

Share Repurchase Programs and Liquidity: An Examination of Dutch Auction Repurchases *

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ABSTRACT

The existing evidence on the liquidity effects of share repurchase programs is mixed. However, previous studies focused solely on open market repurchase programs which do not allow for precise estimates of share buy-back intensity to measure liquidity effects. Since firms are under no obligation to disclose when (or even if) they are repurchasing shares, typically little is known about the precise timing and execution of open market repurchases. Furthermore, open market share repurchase programs are often renewed and can span several years. The indefinite time horizon clouds the ability to measure the permanent impact of share repurchase programs on firm liquidity. Consequently, we examine Dutch auction share repurchase programs to circumvent these problems, and investigate the temporary and permanent effects of repurchase programs on liquidity. The advantage of studying the Dutch auction format is twofold. First, the timing, quantity, and price of repurchases are known from company press releases. Second, Dutch auctions occur over a relatively short period (average tender period is typically 30 days). Therefore, our analysis of Dutch auction share repurchase programs allows us to investigate the short-term effects that occur over the one-month tender period. More importantly, we can examine possible lasting effects on liquidity after the repurchase program is over. We find that the improvement in liquidity is transitory and limited to the one-month tender period when the firm's offer to repurchase shares is outstanding. Improvements in liquidity over longer intervals (or permanent impacts due to the share repurchase program) appear to be the result of an overall price improvement and a reduction in volatility and not because of a structural change in market dynamics. In sum, our results dovetail with those of Cook, Krigman, and Leach (2004) where improved liquidity occurs on the days when the firm actually enters the market and repurchases shares.

Keywords: Share Repurchase Programs, Dutch Auctions, Liquidity

JEL Classification Codes: G35, D82, G14

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1. Introduction

Rather than paying dividends, a firm with available cash may choose to implement a share buy-back program and use the funds to repurchase some of its outstanding stock. Share repurchase programs have taken on increased importance in recent years. A survey of corporate managers by Brav, Graham, Harvey and Michaely (2005) found many managers prefer repurchases because they are more flexible than dividends.² Firms that want to repurchase shares can implement their program through an open market repurchase, targeted share repurchase, a fixed-price tender offer or a Dutch auction tender offer. The distinctive feature of a Dutch auction repurchase is that the firm specifies a price range within which the shares are to be repurchased and the tender offer is open for a specific period of time, typically 30 days.³ Stockholders have the opportunity to specify prices at which they are willing to sell all or a portion of their shareholdings to the firm. At the conclusion of the offer and receipt of the tenders, the firm selects a 'clearing price' (the lowest price per share possible within its specified price range) that permits it to buy-back the announced number of shares from stockholders who agree to sell at or below the selected price.

The objective of this study is to measure changes in the liquidity of a firm's equity resulting from the implementation of a share repurchase program. Specifically, we examine the temporary and permanent effects of the repurchase program on the liquidity of the repurchasing firm's equity when a Dutch auction format is employed. Previous studies examining the impact of repurchase programs on a stock's liquidity have focused on open market repurchase programs. Since firms are under no obligation to disclose when, or even if, they are repurchasing shares in open market programs, the ability of these studies to measure liquidity effects is limited. Furthermore, open market share repurchase programs are often renewed and can span several years. The indefinite time horizon clouds the ability to measure the permanent impact of share repurchase programs on firm liquidity.⁴

The advantage of studying the Dutch auction format is twofold. First, the timing, quantity, and price of share repurchases are known since they are announced in company press releases. Second, Dutch auctions occur over a relatively short period, typically 30

² Furthermore, Fama and French (2001) note that regardless of the changing characteristics of firms from the late 1970s through 1999, the proportion of firms paying cash dividends has declined sharply.

³ In a Dutch auction tender offer, the firm announces the maximum number of shares to be purchased and the firm pays the same price per share for all the shares purchased in the offering.

⁴ In an interesting departure from earlier studies, Cook, Krigman and Leach (2004) obtain survey data from firms as to the timing of their open market repurchases, and then examine the attendant liquidity effects.

days.⁵ Therefore, the Dutch auction format allows us to examine, compare, and measure liquidity over three distinct time periods: a pre-announcement or pre-event period; the tender period; and a post-event period.⁶ By examining these three periods, we are able to measure the temporary impact of the share repurchase program over the duration of the tender period (typically one month), as well as its permanent impact by comparing the post-event period to the pre-event period. This ability to distinguish between temporary or short-term and permanent or long-term liquidity changes is a distinct advantage of using Dutch auction repurchases, which is not possible when using open market repurchases.

Neither the short or long-term effects of repurchase programs on liquidity are well understood. There are reasons to believe the effect could be either **positive or negative**. First consider the short-term impacts. A repurchase program results in an increase of corporate insiders to the trading environment which will have a negative impact on liquidity (see Barclay and Smith, 1988). Specifically, given the prospect of trading against an informed insider, other market players may be reluctant to participate in the trading process. In contrast, by announcing a repurchase program, management is reducing information asymmetry about the probability distribution of the stock price and therefore increasing liquidity. In effect, the repurchase acts as a signal (see Bagwell, 1992) about the price and leads to an immediate reduction in price uncertainty in the market.

There can also be two opposing views of the long-term effect of repurchases on liquidity. First, we discuss the possibility of decreased liquidity. Amihud and Mendelson (1986, 1988) argue that there is a larger premium on less-liquid stocks as compensation for market-makers. Specifically, since fewer shares are traded of less liquid stocks, the bid-ask spread is wider to compensate the specialist for providing market making activities with higher inventory holding costs. We extrapolate this logic to stock repurchases to argue that once a repurchase has been consummated, the resulting decrease in shares outstanding may cause an increase in bid-ask spreads (and thus decrease liquidity) as the specialist has fewer shares outstanding for trade on which to make the spread. Another explanation which is information based is also offered by Lesmond, O'Connor and Senbet (2002). They develop a model of financing events to demonstrate that an increase in leverage leads to lower liquidity. In our context, a stock repurchase results in a reduction of equity outstanding and thereby an increase in leverage for the firm. Given the results of Lesmond et al (2002), this suggests that a stock repurchase will result in lower stock liquidity. Further, since managers cannot participate in a repurchase, managerial ownership of the shares outstanding should increase. Since prior studies (e.g. Sarin, Shastri and Shastri, 1999) have shown that increases in ownership concentration reduce liquidity, this suggests that long-term liquidity may decrease after the repurchase.

⁵ The shorter time period is useful since the probability of a large scale structural change (other than the repurchase per se) or some other informational event affecting liquidity is minimized.

⁶ These periods are defined later in the paper.

Next we provide arguments why liquidity could in fact increase. Easley and O'Hara (2004) argue that if information asymmetry and uncertainty about price is reduced, then the spread should decline. Additionally, we argue that if the repurchase serves as a signal that management considers the stock to be undervalued, it would attract attention to the stock and enhance the investor base subsequent to the repurchase with a corresponding increase in liquidity. This will be especially pronounced if the stock is relatively unknown (i.e. a neglected stock). The repurchase may catalyze analysts to initiate coverage of the firm, and new investors may rush in to buy the stock. In this vein, evidence supporting liquidity effects following on initiation of analyst coverage is presented by Irvine (2003).

