another aim is to investigate other determinants of trading liquidity in the after market. To find evidence of the proposed relationship, we regress either trading turnover or the bid–ask spread against underpricing and other factors that the past literature has identified to influence the cross-sectional variations of each of the two liquidity measures, similar to Eqs. (9) and (10). If the bid–ask spread is the dependent variable, the regression has the following specification:

$$\text{BIDASK} = \alpha + \beta_1\text{MAR} + \beta_2\text{RISK} + \beta_3\text{ANN} + \beta_4\text{SIZE} + \beta_5\text{INVPRICE} + \varepsilon, \tag{11}$$

while for trading turnover, the regression specification is as follows:

$$\text{TURNOVER} = \alpha + \beta_1\text{MAR} + \beta_2\text{RISK} + \beta_3\text{ANN} + \beta_4\text{SIZE} + \beta_5\text{RETAIN} + \varepsilon. \tag{12}$$

Here again, we face the same problem as in testing Hypothesis 1 that there may be potential systematic differences between underpriced and overpriced IPOs that cause selection bias in the sample. Therefore, in addition to standard OLS estimation, we reapply the joint probit estimation procedure used in testing Hypothesis 1 to the regressions above. In particular, if the bid–ask spread is considered, Eq. (11) is augmented with the variable UNDPROB and estimated jointly with Eq. (7). The same applies to the case of trading turnover. We also run additional regressions incorporating other firm characteristics such as debt, market-to-book ratio, proxies for transparency (INTA and RD) and indicators for important industries (FIN and TECH) to examine whether the tested relationship is consistent and robust across different specifications and control variables used.

It is also identified that, although the bid–ask spread and trading turnover could be used as separate measures of liquidity, these factors may be themselves inter-related. In particular, Stoll (1978) finds evidence that bid–ask spreads are determined by trading turnover; while Constantinides (1986) favours the reverse argument and his results show that an increase in transaction costs (i.e. bid–ask spreads) causes a decrease in trading turnover. In order to account for a possible inter-relationship and simultaneity between these two proxies for liquidity, we repeat the test of Hypothesis 3 by employing a system of two simultaneous equations, in which bid–ask spread and trading turnover each becomes explanatory variables in the other regression. Other explanatory variables include the level of underpricing and potential determinants of the two proxies for liquidity, which have been previously discussed when constructing Eqs. (9) and (10). The proposed system has the following specifications:

$$\text{BIDASK} = \alpha + \beta_1\text{TURNOVER} + \beta_2\text{MAR} + \beta_3\text{RISK} + \beta_4\text{ANN} + \beta_5\text{SIZE} + \beta_6\text{INVPRICE} + \varepsilon, \tag{13}$$

$$\text{TURNOVER} = \alpha + \beta_1\text{BIDASK} + \beta_2\text{MAR} + \beta_3\text{RISK} + \beta_4\text{ANN} + \beta_5\text{SIZE} + \beta_6\text{RETAIN} + \varepsilon. \tag{14}$$

4. Data

The sample consists of 113 Australian IPOs covering the period from January 1996 to June 1999 (see Table 1). The data set used is compiled from the *Connect* 4, *Securities Industry Research Centre of Asia-Pacific* (SIRCA), *Bourse Data* and *Bloomberg* databases. Consistent with Ritter (1984), the sample excludes IPOs of

Table 1
Sample selection and classification

Period	Total number of applications	Exclusions				Sample size
		Withdrawn applications	Mining firms	Property trusts and investment funds	Stapled securities or missing data	
Jan 1996–Dec 1996	81	6	30	18	3	24
Jan 1997–Dec 1997	86	10	25	11	5	35
Jan 1998–Dec 1998	53	2	5	10	4	32
Jan 1999–Jun 1999	33	2	2	5	2	22
Total	253	20	62	44	14	113

property trusts and issues of convertible notes. Mining companies, despite being a substantial component of the Australian market, are excluded because the majority of them are no liability companies (i.e. shareholders are liable only up to the amount of funds already paid on the share and not any outstanding calls). As this implies a distinct legal and risk structure, mining companies are grouped into a separate category by the ASX, and often excluded in past Australian studies of IPOs such as How and Low (1993) and Lee et al. (1996). By far and away, the predominant pricing method for Australian IPOs is fixed-price offerings; hence in the sample, there are only four book-building IPOs. Daily closing prices, volume and bid–ask quotes of each IPO are obtained the initial 30 days of trading.

Information regarding the post-allocation ownership structure is obtained from the official company announcements lodged with the ASX prior to listing. A company may issue restricted (escrow) securities, which contractually cannot be traded for the period of 12 or 24 months. These are subtracted from the shareholding details and are therefore excluded from the calculations of the equality of ownership distribution. The descriptive statistics of ownership structure in IPOs in the sample are reported in Table 2.

