Trading Restrictions and Value: Marketability as an Option

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Abstract

We examine the usefulness of the option-based framework of Longstaff (1995) to estimate the effect of trading restrictions on the value of common stock. Longstaff's fundamental insight is that marketability can be viewed as an option to sell an asset at the time of one's choosing, so the value of marketability can be estimated using techniques from option pricing. Among other things, Longstaff's model assumes a frictionless market where an investor with perfect timing ability will sell an asset and invest the proceeds to maximize the value of a portfolio. When there are restrictions on selling the asset, this investor is unable to optimize his/her wealth. Longstaff derives the resulting loss in value due to the restriction on trading, which varies with the risk of the asset.

Analyzing a sample of 194 private placements of common stock in the United States from January 27, 2000 through March 27, 2008, we find empirical evidence that both volatility and trading restrictions are related to the percentage discount for on private placements. We categorize trading restrictions as one of two types: either liquidity or marketability. Using a Chow test to identify a structural break in the data, we find that the importance of marketability restrictions (e.g., the number of shares in the private placement relative to the total shares outstanding) is significant for private placements occurring in the last four and one half years of the sample period whereas, during the first part of the sample period, characteristics related liquidity (e.g., turnover and the bid-ask spread) are more important as determinants of discounts on private placements.

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1. Introduction

Restrictions on value arise when considering assets that are not readily marketable (i.e. sold in available market) or cannot be easily liquidated (i.e. converted into cash). Liquidity is valued by investors because the absence of liquidity prevents the investor from converting assets into cash easily. Additionally, investors will pay more for an asset that is readily marketable than an otherwise equal one which is not readily marketable (Bajaj, Denis, Ferris, and Sarin 2001). Hence, restrictions introduce a discount to the value of illiquid securities relative to ones that are otherwise readily marketable. The presence of restrictions affects venture capital, Initial Public Offerings, commercial real estate, hedge funds, and private equity (Das, Jaganathan, and Sarin 2003; Kahl, Liu, and Longstaff 2003; Aragon 2007; Ang and Bollen 2010), all of which represent asset classes to which increasing amounts of wealth are being allocated (Longstaff, 2009). This shift in wealth allocation speaks to the importance of understanding the effects of restrictions on the valuation of such assets.

The focus of the current research is on the discounts for private placements of equity. In this paper, we seek to identify potential determinants of discounts for private placements of common equity over the sample period January 1, 2000 through May 21, 2008. Accordingly, and to obtain our potential determinants, we construct three sets of variables; risk, liquidity, and marketability.[1] The latter two sets of variables will be comprised by trading restrictions.

[1] In particular, our risk variables are constituted by volatility, skewness, and market capitalization. The liquidity variables are comprised of turnover, average bid-ask spread, a market exchange listing dummy variable, and market capitalization. Finally, marketability variables include the relative size of the private placement, the size of the private placement, the total issue size, and the registration dummy. Additionally, while liquidity variables are exogenous to the placement of private equity, marketability variables are considered endogenous to the placement conditional on the liquidity variables.

Longstaff's fundamental insight is that marketability can be viewed as an option to sell an asset at the time of one's choosing (Dyl and Jiang 2008). Put differently, optionality underlies the Longstaff model where the lack of marketability (or locked-in investment) means the loss of exercising a potential option. Hence, one implication of the Longstaff model is that the value of marketability can be estimated using techniques from option pricing.[2] From this perspective, our paper is an investigation into the usefulness of an option-based framework for estimating the effects of trading restrictions on value.

A. Empirical evidence of discounts on nonmarketable common stock

There have been several empirical studies of discounts on nonmarketable common stock.[3] The first, and most comprehensive, is the *Institutional Investor Study Report of the Securities and Exchange Commission* [SEC (1971)], which reported data about institutional purchases of restricted shares. The study examined 398 transactions from 1966-1969; the mean and median discount was approximately 26%. The SEC Study categorized the transactions based on four characteristics—the market where the stock traded, the type of institutional purchaser, the sales of the issuer, and the earnings of the issuer—and reported discounts for each category. Discounts were lowest for stocks listed on the New York Stock Exchange (NYSE), next lowest for stocks listed on the American Stock Exchange (ASE), and highest for stocks trading in the Over-the-Counter (OTC) market.[4] During the 1960s the trading location was, to some extent, a proxy for liquidity, marketability and volatility, so the SEC's findings are consistent with Longstaff's model. Discounts were also lower for firms with larger sales and earnings. Since firm size is

[2] See Appendix A for more details.
[3] See Damodaran (2005) for a review of some of the empirical evidence on the determinants of discounts of illiquidity across different types of assets.
[4] The OTC market was an informal network of dealers who posted bid and ask quotes for common stocks that were not traded on either the NYSE or the ASE. It was the forerunner of today's NASDAQ market, which was founded in 1971.

also, to some extent, a proxy for both liquidity, marketability and volatility, this finding is also consistent with Longstaff's model. Most of the institutional purchasers of restricted stock were banks and investment adviser, but discounts were not related to the types of purchaser.

Wruck (1989) studies private placements from 1979-1985 and finds an average difference of 17.6% between discounts on registered stock and discounts on unregistered stocks. Silber (1991) examines private placements of common stock of publicly traded companies from 1981 through 1988. After eliminating issues that had warrants or other special provisions, he was able to find data for 69 companies. Silber calculates the discount for non marketability as a percentage of the closing price of the public shares on the placement date, and finds a mean percentage discount of 33.75%. He finds that the discount is inversely related to the firm's revenues, to a dummy variable indicating that the firm has positive earnings, and to a dummy variable indicating a customer relationship between the investor the issuer, and is positively related to the size of the restricted block relative to the total shares outstanding. Both the firm's size (revenues) and the presence of positive earnings can be thought of as proxies for risk, so these findings are consistent with the Longstaff framework. Silber also finds that discounts are positively related to the relative size of the privately placed block. Since the relative size of the block can be thought of an indicator of the difficulty of selling the holding, which is tantamount to a trading restriction, this result also supports Longstaff's model.[5] This conclusion is consistent with Maynes and Pande (2008) who study 444 private placements of equity and 542 privately placed special warrants over the period 1993-2005. Their study provides evidence for the

[5] Wruck (1989) also examines private placements of equity, some of which are registered and some of which are not, but she does not control for other characteristics of the issues and issuers and many of the issues in her sample involve ownership changes.

importance of liquidity (e.g. the market capitalization of the firm and turnover) in *both* types of private placements in Canada.

