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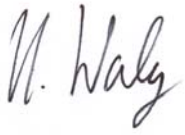

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Do Firms Buy Their Stock at Bargain Prices? Evidence from Actual Stock Repurchase Disclosure*

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Abstract:
We use new data from SEC filings to investigate how S&P 500 firms execute their open market repurchase programs. We find that smaller S&P 500 firms repurchase less frequently than larger firms, and at a price which is significantly lower than the average market price. Their repurchase activity is followed by a positive and significant abnormal return which lasts up to three months after the repurchase. These findings do not hold for large S&P 500 firms. Our interpretation is that small firms repurchase strategically, whereas the repurchase activity of large firms is more focused on the disbursement of free cash.

JEL Classification: G14, G30, G35

Keywords: Stock Repurchases, Stock Buybacks, Payout Policy, Timing, Bid-Ask Spread, Liquidity

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Stock repurchases have become an economically significant payout tool in the US. Little is, however, known about the manner in which the actual repurchase activity is related to market conditions and returns.[1] This is because in the past, firms generally reported only the aggregate number of shares repurchased over the quarter, without distinguishing between market and non-market transactions. Firms were also not required to report any information about the prices of their repurchase trades. As a result, publicly available information about repurchase activity in the open-market has been limited.[2]

Following amendments to in SEC Rule 10b-18, which regulates stock buyback transactions, as of the beginning of 2004, US firms are required to report detailed information about their repurchase activity in their quarterly financial reports.[3] The requirements include reporting the number of shares repurchased per month, the nature of the repurchase (e.g., open market, tender offer, or privately negotiated transaction), the number of shares repurchased under a publicly announced plan, and the average price the firm paid for the shares during the reporting period on a monthly basis.

In this paper we explore this new data source. We hand-collected information about actual repurchases of all S&P 500 firms from their 10Q and 10K filings for the years

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[1] On the economic significance of actual repurchases, see, for example, Stephens and Weisbach (1998), Guay and Harford (2000), Fenn and Liang (2001), Grullon and Michaely (2002), Kahle (2002), Dittmar and Dittmar (2007), and Peyer and Vermaelen (2009).

[2] On the inaccuracy of pre-2004 publicly available repurchase data, see Cook, Krigman, and Leach (2003), and Banyi, Dyl, and Kahle (2008).

[3] SEC Rule 10b-18, which was adopted in 1982, provides a voluntary "safe harbor" from liability for manipulation, when an issuer or its affiliated purchaser bids for or purchases shares of the issuer's common stock, if they follow the rule's timing, price, and volume restrictions.

from 2004 to 2006, and investigate the manner in which firms repurchase their own shares in the open market. In particular we are interested in learning 1) how actual repurchase activity is related to liquidity, 2) whether firms purchase their shares at discounted prices relative to prices paid by other investors, and 3) how actual repurchase activity is related to past and future returns.

We find that illiquidity, measured by the bid-ask spread, is lower in repurchase months (the spread is narrower). Specifically, 64% of the repurchasing firms have a narrower average spread in repurchase months relative to non-repurchase months. The average half bid-ask spread is 0.038% in non-repurchase months and 0.036% in repurchase months. While the difference is small, it equals approximately 5% of the spread and is statistically significant at the 1% level.[4] We also find clear evidence that only smaller S&P 500 firms repurchase their shares at lower prices, compared to other investors. Specifically, we sort our sample into three equal-size groups by firm size. While all S&P 500 firms are relatively large, average firm size in the small-firm group is ten times smaller than the average firm size in the large-firm group. The average monthly price that small firms pay for their stock is 0.416% below the average monthly market price, and the difference is statistically significant at the 1% level. However, for medium-sized and large firms, this difference is negligible and statistically insignificant. Small firms also tend to repurchase less frequently than large firms. On average, small firms repurchased in 47% of the

[4] The absolute difference is small because the bid-ask spreads in the sample are small. This is in turn due to the decimalization of the quotes in the NYSE and NASDAQ exchanges that occurred in 2001, and because the sample comprises S&P 500 firms. Our estimation of the difference is also likely downward- biased because firms repurchase only on a subset of the trading days in each month, while we average the bid-ask spread over all the days of each month.

reported months while large firms repurchased in 69% of the months. Controlling for size, we find that lower bid-ask spread is associated with a repurchase price that is discounted more heavily, relative to the market price. This, in turn, suggests that the more liquid the market the better the firm's ability to buy at favorable prices, and that repurchasing firms consume liquidity rather than provide it.

With respect to the relation between repurchase activity and return, we find that actual repurchase activity increases following poor stock price performance and this increase is sustained for up to two months. This result holds regardless of firm size. We also measure returns after the repurchase month, and find that for the small firms in our sample, actual repurchase activity is followed by a positive and significant abnormal return that lasts up to three months, indicating market timing.[5] For large firms, however, the abnormal return is negative and insignificant. In fact, we show that a short-term strategy that focuses on the actual repurchase activity of the small firms can earn a monthly abnormal return of 0.9%, which is significant at the 1% level. We did not find positive abnormal returns in longer-term horizons (we considered returns for up to two years following the repurchase).

Our interpretation of the findings—that only small S&P 500 firms repurchase at discounted prices, have positive post-repurchase returns, and repurchase less frequently—is that small firms repurchase strategically whereas the repurchase activity of

[5] We identify "market timing" with repurchasing before price increases, and distinguish it from buying at prices lower than the average market prices within the month. We do so because we want to investigate the firm's ability to repurchase at cheap prices separately from the relation between the repurchase and the post-repurchase returns. The repurchase literature sometimes uses the term "market timing" for both.

large firms is more focused on disbursement of free cash. Specifically, two important properties of stock buybacks are the disbursement of free cash and the transfer of wealth among shareholders if the stock is not fairly priced. Given that smaller firms are associated with higher information asymmetry, their motivation to repurchase strategically in order to benefit from underpricing may be higher. At the same time, given that large firms tend to be mature, they are likely to have stronger motivation to disburse free cash regardless of mispricing. Consistent with this interpretation we find that the average dividend yield of large firms is 30% higher than that of small firms. This is because, in general, a larger dividend payout indicates stronger cash disbursement motivation.

It is possible that the smaller firms repurchase conditional on positive information, not in order to benefit from underpricing, but simply because they become privately informed of good information about the availability of free cash. The market receives the good information only when the financial reports are disclosed, and hence the discounted repurchase prices, and the positive correlation between actual repurchase activity and future abnormal returns.

This study is not the first to consider the timing of actual repurchase activity and its relation to prices and liquidity. The most closely related studies include Ikenberry, Lakonishok, and Vermaelen (2000), Brockman and Chung (2001), Cook, Krigman, and Leach (2004), McNally, Smith, and Barnes (2006), Ginglinger and Hamon (2007), and De Cesari, Espenlaub, Khurshed, and Simkovic (2009). Our novel contribution to the

existing literature is in showing that the association between repurchase activity, timing, and liquidity strongly depends on firm size.