We argue that is important for managers to understand the long-term liquidity effects of their repurchasing transactions because of the important relationship between liquidity and the cost of capital (e.g. Affleck-Graves, Callahan, and Chipalkatti 2002; Amihud and Mendelson, 2000). In fact, the managerial concern over liquidity is borne out by survey evidence in Brav, Graham, Harvey and Michaely (2005) where they report that over half of the managers they surveyed indicated that liquidity of their stock is an important or very important factor affecting their repurchase decisions. Given the above discussion where repurchases could either enhance or diminish long-term liquidity, the overall effect is clearly an empirical question with important managerial implications.

Thus, in our analyses, we examine the impact of the Dutch auction on various measures of liquidity such as the bid-ask spread, depth, and volume for the repurchasing firm's shares. Results from this study provide insight into the ongoing discussion on the liquidity effects of other modes of repurchase programs. We find that the true improvement in liquidity is transitory and is limited to the one-month tender period. During the tender period, the implicit demand with price limits announced by the repurchasing firm serves to provide extra depth to the market. We believe that this factor contributes to the increased liquidity during the tender period. Our finding corresponds to the results in Cook, Krigman, and Leach (2004) for open market repurchases where improved liquidity occurs on the days when firms actually enter the market and repurchase shares.

Improvements in the relative spread variable measured over longer intervals following the conclusion of the Dutch auction repurchase, appear to be the result of an overall increase in the price of the common stock. Specifically, the stock price is used as the divisor in computing the relative spread. If this divisor (i.e. the stock price) increases, an automatic reduction in the relative spread will arise. The price increase is presumably due to the well known signaling phenomenon associated with stock repurchases documented initially by Dann (1981), and specifically for Dutch auctions by Bagwell (1992). In sum, our results show that short-term liquidity improves while the repurchase offer is outstanding. However, once the repurchase is concluded, liquidity returns to pre-event levels. Thus, a Dutch auction repurchase is not an effective format if the objective is to enhance long-term liquidity.

The rest of the paper is organized as follows. Section 2 briefly describes details on share repurchase program with a particular focus on the Dutch auction format and surveys related literature. Section 3 describes the methodology. Section 4 presents the data used in this paper. Section 5 presents the empirical results for the liquidity effects of the share repurchase programs in two parts. The first part focuses on the univariate changes in liquidity by examining in turn the spread, depth, and volume. The second part presents a multivariate analysis examining the interaction of these measures. Section 6 concludes the paper.

2. Share Repurchase Programs

To date, there is no clear consensus on the influence of open market share repurchase programs on liquidity. The empirical evidence focuses on the short-term impact of share repurchase programs on liquidity. Specifically, in their seminal work on this topic, Barclay and Smith (1988) present empirical evidence suggesting liquidity decreases around share repurchase announcements. The authors argue that the addition of corporate insiders to the trading place (due to the share repurchase program) increases the probability of trading with an informed trader and therefore decreases the willingness of less informed traders to trade. More recently, Brockman and Chung (2001) also find evidence of decreased liquidity using a sample of open market repurchases from the Hong Kong market. Evidence of a similar decreased liquidity in France is reported by Ginglinger and Hamon (2005). Others studies, including Singh, Zaman and Krishnamurti (1994), Miller and McConnell (1995), and Kim (2004), find no change in liquidity as a result of open market repurchase programs. Franz, Rao, and Tripathy (1995) present evidence of increased liquidity and argue that management reduces information asymmetry by announcing their intention to repurchase shares in the open market.

In a departure from prior studies, Cook, Krigman, and Leach (2004) use survey data from firms that conduct open market repurchase programs, and are able to pinpoint the actual time of the repurchase activity. They document hard evidence of an increased liquidity effect on the days when the firm is actually conducting its repurchases in the market. However, their finding cannot be extrapolated to address the long-term liquidity effects of repurchases unless the firm repurchases shares on a fairly regular basis over the long-term. Clearly, this latter condition is not tenable. We believe that the long-term liquidity effects associated with repurchases cannot be fully explored in the ‘open market share repurchase programs’ setting because there is no finite date for the conclusion of such programs. Without such a date, the researcher will not know over which periods to construct the liquidity variables necessary for the empirical analyses. This is the inherent advantage to examining Dutch auction repurchases which have finite beginning and end dates for the tender period which is typically 30 days in duration.

Dutch Auctions

In a typical Dutch auction tender offer, the firm announces a maximum number of shares to be purchased and specifies a beginning and an ending date for the repurchase of its shares and the intervening tender period is typically 30-days. The firm specifies a price range (instead of a fixed price) within which the shares are to be repurchased. Stock holders have the opportunity to specify prices (within the price range set by the firm) at which they are willing to sell all or a portion of their shareholdings to the firm. At the conclusion of the offer and receipt of the tenders, the firm selects a single ‘final’ price per share (the lowest price within its price range or the ‘clearing price’) that will permit it to buy-back the announced number of shares from those stockholders who agree to sell at or below the selected price. Thus, the firm only pays that amount per share which is necessary, within the stated range, in order to secure the specified number of shares. The firm pays the same price per share for all the shares purchased in the offering.

If the number of shares tendered is less than (or equal to) the number of shares that the firm seeks to purchase, then the purchase price is the highest price of those prices specified by tendering shareholders (within the price range set by the firm). However, if the number of shares tendered is greater than the number of shares sought by the firm, then the firm will select the purchase price that allows it to buy the number of shares it seeks (again, within the price range set by the firm). In the event of oversubscription, only those shares that are tendered at or below the final purchase price (determined by the firm) are eligible for proration (pro rata purchase). The firm retains the right to purchase more than the number of shares originally announced, but is not obligated to do so. No commission charges are incurred by tendering stockholders.

3. Empirical Methods

In this paper, we examine the change in several measures of liquidity surrounding the Dutch auction event over three distinct periods: pre-event, tender period, and, post-event, to test whether these potential changes are statistically significant. As shown in the timeline in Figure 1, Dutch auctions are characterized by three important dates: AD - the announcement date; ED - the expiration date; and RD - the results date. The RD typically occurs the next business day after the ED.

Insert Figure 1 here

More specifically, in our empirical analysis, we examine our liquidity measures over three periods: (1) 75 days prior to the announcement date [AD-76,AD-2], (2) the tender period [AD,ED] which is typically 30-days, and (3) 75 days after the Dutch auction results are announced [RD+2,RD+76]. These dates were chosen to minimize the impact of announcement effects and allow us to focus on structural changes in liquidity. The use of 75 days prior to the announcement of a Dutch auction is a long enough period before the event for investors to be unaware of the upcoming auction and 75 days

afterwards is enough time for the market to have adjusted to the smaller number of shares outstanding subsequent to the repurchase program.

For our liquidity measures, we compute the following variables for each day, and then for each firm and then, finally compute a mean and median across the Pre-Event period, the Tender Period, and the Post-Event Period. Our liquidity variables are as follows: (1) absolute spread; (2) relative spread; (3) effective spread; (4) bid depth; (5) ask depth; (6) total depth; (7) average trade size; (8) daily volume (in shares traded); and, (9) daily volume (in dollars traded). We then compare each of these variables to a baseline period which is defined to be the 75 trading-day window before the pre-event period. In event time, this baseline period spans the window [AD-151, AD-77].

We perform the comparisons by taking the natural log of the ratio of the variable for the period of interest (i.e. the pre-event period, the tender period, or the post-event period) to its analog computed over the baseline period. If the log ratio is zero, it indicates that the variable in the period of interest is equal to its analog from the baseline period; if the log ratio is positive, it indicates the variable in the period of interest is greater than it was during the baseline period, and finally if the ratio is negative, the variable in the period of interest has declined relative to the baseline period. We also perform both a t-test and non-parametric sign test to determine if the variables are the same as the baseline period. In particular, we are interested in testing whether the change in the liquidity measures, observed after the demand shock, disappear. In other words, are these changes transitory?