Table 2 also shows that trading of Australian IPO shares during the first few days is significantly less active compared to US IPOs. Average trading turnover during the first trading day of Australian IPOs is only 4.76% (see Table 2), much lower compared to the figure of 33% as reported by Krigman et al. (1999) for US IPOs. However, the level of trading activity of Australian IPOs during the first four days after the listing date is still exceptionally higher than on subsequent days. We carry out a sequential *t*-test for mean differences in trading turnover from one day to another. The results (not reported here) show that, similar to the observation by Miller and Reilly (1987), trading activity stabilises after day four. [18] This justifies the use of the specified time horizon (day 5 to day 30) in calculating the post-listing trading volume. The bid–ask spread is a relatively more stable figure, with insignificant differences across the initial 30-day period. With regard to the level of underpricing, Table 3 shows that the price-discovery process is essentially completed within the first day of trading. The mean

[18] These results are reported in Pham et al. (2000).

Table 2
Descriptive statistics of ownership structure and after-listing liquidity

Variable ($N = 113$)	Mean	Median	Standard deviation	Minimum	Maximum	Skewness
Breadth of shareholder base						
Average number of investors (for every $1 million worth of shares offered to the market)	149.83	118.84	126.41	11.10	608.05	1.47
Equality of shareholder base[a]						
Proportion of shares held by shareholders with at least 100,000 shares (%)	70.79	73.24	19.19	4.87	99.27	−0.84
Proportion of shares held by shareholders with at least 5% of total shares (%)	45.23	45.57	24.34	0.00	97.19	−0.09
Proportion of shares held by the top-20 shareholders (%)	66.91	70.29	19.85	15.34	99.29	−0.63
Gini coefficient	0.59	0.61	0.19	0.08	0.94	−0.41
Herfindahl index	0.008	0.003	0.019	0.000	0.150	5.53
Original owner retention (%)	51.70	55.36	27.29	0.00	99.27	−0.61
After-listing liquidity						
Trading turnover—day 1 (%)	4.76	2.61	7.11	45.63	0.00	3.42
Daily average trading turnover—from day 5 to day 30 (%)	0.37	0.24	0.38	0.00	1.86	1.86
Bid–ask spread—day 1 (%)	3.05	1.88	3.96	22.22	0.00	2.75
Daily average bid–ask spread—from day 5 to day 30 (%)	3.30	2.32	3.24	0.19	22.02	2.81

[a] These are raw descriptive statistics of the equality of shareholder base and have not excluded the original shareholders, as specified by the formulae (2)–(4).

first-day return of 23.41% is significantly higher than zero at the 1% level of significance, while subsequent returns are not significantly different from zero. [19]

5. Discussion of results

The first evidence supporting our hypotheses is obtained by contrasting the group of underpriced IPOs (91 observations) against overpriced IPOs (22 observations). The results from *t*-tests for mean differences (see Table 4) indicate that underpriced IPOs are likely, on average, to have a higher breadth of shareholder base and lower concentration of large outside investors (with the only exception of the Gini coefficient) compared to overpriced firms. Liquidity is also higher for underpriced IPOs since their average bid–ask spread is lower and trading turnover higher than overpriced IPOs. Although this is consistent with our proposition that the underpricing decision of a

[19] This finding is similar to previous studies on Australian IPOs, such as Lee et al. (1996).

Table 3
Summary statistics of daily unadjusted returns (in %)

Day	Average	Median	Standard deviation	Minimum	Maximum	Skewness
1	23.41*	10.00	46.94	−50.00	370.00	4.20
	(5.35)					
2	1.66	0.00	9.45	−20.00	37.14	1.50
	(1.88)					
3	−0.26	0.00	4.57	−14.28	20.83	0.70
	(−0.63)					
4	−0.36	0.00	5.24	−13.63	28.00	1.55
	(−0.75)					
5	0.06	0.00	4.27	−10.85	19.56	1.14
	(0.14)					

Note: Figures in brackets present *t*-statistics, testing whether average daily returns equal zero.
* Significant at the 1% level for a two-tail test.

Table 4
Difference between underpriced and overpriced IPOs

Variables	Underpriced IPOs ($N_1 = 91$)		Overpriced IPOs ($N_2 = 22$)		*t*-statistic[a]
	Mean	Standard deviation	Mean	Standard deviation	
Ownership structure					
BREADTH	168.83	152.03	117.12	92.94	1.52**
INSTITUTION	17.29	18.35	27.33	19.46	−2.28*
BLOCK	−8.61[b]	20.92	2.07	17.82	−2.21*
TOP20	14.51	16.06	24.68	16.90	−2.64*
GINI	0.58	0.20	0.61	0.15	−0.66
HERFINDAHL	0.06	0.05	0.09	0.06	−2.11*
Level of liquidity					
BIDASK	2.82	3.02	5.24	3.56	−3.23*
TURNOVER	0.38	0.37	0.23	0.22	1.82*