Cook, Krigman, and Leach (2004), (henceforth, CKL (2004)) investigate actual repurchases in the US before the regulation amendment, using repurchase data disclosed voluntarily by 64 firms during a one-year period ending March 1994. They find that the bid-ask spread is narrower on repurchase days and interpret these findings as evidence that repurchases contribute to market liquidity. Using US data, Brockman, Howe, and Mortal (2008) show that stock market liquidity increases the likelihood of a repurchase over dividends. Outside the US, De Ridder and Rasbrant (2009) report narrower spreads on repurchase days in Sweden. In contrast, Brockman and Chung (2001), and Ginglinger and Hamon (2007) study the relation between the bid-ask spread and actual repurchases in Hong Kong and France, respectively, and report wider bid-ask spreads on repurchase days (months) and suggest this indicates that actual repurchases reduce liquidity.

With respect to repurchasing at discounted prices, CKL 2004 find that NYSE firms pay less than representative daily prices while NASDAQ firms pay more. While most of our findings are consistent with the findings in CKL (2004), we did not find any difference between NYSE firms and NASDAQ firms in terms of their ability to repurchase at favorable prices. This may be because we focus on S&P 500 firms, and hence our NASDAQ and NYSE firms are similar in size. Other studies also report that differences between NYSE and NASDAQ that existed in the 1990s disappeared in the 2000s, following changes in NASDAQ trading mechanisms. In a recent contemporaneous study,

De Cesari et al. (2009) also investigate actual repurchase activity in the US using post-regulation-change data. Similarly to our study, they find that firms are able to repurchase at discounted prices. They focus on the impact of ownership structure, and show that a firm's ability to repurchase at discounted prices is positively related to insider and institutional ownership at low levels of ownership, and negatively related to insider and institutional ownership at high levels of ownership. Their interpretation is that because insiders and institutions are better-informed investors, at low levels of ownership of these investors, their presence increases the incentive to repurchase based on information. However, at high levels of ownership of these informed investors, it becomes more difficult for the firm to benefit from information because competition with these informed investors in the financial markets is also more intensive. Brockman and Chung (2001) find that in Hong Kong firms repurchase at a lower cost than the cost that would result from a naïve accumulation strategy. McNally et al. (2006) show that firms in Canada are able to repurchase at prices that are a remarkable 5.5% lower than prices paid by other investors.

Consistent with our findings, both CKL (2004) and De Cesari et al. (2009) also find that actual repurchase activity tends to increase following price drops, and interpret this result as evidence for "price support motivation." In Canada, Ikenberry et al. (2000), and McNally et al. (2006) also report negative returns before actual repurchase activity. Zhang (2005) reports negative returns in Hong Kong in the 20-day period before actual repurchases, and Ginglinger and Hamon (2007) document that firms in France also tend to repurchase after price drops.

The literature provides mixed evidence with respect to market timing of repurchase activity. CKL (2004) do not find abnormal returns following actual repurchase activity, but De Cesari et al. (2009) find positive abnormal returns consistent with our results. Outside the US, Zhang (2005) finds significant positive short-term abnormal returns following repurchase trade in Hong Kong, and Chung, Isakov, and Perignon (2007) report similar results in Switzerland. In Canada, Ikenberry et al. (2000), and McNally et al. (2006), also report price increases after repurchase activity, interpreting these findings as evidence of market timing. Ginglinger and Hamon (2007), however, find no significant price increases after actual repurchase activity in France. Given their findings that firms increase their repurchase activity following price drops, their interpretation is that, in France, firms repurchase for price support rather than as a result of market timing.

It is worthwhile to compare our findings on actual repurchases to findings about the announcement of open-market repurchase programs in the US. Announcements of repurchase programs and their impact on prices and liquidity have been studied extensively.[6] Announcements and actual repurchases, however, are different events. Most actual repurchase activity is spread over a period that lasts up to 3 years following the announcement, and announcing firms often repurchase much less or much more than the originally announced quantity (see Stephens and Weisbach 1998). In addition, most firms have several concurrent and overlapping announced programs (see Jagannathan and Stephens 2003). In fact, announcements merely reveal that the firm may be "in the

[6] See, for example, Vermaelen (1981), Comment and Jarell (1991), and more recently, Grullon and Michaely (2004).

market," and are often only marginally connected to actual repurchase activity. Studies of repurchase program announcements in the US provide mixed evidence about their impact on the bid-ask spread (Barclay and Smith 1988, Miller and McConnell 1995, Franz, Rau, and Thripathy 1995), suggesting dependency on information, while we find a narrowing of the bid-ask spread in actual repurchase months, suggesting a relation to liquidity. Oded (2009) shows that bid-ask spreads and program completion rates are negatively correlated, while Bonaime (2010) finds that program completion rates increased following the 2004 regulatory change.

Other studies of program announcements focus on long-run returns and find significant positive abnormal return in the years that follow the announcements (Ikenberry, et al. 1995, 2000, and Peyer and Vermaelen 2009)[7]. While our focus is the short term, specifically, one to three months before and after the repurchase, for comparison with this literature, we also considered longer horizons (up to two years following the actual repurchase). As mentioned earlier, unlike previous studies, we found no significant relation between actual repurchase and long-run returns. The difference in findings may be due to the fact that we measure abnormal returns relative to actual repurchase rather than relative to repurchase announcement, or because our sample is more recent.

The remainder of this paper is organized as follows. Section I describes the data and the methodology. Section II provides sample statistics and examines how repurchase activity is related to firm characteristics and liquidity. Section III analyzes the relation between

[7] Mitchel and Stafford (2000) however, report that long-run returns following repurchase announcements are positive and significant only on an equal-weighted basis but not on value-weighted basis.

repurchase price and market price. Section IV examines the relation between repurchase activity and past and future returns, and Section V concludes.

I. Data

Our initial sample comprises 500 firms that were included in the S&P 500 in January 2004. The sample period covers the 36 months between January 2004 and December 2006. The repurchase data were obtained from filings to the SEC in 10Q and 10K forms, available on the SEC website (www.sec.gov). The data retrieved from these filings include the firm name, ticker, number of shares repurchased, and the average repurchase price during the month. Data on outstanding shares, prices, and returns were obtained from the CRSP. The data sets (obtained from the SEC and CRSP) were merged based on firm ticker. From the original sample of 500 firms, we eliminated firms that were delisted and therefore had no filings available on www.sec.gov.[8] We also eliminated firms with erroneous repurchase data and firms that could not be matched correctly with the CRSP data, resulting in 470 firms. Of these 470 firms, 416 reported repurchase activity in SEC filings during the sample period ("repurchase firms") while 54 firms reported no such activity ("non-repurchase firms").