Hertzel and Smith (1993) study a sample of 106 all-equity private placements that occurred between January 1, 1980, and May 31, 1987, to investigate whether discounts on private placements reflect information costs borne by private investors. However, their findings can also be interpreted in the light of Longstaff's framework. Hertzel and Smith report a mean (median) discount of 20.14% (13.25%), where discounts are measured relative to the share price 10 days after the announcement of the placement. Like Silber, they find that discounts are directly related to the relative size of the block, although, unlike Silber, they do not interpret this result in terms of the illiquidity of a large block of shares. Discounts are also directly related to financial distress, which is an indicator of risk. Discounts are negatively related to the firm's book-to-market ratio, which Hertzel and Smith interpret as indicating that private placement discounts are significantly higher when intangible assets are an important component of firm value. Since firms with a high proportion of intangible assets, such as growth opportunities, also tend to be more volatile firms, this finding also supports Longstaff's option based model.[6] They find smaller discounts for larger placements, which they interpret as a measure of firm size. Finally, discounts are higher for unregistered shares, another indicator of non-marketability. Overall, all of Hertzel and Smith's findings are consistent with Longstaff's model.

Bajaj et al. (2001) examine discounts on 88 private placements that were pure equity transactions occurring between January 1, 1990, and December 31, 1995. Following Hertzel and Smith (1993), they use the stock price 10 trading days after the announcement date to compute the discount, and they report a mean (median) percentage discount of 22.21% (20.67%). The

[6] George, we need a reference relating market-to-book and volatility.

discounts are positively related to the percentage of shares issues, which reflects a premium for non-marketability, and to the standard deviation of returns, which is the risk measure used in Longstaff's framework. Discounts are smaller when the firm's Altman's Z-score is better and when the shares are registered. As with the other studies, all of these findings support Longstaff's analysis.

Chen and Xiong (2001) study the impact of illiquidity on security valuation for several types of shares listed by companies in China. Using auction and private transfer data on various types of shares associated with Chinese corporations, they find that volatility and the illiquidity discount are not statistically significant, which is inconsistent with the Longstaff model. Kooli, Kortas, and L'her (2003) find that the median discount for the lack of marketability varies with the size. However, while there are many studies on the effects of marketability and liquidity on the discount for private placement, most of these studies examine variables in a more or less "kitchen-sink" approach. In contrast to the prior literature, our approach to finding determinants is more structural in nature. Angrist, Curtis, and Kerrigan (2011) study 1,863 private placement transactions from 1980-2009 and find that stock price volatility is a positive and important predictor of private placement discounts. Hou and Howell (2012) use the Longstaff model after controlling for leverage positions, to find that volatility is positively related to illiquidity discounts using a sample of restricted shares taken from the Chinese stock market over the period 1994-2004. Their empirical results also imply that, after controlling for leverage positions, the size of the illiquidity discounts is greatly diminished. In sum, most of these studies find that stock price volatility is a positive and significant predictor of private placement discount, which is consistent with the Longstaff model.

In sum, Longstaff provides a rigorous model of the relation between risk, a restriction on trading, and the value of an asset. Overall, there have been a number of studies of equity issues with restrictions on trading, and the results of these studies are generally consistent with the implications of Longstaff's model. However, these studies were not designed to provide a direct test of Longstaff's analysis. The choice of independent variables was, at best, *ad hoc*.

Traditionally, variables associated with liquidity have constituted major determinants of variation in the private placements of common equity. Recently, however, financial markets, and in particular the stock market, have seen structural changes in the technological advancements in the way that traders can carry out trades (e.g. electronic trading platforms, electronic communication networks (ECNs), SuperDOT system). This large degree of automation affected the liquidity of financial markets, which, consequently serves to motivate the search for structural changes in our sample. In particular, our analysis focuses on the period January 2000 through May 2008, a period during which many changes were occurring with regards to the manner in which trades were being placed. Over the period 2001-2005, the cost to trade common stock dropped quite significantly, NASDAQ acquired two major ECNs, and Better Alternative Trading Systems (BATS) was founded (Anderson and Dyl, 2012). Over the period from 1993-2008, Chordia, Roll, and Subrahmanyam, (2011) observe a substantial decline in trading costs. Over the period February 2001-December 2005, Hendershott, Jones, and Menkveld (2011) find that technology has made it easier to execute algorithmic trades. Using data from the leading exchanges from 120 countries through August 2001, Jain (2005) finds that electronic trading enhances the liquidity of markets. These papers all indicate that recent enhancements in electronic trading have caused liquidity constraints to become less important.

B. Overview of data and empirical results

Our data consists of 3,580 announcements over the sample period January 1, 2000-May 21, 2008. We obtain relevant information for the private placements of equity from the Securities Database Corporation (SDC) and all other pertinent data from the Center for Research in Security Prices (CRSP). SEC EDGAR and SEC INFO provided us with newspaper and magazine articles which also contained invaluable information regarding the placements. After matching SDC data to CRSP, we eliminate all foreign firms, duplicate announcements, and any placement that was not entirely equity. The last constraint eliminates any private placement that is not a "clean" placement, and would include, but is not limited to any placement consisting solely of common stock, and would include debentures, warrants, convertible debt, senior unsecured debt, preferred stock. We also eliminate any transaction that was made exclusively to members of the board, was involved with the resignation of a board member, consisted of PIPEs, was involved with a merger or change of ownership or control, or no detailed information about the terms of the placement were provided. All these restrictions led us to 194 placements over the period January 27, 2000 through March 27, 2008.