Notes: Underpriced IPOs have market-adjusted initial returns (MAR) less than zero. Overpriced IPOs have market-adjusted initial returns equal to or more than zero. Tested variables include the breadth of shareholder base (BREADTH), proportion of total shares held by shareholders with at least 100,000 shares (LARGE), proportion of block holders (BLOCK), holding proportion of top-20 investors (TOP20), the Gini coefficient (GINI) and the square root of the Herfindahl index (HERFINDAHL), the average trading turnover (TURNOVER) and the average bid–ask spread (BIDASK) for the period starting from day 5 to day 30 after the listing day.
* Significant at 5% level.
** Significant at 10% level.
[a] Based on one-sided *t*-test (two independent samples, equal variances) for mean difference between the two groups of underpriced and overpriced IPOs. The degrees of freedom (d.f.) equal to 111 (d.f. $= N_1 + N_2 - 2$).
[b] Negative figures are possible since we adjust these proportions for the original owners' retained shares in each IPO to estimate the concentration of shareholdings of outside investor (see formulae (2)–(4)). This negative figure basically means that for many companies there are no outside investors with at least 5% ownership.

Table 5
Probit regression exploring the possible determinants of underpricing decisions

Independent variables	Dependent variable: UNDPROB			
	Coefficient	*t*-Statistic	*p*-Value	Pseudo R^2
RISK	−3.315	−0.656	0.51	12.9%
MB	−0.374	−2.022	0.04	
SIZE	−0.053	−0.715	0.47	
DEBT	1.863	2.659	0.01	
INTA	−0.004	−0.471	0.63	
RD	−0.001	−0.066	0.95	
FIN	−0.440	−0.879	0.34	
TECH	0.619	1.177	0.24	
Constant	1.370	1.427	0.15	

Note: The results are based on the regression specified in Eq. (7). The dependent variable (UNDPROB) takes value of 1 if an IPO is underpriced and 0 otherwise. Explanatory variables include after-market standard deviation of daily returns (RISK), log of firm size (SIZE), log of the market-to-book ratio (MB), book value of debt over total assets (DEBT), intangible assets over total assets (INTA), R&D expenditures over by total assets (RD), dummy for financial firms (FIN) and dummy for high-tech and Internet firms (TECH).

firm can have consequences on its post-listing ownership structure and trading activities, the question that remains unanswered is whether this effect is purely coincidental or actually arises from the motivation of the issuer to attain the most beneficial ownership structure. We address this issue by exploring firm characteristics that may systematically differ between underpriced and overpriced IPOs.

The results from the probit model indicate that IPOs with less debt and high market-to-book ratios are less likely to underprice their shares (see Table 5). How does this result relate to the issuer's effort to attain the most beneficial ownership structure? First, we consider the case of less debt. As debt has always been regarded as an alternative mechanism to combat agency costs (Jensen and Meckling, 1976), a company with less debt would benefit more significantly from the monitoring activities of large shareholders. Alternatively, if large shareholders are not interested in monitoring, they may still enjoy higher private benefits of control due to reduced intensity of debt-holder monitoring and fewer unavoidable interest payments. According to Zingales (1995), these two sources of increase in cash flow and control rights allow the issuer to bargain and extract higher surplus from selling to large shareholders. Without the need to market the issue to dispersed shareholders, the initial owner in a firm with less debt is therefore less interested in underpricing the issue. On the other hand, debt-laden companies face the imminent need to rebalance their accounts through future public issues (Pagano et al., 1998). They would therefore be more likely to underprice their share to facilitate after-market liquidity.

Second, we look at high market-to-book firms. Gompers (1995) reports that these companies are associated with more agency costs and greater need for external monitoring actions. The empirical results in Pagano et al. (1998) also show that these IPOs are actually faced with lower future profitability because the owner would normally attempt to go public at the best time of his company. This is consistent with

the pervasive evidence of long-run IPO under-performance. [20] According to Burkart et al. (1997) and Kahn and Winton (1998), large-shareholder activisms should have the greatest impact under these circumstances. This implies that the initial allocation decision would probably favour large shareholders because it is not as easy to subsequently change the ownership structure (Bebchuk and Zingales, 1996). Meanwhile, Zingales (1995) also argues that for firms facing potentially declining performance, it is more desirable to bargain with a potential buyer than to sell to dispersed shareholders. Therefore, a high market-to-book firm would be unlikely to see the need for underpricing its shares. Overall, the probit model suggests that underpricing decisions are dependent on a number of firm characteristics which may also reflect what ownership structure is the most optimal when subsequent sales are taken into account. This is consistent with the proposition of IPO being the important first stage in the process of selling a company (Zingales, 1995; Mello and Parsons, 1998; Pagano et al., 1998).

In testing the relationship between underpricing and ownership structure (Hypothesis 1), we expect the coefficient estimate for underpricing (MAR) should be positive when regressed against the breadth of new shareholder base and negative when regressed against proxies for the inequality of new shareholder distribution. The results in Table 6 (Model 1) are consistent with our expectations. After controlling important underlying firm characteristics, the relationships follow the directions predicted and are consistently significant at the 0.01, 0.05 or 0.10 levels. [21] Consistent with Brennan and Franks (1997) and Michaely and Shaw (1994), these results imply that underpricing is a factor that helps to attract outside dispersed investors. However, as the probit regression results reveal the presence of some systematic differences in firm characteristics between underpriced and overpriced IPOs, it is possible that this relationship may be spurious and/or due to selection bias. We control for this potential problem by the estimating Eq. (8) in a simultaneous model with dummy endogenous variable as described earlier, and find that proxies for ownership structure are still significantly related to the level of underpricing, with the only exception of one proxy—LARGE (see Model 2 in Table 6). There is also little evidence of a systematic difference or selection bias as the coefficients for the indicator variable UNDPROB are consistently not significant.