In December 2003, the Securities and Exchange Commission adopted several amendments to Rule 10b-18 to enhance the transparency of actual repurchase activity. The amendments require disclosure in quarterly and annual reports all issuer repurchases

[8] Reports of delisted firms were not found in a standard search procedure of sec.gov and therefore these firms were not included in our study.

of equity securities in the last fiscal quarter. Thus, since 2004, this information is publicly available through the 10Q and 10K reports. Stock repurchase transactions are generally reported under the heading "Issuer Purchases of Equity Securities." For each month of the quarter, the firm reports: the total number of shares repurchased, the average repurchase price, the number of shares repurchased under a publicly announced repurchase program, and the number of shares remaining in its announced repurchase program at the end of the month. An example of actual repurchase reporting to the SEC is provided in Appendix A.

For the 416 firms for which repurchase data were available in 10Q and 10K filings, several monthly observations were stated as repurchases at special prices not performed through the open market (such as tender offer repurchases, privately negotiated repurchases, and repurchases directly from managers). These monthly observations were eliminated from the sample.[9] Sixteen monthly observations were also removed after a review of the financial report revealed that they were accelerated stock repurchases transactions rather than open-market repurchases, even though they were reported under open-market transactions.[10] Price outliers were also removed using the following rule: If the average monthly repurchase price reported by the firm fell outside the daily high-low range during the month, the observation was removed (232 out-of-range monthly observations were removed under this rule).

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[9] Under the new requirements of Rule 10b-18, a firm is required to briefly disclose in a footnote the nature of the repurchase transaction. We used these footnotes to eliminate from the sample those transactions that were not performed through the open market.

[10] Accelerated stock repurchase transactions were removed from the sample because they are performed in the open market over several months after they are reported.

The repurchase prices and quantities were adjusted for splits. Several firms did not have return data for all 36 months because they were delisted (for various reasons). We adjusted these firms' returns for the specific delisting month using CRSP delisting returns data.[11] The final sample consists of 16,526 monthly observations from 470 firms, of which 8,501 are non-zero repurchases. Out of the 470 firms in the final sample, 416 had at least one repurchase observation reported during the sample period. For these 416 firms we have 14,669 observations (of which 8,501 are non-zero).

II. Sample Statistics

Table 1 reports general characteristics of the firms in the sample. Panel 1A provides statistics of the complete sample of 470 firms. In the table, *Mean* is the average of the firm-level averages, *Median* and *Std* are the median and standard deviation of the firm-level averages, respectively. The mean (median) firm size is about $22.3 ($10.7) billion, and the mean (median) monthly dividend yield is 0.13% (0.11%). The mean (median) monthly return is positive at 1.11% (1.09%). The mean (median) monthly *Alpha* abnormal return, measured using a 4-factor model which includes the three Fama-French (1993) factors and the Carhart (1997) momentum factor, is negative at -0.18% (-0.06%). The mean (median) monthly market volume is $2,671 ($1,489) million.

[11] Adjusting for delisting is important when comparing portfolio performance. Not including the delisted returns causes upward bias in the portfolio performance. For further discussion see Shumway (1997).

Panel 1B provides statistics of repurchasing vs. non-repurchasing firms. Of the 470 firms, 416 (89%) had at least one month of repurchase activity whereas 54 (11%) had no repurchases reported in SEC filings during the sample period. The panel shows that the market capitalization of repurchasing firms is about two-times greater than that of non-repurchasing firms, and that the difference is statistically significant.[12] *Dividend Yield* and *Alpha* (abnormal return relative to four factors) are also significantly higher for repurchasing firms. However, *Ret* (naïve return) is not significantly higher for repurchasing firms and the difference in *Market Volume* is significantly higher for repurchasing firms only under the Wilcoxon measure. These findings are consistent with earlier documentations of repurchase activity in the literature.[13]

Because we focus on S&P 500 firms, naturally most of the firms in the sample are NYSE rather than NASDAQ firms. Of the 470 firms in the sample, 398 (84.7%) are from NYSE and 72 (15.3%) are from NASDAQ.

Table 2 reports statistics of repurchase activity. The characteristics are equally weighted across all 8,501 repurchase months of the 416 firms that had repurchase activity during the sample period. The average (median) amount spent on repurchasing shares, in a month in which the firm did repurchase, is $104 million ($27 million). The mean (median) market volume in repurchase months is $3,244 million ($1,725 million). In months with repurchase, monthly repurchase trade accounts for 3.3% of the monthly dollar volume of trade in the stock, and accounts for about 0.41% of the market

[12] The standard deviation of the market capitalization of non-repurchasing firms is high because of WalMart, with a market capitalization of $285 billion.

[13] On the tendency of repurchasing firms to also be dividend payers, see for example, Grullon and Michaely (2002). On the high abnormal returns on stocks of repurchasing firms, see for example, Peyer and Vermaelen (2009).

capitalization. The medians of the repurchase activity variables we consider tend to be low relative to their means, indicating positive skewness. The standard deviations of the variables tend to be high relative to their means.

In **Table 3** we investigate the relation between repurchase and liquidity. To do so, we include only firms that have both repurchase months and non-repurchase months. Of the 416 firms with at least one month of repurchase activity, 22 repurchased in all months reported, and as a result, the analysis in Table 3 is based on 394 firms. The liquidity measure we consider is the half bid-ask spread (*HBAS*), calculated as the daily average of the half bid-ask spread over the month, based on CRSP daily closing bid and ask quotes. The volume of trade in dollars is also reported in the table (*MktVol*). Rows (1) to (6) report the results for the average values of *HBAS* in repurchase vs. non-repurchase months. The results show that *HBAS* is significantly lower in repurchase months relative to non-repurchase months. Specifically, the average half bid-ask spread is 0.038% in non-repurchase months and 0.036% in repurchase months. The difference amounts to approximately 5% of the spread, and is statistically significant at the 1% level. As the table shows, *MktVol* is also higher in repurchase months relative to non-repurchase months. However, the difference is insignificant.

Rows (7) to (10) of Table 3 report the results of a binomial test of the relation between repurchasing and liquidity. For each of the variables *HBAS* and *MktVol*, we counted the number of firms for which the difference in the average value of the variable in repurchase months less the average value in non-repurchase months is positive, and the

number of firms for which this difference is negative. As Table 3 demonstrates, there are 253 firms (64%) for which average *HBAS* in repurchase months was lower than in non-repurchase months (a negative difference in *HBAS*) but only 141 firms (36%) for which average *HBAS* in repurchase months was higher than in non-repurchase months (a positive difference in *HBAS*). There were 159 firms (40%) for which average *MktVol* in repurchase months was lower than in non-repurchase months (a negative difference in *MktVol*) and 235 firms (60%) for which the average *MktVol* in repurchase months was higher than in non-repurchase months (a positive difference in MktVol). As the bottom row of Table 3 indicates, the difference in the number of firms is statistically significant at the 1% level for both *HBAS* and *MktVol* (confirmed with a binomial distribution test under the assumption of equal chance for positive and negative outcomes). The results of this non-parametric test are thus consistent with the results reported for the *t*-stat values of *HBAS* and *MktVol* in repurchase months vs. non-repurchase months. Overall the results in Table 3 indicate that actual repurchase activity is negatively related to the bid-ask spread, and positively related to market volume. Both findings suggest that repurchase activity is positively correlated with liquidity.