Motivated by the structural changes that occurred during our period, we use a Chow (1960) test to identify a structural break in the relation between liquidity and discounts in the private placements of common stock over our sample period. Our results imply that a structural break occurred around August 2003 and that post August 2003, liquidity restrictions are less important determinants of variation in the placements of private equity and that marketability restrictions play a more important role in the determination of variation in the discounts for private placements of common equity. The significance of marketability restrictions in explaining the percentage discount in private placements for our sample period is associated with

the period following the break in the sample, which occurred in August 2003. Finally, the lack of significance of the liquidity restrictions in explaining the percentage discount in private placements for our sample period is driven mainly by the lack of significance in the period following our structural break. Our results also imply that volatility is an important determinant for the variation in the private placements of common stock, which is consistent with the predictions of the Longstaff model. Moreover, results from the Chow (1960) test also imply that, while volatility is an important determinant for explaining the variation in the percentage discount, this importance can be attributed to the period before August 2003. Taken together, these results bring new light to our understanding of trading restrictions and volatility as determinants for the percentage discount in private placements of common stock. These results are consistent with the literature that is cited above.

The rest of the paper is organized as follows. Section 2 presents the methodology and summarizes the data. Section 3 presents the empirical analysis. Section 4 concludes.

2. Methodology and Data

This section describes our sample and data and explains the underlying rationale for the structure of our regression analysis.

2.1 Sample and Data

The sample of private placements of equity is obtained from the Securities Data Corporation (SDC) database. There were a total of 3,580 announcements of private placements of equity from January 1, 2000 through May 21, 2008. We eliminate any companies where the type of security was something other than Ordinary Shares, Ordinary/Common Shares, or

Common Shares. We then used ticker symbols to find the SDC firms in the Center for the Study of Security Prices (CRSP) database. After matching the SDC firms to CRSP, we eliminate foreign firms, duplicate announcements, and any placements that were not entirely equity.

Various sources were searched for detailed information about each of the remaining private equity placements. These sources included the news announcements page on the website of the company in question, the SEC's EDGAR and INFO databases, and newspaper and magazine articles about the placement. Based on information from the sources, transactions were eliminated for a variety of reasons. Most generally, any placement that involved any kind of warrants, options, debentures; convertible debt, subordinated debt, senior unsecured debt, preferred stock. Although most firms that were eliminated for not being a "clean" placement of equity contained warrants, a substantial number also involved contain preferred stock with or without a feature to convert the preferred stock to common stock. The following types of transactions were also eliminated: those with members of the board of directors or executive officers exclusively; those involving the resignation of a board member; those that required shareholder approval and were later rescinded; PIPE transactions; those involved with a merger or a change of ownership or control; and any announcement where no detailed information about the terms of the placement.

The remaining 330 transactions were classified according to the registration of the shares to be issued. There were 50 transactions with shares that were registered and 280 transactions that were either unregistered with no commitment to register or unregistered with some commitment to register in the future. After further eliminating observations with missing data points, the final sample contained 194 observations with issue dates between January 27, 2000 to March 27, 2008. No one

Table 1 shows information about the firms and equity placements in our sample. The firms are generally small. The mean (median) stock price one month prior to the placement was $13.36 ($8.63) and the mean (median) number of shares outstanding one month before the placement was 26 (21) million shares. The mean (median) market capitalization of the firm one month before the placement was $287 ($172) million, and only 12.9% of the firms were listed on the NYSE. The mean (median) trading volume was 6.3 (3.0) million shares and the mean (median) annual share turnover was 231% (136%).

The average issue price of the private placement was $11.51, which was a discount of 13.3% from the share price immediately before the announcement of the private placement. The average issue size was 3.6 million shares, or $28 million. The average issue size as a percentage of shares outstanding before the issue was 14.7%. Eighty seven percent of the issues were either registered or there was a commitment that they would be registered within a short time of the issue. The mean (median) stock price of the firm 10 days after the announcement of the private placement was $13.15 ($8.01).

2.2 Research Methodology

The aim of our empirical analysis is to examine how discounts on private placements are related to various variables. Motivated by earlier discussions, we focus on three sets of variables that are potential determinants of discounts on private placements. The first set of variables is risk measures, which are inherent in stock return dynamics. As argued in Longstaff (1995), large fluctuations in stock prices translate to high opportunity costs for investors who are restricted from trading their stock positions. In Longstaff's framework, the standard deviation of returns is used to measure the dispersion of return distribution. The second are liquidity or illiquidity measures, which are exogenous to the particular private placement. Liquidity or illiquidity of the

trading of a firm's stock reflects the potential cost of issuing additional stocks in the open market, as an alternative to private placement. Thus, the more illiquid a firm's stock is, the higher discount is expected for private placement. The last are marketability measures, which are endogenous to the particular private placement. Given the liquidity/illiquidity of a firm's stock, a larger size of the private placement makes it less marketable. This implies an inverse relation between marketability measures and discounts of private placements. The variables used in our regression analysis are measured as follows.

2.2.1 Risk Variables

We consider three variables as measures of risk in our analysis. The first is volatility, which is the risk variable in Longstaff's model. We use the standard deviation of the stock's daily returns during the six months preceding the announcement date for the private placement as our measure of volatility. Dyl and Jiang (2008) present evidence that a common stock's historical volatility is a reasonable proxy for future volatility for the stock. We also consider the skewness of the returns distribution, measured as the skewness of the daily returns during the six months preceding the announcement of the issue. There is evidence that skewness matters in valuing options.[7] The third variable is market capitalization one month before the announcement of the private placement. We consider market capitalization as a possible proxy for risk, because, ceteris paribus, larger firms are generally more stable than smaller firms. The last variable of risk used in our study is the past performance of a firm's stock, measured by a stock's past 6-month return in excess of market return. A lower realized return of a firm's stock relative to market

[7] Skewness of asset return distribution can be modeled through a "leverage effect", i.e., a negative correlation between asset return and volatility, as in Heston (1993)'s stochastic volatility model framework, or with a negative average jump size as in Merton (1976)'s jump diffusion model framework. In both cases, skewness is shown to have direct effect on option prices.

portfolio may reflect higher expected returns of investors on the stock due to perceived higher risk associated with the firm.

Summary statistics of the risk variables are reported in Panel A of Table 2. The mean (median) volatility is .049 (.045), with a range from .087 at the 95th percentile to .019 at the 5th percentile. The mean (median) skewness is .85 (.677) and it ranges from 2.794 at the 95th percentile to -.324 at the 5th percentile. The mean and median market capitalizations of the firms in the sample are $287 million and $172 million, respectively, so there more of the firms in the sample are smaller firms rather than larger firms. The market capitalization of the largest firm in the sample is only $902 million.