We did not find evidence that ownership is significantly influenced by firm factors such as size, risk, leverage, growth (i.e. market-to-book ratio) and proxies for transparency (i.e. intangible assets and R&D expenditures). It should be noted that these results might not constitute conflicting evidence against previous studies such as Demsetz and Lehn (1985) and Shleifer and Vishny (1986), who found some significant correlations. The difference arises here because past research often investigates more established companies, of which ownership structure, after a period of competitive trading, has become optimised to reduce agency costs and asymmetric

[20] See Ibbotson and Ritter (1995) for an extensive review on long-run IPO under-performance.

[21] In Pham et al. (2000), we test Hypothesis 1 using univariate regressions between underpricing and ownership structure variables without any control variables and obtain similar results.

Table 6
The effects of underpricing on ownership structure after allocation

Independent variables	Model 1: Single equation						Model 2: Joint estimation					
	BREADTH	LARGE	BLOCK	TOP20	HERFINDAHL	GINI	BREADTH	LARGE	BLOCK	TOP20	HERFINDAHL	GINI
MAR	56.509	−0.043	−0.063	−0.051	−0.020	−0.045	54.029	−0.038	−0.058	−0.048	−0.019	−0.054
	(0.01)	(0.09)	(0.04)	(0.06)	(0.02)	(0.05)	(0.01)	(0.15)	(0.07)	(0.08)	(0.10)	(0.09)
MB	−28.477	0.034	0.035	0.023	0.014	0.002	−13.967	0.008	0.007	0.003	0.002	0.049
	(0.11)	(0.07)	(0.06)	(0.13)	(0.01)	(0.99)	(0.69)	(0.84)	(0.88)	(0.90)	(0.90)	(0.15)
RISK	789.293	−1.151	−0.700	−0.737	−0.34	−0.657	988.880	−1.505	−1.088	−1.003	−0.506	0.027
	(0.09)	(0.20)	(0.37)	(0.33)	(0.10)	(0.44)	(0.09)	(0.15)	(0.30)	(0.24)	(0.10)	(0.49)
SIZE	−14.083	4×10^{-5}	−0.001	−0.004	−0.001	0.003	−11.825	0.004	−0.006	−0.007	−0.003	0.005
	(0.04)	(0.99)	(0.91)	(0.60)	(0.49)	(0.60)	(0.09)	(0.73)	(0.63)	(0.37)	(0.49)	(0.36)
DEBT	70.445	0.043	−0.038	−0.072	−0.061	0.026	−1.141	0.084	0.101	0.023	−0.001	−0.219
	(0.19)	(0.59)	(0.69)	(0.30)	(0.98)	(0.64)	(0.99)	(0.64)	(0.65)	(0.87)	(0.98)	(0.17)
INTA	−0.018	−0.001	−0.001	−0.001	3×10^{-4}	4×10^{-4}	0.148	−0.001	−0.001	−0.001	3×10^{-4}	0.001
	(0.98)	(0.32)	(0.58)	(0.30)	(0.48)	(0.57)	(0.82)	(0.24)	(0.49)	(0.22)	(0.48)	(0.27)
RD	−2.396	0.008	0.007	0.007	0.001	-4×10^{-5}	2.543	0.008	0.007	0.007	0.001	5×10^{-4}
	(0.32)	(0.12)	(0.12)	(0.12)	(0.43)	(0.99)	(0.30)	(0.14)	(0.14)	(0.13)	(0.43)	(0.47)
FIN	33.574	0.113	0.058	0.080	0.057	−0.20	55.381	0.074	0.016	0.051	0.039	0.055
	(0.53)	(0.12)	(0.63)	(0.31)	(0.47)	(0.69)	(0.45)	(0.42)	(0.92)	(0.56)	(0.47)	(0.31)
TECH	98.812	−0.171	−0.145	−0.172	−0.047	0.020	72.656	−0.125	−0.096	−0.139	−0.026	−0.067
	(0.03)	(0.00)	(0.01)	(0.00)	(0.39)	(0.66)	(0.23)	(0.09)	(0.29)	(0.02)	(0.39)	(0.28)
UNDPROB							169.265	−0.301	−0.328	−0.258	−0.143	−0.580
							(0.58)	(0.45)	(0.52)	(0.49)	(0.35)	(0.14)
Constant	240.840	0.228	−0.031	0.254	0.093	0.480	84.887	0.506	0.271	0.462	0.113	−0.056
	(0.02)	(0.07)	(0.80)	(0.01)	(0.02)	(0.00)	(0.76)	(0.21)	(0.57)	(0.13)	(0.12)	(0.47)