In **Table 4** we investigate whether repurchase characteristics depend on firm size. Specifically, we sort the 416 repurchasing firms into three equal-size groups by their average size (market capitalization) over the sample period. Panel 4A reports firm characteristics while Panel 4B reports payout characteristics of the different size groups. The bottom three rows in each panel report the difference between the large-firm group and the small-firm group, and the statistical significance of the difference using *t*-stat and

the Wilcoxon non-parametric test. Starting with Panel 4A, firm-size ranges are \$0.5-\$7.6 billion in the small-firm group, \$7.6-\$18 billion in the medium-sized firm group, and \$18-\$357 billion in the large-firm group. Thus, while all S&P 500 firms are relatively large, the average firm size in the small-firm group is ten times smaller than the average firm size in the large-firm group. Panel 4A also reports firm characteristics across firm-size groups. The average *HBAS* decreases from 0.046% in the small-firm group to 0.028% in the large-firm group, and the difference is statistically significant at the 1% level. The negative correlation between firm size and *HBAS* is consistent with larger firms being more liquid. We also verified that the results about *HBAS* in Table 3 hold for each size group. That is, for each group the bid-ask spread is statistically larger in repurchase months than in non-repurchase months.[14] *RetStd* is the standard deviation of the return, and is naturally negatively correlated with size. *Number of Analysts* and *Dispersion of Analysts* are, respectively, the number of analysts covering the firm, and the dispersion of their quarterly earnings forecast, normalized by the forecast mean, and calculated based on monthly updates of forecasts from IBES. Naturally, larger firms have more coverage because they attract greater investor interest, and show less dispersion in analyst forecasts due to lower information asymmetry.

Focusing on payout characteristics in the different groups, in Panel 4B, we report average repurchase frequency (*RepFreq*) across firm groups, where for each firm, *RepFreq* is the ratio between the number of months in which the firm reported a positive repurchase value and the total number of months in which the firm appears in the sample. As Panel

[14] The difference in *HBAS* between repurchase months and non-repurchase months also decreases with size across the groups. However, this decrease is not statistically significant.

4B indicates, larger firms repurchase more frequently: Repurchase frequency in the small-firms group is 47% and 69% in the large-firm group. Repurchase dollar volume relative to market dollar volume (*ReptoMktVol*) is similar in all groups: 3.7%, 3.0%, and 3.3% for small, medium-sized and large firms, respectively. In sum, the results indicate that repurchase frequency is positively correlated with firm size. However, in repurchase months, repurchase dollar value relative to market volume is similar across firm-size groups.

The variable *Rep/Size* is the monthly dollar value of a firm's repurchase as a percentage of the firm's preceding month market capitalization, namely, "the repurchase yield." *Dividend Yield* is the monthly dividend yield represented as a percentage. As Panel 4B shows, *Rep/Size* is similar across firm-size groups (the small differences are not statistically significant). However, dividend yield increases with firm size. The average monthly dividend yield in the large-firm group is 21% greater than the dividend yield in the small-firm group (0.148% vs. 0.122%, respectively). The *t*-statistics of the difference in the dividend yield between the large-firm and small-firm groups is 1.86, and the Wilcoxon is 2.68. The difference in the *Total Payout Yield*, which is the sum of *Rep/Size* and the *Dividend Yield*, is, however, insignificant. The last three columns of Panel 4B report the significance of payout across the size groups relative to earnings (ratio) rather than market value (yield). The findings for the payout ratios (repurchase, dividend and total payout) are similar to the findings for the yield, that is, while the difference in *Dividend Payout Ratio* between the large-firm group and the small-firm group is statistically significant, the differences in *Repurchase Payout Ratio* and *Total Payout*

Ratio are not. With the exception of *ReptoMktVol* and *HBAS* (Panel 4A), which are calculated based on 8,501 repurchase months, all variables in Table 4 are calculated based on the complete sample of 14,669 observations (repurchase and non-repurchase months).

III. Repurchase Price Analysis

In this section we investigate whether firms repurchase their shares at prices below current market price. We expect that repurchasing at favorable prices would be a challenge for firms because of the requirements of SEC Rule 10b-18. Specifically, Rule 10b-18 requires that the firm refrain from bidding up the price, that is, firms cannot post a buy-limit order that is higher than the current bid or the most recent independent trade (the higher of the two). Thus, if a firm tries to benefit from private information, it is at a disadvantage relative to other traders because its trading strategy is restricted.

A. Average Repurchase Price Relative to Market Price

We start by considering the naïve difference between the average monthly repurchase price and the average monthly market price. The average monthly repurchase price we obtained from the financial reports is adjusted for splits using the CRSP price adjustment factor. Following CKL (2004), we define our variable of interest, *Diff* (in %), for firm *i* in month *t*, as the month-average repurchase price paid by the firm (*RepPrc*) less the month-average market price (*MktPrc*) divided by the average market price. Specifically,

$$Diff = (RepPrc - MktPrc) / (MktPrc),$$

The month-average repurchase price, *RepPrc*, is from the firm's financial report and the month-average market price, *MktPrc*, is calculated as the value-weighted average of the CRSP daily close prices (adjusted for splits), based on daily trade volume. [15] A positive *Diff* means that the firm repurchased at a price higher than the market price on average, and a negative *Diff* means that the firm repurchased at a price lower than the market price, on average. In our analysis of *Diff*, we start with simple statistics, and then investigate the dependency of *Diff* on various explanatory variables.

Table 5 reports averages and *t*-statistics of the *Diff* measure for the different firm-size groups considered in Table 4. The market price input for *Diff* is the market price from CRSP, value weighted within the month based on daily trade volume. In Column (1) the average *Diff* is reported equally weighted based on the *Diff* averages of the 416 repurchasing firms, each firm's *Diff* average being calculated equally weighted over the firm's monthly differences. In Column (3) average *Diff* is reported equally weighted based on all 8,501 repurchase observations. For completeness we also report the results for the complete sample at the bottom of the table.

The results indicate that only small firms repurchase their stock at prices lower than the market price. When *Diff* is calculated based on the 416 repurchasing firms, with firms being equally weighted (Column (1)), *Diff* is -0.416 in the small-firm group and statistically significant at the 1% level. However, in the medium-sized and large-firm

[15] Results using the average of the open and close prices or the average of the daily high and low prices, instead of close prices, are qualitatively similar.

groups *Diff* is merely -0.024 and -0.010, respectively, and statistically insignificant. The results are qualitatively similar when *Diff* is calculated equally weighted over observations rather than over firms (Column (3)).[16] These findings suggest that, on average, small S&P 500 firms buy at favorable prices, while large S&P 500 firms do not.