Following this analysis of liquidity changes over various time periods, we employ a multivariate approach to assess which specific characteristics of the Dutch auction can explain a significant share of the observed changes in liquidity variables (1) through (9), listed above. The parameters we consider are (i) the volatility; (ii) the daily volume; (iii) the price level; and, (iv) the number of shares outstanding. More specifically, we use the change in the liquidity variables as dependent variables and regress them against the changes in parameters (i) through (iv). Our multivariate analysis framework closely follows Kumar, Sarin, and Shastri (1998) who examine the impact of options trading on liquidity of the underlying security.⁷

4. Data

We restrict the sample to Dutch auction repurchases conducted by firms listed on the New York Stock Exchange to control for market structure and trading protocols.⁸ The

⁷ The need to control for these variables is explained in Kumar, Sarin, and Shastri (1998), and we omit a further discussion in the interests of brevity.

⁸ Controlling for market structure (i.e. auction versus dealer markets) is important whenever liquidity effects are studied. See Huang and Stoll (1996, 2001), Blume and Goldstein (1997), Jones and Lipson (1999), Chordia, Sarkar, and Subrahmanyam (2005) as examples of studies where differences in market structure affect stock characteristics such as liquidity.

sample has been identified from Thomson Financial's SDC database and the data have been verified through time-stamped press releases from Lexis/Nexis and Dow Jones and Reuters' Factiva database. These press releases yielded information about the exact date and time of the announcement of each Dutch auction share repurchase program, as well as the terms of the program. These data were then augmented with the TAQ database. The TAQ is compiled by the New York Stock Exchange (NYSE) and contains intraday transactions data (trades and quotes) for all securities traded on the NYSE. This dataset, therefore, allows us to construct our desired liquidity measures in addition to allowing us to precisely define the pre-event, tender and post-event periods. Table 1 presents the frequency distribution of our sample observations.

Insert Table 1 here

As seen in Table 1, our sample starts in 1993 because that is the first year for which the TAQ data is available. The sample ends in 2002, and we note that the number of repurchases peaks in the bull market of the late 1990s. Table 2 provides descriptive statistics of the sample.

Insert Table 2 here

The mean premium of the high price of the Dutch auction's price range is approximately 8% over the existing market price. Interestingly, the low price of the price range is often below the market price that existed prior to the announcement. The results of the Dutch auction are typically announced within 2 days of the expiration of the tender offer period. If the offer is oversubscribed, the firm purchases the shares that are tendered at or below the final price on a pro-rata basis. In our sample, 25 offers (34% of the 73-observation sample) are oversubscribed. The average proration factor for the oversubscribed offers is approximately 77%. The proration factor does not indicate the number of shares that may have been tendered at prices above the final price at which the auction is consummated.

Cumulative Returns

A standard event study around the announcement, expiration, and results dates was conducted to document the equity market's response to the Dutch auction.⁹ To perform this event study, we use returns over a consistent 255 trading day period (about one year) ending on day -152 prior to the announcement date, to estimate the benchmark return process.¹⁰ This benchmark is used in our statistical tests to detect 'abnormal returns'

⁹ We perform this analysis to confirm that our results are comparable to the Bagwell (1992) results since our sample is drawn from a later period. In table 3, the average cumulative abnormal return over the (AD, ED) window is about 9.1% and this is consistent with the 6.7% reported by Bagwell (1992) over her (AD-1, ED) period.

¹⁰ Note that the estimation period ends the day prior to the first day of the baseline period.

during the event windows of interest. In the event study, we use size-adjusted buy-and-hold abnormal returns. Specifically, we compute buy-and-hold returns for the firm in question, and deduct from this the equivalent return for the equally weighted CRSP size decile portfolio over the same time frame. Statistical tests then compare this value to the value in the estimation period. Table 3 summarizes the event study findings.

Insert Table 3 here

The detailed stock return results are presented in the appendix. The appendix shows that the impact of the Dutch auction announcement is immediate and the price reaction does not linger over the entire tender period.¹¹ Further, in the last row of Table 3, the return over the post-event period, [RD+2, RD+76], is insignificant. In other words the price is apparently reacting to an information event and there is no evidence of any trading momentum in the post-event period after the Dutch auction is concluded.

5. Empirical Results

In this section, we present the effects of the share repurchase program on market liquidity. The empirical results are presented in two parts. The first part focuses on univariate measures of liquidity and shows how these measures change relative to the baseline period over the pre-event period, the tender period, and the post-event period. There are three broad measures of liquidity included in this section - spread, depth, and trading volume. The second part presents a multivariate analysis of changes in liquidity in order to control for changes in other variables such as volatility, price levels and shares outstanding.

A. Univariate Analysis

Spreads

One measure of liquidity is the quoted spread. A variety of measures of the quoted spread have been employed in the literature. In general, as the quoted spread decreases, liquidity improves, since it is less costly to convert into cash. In Table 4, we present the absolute spread (in dollars), the relative quoted spread¹², and the relative effective spread¹³ over

¹¹ The detailed results in the Appendix clearly show that the stock price reaction to the announcement is confined to the Announcement period (AD-1, AD+1). The returns in the interim period before the expiration date (AD+2, ED-2) are insignificant. There appears to be some abnormal return on the expiration date of the offer.

¹² The relative quoted spread is defined as the absolute spread divided by the average of the bid and ask prices.

¹³ The relative effective spread is defined as two times the absolute value of the difference between the transaction price and the average of the prevailing bid and ask prices divided by the average of the prevailing bid and ask prices.

four time periods - the baseline period, the pre-event period, the tender period and the post event period. The table presents summary statistics for the sample of 73 firms included in our final sample. The reported mean and median values are aggregated first by period (i.e. baseline, pre-event, tender and post-event periods) and then at the firm level. The absolute and relative spreads are the time-weighted averages of all bid-ask spreads quoted on each day in the appropriate period. The weighting procedure takes into consideration the length of time each quote is exposed to the market. The relative effective spread is not time averaged as it measures the effective spread paid by each transaction.

Insert Table 4 here

As shown in Table 4, spreads are dramatically lower over the approximately 30 day tender period, irrespective of the specific spread measure employed. The mean absolute spread goes from \$0.193 to \$0.157, while the mean relative spread drops from 0.939% to 0.688% and the mean relative effective spread drops from 0.00633% to 0.00511%. In the post-event period, the absolute spread more or less returns to its pre-event levels. The relative spreads, however, remain lower than their pre-event levels. Given that the absolute spread has returned to its pre-event levels, this reduction in the relative spreads is likely due to the increased price following the share repurchase announcement.

Figure 2 presents a slightly different examination of the relative quoted spread and relative effective spread. Rather than presenting aggregated data across each event period, the data are aggregated by date, relative to the announcement date and the results date. This ‘time series’ examination allows us to examine the stability of these liquidity measures across the study periods. The baseline, pre-event period, tender period and post-event period have been delineated to facilitate their identification. Note that the tender period is capped at 20 days to ensure representation of all 73 firms in the sample.

Insert Figure 2 here

While the aggregated data clearly show a reduction in spreads in the tender period, this is a testable hypothesis. Table 5 presents two statistical tests for a change in liquidity in the pre-event period, the tender period and the post-event period relative to the baseline period.