Note: Model 1 is a single-equation OLS regression relating ownership structure (dependent variable) on market adjusted initial return (MAR)—a proxy for underpricing (Eq. (8)). There are six different measures of ownership structure: the breadth of shareholder base (BREADTH), proportions of shares held by shareholders with at least 100,000 shares (LARGE), block holders (BLOCK) and top-20 investors (TOP20), the Gini coefficient (GINI) and square root of the Herfindahl index (HERFINDAHL). Model 2 accounts for potential systematic differences between underpriced and overpriced IPOs by augmenting the equation in Model 1 with the probit variable UNDPROB (equals 1 for underpriced IPO, 0 otherwise) and estimating it jointly with Eq. (7). The estimation procedure for this model is based upon Heckman (1978). Control variables include after-market standard deviation of daily returns (RISK), log of firm size (SIZE), log of the market-to-book ratio (MB), book value of debt over total assets (DEBT), intangible assets over total assets (INTA), R&D expenditures over total assets (RD), dummy for financial firms (FIN) and dummy for high-tech and Internet firms (TECH). All *p*-values are reported in parentheses. Standard errors are adjusted for heteroscedasticity using White's (1980) covariance matrix.

information. Our study, in contrast, looks at the initial ownership structure chosen by the issuer, which according to Bebchuk and Zingales (1996) may not be socially efficient but rather privately optimal. However, we do find some weak evidence of new shareholder distribution of high-tech and Internet firms being less concentrated than the others (coefficients of the variable TECH are significant in four out of six proxies for ownership structure), indicating that the issuers of these IPOs may be more interested in retaining control and building liquidity to facilitate further sales.

In testing Hypothesis 2, we run two separate sets of multivariate regressions with the two proxies for liquidity, trading turnover and bid–ask spread, being dependent variables as specified in Eqs. (9) and (10). Since higher trading turnover means better liquidity, it is expected that this factor would be positively related to the breadth of shareholder base and negatively related to each proxy for the inequality of shareholder distribution. In contrast, as higher bid–ask spread implies lower liquidity, we expect the coefficients to have the opposite signs compared to the model with trading turnover being the depend variable. The results reported in Table 7 (for trading turnover) and Table 8 (for the bid–ask spread) show evidence that the two proxies for liquidity are consistently related to the proposed ownership structure variables, as the coefficients all follow the expect signs discussed earlier; and most are significant at either the 0.01 or 0.05 levels while only two coefficients are significant at the 0.10 level (see Table 8). This finding implies that increasing the number of shareholders and reducing the concentration of shareholding distribution could improve liquidity in the secondary market, a result consistent with past propositions by Demsetz (1968), Bhide (1993) and Holmström and Tirole (1993).

With regard to other control variables, the results do not support the relationship between liquidity and size, but confirms our expectation that liquidity is influenced by the extent of information releases (ANN) during the chosen period of measurement (i.e. one month after the listing date). In addition, based on the review by Karpoff (1987) and the empirical results in Stoll (1978), we expect trading volatility (RISK) to be positively related to both trading turnover and the bid–ask spread and find evidence consistent with this prediction. When trading turnover is the dependent variable, the coefficient of owner retention (RETAIN) is significant and follows the expected negative sign, confirming the inability and unwillingness of the original owners to commit to trading during the early stage of their IPOs. Interestingly, we do not find evidence of a relationship between the bid–ask spread and the inverse of price (INVPRICE) as documented in Stoll (1978), possibly due to the fact that, in contrast to mature companies, prices of IPOs tend to be clustered together, while the bid–ask spread does vary widely. [22]

Combining the results of the first two hypotheses, this study has found evidence supporting the argument that underpricing affects ownership structure, which in turn determines after-listing liquidity. Therefore, we expect that that there should exist a positive and significant relationship between the degree of IPO underpricing and the level of after-market liquidity, which is proposed in Hypothesis 3. The results in

[22] Our sample of IPO prices exhibits two main clusters, around either 0.2 or 1 Australian dollar.

Table 7
Regressions results for the relationship between ownership structure and liquidity, with trading turnover being the dependent variable

Independent variables	Dependent variable: Trading turnover					
	(1)	(2)	(3)	(4)	(5)	(6)
BREADTH	7.1×10^{-6}					
	(0.00)					
LARGE		−0.005				
		(0.01)				
BLOCK			−0.004			
			(0.01)			
TOP20				−0.007		
				(0.00)		
GINI					−0.006	
					(0.02)	
HERFINDAHL						−0.015
						(0.00)
RETAIN	−0.002	−0.004	−0.003	−0.004	−0.001	−0.003
	(0.10)	(0.03)	(0.08)	(0.02)	(0.36)	(0.05)
RISK	0.043	0.044	0.047	0.043	0.041	0.047
	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)	(0.01)
SIZE	0.0004	0.0002	0.0003	0.0002	0.0003	0.0002
	(0.11)	(0.25)	(0.020)	(0.23)	(0.26)	(0.25)
ANN	0.001	0.001	0.001	0.001	0.001	0.001
	(0.03)	(0.01)	(0.02)	(0.02)	(0.02)	(0.03)
Constant	−0.004	-9.4×10^{-5}	−0.002	0.001	0.0003	3.3×10^{-5}
	(0.14)	(0.78)	(0.42)	(0.67)	(0.91)	(0.99)