B. Determinants of the Difference between Repurchase Price and Market Price

In this subsection we conduct a multivariate regression analysis of the difference between repurchase price and market price (of the *Diff* measure). We consider the following explanatory variables. *LnSize* is the natural log of the average market cap of the firm over repurchase months. *HBAS(t-1)* is the average of the daily average of the half bid-ask spread as a percentage, in the month before the repurchase month, calculated based on the daily bid and ask quotes from CRSP. *RepFreq* is the ratio between repurchase months to total number of months the firm has in the sample. *RetStd(t-1)* is the 1-month lag of the return standard deviation.[17] *Rep/Size* is the ratio between the monthly repurchase dollar value and the market capitalization of the firm in the previous month. *ReptoMktVol* is the ratio between the average monthly repurchase dollar value in the stock and the average monthly market dollar value of trade in the stock.

[16] The results are also qualitatively similar when calculated value is weighted by the dollar value of the repurchase rather than equally weighted.

[17] We are interested in the manner in which *Diff* depends on the characteristics of the firm. Accordingly, for *HBAS* and *RetStd* we use the 1-month lags rather than contemporaneous variables in order to avoid the contemporaneous dependencies between these variables and *Diff* that could impact our results.

Table 6 provides results of regression analysis of *Diff*, the difference between average monthly repurchase price and average monthly market price. The analysis is based on 8,501 repurchase observations. In the calculation of *Diff*, the monthly repurchase price is taken from the firm's financial reports, and the monthly market price is the calculated value weighted by trade volume over the daily close market price from CRSP.

Recall that according to the definition of *Diff*, the more negative *Diff*, the more favorable the price at which the firm repurchases. Accordingly, the more negative the coefficient of the control variable, the lower the price at which the firm is buying. The coefficient of *LnSize* is positive and significant in all regressions, suggesting that small firms repurchase shares at lower prices relative to large firms, consistent with our findings in Table 5. This result holds even when we control for liquidity using *HBAS(t-1)*, the 1-month lag of *HBAS* (see regression (2)). The coefficient of *HBAS(t-1)* is positive and significant after controlling for size in all regressions, suggesting that given size, the more liquid the market, the better the firm's ability to buy at favorable prices. The coefficient of *RepFreq*, the ratio between repurchase months and total months, is positive and significant in all regressions, indicating that firms that repurchase frequently do not do so at favorable prices. The coefficient of *RetStd(t-1)*, the 1-month lag of the standard deviation of the return, is insignificant, suggesting that the standard deviation of return is unrelated to a firm's ability to repurchase at favorable prices. Lastly, the coefficients of *Rep/Size*, the ratio between the firm's monthly repurchase volume and market capitalization, and *ReptoMktVol*, the ratio between the monthly repurchase dollar value and the monthly market dollar volume, are both insignificant, suggesting that the amount

repurchased does not affect a firm's ability to purchase at favorable prices, either when scaled by market cap, or when scaled by market volume of trade. In sum, the regression results in Table 6 support our interpretation of the results in Table 5 that smaller firms are more capable of buying at favorable prices within the month.

C. Discussion of Findings about Repurchase Activity Characteristics

We summarize the main findings in Sections II and III as follows:

- Repurchase activity is positively correlated with liquidity (Table 3)
- Small firms repurchase at relatively low frequency while large firms repurchase at relatively high frequency (Table 4)
- Small firms repurchase at favorable prices within the month; large firms do not (Table 5 and Table 6).

We suggest the following interpretation of these findings. Small firms repurchase strategically depending on market conditions and are therefore able to repurchase at favorable prices within the month and profit from mispricing. Because they repurchase strategically, their repurchases are infrequent. Large firms do not repurchase strategically depending on market conditions, but rather repurchase on a regular basis. They do not aim to buy at favorable prices, and are more focused on the execution of their repurchase programs. As a result, their purchases are frequent and executed at prices which are, on average, close to the average market price.

Why do small firms differ from large firms in their repurchase characteristics? It is possible that because information asymmetry about small firms is high, for small firms, repurchasing in order to benefit from information dominates repurchasing for free cash disbursement. Because their markets are less liquid, small firms' repurchase trade is also constrained, which further limits their repurchase activity and reduces their repurchase frequency. In contrast, information asymmetry about large firms is low, and therefore large firms are not motivated by benefits from information. Large firms also tend to be more mature, and hence their motivation to repurchase in order to disburse free cash is likely stronger. At the same time, large firms are relatively liquid so they need to worry less about the effect their repurchase activity might have on the repurchase price, and hence they can repurchase on a regular basis.

Because our study cannot indicate causality, we cannot state whether repurchases reduce the bid-ask spread or firms tend to repurchase when the bid-ask spread is low. Put differently, we cannot infer from the negative correlation found between repurchase volume and the bid-ask spread whether repurchasing firms consume liquidity or provide it. The findings in Table 6, indicating that the bid-ask spread after controlling for size is positive and significant in explaining *Diff* (a higher bid-ask spread means higher purchase prices relative to the market price), also suggest that repurchase trade consumes liquidity rather than provide it. This is because a liquidity consumer is adversely affected by the bid-ask spread, whereas a liquidity provider benefits from the bid-ask spread.[18]

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[18] McNally and Smith (2010), however, find that in Canada most repurchase orders are limit orders and hence suggest that repurchases provide liquidity. In the US, data on order type (limit or market) are not publicly available.

Lastly, the notion "benefit from underpricing" deserves further clarification. Because repurchase is a zero-sum game, it is always the case that some shareholders gain at the expense of others. More specifically, when the firm repurchases to benefit from underpricing it is the staying shareholders that gain at the expense of the selling shareholders. We assume that managers will side with the staying shareholders because their future compensation will be determined by the staying shareholders and because managers tend to be staying shareholders themselves. Accordingly, our focus is the wealth of the staying shareholders.[19]

IV. Actual Repurchase and Stock Price Performance

The results in Section III indicate that small firms are able to repurchase shares at favorable prices relative to monthly averages. The results do not tell us, however, what firms, if any, also benefit from this execution strategy in the post-repurchase period. For example, if large firms are better informed about their expected performance, they might be buying at less favorable prices in order to benefit from post-repurchase price appreciation. In this section we investigate the manner in which repurchase activity is related to past returns and future returns. For this purpose we conduct several tests, utilizing several regression and vector auto regression (VAR) models. We find that repurchase activity increases following price drops regardless of firm size. However, only the small firms in our sample realize positive and significant post-repurchase abnormal

[19] Whose value the firm is maximizing, the staying shareholders or the departing shareholders, is an open question in corporate finance (see Dybvig and Zender, 1991).

returns. These positive abnormal returns last up to three months. We did not find a significant relation between actual repurchase and longer return horizons (we investigated returns of up to two years following the actual repurchase). By constructing portfolios that are long small repurchasing firms and short non-repurchasing firms we show that these abnormal returns are also economically significant. We conclude that smaller S&P 500 firms are able to both repurchase at favorable prices and gain from post-repurchase price appreciation.