2.2.2 Liquidity Variables

We include four liquidity variables in the analysis. The first is turnover, computed as the ratio of the average trading volume during the six months preceding the private placement announcement date divided by the shares outstanding one month before the announcement date. The second variable is the average bid-ask spread during the month preceding the announcement date. In our preliminary regression analysis, we also had a relative bid ask spread measure computed as the ratio of the absolute bid-ask spread to the average of the bid and ask prices. However, we did not include those results in our formal results because the relative bid-ask spread measure was not statistically significant and furthermore, it did not change any of our results. Both of these liquidity measures are widely used in the existing literature. We also include a dummy variable that equals one if the company was listed on the NYSE and zero otherwise as a liquidity variable. Ceteris paribus, the market for the stock of listed companies is broader and deeper than the market for the stock of unlisted companies. Market capitalization is

also included as a liquidity variable because, ceteris paribus, the market for larger firms' stock is more liquid than that for smaller firms.

Statistics describing the liquidity variables used in the regression are shown in Panel B of Table 2. The mean (median) six-month turnover rate is 1.161 (.682) times, and the range is huge. The share turnover of the firm at the 95th percentile is over 12 times every six months, whereas the turnover for the firm at the 5th percentile is only 0.034 times in six months. The mean (median) bid-ask spread is 1.1 % (0.8%). These are very low spreads for such small companies, but most of our sample period is after stocks changes to decimal trading.[8] Finally, only 12.9% of the firms in our sample are listed on the NYSE.

2.2.3 Marketability Variables

We use four variables as possible indicators of the marketability of each of the private placements in our sample. The first is relative size, defined as the number of shares in the private placement divided by the total number of shares outstanding for the company. The second is total issue size, computed as the number of shares in the private placement times the offer price for those shares. The third is liquidation time, which is the length of time it would take to sell the private placement in the open market. We estimate this variable by dividing the number of shares in the placement divided by the average trading volume over the six months preceding private the offering. The last marketability variable is registration, an indicator variable that is one if the placement was registered with the SEC and zero otherwise. Unregistered shares in publicly traded firm are not freely tradable in the open market. Such stock is also called Rule 144 stock,

[8] The NYSE changed from fractional to decimal tick sizes in January, 2001, and NASDAQ followed suit in April, 2001.

because is can be dribbled out into the open market over time subject to the restrictions of Rule 144.[9]

Summary statistics of the marketability variables used in the regression are reported in Panel C of Table 2. The mean (median) relative size of the placements is our sample is 14.7% (13.5%) of the shares outstanding, so these are large blocks of stock. The average (median) issue size as $28 million ($19 million), and it would take an average of 2.5 months to liquidate the block in the open market if the purchaser accounted for all of the sales. Thus, if the purchaser was responsible for 10% of the open market sales, it would take over two years to liquidate the position. The table also shows that 87.2% of the share issues in our sample either were registered with the SEC or there was a commitment to register them.

Table 3 reports correlations among the variables. In general, there are few strong correlations between the independent variables. Issue size and market capitalization are moderately correlated, which is sensible because presumably larger firms tend to have bigger equity issues. This moderate correlation may lead to potential biases in the parameter estimates of a linear regression model that includes both of these variables, which may influence our results.

3. Regression Results

In this section, we perform linear regressions of discounts on the private placements against various variables. The discount on the private placements is measured by the relative difference between offer price and pre-announcement stock price The pre-announcement stock price was taken to be the stock price one day before the announcement of the issue of private equity. It should be noted that in cases where the filing date and the issue date were different, we

[9] These restrictions are described at http://www.sec.gov/investor/pubs/rule144.htm.

took the announcement date to be the earlier of the two dates, since the information contained in the announcement would presumably be known to the market by the earlier of the dates. The independent variables are the three sets of variables as described in the preceding section. We first perform the regressions for each set of variables and then the joint regressions with all three sets of variables for the entire sample period from January 2000 to March 2008. Motivated by statistical tests detecting potential shifts in the linear regressions, we then perform our analysis over two sub-periods, from January 2000 to August 2003 and from September 2003 to March 2008. The regressions results are summarized as follows.

3.1 Separate Regressions for the Entire Sample Period: January2000 to March 2008

As a first step, we estimate the regression parameters for separate regressions of the risk, liquidity and marketability variables on the private placement discount to see which variables of each type are most closely associated the size of the discount. The results are reported in Table 4. Among all risk variables, only the standard deviation of stock returns (volatility) is statistically significant at the 10% significance level, whereas among all marketability variables the relative size of private placement is highly significant at 1% level. Both variables are positively correlated with the discount on private placements. Surprisingly, none of the liquidity/illiquidity variables turns out to be significant. As a matter of fact, the adjusted R^2 is negative at -0.51%, suggesting that these variables have no explanatory power of the variations in private placement discount. In comparison, the marketability variables have the highest explanatory power with and adjusted R^2 of 3.67% followed by risk variables with and adjusted $R^2$of 1.35%.

Overall, the results suggest that there is a quite robust relation between the discount of private placements and standard deviation of stock returns as well as the relative size of private placement. The statistical link between discounts of private placement and liquidity variables are

rather weak. As we motivated at length in the introduction, there were several structural changes that occurred during our period. Consequently, in the next sub-section, we use a Chow test to identify a structural break in the relation between the private placement discounts and liquidity over our sample period and then carry out our empirical analysis on the resultant sub-samples.

3.2 Structural Breaks and Sub-period Results

The results reported in the proceeding section are interesting at least from the following perspectives. First all, they suggest that among all risk variables, the standard deviation has the strongest correlation with discounts of private placement. Similarly, among all marketability variables, the relative size of private placement has the strongest correlation with discounts. Secondly, among three different sets of variables, it appears that marketability has the highest explanatory power for the magnitude of discounts, followed by risk. Contradicting findings in previous literature, we find that liquidity variables have virtually no explanatory power for discounts.