Note: The results are based on Eq. (9). Each regression uses one of the proxies for ownership structure as the main explanatory variable, i.e. the breadth of shareholder base (BREADTH), proportion of total shares held by shareholders with at least 100,000 shares (LARGE), proportion of shares owned by block holders (BLOCK), proportion of shares owned by top-20 investors (TOP20), the Gini coefficient (GINI) or the square root of the Herfindahl index (HERFINDAHL). The common control variables are original owner retention (RETAIN), after-market standard deviation of daily returns (RISK), log of firm size (SIZE) and log of the number of company announcements made during the initial month of trading (ANN). All *p*-values are reported in parentheses and based on the standard errors adjusted for heteroscedasticity using White's (1980) heteroscedasticity-consistent covariance matrix.

Table 9 consistently show that higher underpricing leads to lower bid–ask spread and higher trading turnover, regardless of whether or not the control variables are included (Model 1). This result remains consistent even after controlling for potential systematic differences between underpriced and overpriced IPO by estimating the main regression of interest jointly with the probit model of underpricing decisions (Eq. (7)). Thus, the relationship is not only robust but also independent from the possible underlying firm factors that might simultaneously influence both underpricing and post-listing differences.

With regard to other control variables specified in Eqs. (11) and (12), we find similar results to those obtained when testing Hypothesis 2. In particular, trading turnover is positively related to ANN and RISK, while negatively related to RETAIN. The bid–ask spread is related positively to RISK, but negatively to ANN. High-tech

Table 8
Regressions results for the relationship between ownership structure and liquidity, with the bid–ask spread being the dependent variable

Independent variables	Dependent variable: Bid–ask spread					
	(1)	(2)	(3)	(4)	(5)	(6)
BREADTH	-3.4×10^{-5}					
	(0.06)					
LARGE		0.049				
		(0.06)				
BLOCK			0.050			
			(0.01)			
TOP20				0.066		
				(0.01)		
GINI					0.074	
					(0.03)	
HERFINDAHL						0.155
						(0.01)
INVPRICE	−0.004	0.004	0.003	0.004	0.007	−0.003
	(0.09)	(0.10)	(0.20)	(0.15)	(0.01)	(0.28)
RISK	0.548	0.561	0.569	0.567	0.492	0.548
	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
SIZE	−0.001	−0.001	−0.001	−0.0004	−0.0005	−0.0005
	(0.22)	(0.51)	(0.52)	(0.62)	(0.63)	(0.61)
ANN	−0.008	−0.012	−0.010	−0.010	−0.001	−0.009
	(0.02)	(0.00)	(0.01)	(0.01)	(0.05)	(0.01)
Constant	−0.038	0.022	0.033	0.017	−0.011	0.017
	(0.00)	(0.11)	(0.01)	(0.21)	(0.64)	(0.20)
Adjusted R^2	0.342	0.384	0.407	0.418	0.386	0.393

Note: The results are based on Eq. (10). Each regression uses one of the proxies for ownership structure as the main explanatory variable, i.e. the breadth of shareholder base (BREADTH), proportion of total shares held by shareholders with at least 100,000 shares (LARGE), proportion of shares owned by block holders (BLOCK), proportion of shares owned by top-20 investors (TOP20), the Gini coefficient (GINI) or the square root of the Herfindahl index (HERFINDAHL). The control variables include the inverse of issue price (INVPRICE), after-market standard deviation of daily returns (RISK), log of firm size (SIZE) and log of the number of company announcements in the first month (ANN). All *p*-values are reported in parentheses and based on the standard errors adjusted for heteroscedasticity using White's (1980) heteroscedasticity-consistent covariance matrix.

and Internet companies also seem to possess higher liquidity. Overall, all of the regression results exhibit high degrees of explanatory power, with factors in the full models accounting for about 45.7% and 57.7% of cross-sectional variations in bid–ask spreads and trading turnover, respectively. As the presence of heteroscedasticity is detected, all statistics are based on the adjusted standard errors using White's (1980) covariance matrix.

We also consider the possibility that the bid–ask spread and trading turnover may be determined simultaneously. The three-stage least-squares method is used to estimate a system of two equations ((13) and (14)), in which the bid–ask spread and trading turnover are each treated as an explanatory variable in the other regression. As the coefficients of both variables are not statistically significant, we cannot