A. Determinants of Monthly Repurchase Activity – Regression Analysis

We investigate how current repurchase activity depends on past returns. In addition we consider the manner in which current repurchase activity depends on other factors such as the bid-ask spread and past repurchase activity. In the analysis, we utilize both Tobit and Probit models. The Tobit model (also known as "the censored model") is used when the dependent variable is censored at some bound (in our case zero repurchase). In the Probit model the dependent variable assumes the value of 1 in months with non-zero repurchase value, and 0 otherwise. Estimating the Probit model allows us to study the probability of a repurchase. A detailed description of the Tobit and Probit procedures we use appears in Appendix B.

Table 7 reports results for Tobit and Probit analysis of monthly share repurchase on past returns. We run several specifications. The dependent variable in all regressions is *Rep/Size*, the monthly fraction of shares repurchased, measured as the ratio between the dollar value of repurchase reported and the market capitalization of the firm. We use the

following notation for the independent variables. *Ret* is the repurchase-month return, and *HBAS* is the average half bid-ask spread in month *t*. *HBAS (t-1)* is the half bid-ask spread in the month preceding repurchase. The other lagged independent variables are named in a similar manner. In order to measure the change in the dependent variable resulting from a unit change in any independent variable, we need to estimate the variables' marginal effects. This is because we are estimating non-linear models (Tobit and Probit as opposed to a standard OLS). The marginal effects are usually estimated at the mean of the explanatory variables.

Panels 7A and 7B of Table 7 report the Tobit model and Probit model results, respectively. Both panels report the marginal effects of the independent variables (which are a function of the estimated parameters, and reflect their impact on the dependent variable). See Appendix B for the estimation of the marginal effects in the Tobit and Probit models. Starting with Panel 7A (Tobit model) the marginal effects of *Ret* and *HBAS* are negative and statistically significant when these variables are considered alone or together (regressions (1) through (3)). The marginal effect of *HBAS(t-1)* is, however, insignificant (regression (4)). The marginal effect of *Rep/Size(t-1)*, the 1-month lagged fraction of shares repurchased is positive and significant (regressions (5) and 7)), and the marginal effect of *Ret(t-1)*, the 1-month lagged return is negative and significant (regressions (6) and (7)). When we use three lags of *Rep/Size* and three lags of *Ret* together in regression (8), the explanatory variables lagged *Rep/Size* in months *t-1*, t-3,

and lagged *Ret* in months *t-1* and *t-2* are significant.[20] *HBAS* and *Ret* are also significant when these variables are included (regressions (9) and (10)). The results of the Probit model (Panel 7B) are qualitatively similar.

To gain a sense of the implied economic magnitude, consider the impact of a change in *Ret(t-1)* on the change in *Rep/Size*. Recall that the average *Ret* is 1.16% (See Table 1, Panel 1B), and consider, for example, specification (6) of Panel 7A (Tobit model). The coefficient of *Ret(t-1)* is -0.004. Thus, estimating the marginal effect at the average values, an increase of one standard deviation (6.46%) in *Ret(t-1)* to 7.62% will result in a decrease of -0.027% in *Rep/Size* from 0.233% to 0.206%, or a decrease of about 10% in *Rep/Size*. Overall the findings in Table 7 suggest that a decrease in the previous month return results in a positive and significant increase in repurchase activity. Moreover, note that earlier lags of return also impact *Rep/Size*. We will further investigate this dynamic relation in the next section using a vector auto regression model that includes both actual repurchases and returns as dependent variables (a bivariate VAR model).

We also repeated the analysis for the different firm-size groups considered in Section III. There were no significant differences between the size groups. That is, repurchase activity increases following a price drop regardless of firm size.

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[20] Stephens and Weisbach (1998) find that current quarter repurchase is negatively related to past quarter return, consistent with our findings here. However, their findings concerning the relation between current quarter repurchase and past quarter repurchase are inconclusive.

Our interpretation of the results in Table 7 is that the more negative the return, the more the firm repurchases. Firms seem to respond to a price drop by increasing their repurchase activity starting from the month of the drop in price. This relation between negative return and repurchase activity fades after approximately three months.[21]

Because firm characteristics such as market-to-book, leverage, cash, and dividend yield change very slowly we do not expect them to affect repurchase activity at the firm level on a monthly basis, and hence we did not include them in Table 7. Still, we have verified that our results at the cross-section of firms are consistent with the literature (e.g., Dittmar, 2000, Table 5). Specifically, following the Dittmar methodology, we find that at the cross-section of the 416 firms in our sample, repurchase activity declines with market-to-book, leverage, and dividend yield, and increases with cash flow.

B. The Dynamic Relation between Repurchase and Return

We next turn to investigate the dynamic relation between actual repurchase activity and return utilizing a bivariate vector auto regression (VAR) model. The main advantage of a VAR model over a standard regression model is the dynamic setup used to capture the evolution and interdependencies between the variables. Because repurchase data are censored (repurchase values can only be nonnegative) a Tobit-VAR model is more appropriate than an OLS-VAR model. Accordingly, our analysis utilizes a Tobit-VAR. The procedure is described in detail in Appendix B.

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[21] We also investigated the significance of turnover (market dollar volume/outstanding shares) in month *t*. Turnover was significant in the Tobit model, consistent with our earlier results that actual repurchase activity is positively correlated with liquidity. In the Probit model turnover was insignificant.

The repurchase variable utilized in all the VAR models we consider is *Rep/Size,* the ratio between the repurchase dollar value in month *t* and the market capitalization of the previous month. We use two different measures for return: The first measure is *Alpha*, the monthly abnormal return, calculated using a 4-factor model that is based on the three Fama-French factors and the Carhart (1997) momentum factor. *Alpha* is calculated out of sample as in Brennan, Chordia, and Subrahmanyam (1998). The second measure we use is *Ret,* the return in month *t*. Both *Alpha* and *Ret* are adjusted for delisting as in Shumway (1997).

We sort all our 416 repurchasing firms into three equal-size groups, based on the firms' average market capitalization over the sample period. We denote the group with the smallest firm size as small firms, the middle group as medium-sized firms, and the group with the largest firms as large firms. For each group we then estimate a Tobit-VAR model, i.e., a VAR model in which the return equation (*Alpha* or alternatively, *Ret*) is estimated using an OLS model and the *Rep/Size* equation is estimated using a Tobit model. The models are estimated with three lags of *Rep/Size* and three lags of return (*Alpha* or alternatively, *Ret*). This is because our results in Section VI.A suggest that the mutual impact of repurchase and return lasts for up to three months.[22] After the model is estimated, we estimate the impulse response of *Rep/Size* to a shock in *Alpha* and a shock in *Ret*, and the impulse response of *Alpha* and *Ret* to a shock in *Rep/Size*. We focus primarily on *Alpha* but report our findings also for *Ret*.

[22] Indeed, we also considered VAR models that include six lags of *Rep/Size* and *Ret*. The results under these models were qualitatively similar to the results obtained with 3-lag VAR models.