Motivated by the documentation of structural changes that occurred during our period, we note that our analysis may ignore potential structural breaks for the relation between discounts and liquidity variables. This is because linear regressions estimated across the entire sample do not speak to the stability of the parameter estimates over time. To be prudent, we employ a Chow (1960) test to examine the stability of the parameter estimates over the period from 2000 to 2008. The Chow test allows us to determine whether or not the parameter estimates associated with 2 sets of linear regression models are identical. The Chow test also provides us with valid statistical inference regarding when this structural break occurs. For details of the Chow test, please refer to Chow(1960), Fisher (1970) or Gujarati(1970a) and for extensions to

the multivariate regression framework, please refer to Gujarati (1970b), Harvey (1976), Dufour (1982), or Cantrell, Burrows, and Vuong (1991). Finally, Toyoda (1974) and Schmidt and Sickles (1977) consider the Chow Test when the error variances exhibit heteroskedasticity.

We perform the Chow test to both regressions with a single set of variables in Table 4 as well as regressions with multiple sets of variables in Table 6 in the following sub-section. Since the Chow test can provide insight into the stability of an econometric model over time and the 6 month return volatility variable seemed to provide a strong and stable relation to the discount variable, we decided to focus on the marketability and liquidity variables. Specifically, our focus was on the Share percentage variable and the Turnover variable. As a first pass, we used the Chow test to locate a structural break in a single set of variables. In each case, we performed the Chow Test in 2 successive steps. The first step consisted of running the Chow Test on the sample focusing on 2000 to 2008, the complete set of years in our sample, as the set of years over which potential structural breaks could occur. For the Share percentage variable, the only year that provided significant results was 2003 (F-Value=4.46, with degrees of freedom of 2 in the numerator and 190 in the denominator of the Chow Test Statistic, p-value=0.0128). For the Turnover variable, the results were similar, we also found that there was a structural break in 2003 (F-Value=2.88, with degrees of freedom of 2 in the numerator and 190 in the denominator of the Chow Test Statistic, p-value=0.0585). Conditional on the first step determining that there was a structural break in 2003 for both the Share percentage variable and the Turnover variable, the second step consisted of carrying out the Chow Test to determine the specific quarter within which the break occurred. The second step focused on a multiple variable framework with the focus being on determining which quarter the break occurred. We tested the first quarter in 2003, the second quarter in 2003, the third quarter in 2003, the fourth quarter 2003, and the first quarter

2004. Specifically, the results of the Chow test indicate that there was a structural break in September of 2003 (F-Value=3.12, with degrees of freedom of 3 in the numerator and degrees of freedom of 188 in the denominator of the Chow Test Statistic, p-value=0.0273). Quite interestingly, the Chow tests provide consistent results for regressions with a single set of variables and regressions with multiple sets of variables.

We therefore reexamine the results of our regression analyses separately for each of these sub-periods. The sub-periods are from January 27, 2000 through August 8, 2003, when there are 85 private placements in our sample, and from September 1, 2003 through March 27, 2008, for which we have109 observations. Following the procedure used for the overall sample period, we firs estimate separate regression of risk, liquidity, and marketability on private placement discounts. These findings are reported in Table 6. The results based on two sub-periods provide an interesting contrast to each other. The results show that while the standard deviation of stock returns is significant for the entire sample, the significance is mainly driven by the first sub-period. The coefficient estimates for the standard deviation of stock returns are positive in both sub-periods, but only significant in the first sub-period. On the other hand, while the relative size of private placement is significant for the entire sample, the significance is mainly driven by the second sub-period. The coefficient estimates for the relative size of private placement are positive in both sub-periods, but only significant in the second sub-period. We also note that issue size is weakly significant (at 10% level) with a negative relation with discounts in the second sub-period. Interestingly, while none of the liquidity variables is significant over the entire sample period, turnover and NYSE dummy are both significant at 5% level in the first sub-period. Both variables are negatively correlated with the discounts of private placement. It appears that the lack of significance for liquidity variables over the entire sample period is

mainly driven by the second sub-period where none of the variables is significant. In fact, the adjusted R^2 for the regression with liquidity variables is negative at -2.06% in the second sub-period.

We then perform the joint regressions in Table 7 over two sub-periods. The estimates are reported in Table 7. Overall, the results are consistent with the findings in Table 6. In all regressions in the first sub-period, both risk and liquidity variables are consistently significant, whereas none of the marketability variables is significant. In contrast, all regressions in the second sub-period, while the risk variable remains significant, both liquidity variables are no longer significant. The relative size of private placement is significant in all three regressions.

It is apparent from Table 7 that the liquidity variables were most important in explaining the discount on the private placements in our sample during the period from 01/27/2000 to 08/29/2003. Liquidity variables include turnover, bid-ask spread, market capitalization, and the exchange dummy. However, marketability variables were more important from 09/08/2003 through 03/27/2008. In addition, as we saw in Table 6, to being relatively important in explaining the entire sample. Marketability variables include the issue size, share percentage, liquidation time, and the registration dummy variable.

3.3 Joint Regressions for the entire sample period January 2000 – March 2008

In the joint regressions, we include a total of five variables. Among the risk variables, volatility is included as it is statistically significant. Among the marketability variables, other than the relative size which is highly significant in Table 4 we also include the registration dummy. Among the liquidity variables, we include turnover and NYSE dummy. We perform regressions with different combinations of the above variables. The results are reported in Table 5. With both risk and liquidity variables included in the regression (R+L), the volatility variable

becomes more significant (at 1% significance level) with a positive sign, and interestingly turnover is now also significant (at 5% significance level) with a negative sign. The NYSE dummy remains insignificant. With both liquidity and marketability variables included in the regression (L+M), the only significant variable is relative size of private placement (at 5% significance level) with a positive sign. With both risk and marketability variables included in the regression (R+M), both standard deviation of stock returns and relative size of private placement remain significant (at 5% significance level). The registration dummy is now weakly significant (at 10% significance level). With all five variables included in the regression (R+L+M), the only significant variables are standard deviation of stock returns and relative size of private placement (at 1% and 5% significance levels, respectively). We also note that adjusted R^2s of all regressions are positive, raked from high to low by the R+L+M regression at 5.74%, the R+M regression at 5.38%, the R+L regression at 3.17%, and the L+M regression at 2.68%.