Insert Table 5 here

The first test examines if the mean is statistically different from zero. This simple *t*-test of the mean is presented at three different significance levels: at the 1% level, the 5% level, and the 10% level. The results confirm our earlier suspicion of a significant change in the tender period spreads. All three measures of the spread show a significant reduction in the tender period at the 1% level. The mean reduction in the absolute spread for the sample of Dutch auction firms is approximately 24 percent; while the mean reduction in the relative quoted spread is 32 percent. The relative effective spread declines by 26 percent. Clearly, these results indicate a significantly lower spread over the 30-day tender period relative to the baseline period, suggesting a vast improvement in liquidity over that window.

The post-event period also shows a reduction in the mean spread. The reduction in spread is much smaller than that observed in the tender period, but it is also statistically significant. The reduction in the absolute spread, relative quoted spread, and relative effective spread is approximately four percent, 14 percent and 15 percent, respectively. The pre-event period also shows a small reduction in the spread relative to the baseline period. However, with the exception of the relative effective spread, the changes are not significantly different from zero.

The second test in Table 5 is a nonparametric sign-test. The results for this test support the findings presented above. In other words, the nonparametric sign test concludes that the spread, regardless of the measure used, shows a reduction in the tender period and post-event period. However, the marginal significance of the change in the absolute spread in the post-event period disappears. These results taken in conjunction with the cumulative returns presented above suggest the improvement in liquidity as measured by the spread is temporary and limited to the 30 day tender period. Apparent improvements in the relative spread measured over the post-event interval (i.e. permanent impacts) due to the share repurchase program appear to be the result of an overall price increase.

Quoted Depths

We next examine the quoted depths. Quoted depths are measured at the bid, the ask, and the combined bid and ask. As quoted depth increases, market liquidity improves since the number of shares the specialist and/or limit order traders are willing to trade increases. Table 6 presents mean and median quoted depths for the baseline, pre-event, tender, and post-event periods for the sample of 73 firms.

Insert Table 6 here

The reported depths are time weighted according to the amount of time each quote was exposed to the market. The results show dramatic increase in the quoted depths during the tender period and a reduction in the quoted depths in the post-event period. This is not surprising as the number of outstanding shares is reduced in the post-event period, and

therefore, potentially limiting the supply of shares at any given time. Both the mean and median reported values show a balanced order book in the baseline, pre-event and post-event periods. However, during the tender period the order book is imbalanced with the number of shares quoted at the bid exceeding the number of shares quoted at the ask. This observation suggests limit order traders are providing liquidity disproportionately to one-side of the market -the bid side over the 30 day tender period.

Figure 3 presents a time series examination of the quoted depths by day relative to the Dutch auction announcement and the results day. Again, the improvement in liquidity as measured by the quoted depth in the tender period is dramatic.

Insert Figure 3 here

Table 7 presents two tests for changes in the quoted depth in the pre-event, tender and post-event periods. The results confirm our earlier analysis. The quoted depths show dramatic increase in the tender period, and the result is statistically and economically significant. On average, the total depth improved by approximately 87 percent during the tender period. The post-event period shows a sizable reduction in the quoted depth: the bid and ask quoted depths decrease by approximately 20 percent relative to the baseline period.

Insert Table 7 here

The second test is a nonparametric rank test which supports the conclusions drawn above. In general, the results show over 90 percent (66 out of 73 firms) of the sample show an improvement in the total quoted depth over the tender period relative to the baseline period; while in the post event period approximately 68 percent (50 out of 73 firms) show a reduction in the quoted spread. Similar to the results for the spread, the analysis of the quoted depth suggests there is a temporary improvement in liquidity during the tender period; however, unlike the analysis of the spread the permanent impact on liquidity of the share repurchase program is negative as the quoted depths decrease significantly. Of course, this does not control for other changes in the market such as the change in the number of outstanding shares.

Trading Volume

Our third general measure of liquidity is based on trading data. We measure the volume per trade, daily volume in shares, and daily dollar volume. In general, as volume increases, liquidity improves since more shares trading means it is easier to convert into

cash. Table 8 presents the mean and median summary data for each of our four analysis periods. The tender period once again shows a large improvement in liquidity with volume per trade, daily volume, and daily dollar volume, all increasing.

Insert Table 8 here

Table 9 presents the statistical analysis of the relative trading volumes. When liquidity is measured in terms of trading volume, there is clearly a significant impact during the tender period. All three measures show a large positive jump relative to their baseline levels. Larger trades appear to be happening more often during the tender period. The average volume per trade increases by 35 percent, while average daily volume increased by nearly 65 percent. Not surprisingly, average daily dollar volume also increases during the tender period by over 72 percent. The change in the tender period relative to the baseline period for each of these variables is statistically significant using both a standard t-test and a nonparametric sign test.

Insert Table 9 here

In the post-event period, there is evidence that liquidity is reduced relative to the baseline period. The average trade size decreases by approximately 12 percent, as does the daily volume. These results are significant at the 1 percent and 5 percent level of significance respectively. There is no statistical change in the daily dollar volume in the post-event period. The nonparametric results also show a statistically significant reduction in daily volume in the post-event period. Both the t-test and nonparametric sign test show no changes in the pre-event trading volume relative to the baseline period.

In summary, the univariate analysis finds that there is a significant improvement in liquidity during the tender period, irrespective of the liquidity measure used. This result presents a nice correspondence with the results in Cook, Krigman, and Leach (2004). Specifically, they find that liquidity improves when the firm actually participates in the market and repurchases shares, while we find that liquidity improves between AD and ED when the firm is entertaining offers to sell from stockholders. In both these cases, there is a large external purchaser of shares, which leads to increased liquidity. However, once the repurchase is completed, our univariate evidence on liquidity effects for the post-event period is mixed -- spreads generally showing improvements, while depths and trading volumes decline.

B. Multivariate Regression Analysis

The preceding univariate analysis examines the liquidity measures in isolation. However, there may be other factors causing the changes observed above, and consequently, a multivariate analysis is necessary. For example, the number of shares is obviously

changing over the sample period as a result of the repurchase. For most share repurchase programs this is problematic since it is difficult to observe the timing and the number of shares being repurchased. One advantage of examining Dutch auctions is that we can observe the results of the firm's share repurchasing activity over our study period. Thus, we are able to control for the number of share repurchased, or more specifically, the number of shares outstanding. We also control for changes in volatility over the study period, average daily volume, and price levels in the multivariate analyses of liquidity effects.

The estimated model is a change model with the log ratio of the different liquidity measures relative to their baseline values being used as the dependent variables. Changes in the control variables relative to their baseline value are used as independent variables. To distinguish the pre-event, tender, and post-event periods, indicator variables for the tender and post-event period are added as explanatory variables. The model is stacked with three observations for each Dutch auction included in the sample. The total number of observations included in each regression is 219 or 73 firms times 3 event periods. Specifically, the linear regression model estimated is:

$$\ln\left(\frac{liquidity_{t,i}}{liquidity_{base,i}}\right) = \beta_0 + \beta_1 \ln\left(\frac{volatility_{t,i}}{volatility_{base,i}}\right) + \beta_2 \ln\left(\frac{volume_{t,i}}{volume_{base,i}}\right) + \beta_3 \ln\left(\frac{price_{t,i}}{price_{base,i}}\right) + \beta_4 \ln\left(\frac{so_{t,i}}{so_{base,i}}\right) + \beta_5 tender_{t,i} + \beta_6 post-event_{t,i} + \varepsilon_{t,i}$$

where $liquidity_{t,i}$ is the average time weighted spread or quoted depth or volume for period t : t is one of pre-event, tender, or post-event period, and firm i , and $liquidity_{base,i}$ is the corresponding value for the baseline period. Therefore the log ratio is interpreted as a percentage change relative to the baseline period. The other variables, $volatility_{t,i}$ (standard deviation of daily stock returns), $volume_{t,i}$ (average daily volume), $price_{t,i}$ (average mid-quote), and $so_{t,i}$ (shares outstanding) are defined in the same way. Finally, $tender_{t,i}$ and $post-event_{t,i}$ are indicator variables equal to one for the tender and post-event periods respectively and zero otherwise.