Table 9
Multivariate regressions of the determinants of post-listing liquidity

Independent variables	Dependent variable: Bid–ask spread				Dependent variable: Trading turnover			
	Model 1: Single equation		Model 2: Joint estimation		Model 1: Single equation		Model 2: Joint estimation	
	Regression 1	Regression 2	Regression 1	Regression 2	Regression 1	Regression 2	Regression 1	Regression 2
MAR	−0.025	−0.025	−0.024	−0.024	0.004	0.004	0.004	0.004
	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)
INVPRICE	0.002	-2×10^{-4}	0.001	−0.002				
	(0.43)	(0.95)	(0.52)	(0.74)				
RETAIN					−0.003	−0.003	−0.004	−0.006
					(0.00)	(0.00)	(0.00)	(0.01)
RISK	0.644	0.636	0.587	0.550	0.036	0.029	0.043	0.038
	(0.01)	(0.01)	(0.01)	(0.23)	(0.00)	(0.04)	(0.00)	(0.08)
SIZE	-3×10^{-4}	-4×10^{-4}	-6×10^{-4}	−0.002	2×10^{-4}	2×10^{-4}	2×10^{-4}	3×10^{-4}
	(0.73)	(0.67)	(0.73)	(0.44)	(0.00)	(0.08)	(0.20)	(0.10)
ANN	−0.008	−0.008	−0.007	−0.008	0.001	0.001	6×10^{-4}	5×10^{-4}
	(0.02)	(0.01)	(0.06)	(0.16)	(0.00)	(0.09)	(0.25)	(0.62)
MB		−0.003		−0.012		9×10^{-5}		0.001
		(0.23)		(0.27)		(0.67)		(0.19)
DEBT		−0.009		0.035		3×10^{-4}		−0.003
		(0.41)		(0.52)		(0.76)		(0.30)
INTA		3×10^{-5}		-4×10^{-5}		1×10^{-6}		-6×10^{-6}
		(0.85)		(0.88)		(0.92)		(0.73)
RD		9×10^{-4}		9×10^{-4}		-2×10^{-5}		-2×10^{-5}
		(0.45)		(0.69)		(0.66)		(0.78)
FIN		0.008		−0.006		−0.002		−0.001
		(0.31)		(0.75)		(0.05)		(0.41)
TECH		−0.019		−0.003		0.004		0.003
		(0.06)		(0.90)		(0.00)		(0.13)
UNDPROB			−0.032	−0.107			0.003	0.009
			(0.26)	(0.33)			(0.08)	(0.16)
Constant	0.028	0.037	0.058	0.137	−0.001	−0.001	−0.003	−0.007
	(0.01)	(0.20)	(0.05)	(0.19)	(0.00)	(0.61)	(0.18)	(0.15)
Adjusted R^2	0.427	0.457			0.497	0.577		

Note: Model 1 is a single-equation OLS regression relating either the bid–ask spread or trading turnover on market adjusted initial return (MAR)—a proxy for underpricing. Model 2 accounts for potential systematic differences between underpriced and overpriced IPOs by augmenting the equation in Model 1 with the probit variable UNDPROB (equals 1 for underpriced IPO, 0 otherwise) and estimating it jointly with Eq. (7). The estimation procedure for this model is based upon Heckman (1978). INVPRICE is the inverse of issue price. RETAIN is original owner retention. ANN is log of the number of company announcements in the first month. MB is log of the market-to-book ratio. RISK is after-market standard deviation of daily returns. SIZE is log of firm size. DEBT is book value of debt over total assets. INTA is intangible assets over total assets. RD is R&D expenditures over total assets. FIN and TECH are dummy variables for financial and high-tech (or Internet) firms. All *p*-values are reported in parentheses. Standard errors are adjusted for heteroscedasticity using White's (1980) covariance matrix.

confirm the presence of simultaneity in our sample (see Table 10). Nonetheless, we still find a significant negative relationship between underpricing and the bid–ask spread (at 5% level) and a positive relationship between underpricing and trading

Table 10
Three-stage least-square estimation of the simultaneous equation model of the bid–ask spread and trading turnover

Independent variables	Bid–ask spread		Trading turnover	
	Coefficient	*p*-Value	Coefficient	*p*-Value
TURNOVER	4.321	0.31		
BIDASK			−0.020	0.82
MAR	−0.043	0.02	0.004	0.08
INVPRICE	0.002	0.39		
RETAIN			−0.003	0.03
RISK	0.467	0.03	0.050	0.42
ANN	−0.012	0.05	0.001	0.49
SIZE	−0.001	0.56	0.0002	0.15
Constant	0.039	0.09	0.0004	0.99

Note: The results are based on the estimation of the simultaneous system of two Eqs. (13) and (14). The main independent variable is market adjusted initial return (MAR), which is a proxy for underpricing. INVPRICE is the inverse of issue price. RETAIN is original owner retention. ANN is log of the number of company announcements made during the initial month of trading. MB is log of the market-to-book ratio. RISK is after-market standard deviation of daily returns. SIZE is log of firm size. The coefficients are estimated using the method of three-stage least-squares.

turnover (at 10% level). The strengths of these relationships are slightly weaker compared to the single-equation models. We also repeat the estimation using two-stage least-square method and obtain very similar results, which are not reported here. The overall evidence suggests that regardless of different specifications of modelling liquidity, this factor is significantly and consistently influenced by the degree of underpricing of an IPO.