4. Summary and Conclusions

The goal of this paper is to identify potential determinants of the percentage discounts in the placements of private equity. We categorize our potential determinants into three sets of variables. The three sets of variables are i) liquidity or illiquidity variables (these are exogenous to the private placement), ii) marketability variables (in particular the size of the private placement), these variables are endogenous to the private placement, but conditional on the liquidity or illiquidity variables, and iii) optionality. While, each set of variables captures a different effect, we categorize liquidity and marketability variables as trading restrictions.

Overall, using data on 194 placements of common equity from January 27,2000-March 27,2008, we find empirical evidence that both volatility and trading restrictions are related to the percentage discount in private placements.

However, more recently, financial markets have seen structural changes which affect the importance of liquidity as a constraint as a means for trading. In particular, among other things, over the period 2001-2005, the cost to trade common stock dropped quite significantly (Anderson and Dyl, 2012). Consequently, we use a Chow test to search for a structural break in the relation between liquidity and discounts during our sample period. Our results imply that a structural break occurred around August 2003, and that post August 2003, liquidity restrictions are less important determinants of variation in the percentage discounts for private placements of equity. Indeed, our results also imply that marketability restrictions play a more important role in the determination of variation in the percentage discounts for private placements of common equity.

Taken together, our results shed new and important light on the potential determinants in the percentage discount in the placements of common equity.

Appendix A: Valuing marketability as an option

Longstaff's fundamental insight is that marketability is can be construed as the option to sell an asset at the time of one's choosing (i.e., a put option). Thus, the value of marketability can be estimated using techniques from option pricing theory. Longstaff's analysis assumes that an asset is continuously traded in a frictionless market with a constant, riskless, rate of interest and populated by investors with perfect market timing (i.e., prescience) who sell the asset and invest the proceeds in the riskless asset to maximize the value of their portfolios. If the investors are restricted from selling the asset for a period of time equal to T, they cannot trade optimally to maximize the value of their portfolios. That is, the restriction on marketability imposes an opportunity cost on the investors that reduces the end-of-period value of their portfolios. Longstaff derives a model that estimates the loss in value that results when trading is restricted for a period of time, so the asset is not marketable. This amount can be thought of as an upper bound on the value of marketability.

The resulting model is as follows:

$$Maximum\ Discount = \left(2 + \frac{\sigma^2 T}{2}\right)\left(\mathrm{N}(d)\right) + \sqrt{\frac{\sigma^2 T}{2\pi}}\exp\left(-\frac{\sigma^2 T}{8}\right) - 1 \qquad \text{(A.1)}$$

where: σ = the standard deviation of the firm's daily stock returns (annualized);

T = the length of time that the shares are illiquid; and

N(d) = the probability that a standardized, normally distributed, random variable is $\leq$ d, where $d = \frac{\sqrt{\sigma^2}T}{2}$.

Equation (A.1) provides a measure of the largest percentage discount for the absence of liquidity that can occur in a market with rational investors when the volatility of the stock's daily returns is σ and the period of illiquidity is T days. The opportunity cost of the trading restriction is a function of both the risk of the asset (σ), measured as the volatility of the firm's returns, and the degree to which the asset is nonmarketable. Longstaff's model uses an absolute restriction on trading—a length of time (T) that the stock cannot be sold—as a proxy for the extent to which the asset is not marketable.

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Table 1 Firm and Issue Characteristics

This table provides information about the issuing firms and the specific private placements in our sample.

Characteristic	Mean (σ)	Median	95th Percentile	5th Percentile
Stock Price (t = 0)	$13.36 (15.84)	$8.63	$41.75	$1.44
Shares Outstanding (Million)	25.97 (21.44)	20.53	77.84	5.41
Market Capitalization (Million)	$286.52 (546.26)	$172.20	$902.63	$32.04
Listed on NYSE (Yes = 1)	0.129 (0.336)	0	1.000	0.000
Trading Volume (Annual) (Thousands)	6,287. (11,352.)	3,033.	22,450.	210.
Turnover (Annual)	231% (331.1)	136%	658%	26%
Issue Price (per share)	$11.51 (13.39)	$7.500	$37.14	$1.15
Issue Price Discount (t = 0)	13.30% (8.69)	11.93%	29.92%	3.61%
Issue Size (Millions of shares)	3.562 (3.709)	2.50	10.00	0.550
Relative Size (% of shares outstanding)	14.68% (11.29)	13.45%	24.76%	5.02%
Issue Size (Million)	$27.78 (33.23)	$18.25	$76.00	$3.74
Registered (Yes = 1)	0.872 (0.335)	1.000	1.000	0
Stock Price (t = 10)	$13.15 (14.55)	$8.01	$45.06	$1.28

Table 2 Regression Variables

This table shows descriptive statistics for the 10 independent variables that we examine in our regression analyses. The dependent variable in the regression is the issue price discount on the private placement, where the issue price discount is the difference between the offer price and the market price of the stock immediately preceding the announcement of the private placement.

Independent Variables	Mean (σ)	Median	95th Percentile	5th Percentile
	A. Risk Variables			
Volatility (6 month)	0.049 (0.023)	0.045	0.087	0.019
Skewness (6 month)	0.885 (1.12)	0.677	2.794	-0.324
Market Capitalization ($Million)	$286.52 (332.33)	$172.20	$902.63	$32.04
	B. Liquidity Variables			
Turnover (6 month)	1.161 (1.65)	0.682	12.67	0.034
Bid-Ask Spread (%)	0.011 (0.012)	0.008	0.0271	0.002
Listed on NYSE (Yes = 1)	0.129 (0.336)	0	1.000	0
	C. Marketability Variables			
Relative Size (% of shares outstanding)	0.147 (0.113)	0.135	0.248	0.050
Issue Size ($Million)	$27.79 (33.23)	$18.83	$76.00	$3.74
Liquidation Time (Months)	2.495 (4.25)	1.116	8.056	0.156
Registered (Yes = 1)	0.871 (0.336)	1.000	1.000	0