Spreads

Table 10 presents the multivariate results for the absolute spread, relative spread and relative effective spread. First, the models explain a large percentage of the observed changes in the dependent variables with the R^2 ranging from 35% to nearly 62%. Furthermore, the F-value clearly indicates the overall significance of the regression. The p-values on the F-value are all less than 0.001. Changes in liquidity are clearly related to changes in volatility, volume, price levels and the share repurchase program.

In terms of the control variables used in the estimated models, the relationships are as expected. For example, as volatility increases, spreads increase implying liquidity

decreases; as volume increases, spreads decrease implying liquidity increases; and as price levels appreciate, spreads decrease and liquidity increases. It is somewhat surprising, however, that the change in number of shares outstanding does not appear to be related to liquidity.

Insert Table 10 here

The results of primary interest, however, are the estimated coefficients on the tender and post-event indicator variables. First, the tender indicator variable captures temporary liquidity impacts of the share repurchase program, i.e. while the repurchasing firm is entertaining offers to sell from stockholders. From the significant coefficient for $Tender_{t,i}$, all three of the spread measures show statistically and economically significant reductions in this 30-day tender period after controlling for other factors. The absolute spread decreases by approximately 16 percent, while the relative quoted spread decreases by nearly 17 percent and the relative effective spread decreases by 11.5 percent. The p-values all show significance at the 1% level.

The post-event indicator variable captures permanent liquidity impacts of the share repurchase program. The insignificance of the estimated parameters on the post-event indicator variables across all the liquidity measures is evidence that there are no permanent liquidity impacts after controlling for other changes. Perceived permanent improvements in spread seen in the univariate analysis disappear after taking into account other factors and in particular after taking into account the change in price levels.

Quoted Depths

Table 11 presents the results for the depth measures of liquidity. Specifically, we examine the quoted depth at the bid and ask as well as the aggregated depth at both the bid and ask. Again, the overall regressions are highly significant as evidenced by the R^2 (ranging from 44% to 55%) and F-values (with p-values less than 0.0001). In terms of the control variables, changes in the quoted depths are clearly related to changes in volatility, changes in the average daily volume as well as changes in the price level. Specifically, as the volatility increases, quoted depths or liquidity decreases; as the volume increases, liquidity increases; and as price levels increase, liquidity decreases.

Insert Table 11 here

But again, the variables of primary interest are the tender period and post-event period indicator variables. In the tender period, the depths show significant liquidity improvements. The quoted depth at the bid and ask increase by 81 and 45 percent, respectively, while the aggregated depth improves by approximately 65 percent. The p-

values all show significance at the 1% level. The depths show no improvement in the post-event period after controlling for market characteristics. Therefore, liquidity as measured by the quoted depth, experiences a temporary improvement during the 30-day tender period while share repurchase offers are being entertained; however it does not experience a permanent improvement after these activities are over.

Trading Volume

Table 12 presents the results for the volume measures of liquidity. The table presents three separate regressions relating changes in the volume per trade, daily volume and average dollar volume per day to other market changes around the Dutch auction repurchase program.¹⁴

Insert Table 12 here

Overall, Table 12 shows that a large percentage of the change in volume is captured in these regression models. The R^2 ranges from 26% to 45%. The overall significance of the regression as measured by the F-value is also high with associated p-values less than 0.001. In terms of the control variables, or changes in volatility, changes in price, and changes in shares outstanding, there is limited explanatory power added by the inclusion of these variables in the regression model. For example, the change in volatility variable does not enter the volume per trade regression significantly, and while it is significant in the other two regressions, its positive coefficient indicates increased volatility increases volume, and therefore, improves liquidity. This somewhat odd finding may be the result of increased trading asymmetries or day trading. The change in the price level only enters the final regression significantly. This is not surprising as the independent variable incorporates the price level. The final control variable, or changes in the shares outstanding, does not enter any of the regressions significantly.

Again, the variables of primary interest are the tender period and post-event period indicator variables. In the tender period, the volume shows significant liquidity improvements. The volume per trade, daily volume and dollar volume all increase by 41%, 65% and 65%, respectively. The p-values all show significance at the 1% level. The volume measures show no improvement in the post-event period after controlling for the market characteristics. Therefore, liquidity as measured by volume experiences a temporary improvement during the tender period while share repurchase activity transpires. However, it does not experience a permanent improvement after these activities are concluded.

6. Conclusion

¹⁴ Note the regression model has been modified from Tables 10 and 11 with the exclusion of changes in daily volume as independent regressor.

Prior studies that examine the impact of share repurchase programs on a stock's liquidity have focused on open market repurchases. However, open market programs do not allow for precise estimates of share buy-back intensity to measure liquidity effects because firms are under no obligation to disclose when, or even if, they are repurchasing shares. Our contribution to the literature is that we examine the impact of share repurchase programs on liquidity where we are able to definitively identify the timing, quantity, and price of the repurchase transactions by examining Dutch auction repurchase programs. Under a Dutch auction format, the timing and actual number of shares a firm will acquire is known. Furthermore, since the timing of the event is known and the event period is relatively short (the tender period is typically 30-days in duration), we are able to study both the temporary and the permanent impact of share repurchase programs on liquidity.

Our results suggest that liquidity is significantly enhanced during the tender period but the improvement in liquidity is transitory and is limited to this relatively short time period. During this specific period, the implicit demand with price limits announced by the repurchasing firm serves to provide extra depth to the market and is responsible for the increased liquidity. These results correspond to the results in Cook, Krigman, and Leach (2004) for open market repurchases where improved liquidity occurs on the days when firms actually enter the market and repurchase shares.

We also find that, although liquidity is significantly enhanced during the tender period, no evidence of increased liquidity is detected over the seventy five day period subsequent to the conclusion of the repurchase. Relative spreads are lower in the seventy five day post-event period, but these apparent improvements are the result of an overall increase in the price of the shares.¹⁵ The price increase that we document is conceivably due to the well known signaling phenomenon associated with stock repurchases documented initially by Dann (1981) and specifically for Dutch auctions by Bagwell (1992). Recently, Brav, Graham, Harvey and Michaely (2005) surveyed corporate financial executives and they document that "...repurchases are made out of residual cash flow after investment spending" and that among other things, executives accelerate repurchases "...when they believe their stock price is low". The survey results further support the signaling role of repurchases.

In view of the existing literature, our results (a) confirm that Dutch auctions signal undervaluation, and (b) short-term liquidity improves during the tender period when the firm's repurchase offer remains outstanding. However, a discrete event with finite start and end dates, like a Dutch auction repurchase is not an effective format if the objective is to enhance long-term liquidity.

¹⁵ Specifically, the stock price is used as the divisor in computing the relative spread. If this divisor (i.e. the stock price) increases, there is an automatic reduction in the relative spread.