Table 8 reports our findings for the smallest and largest groups (small firms and large firms, respectively). In Panel 8A we report the cumulative impulse response of *Rep/Size* to negative shocks in *Alpha* and *Ret*. Columns (1) and (2) report the impulse response of *Rep/Size* to a negative one-standard-deviation shock in *Alpha* for the small-firm group and the large-firm group, respectively. For both small and large firms, the impulse is positive from the start and statistically significant. The cumulative magnitude is approximately the same for small firms and large firms (0.31% vs. 0.27%, respectively). Columns (3) and (4) of Panel 8A report the impulse response of *Rep/Size* to a negative one-standard-deviation shock in *Ret* for the small-firm group and the large-firm group, respectively. The response is statistically significant for both groups. The cumulative magnitude of the impulse response is four times greater for small firms than for large firms (0.12% vs. 0.03%, respectively).

Figure 1 depicts the impulse response of repurchase to a shock in return for small firms and large firms, as reported in Panel 8A of Table 8. Graphs 1A and 1B depict the impulse response of *Rep/Size* to a negative one-standard-deviation shock in *Alpha* for the small-firm group and the large-firm group reported in Columns (1) and (2) of Panel 8A, respectively. The middle line in the graphs is the impulse response and the top and bottom lines are 5% confidence intervals, calculated using a simulation of 100,000 draws (see Appendix B). Graphs 1C and 1D depict the impulse response of *Rep/Size* to a negative one-standard-deviation shock in *Ret* for the small-firm group and the large-firm

group reported in Columns (3) and (4) of Panel 8A, respectively. As the graphs show, the results for a shock in *Ret* are qualitatively similar to the results for a shock in *Alpha*.

In Panel 8B we report the cumulative impulse response of *Alpha* and *Ret* to a positive shock in *Rep/Size*. Columns (1) and (2) report the impulse response of *Rep/Size* to a positive one-standard-deviation shock in *Alpha* for the small-firm and large-firm groups, respectively. The results suggest that the response is positive only for the smaller firms. The positive response reaches 0.62% for small firms and is highly significant, with a *t*-statistic of 2.07. For large firms the cumulative response is -0.12% and is not statistically significant. Columns (3) and (4) of Panel 8B report the impulse response of *Ret* to a positive one-standard-deviation shock in *Rep/Size* for the small-firm and large-firm groups, respectively. The response of *Ret* for small firms is at 0.69%. For large firms it becomes stable at only 0.07% and is not statistically significant. Overall, the results for *Ret* are qualitatively similar to the results for *Alpha*.

Figure 2 depicts the impulse response of return to a shock in repurchase for small firms vs. large firms, as reported in Panel 8B of Table 8. Graphs 2A and 2B depict the impulse response of *Alpha* to a positive one-standard-deviation shock in *Rep/Size* for the small-firm group and the large-firm group reported in Columns (1) and (2) of Panel 8B, respectively. As the graphs show, the response is positive for small firms and about zero for large firms. The 5% confidence intervals indicate that the response of the small-firm group is positive even for the lower confidence interval, while the response of the large-firm group is strongly negative. Graphs 2C and 2D depict the impulse response of *Ret* to

a one–standard-deviation shock in *Rep/Size* for the small-firm and the large-firm groups reported in Columns (3) and (4), respectively, of Panel 8B. As the graphs show, the response of *Ret* to a shock in *Rep/Size* is qualitatively similar to the response to a shock in *Alpha*.

The results of the VAR analysis suggest that negative returns stimulate higher repurchase activity for both small and large S&P 500 firms. However, repurchase activity results in positive subsequent returns only for smaller S&P 500 firms. These findings and our findings in Section III (that smaller S&P 500 firms repurchase at a discount relative to the average market price while larger S&P 500 firms do not) suggest that small firms repurchase strategically while large firms do not. Overall, our findings from the VAR analysis support the hypothesis that small firms repurchase to take advantage of superior information, while large firms repurchase regardless. This difference between small and large firms is evident in the relation between repurchase price and market price (*Diff*), in the frequency of repurchasing, and in the relation between repurchase and future returns.

C. Economic Significance of Abnormal Post-Repurchase Returns

To investigate the economic significance of the relation between actual repurchases and returns, we next form portfolios in which we buy firms that repurchase in the month and short firms that do not. We hold this position for various horizons. The portfolios are repurchase-value weighted using the variable *Rep/Size* for the firms that we buy, and

equally weighted for the firms that we short.[23] We then measure the average cumulative *Alpha* and return relative to the base amount invested (which is equal to the amount shorted).

Table 9 reports the performance of various repurchase portfolios. Panel 9A reports cumulative *Alphas* and returns of portfolios constructed for different horizons. The first row of the panel reports the average cumulative *Alpha* for the entire sample. In this row, Column (1) reports the average 1-month *Alpha* of portfolios that buy firms that repurchased in the previous month and short firms that did not, and hold the portfolio for one month. Column (2) of this row reports the average cumulative 2-month return of portfolios that are constructed in the same manner but are held for two months. Cumulative average *Alpha*s for 3-month, 4-month, and 5-month portfolios are constructed in a similar manner and reported in Columns (3), (4), and (5), respectively. As the first row shows, the average 1-month portfolio *Alpha* is negative but insignificant. The cumulative *Alpha* is higher for the 2-month portfolio and peaks after three months, where it is positive at approximately 0.5% and significant at the 5% level. The average *Alpha*s of the 4-month and 5-month portfolios are positive but insignificant.

The second and third rows in Panel 9A report the average cumulative *Alphas* of portfolios constructed based on the small-size third of the firms and the large-size third of the firms in our sample, respectively (results for the medium-sized portfolio are not reported). Here we implement the long-short strategy for each size group separately. The results show

[23] We value-weight by repurchase volume because if repurchase is related to future return, we want to give more weight for larger repurchases.

that the positive average *Alpha* reported for the entire sample actually originates in the smaller firms, and that the *Alpha*s for these firms are actually highest in the second month after the repurchase. The larger firms actually have negative but insignificant average *Alpha*s. The lower section of Panel 9A reports average cumulative returns (rather than *Alpha*s) in a similar manner. The results for the cumulative return are qualitatively similar to the results reported for *Alpha* in the upper section of the table. However, the results for the return are less significant. The average cumulative return on the 3-month portfolio of the small-firm group is significant only at the 10% level.

The results in Panel 9A indicate that the highest average *Alpha* and return are earned by the smaller firms in the second month following the repurchase. One possible explanation for the delay in the price response to actual repurchase is that while firms report repurchase activity on a monthly basis (in the financial report), this information becomes public only at the time of the quarterly reporting. The report is released three months after the repurchase on average, and hence the delay.

Although we focus on the short term, we also constructed 12-month and 24-month portfolios (Columns (6) and (7), respectively) to compare our findings to earlier literature on long-run performance of repurchase-announcing firms, which finds positive and significant abnormal returns (e.g., Ikenberry et al. 1995 and Peyer and Vermaelen 2009). As the table shows, average 12-month and 24-month *Alpha*s are insignificant for the

entire sample, and for the small-firm group and the large-firm group separately.[24] The difference between our findings and the findings in the above-mentioned literature on long-run abnormal returns may be due to the fact that we measure abnormal returns relative to actual repurchase while the literature considered above measures abnormal return relative to repurchase announcements. Alternatively, it is possible that our more recent sample accounts for this difference.