Table 3: Simple Correlations between Regression Variables

	Issue Price Discount	Volatility (6 month)	Skewness (6 month)	Mkt. Capitalization ($Million)	Turnover (6 month)	Bid-Ask Spread (%)	Listed on NYSE(Yes=1)	Relative Size (% of Shares Outstanding)	Issue Size ($ Million)	Liquidation Time (Months)	Registered (Yes=1)
Issue Price Discount	1										
A. Risk Variables											
Volatility (6 month)	0.153**	1									
Skewness (6 month)	0.090	0.482***	1								
Mkt. Capitalization ($Million)	0.033	-0.015	-0.099	1							
B. Liquidity Variables											
Turnover (6 month)	-0.081	0.391***	0.284***	0.054	1						
Bid-Ask Spread (%)	-0.080	-0.042	-0.037	0.082	-0.119*	1					
Listed on NYSE (Yes=1)	-0.004	-0.129*	0.002	-0.018	-0.145***	-0.100	1				
C. Marketability Variables											
Relative Size (% of Shares Outstanding)	0.178**	0.021	-0.051	-0.184**	-0.216	-0.006	-0.052	1			
Issue Size ($ Million)	-0.081	-0.115	-0.079	0.541***	0.087	0.089	0.021	0.034	1		
Liquidation Time (Months)	0.014	-0.198***	-0.064	-0.144**	-0.286***	0.382***	0.019	0.508***	-0.097	1	
Registration(Yes=1)	0.117	-0.04	-0.097	0.041	-0.217***	0.144**	0.102	0.015	0.009	0.090	1

***denotes significance at the .01 level.
**denotes significance at the .05 level.
*denotes significance at the .10 level.

Table 4 Separate Regressions of Risk, Liquidity, and Marketability, 01/27/2000-03/27/2008

This table shows the coefficients and significant levels when for regressions of the risk, liquidity, and marketability variables separately on the discount.

Independent Variable	Risk Variables	Liquidity Variables	Marketability Variables
Intercept	0.138 (0.121)	0.178 (0.120)	0.259** (0.118)
Volatility (6 month)	0.659* (0.330)		
Skewness (6 month)	0.001 (0.0064)		
Mkt. Capitalization (log)	-0.002 (0.006)	-0.002 (0.0064)	
Past Returns (6month)	-0.0069 (0.0119)		
Turnover (6 month)		-0.492 (0.389)	
Bid-Ask Spread		-0.052 (0.041)	
Listed on NYSE (Yes=1)		-0.008 (0.019)	
Relative Size (% of Shares Outstanding)			0.173*** (0.063)
Issue Size (log)			-0.009 (0.007)
Liquidation Time (log)			-0.548 (0.566)
Registration (Yes=1)			0.030 (0.0185)
N	190	194	194
Adj R^2	1.35%	-0.51%	3.67%

***denotes significance at the .01 level.
**denotes significance at the .05 level.
*denotes significance at the .10 level.

Table 5 Separate Regressions of Risk Variables, Liquidity Variables, and Marketability Variables

Independent Variable	01/27/2000-08/29/2003			09/08/2003-03/27/2008		
	Reg. 1 (Risk Measures)	Reg. 2 (Liq. Measures)	Reg. 3 (Mkt. Measures)	Reg. 1 (Risk Measures)	Reg. 2 (Liq. Measures)	Reg. 3 (Mkt. Measures)
Intercept	-0.006	0.048	0.046	0.169	0.281	0.400**
	(0.135)	(0.133)	(0.141)	(0.199)	(0.204)	(0.181)
Volatility (6 month)	0.841**			0.941		
	(0.360)			(0.646)		
Skewness (6 month)	-0.0049			0.0001		
	(0.0083)			(0.01)		
Past Returns (6 month)	-0.00001			-0.012		
	(0.012)			(0.021)		
Mkt. Capitalization (log)	0.00475	0.006		-0.04	-0.007	
	(0.0069)	(0.0072)		(0.01)	(0.0108)	
Turnover (6 month)		-1.08**			-0.259	
		(0.517)			(0.542)	
Bid-Ask Spread		-0.054			-0.058	
		(0.066)			(0.057)	
Listed on NYSE (Yes=1)		-0.064**			0.008	
		(0.026)			(0.027)	
Relative Size (% of Shares Outstanding)			0.063			0.201**
			(0.130)			(0.080)
Issue Size (log)			0.003			-0.017*
			(0.008)			(0.010)
Liquidation Time (log)			-0.001			-0.0073
			(0.007)			(0.009)
Registration (Yes=1)			0.0319			0.025
			(0.0242)			(0.027)
N	78	85	85	112	109	109
Adj R^2	2.51%	6.31%	-1.99%	0.43%	-2.06%	4.43%

***denotes significance at the .01 level.
**denotes significance at the .05 level.
*denotes significance at the .10 level.

Table 6 Joint Regressions of Risk, Liquidity and Marketability Variables, 2000-2008

Independent Variable	R+L	L+M	R+M	R+L+M
Intercept	0.102*** (0.015)	0.0930*** (0.021)	0.057** (0.230)	0.0625*** (0.023)
		A. Risk Variables		
Volatility (6 month)	0.843*** (0.299)		0.596** (0.271)	0.789*** (0.296)
		B. Liquidity Variables		
Turnover (6 month)	-0.872** (0.406)	-0.2544 (0.3860)		-0.677 (0.412)
Listed on NYSE (Yes=1)	0.0001 (0.0186)	-0.0032 (0.0187)		0.00073 (0.018)
		C. Marketability Variables		
Relative Size (% of Shares Outstanding)		0.133** (0.055)	0.133** (0.054)	0.126** (0.0541)
Registration(Yes=1)		0.0273 (0.0189)	0.031* (0.018)	0.0246 (0.0186)
N	194	194	194	194
Adj R^2	3.17%	2.68%	5.38%	5.74%

***denotes significance at the .01 level.
**denotes significance at the .05 level.
*denotes significance at the .10 level.