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Table 1. Distribution of Dutch Auction Sample

The sample consists of NYSE listed firms that made dutch auction repurchases in the 1993-2002 time frame. The sample was obtained from the SDC Platinum Database.

Year	Number of Observations	Percent of Sample
1993	2	2.74
1994	5	6.85
1995	7	9.59
1996	16	21.92
1997	11	15.07
1998	12	16.44
1999	8	10.96
2000	5	6.85
2001	4	5.48
2002	3	4.11
All	73	100

Table 2. Summary Statistics

The sample consists of Dutch Auction repurchases conducted by NYSE listed firms from 1993 to 2002. The price range is the difference between the high and low price indicated by the firm for the Dutch auction. The premiums are calculated using the closing price prior to the announcement.

Variable	Mean	Median	Minimum	Maximum
Price Range (difference between announced high and low price)	\$4.03	\$3.00	\$0.45	\$40.00
Premium of high price over pre-announcement market price	8.08%	7.02%	-0.88%	26.12%
Premium of low price over pre-announcement market price	-7.45%	-7.95%	-16.67%	11.98%
Number of Shares Firm Plans to Repurchase (millions of shares)	7.40	4.00	0.40	50.00
Number of days between Announcement Date, AD, and Expiration Date, ED	32	30	25	51
Number of days between Expiration Date, ED, and Results Date, RD	2	1	1	4
Premium of Final Price over pre-announcement market price	4.82%	4.30%	-12.37%	29.83%
Number of Shares Firm Repurchases (millions of shares)	6.53	3.46	0.00	50.00
Proration Factor (in 25 of 73 observations)	77.27	84.49	34.04	97.67

Table 3. Cumulative Abnormal Returns

The sample consists of 73 NYSE listed firms conducting a Dutch Auction repurchase. Returns are measured over four periods relative to the announcement day (AD), expiration day (ED) and results day (RD). The baseline period is defined as [AD-151, AD-77]; the pre-event period is [AD-76, AD-2]; the tender period is [AD,ED]; and, the post-event period is defined as [RD+2, RD+76]. The abnormal returns are calculated as size adjusted buy-and-hold abnormal returns. Specifically, each firm's buy-and-hold return over the particular event window is extracted, and from this quantity, a buy-and-hold return of the equally weighted portfolio of firms in the same size decile (on the CRSP database) is then deducted from the former to give the buy-and-hold size-adjusted abnormal return. Two different tests for significance of the abnormal return are presented - (a) A transformed t -test that makes an adjustment for skewness of buy-and-hold returns, and (b) A non-parametric generalized sign-test that compares the ratio of the number of positive to negative abnormal returns in the event window to a similar ratio computed using data from the estimation period. *** denotes significance at the 1% level.

Period	Mean Buy and Hold Size Index Adjusted Abnormal Returns	Number of Negative to Positive Buy and Hold Size Index Adjusted Abnormal Returns
[AD-151,AD-77]	-1.04%	43:30
[AD-76,AD-2]	2.06%	39:34
[AD,ED]	9.10% ***	10:63 ***
[RD+2,RD+76]	0.77%	34:39

Table 4. Spreads

The mean and median absolute spread, relative quoted spread, and relative effective spread for a sample of 73 firms conducting a Dutch auction. Spreads are measured over four periods relative to the announcement day (AD), expiration day (ED) and results day (RD). The baseline period is defined as [AD-151, AD-77]; the pre-event period is [AD-76, AD-2]; the tender period is (AD, ED); and, the post-event period is defined as [RD+2, RD+76].

Measure	Interval	Absolute Spread (\$)	Relative Quoted Spread (%)	Relative Effective Spread (%)
Mean	[AD-151, AD-77]	0.196	0.950	0.00658
	[AD-76, AD-2]	0.193	0.939	0.00633
	(AD,ED)	0.157	0.688	0.00511
	[RD+2,RD+76]	0.195	0.844	0.00577
Median	[AD-151, AD-77]	0.166	0.739	0.00534
	[AD-76, AD-2]	0.173	0.749	0.00510
	(AD,ED)	0.139	0.605	0.00413
	[RD+2,RD+76]	0.174	0.688	0.00479

Table 5. Relative Spreads

The pre-event relative spreads are calculated as the log ratio of the pre-event period [AD-76, AD-2] to the baseline period [AD-152, AD-77]; while the tender period relative spreads are calculated as the log ratio of the tender period to the baseline period; and, the post-event relative spreads are calculated as the log ratio of the post-event period to the baseline period. Relative spreads are used to examine the change in liquidity by looking at the absolute spread, relative quoted spread, and relative effective spread. Two different tests for significance of a change in liquidity are presented - a standard *t*-test and a non-parametric sign-test. Significance at the 10%, 5% and at the 1% level is denoted as *, **, ***, respectively.

Measure	Interval	Log of the ratio after scaling by baseline period equivalent value for the following variables		
		Absolute Spread	Relative Quoted Spread	Relative Effective Spread
Mean	[AD-76, AD-2]	-0.017	-0.025	-0.051**
	(AD,ED)	-0.241***	-0.320***	-0.257***
	[RD+2,RD+76]	-0.038*	-0.136***	-0.148***
Neg:Pos	[AD-76, AD-2]	44:29	39:34	46:27**
	(AD,ED)	68:5***	66:7***	63:10***
	[RD+2,RD+76]	40:33	55:18***	57:16***

Table 6. Quoted Depths

The mean and median bid size, ask size and total depth for a sample of 73 firms conducting a Dutch auction. Quoted depths are measured over four periods relative to the announcement day (AD), expiration day (ED) and results day (RD). The baseline period is defined as [AD-151, AD-77]; the pre-event period is [AD-76, AD-2]; the tender period is (AD,ED); and, the post-event period is defined as [RD+2, RD+76].

Variable	Interval	Bid Size	Ask Size	Total Depth
Mean	[AD-151, AD-77]	53.75	53.58	107.33
	[AD-76, AD-2]	48.54	47.94	96.48
	(AD,ED)	162.43	116.61	279.04
	[RD+2,RD+76]	41.30	41.20	82.50
Median	[AD-151, AD-77]	32.88	32.73	67.08
	[AD-76, AD-2]	31.20	29.79	60.89
	(AD,ED)	86.64	72.07	174.17
	[RD+2,RD+76]	29.37	30.18	51.89

Table 7. Relative Quoted Depths

The pre-event relative quoted depths are calculated as the log ratio of the pre-event period [AD-76, AD-2] to the baseline period [AD-152, AD-77]; while the tender period relative quoted depths are calculated as the log ratio of the tender period to the baseline period; and, the post-event relative quoted depths are calculated as the log ratio of the post-event period to the baseline period. Relative quoted depths are used to examine the change in liquidity by looking at the bid size, ask size and total depth (bid size plus ask size). Two different tests for significance of a change in liquidity are presented - a standard *t*-test and a non-parametric sign-test. Significance at the 10%, 5% and at the 1% level is denoted as *, **, ***, respectively.

Measure	Interval	Log of the ratio after scaling by baseline period equivalent value for the following variables		
		Bid Size	Ask Size	Total Depth
Mean	[AD-76, AD-2]	-0.039	-0.085**	-0.069*
	(AD,ED)	1.014**	0.697***	0.8696***
	[RD+2,RD+76]	-0.204***	-0.197***	-0.209***
Neg:Pos	[AD-76, AD-2]	45:28*	40:33	49:24*
	(AD,ED)	5:68***	12:61***	7:66***
	[RD+2,RD+76]	43:30	50:23***	50:23***

Table 8. Trading Volume

The mean and median volume per trade, daily volume and daily dollar volume for a sample of 73 firms conducting a Dutch auction. Trading volumes are measured over four periods relative to the announcement day (AD), expiration day (ED) and results day (RD). The baseline period is defined as [AD-151, AD-77]; the pre-event period is [AD-76, AD-2]; the tender period is (AD, ED); and, the post-event period is defined as [RD+2, RD+76].