6. Conclusion and implications

This paper examines the relationship between the degree of underpricing of IPOs, their ownership structure after the share allocation, and the ensuing level of post-listing liquidity. After controlling for a number of firm characteristics, we find that the level of underpricing is positively related to the breadth of shareholding base, and negatively related to the inequality of outside shareholder distribution formed after the allocation process. These dimensions of ownership structure in turn affect the variations in the level of liquidity after trading commences. As a result, there should be a positive relationship between the degree of underpricing of an IPO and its post-listing liquidity. Our empirical analysis yields statistically significant evidence in support of this proposition. This result remains robust even after controlling for a number of underlying firm characteristics that may drive both underpricing decisions and post-listing differences in ownership structure and trading.

We also provide an explanation that ownership structure plays the main role in forming for the relationship between underpricing and liquidity. By underpricing an IPO, a company could achieve a broader and more equal ownership structure after the allocation process, because the participation of small investors is more likely

increase if the rewards they receive outweigh their information disadvantage. This result is consistent with Rock's (1986) winner's curse hypothesis and the empirical results in Michaely and Shaw (1994) and Brennan and Franks (1997). We also argue that if an IPO prefers the benefits of concentrated ownership structure, the degree of underpricing should be lower, because not only do large shareholders possess superior information about its true value, but they also derive greater private benefits of control.

The above findings also infer a practical implication that issuers can select an appropriate range of underpricing levels to achieve either a higher level of liquidity or a concentrated ownership structure. Our probit regression results, to some extent, also provide further support for this view by identifying that firms with potentially higher agency costs (e.g. less debt and higher market-to-book) are less interested in underpricing their shares because they would benefit more in the future with large shareholders onboard. Thus, due to variations in some particular firm characteristics, issuers do have different views regarding what ownership structure is optimal when future sell-offs are considered, and would make underpricing decisions accordingly. This is consistent with Zingales' (1995) explanation of an IPO as a stage in the sale of a company and highlights the importance of looking at liquidity and ownership structure as the main objectives in the going public process.

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Appendix A. Calculating the Gini coefficient

The Gini coefficient of a particular distribution is twice the area between the Lorentz curve representing that distribution and the diagonal line running from $(0, 0)$ to $(1, 1)$. The table below depicts how the distribution of shareholders is reported to the ASX. In order to calculate the Gini coefficient, the Lorentz curve for such a discreet distribution is constructed. This is accomplished by first subtracting the holdings of the original shareholders from the distribution since the purpose of this exercise is to calculate the Gini coefficient of the new investor base only. Then, a plot of the cumulative percentage of the number of investors against the cumulative percentage of shareholding is obtained (see Fig. 1). The area under the curve is calculated by aggregating five geometric areas formed by the turning points. Gini coefficient is one minus twice of that area. The following example calculates the Gini coefficients

of two companies in the sample: Cable–Wireless Optus (CWO) and CDS Technologies (CDX).

Code		Range of holdings of individual outside shareholders					Gini
		0–999	1000–4999	5000–9999	10,000–99,999	More than 100,000	
CWO	No. of shareholders	15,674	41,994	7418	4118	481	0.850
	Cumulative %	22	83	93	99	100	
	No. of shares (in thousands)	7837	104,985	556,350	329,841	528,962	
	Cumulative %	0	10	16	48	100	
CDX	No. of shareholders	6	529	6	7	0	0.203
	Cumulative %	1	98	99	100	100	
	No. of shares (in thousands)	1377	1065	41	255	0	
	Cumulative %	0	78	81	100	100	

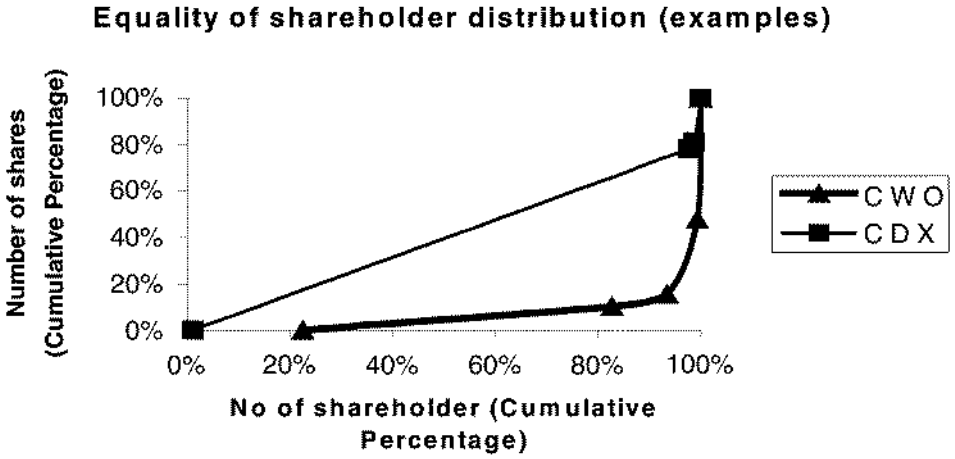

Fig. 1. Plot of the cumulative percentage of the number of investors against the cumulative percentage of shareholding.

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