Table 7 Joint Regressions of Risk, Liquidity, and Marketability Variables for Sub-periods

Independent Variable	01/27/2000-08/29/2003				09/08/2003-03/27/2008			
	R + L	L + M	R + M	R + L + M	R + L	L + M	R + M	R + L + M
Intercept	0.098*** (0.017)	0.126*** (0.029)	0.0579** (0.030)	0.090*** (0.0296)	0.089*** (0.024)	0.089 (0.029)	0.044 (0.035)	0.046 (0.035)
A. Risk Variables								
Volatility (6 month)	0.957*** (0.301)		0.581** (0.285)	0.974*** (0.306)	1.299** (0.565)		0.974** (0.511)	1.21** (0.561)
B. Liquidity Variables								
Turnover (6 month)	-1.825*** (0.544)	-0.972** (0.538)		-1.844*** (0.579)	-0.756 (0.569)	-0.064 (0.533)		-0.563 (0.573)
Listed on NYSE (Yes=1)	-0.057** (0.025)	-0.0628** (0.027)		-0585** (0.0256)	0.014 (0.026)	0.013 (0.026)		0.011 (0.026)
C. Marketability Variables								
Relative Size (% of Shares Outstanding)		-0.023 (0.102)	0.043 (0.099)	-0.068 (0.098)		0.149** (0.071)	0.136* (0.069)	0.133* (0.070)
Registration (Yes=1)		0.022 (0.023)	0.034 (0.023)	0.018 (0.022)		0.027 (0.028)	0.036 (0.026)	0.0285 (0.027)
N	85	85	85	85	109	109	109	109
Adj R^2	16.86%	6.42%	3.98%	16%	2.58%	1.82%	5.77%	5.12%

***denotes significance at the .01 level.
**denotes significance at the .05 level.
*denotes significance at the .10 level.

Table 8 Sub-sample Firm and Issue Characteristics

This table provides information about the issuing firms and specific private placements in each of our subsamples.

Independent Variable	01/27/2000-08/29/2003				09/08/2003-03/27/2008			
	Mean (σ)	**Median**	**95th Percentile**	**5th Percentile**	**Mean (σ)**	**Median**	**95th Percentile**	**5th Percentile**
Stock Price (t = 0)	$16.44 (20.27)	$9.95	$50	$2.151	$10.96 (10.75)	$8.09	$31.01	$1.22
Shares Outstanding (Million)	23.69 (15.73)	19.57	64.23	9.068	27.75 (24.94)	23.23	78.79	4.194
Market Capitalization (Million)	$358.74 (743.996)	$202.003	$1166.61	$32.04	$230.2 (308.92)	$134.54	$695.16	$32.27
Listed on NYSE (Yes = 1)	0.07059 (0.2577)	0	1	0	0.1743 (0.3813)	0	1	0
Trading Volume (Annual) (Thousands)	5,309 (6,345.15)	3,033.02	22,450.8	210.7	7,049.66 (14.058.53)	2,633.02	26,674.41	142.64
Turnover (Annual)	229.8% (263.64)	155.89%	583.85%	30.19%	232.38% (376.61)	123.17%	657.8%	21.25%
Issue Price (per share)	$14.21 (17.15)	$8.25	$45	$1.846	$9.39 (9.01)	$7	$29.5	$1
Issue Price Discount (t = 0)	12.77% (6.36)	12.13%	24.55%	3.72%	13.71% (10.16)	11.13%	37.84%	3.5%
Issue Size (Millions of shares)	2.93 (2.34)	2.045	7.2	0.9	4.05 (4.45)	2.86	11	0.438
Relative Size (% of shares outstanding)	13.31% (6.86)	12.53%	20.44%	5.38%	15.74% (13.73)	13.96%	31.64%	5.01%
Issue Size ($Million)	$29.02 (27.98)	$21.2	$76	$4.999	$26.84 (36.92)	$17.09	$72	$2.4
Registered (Yes = 1)	0.9059 (0.2937)	1	1	0	0.844 (0.3645)	1	1	0
Stock Price (t = 10)	$16.17 (17.85)	$10.37	$49.25	$2.05	$10.79 (10.87)	$7.39	30.5	1.02
N	85	85	85	85	109	109	109	109

Table 9 Sub sample Regression Variables

This table shows descriptive statistics, corresponding to each subsample, for the 10 independent variables that we examine in our regression analyses. The dependent variable in the regression is the issue price discount on the private placement, where the issue price discount is the difference between the offer price and the market price of the stock immediately preceding the announcement of the private placement.

	01/27/2000-08/29/2003				09/08/2003-03/27/2008			
Independent Variable	**Mean (σ)**	**Median**	**95th Percentile**	**5th Percentile**	**Mean (σ)**	**Median**	**95th Percentile**	**5th Percentile**
				Risk Variables				
Volatility (6 month)	0.057 (0.024)	0.0562	0.111	0.0269	0.042 (0.019)	0.0393	0.0763	0.016
Skewness (6 month)	0.8313 (0.9761)	0.6105	2.103	0.267	0.9258 (1.2148)	0.726	3.037	0.392
Market Capitalization ($Million)	$358.74 (743.996)	$202.003	$1166.61	$32.04	$230.2 (308.92)	$134.54	$695.16	$32.27
				Liquidity Variables				
Turnover (6 month)	229.8% (263.64)	155.89%	583.85%	30.19%	232.38% (376.61)	123.17%	657.8%	21.25%
Bid-Ask Spread (%)	0.0125 (0.0107)	0.0088	0.0266	0.0032	0.0098 (0.0136)	0.0055	0.0271	0.0016
Listed on NYSE (Yes=1)	0.07059 (0.2577)	0	1	0	0.1743 (0.3813)	0	1	0
				Marketability Variables				
Relative Size (% of shares outstanding)	0.1331 (0.0686)	0.1253	0.2044	0.0538	0.1574 (0.1373)	0.1396	0.3164	0.0501
Issue Size ($Million)	$29.02 (27.98)	$21.2	$76	$4.999	$26.84 (36.92)	$17.09	$72	$2.4
Liquidation Time (Months)	197.42 (258.19)	107.67	720.46	9.78	290.27 (517.06)	116.68	1012.78	17.18
Registered (Yes=1)	0.9059 (0.2937)	1	1	0	0.844 (0.3645)	1	1	0
N	85	85	85	85	109	109	109	109