Measure	Interval	Volume per Trade (shares)	Daily Volume (shares)	Average Dollar Volume per Day (\$)
Mean	[AD-151, AD-77]	1,492	214,117	5,001,197
	[AD-76, AD-2]	1,399	194,724	4,807,103
	(AD,ED)	2,146	286,906	7,780,658
	[RD+2,RD+76]	1,343	170,302	4,870,375
Median	[AD-151, AD-77]	1,324	74,723	1,835,532
	[AD-76, AD-2]	1,290	66,332	1,777,263
	(AD,ED)	2,037	112,848	2,957,437
	[RD+2,RD+76]	1,243	62,908	1,456,348

Table 9. Relative Trading Volume

The pre-event relative trading volumes are calculated as the log ratio of the pre-event period [AD-76, AD-2] to the baseline period [AD-152, AD-77]; while the tender period relative trading volumes are calculated as the log ratio of the tender period to the baseline period; and, the post-event relative trading volumes are calculated as the log ratio of the post-event period to the baseline period. Trading volumes are used to examine the change in liquidity by looking at the volume per trade, daily volume and daily dollar volume. Two different tests for significance of a change in liquidity are presented - a standard *t*-test and a non-parametric sign-test. Significance at the 10%, 5% and at the 1% level is denoted as *, **, ***, respectively.

Measure	Interval	Log of the ratio after scaling by baseline period equivalent value for the following variables		
		Volume per Trade	Daily Volume	Average Dollar Volume per Day
Mean	[AD-76, AD-2]	-0.049	-0.027	-0.02
	(AD,ED)	0.350***	0.644***	0.721***
	[RD+2,RD+76]	-0.119***	-0.122**	-0.02
Neg:Pos	[AD-76, AD-2]	41:32	41:32	41:32
	(AD,ED)	13:60***	11:62***	12:61***
	[RD+2,RD+76]	44:29	46:27**	39:34

Table 10. Regression Analysis of Relative Changes in Spread over Pre-event, Tender, and Post-event Periods.

OLS regression estimates of a model explaining the relative change in spread around a Dutch auction repurchase program. Each model is a stacked regression with 219 observations, or in other words there are 73 firms included in the analysis with three event periods each ($73 \times 3 = 219$). The p -values are placed in parentheses below the estimated coefficients.

Regression Coefficients and Statistics	Dependent Variable in the Model		
	Spread	Relative Quoted Spread	Relative Effective Spread
Intercept	-0.0233 (0.211)	-0.0225 (0.227)	-0.0481 (0.029)
$\ln \left\{ \frac{volatility_{t,i}}{volatility_{base,i}} \right\}$	0.0475 (0.040)	0.0477 (0.039)	0.0474 (0.080)
$\ln \left\{ \frac{volume_{t,i}}{volume_{base,i}} \right\}$	-0.105 ($<.0001$)	-0.102 ($<.0001$)	-0.059 (0.026)
$\ln \left\{ \frac{price_{t,i}}{price_{base,i}} \right\}$	0.112 (0.086)	-0.892 ($<.0001$)	-0.787 ($<.0001$)
$\ln \left\{ \frac{SO_{t,i}}{SO_{base,i}} \right\}$	-0.074 (0.622)	-0.067 (0.655)	-0.056 (0.752)
$Tender_{t,i}$	-0.162 ($<.0001$)	-0.168 ($<.0001$)	-0.115 (0.001)
$Postevent_{t,i}$	-0.0528 (0.123)	-0.0497 (0.146)	-0.0395 (0.325)
F -value	18.98 ($<.0001$)	58.65 ($<.0001$)	27.48 ($<.0001$)
R^2	0.350	0.624	0.438
Adjusted R^2	0.331	0.613	0.422

Table 11. Regression Analysis of Relative Changes in Quoted Depth over Pre-event, Tender, and Post-event Periods.

OLS regression estimates of a model explaining the relative change in quoted depth around a Dutch auction repurchase program. Each model is a stacked regression with 219 observations, or in other words there are 73 firms included in the analysis with three event periods each ($73 \times 3 = 219$). The p -values are placed in parentheses below the estimated coefficients.

Regression Coefficients and Statistics	Dependent Variable in the Model		
	Bid-size	Ask-size	Total
Intercept	-0.0128 (0.839)	-0.0625 (0.333)	-0.0459 (0.431)
$\ln \left\{ \frac{volatility_{t,i}}{volatility_{base,i}} \right\}$	-0.2167 (0.006)	-0.1319 (0.099)	-0.1591 (0.028)
$\ln \left\{ \frac{volume_{t,i}}{volume_{base,i}} \right\}$	0.435 ($<.0001$)	0.528 ($<.0001$)	0.477 ($<.0001$)
$\ln \left\{ \frac{price_{t,i}}{price_{base,i}} \right\}$	-0.651 (0.003)	-0.287 (0.204)	-0.434 (0.034)
$\ln \left\{ \frac{SO_{t,i}}{SO_{base,i}} \right\}$	0.324 (0.526)	0.530 (0.311)	0.406 (0.390)
$Tender_{t,i}$	0.813 ($<.0001$)	0.451 ($<.0001$)	0.654 ($<.0001$)
$Postevent_{t,i}$	-0.0098 (0.933)	0.0428 (0.717)	0.0088 (0.934)
F -value	43.82 ($<.0001$)	27.6 ($<.0001$)	42.7 ($<.0001$)
R^2	0.554	0.439	0.547
Adjusted R^2	0.541	0.423	0.534

Table 12. Regression Analysis of Relative Changes in Volume over Pre-event, Tender, and Post-event Periods.

OLS regression estimates of a model explaining the relative change in volume around a Dutch auction repurchase program. Each model is a stacked regression with 219 observations, or in other words there are 73 firms included in the analysis with three event periods each ($73 \times 3 = 219$). The p -values are placed in parentheses below the estimated coefficients.

Regression Coefficients and Statistics	Dependent Variable in the Model		
	Volume per Trade	Daily Volume	Average Dollar Volume per Day
Intercept	-0.0450 (0.288)	-0.0430 (0.449)	-0.0445 (0.431)
$\ln \left\{ \frac{volatility_{t,i}}{volatility_{base,i}} \right\}$	-0.0674 (0.175)	0.3326 ($<.0001$)	0.3373 ($<.0001$)
$\ln \left\{ \frac{price_{t,i}}{price_{base,i}} \right\}$	-0.083 (0.577)	0.157 (0.428)	1.159 ($<.0001$)
$\ln \left\{ \frac{SO_{t,i}}{SO_{base,i}} \right\}$	-0.085 (0.804)	0.572 (0.213)	0.598 (0.190)
$Tender_{t,i}$	0.407 ($<.0001$)	0.648 ($<.0001$)	0.650 ($<.0001$)
$Postevent_{t,i}$	-0.0715 (0.357)	-0.0427 (0.681)	-0.0368 (0.722)
F -value	14.80 ($<.0001$)	27.54 ($<.0001$)	34.61 ($<.0001$)
R^2	0.258	0.393	0.448
Adjusted R^2	0.240	0.378	0.435

Figure 1. Dutch auction timeline. RD typically occurs the next business day after ED.

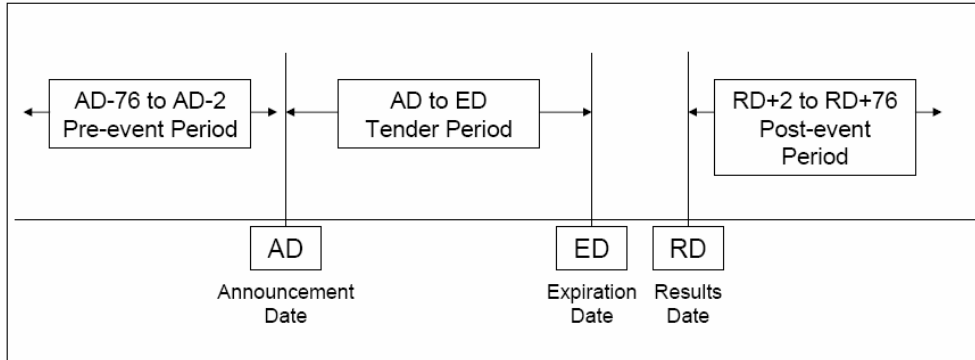


Figure 2. Profile of Daily Average Spreads The average dollar spread, average relative quoted spread, and average relative effective spread for a sample of 73 firms conducting a Dutch auction. AD is the announcement date, ED is the expiration date and RD is the results date (i.e. announcement of the results of the Dutch auction). Four periods are identified – the baseline period is defined as [AD-151, AD-77]; the pre-event period is [AD-76, AD-2]; the tender period is (AD,ED); and, the post-event period is defined as [RD+2, RD+76].

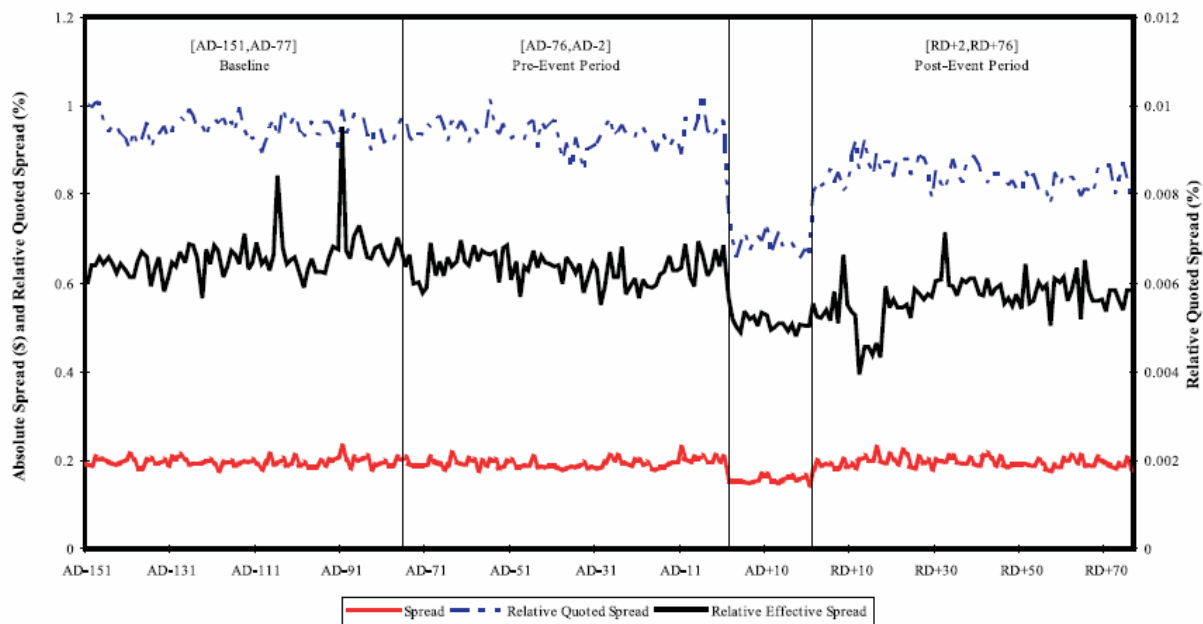
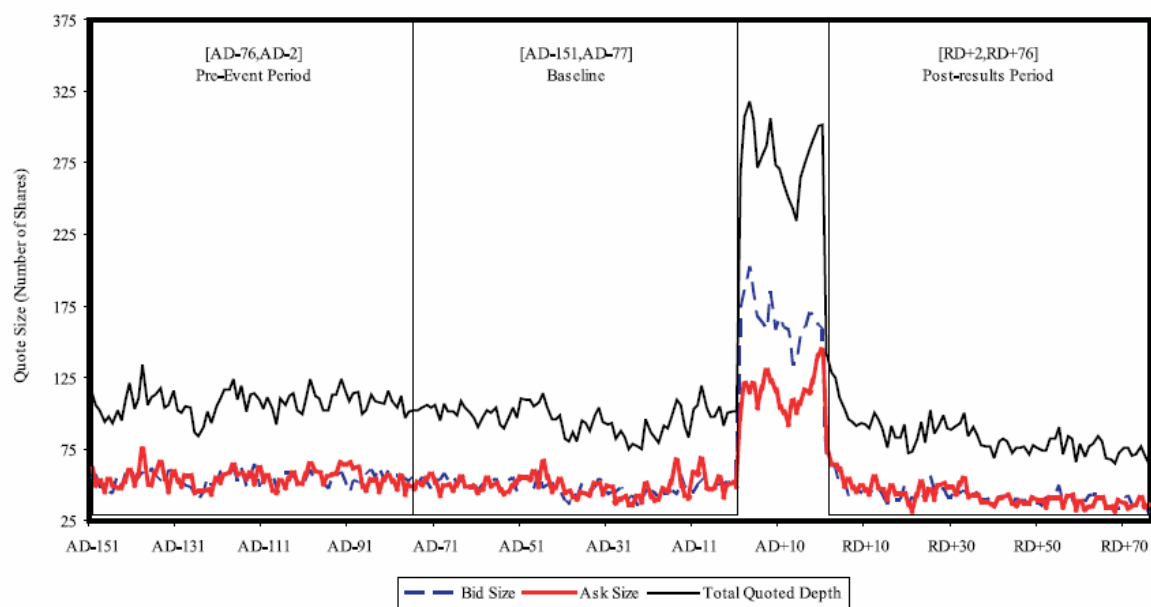


Figure 3. Daily Average Quoted Depths The average relative quoted depths for a sample of 73 firms conducting a Dutch auction relative to the announcement date (AD), expiration date (ED), and results date (RD). The four periods included in our analysis are defined as follows: the baseline period is [AD-151, AD-77]; the pre-event period is [AD-76, AD-2]; the tender period is (AD,ED); and, the post-event period is [RD+2, RD+76].



APPENDIX

Figure A-1. Cumulative Returns over Pre-event, Tender, and Post-event Periods. Cumulative returns are calculated as size-adjusted buy-and-hold returns. AD is the announcement date, ED is the expiration date and RD is the results date (i.e. announcement of the results of the Dutch auction). *, **, *** denote significance at the .05, .01, and .0001 levels respectively. The analysis was performed using a consistent 255 day period to estimate the benchmark ending on day [AD-152]. Note also that the cumulative abnormal returns over the [AD+2,ED-2] window was statistically insignificant.