In Panel 9B we investigate the magnitude of the gain of a strategy that focuses on the small-firm group in the second month after the repurchase, as the results in Panel 9A suggest this strategy is likely to yield the greatest possible gain. Specifically, at the beginning of month t+2, we form a portfolio that buys all firms that had a repurchase in month t, and shorts all other firms. The portfolio is held for one month. For example, at the beginning of March 2004 we buy all firms that reported a repurchase in January 2004, and short all other firms, and hold this portfolio until the end of March 2004. At the end of the month the portfolio is sold. Each month a portfolio is constructed and the average *Alpha* and return of these portfolios are calculated and reported. Column (1) in Panel 9B shows this strategy earns an *Alpha* of 0.916% per month, or 12% annually, which is higher and more significant than any other strategy considered in Panel 9A. This result confirms that the highest return is indeed earned by investing in small-size firms in the second month after the repurchase. Column (2) in Panel 9B reports the average monthly return on this strategy, which is also higher and more significant than the other monthly returns reported in Panel 9A.

[24] Naïve returns are positive and significant for the 24-month portfolio in the complete sample and for the small-firms group, but do not reflect abnormal performance.

Overall the results reported in Table 9 indicate that a repurchase-based portfolio does earn a positive and significant abnormal return. A portfolio that buys repurchasing S&P500 firms and is held for three months earns an *Alpha* of 0.5% or about 2% annually. These findings are consistent with the results of the regression analysis in Subsection VI.B, which show that the relation between repurchase and return is most significant in month 3 after the repurchase.[25] Furthermore, a portfolio that focuses on smaller S&P500 firms can earn significantly higher returns (12% annually).

V. Conclusion

We use new data from SEC filings to investigate how S&P 500 firms repurchase their own shares in the open market. We find that liquidity, measured by bid-ask spread, is higher in repurchase months (lower bid-ask spreads). This positive correlation between actual repurchase and liquidity is consistent with findings of other studies in the US and in contrast to findings outside the US. We find that small firms repurchase less frequently than large firms. In contrast to large firms, small firms repurchase their stock at a price which is significantly lower than the average market price. Although actual repurchase activity is negatively related to the previous month return regardless of firm size, it is followed by a positive abnormal return only for smaller S&P 500 firms. This positive abnormal return (4-factor alpha) lasts for up to three months after the repurchase. Our interpretation is that, because information asymmetry about small firms is high, small

[25] We acknowledge that because the monthly purchases are disclosed only in the financial report, the strategy is not feasible for uninformed investors. It, however, helps us assess the relation between actual repurchase and return.

firms tend to repurchase strategically, whereas the repurchase activity of large firms is more focused on disbursement of free cash. While earlier literature reports positive and significant long-run abnormal returns following repurchase program announcements, we found no significant long-run abnormal returns following actual repurchases.

References

Banyi, M., Dyl, E., Kahle, K., 2008. Errors in estimating share repurchases. Journal of Corporate Finance 14, 460-474.

Barclay, M., Smith, C., 1988. Corporate payout policy: Cash dividend vs. open market repurchases. Journal of Financial Economics 22(1), 61-82.

Bonaime, A., 2010. Mandatory disclosure and firm behavior: Evidence from share repurchases. Unpublished working paper.

Brennan, M., T. Chordia, Subrahmanyam, A., 1998. Alternative factor specifications, security characteristics, and the cross-section of expected stock returns. Journal of Financial Economics 49, 345-373.

Brockman, P., Chung, D.Y., 2001. Managerial timing and corporate liquidity: Evidence from actual share repurchases. Journal of Financial Economics 61, 417-448.

Brockman, P., Howe, J., S. Mortal, 2008. Stock market liquidity and the decision to repurchase. Journal of Corporate Finance 14, 446-459.

Carhart, M., 1997. On persistence in mutual fund performance. Journal of Finance 52, 57-82.

Chung, D., Isakov, D., Perignon, C., 2007. Repurchasing shares on a second trading line. Review of Finance 11, 253-2007.

Comment, R., Jarrell, G., 1991. The relative signaling power of Dutch-auction and fixed-price self-tender offers and open-market share repurchases. Journal of Finance 46, 1243-1271.

Cook, D., Krigman, L., Leach, C., 2003. An analysis of SEC guidelines for executing open market repurchases. Journal of Business 76, 289-315.

Cook, D., Krigman, L., Leach, C., 2004. On the timing and execution of open market repurchases. Review of Financial Studies 17, 463-498.

De Cesari, A., Espenlaub, S., Khurshed, A., Simkovic, M., 2009. Insider ownership, institutional ownership, and the timing of open market stock repurchases. SSRN working paper.

De Ridder, A., Rasbrant J., 2009. The market liquidity impact of share repurchase trading. SSRN Working Paper.

Dittmar, A., 2000. Why do firms repurchase stock? Journal of Business 73, 331-355.

Dittmar, A., Dittmar, R., 2007, The timing of stock repurchases. SSRN working paper.

Dybvig, P., Zender, J., 1991, Capital structure and dividend irrelevance with asymmetric information. Review of Financial Studies 4, 201-219.

Fama, E., French, K., 1993. Common risk factors in the returns on stocks and bonds. Journal of Financial Economics 33, 3-56.

Fenn, G., Liang, N., 2001. Corporate payout policy and managerial stock incentives. Journal of Financial Economics 60, 45-72.

Franz, D., Rao, R., Tripathy, N., 1995. Informed trading risk and bid-ask spread changes around open market stock repurchases in the NASDAQ market. Journal of Financial Research 3, 311-328.

Ginglinger, E., Hamon, J., 2007. Actual share repurchases, timing and liquidity. Journal of Banking and Finance 31, 915-938.

Grullon, G., Michaely, R., 2002. Dividends, share repurchases, and the substitution hypothesis. Journal of Finance 57, 1649-1684.

Grullon, G. Michaely, R., 2004. The information content of share repurchase programs. Journal of Finance 59, 651-680.

Guay, W., Harford, J., 2000. The cash flow permanence and information content of dividend increases vs. repurchases. Journal of Financial Economics 57, 385-416.

Hamilton, J., 1994. Time Series Analysis. Princeton University Press, Princeton, New Jersey.

Ikenberry, D., Lakonishok, J. Vermaelen, T., 1995. Market underreaction to open-market stock repurchases. Journal of Financial Economics 39, 181-208.

Ikenberry, D., Lakonishok, J., Vermaelen, T., 2000. Stock repurchases in Canada: Performance and strategic trading. Journal of Finance 55, 2373-2397.

Jagannathan, M. Stephens, C., 2003. Motives for multiple open-market repurchase programs. Financial Management 32, 71-91.

Jagannathan, M., Stephens, C., Weisbach, M., 2000. Financial flexibility and the choice between dividends and stock repurchases. Journal of Financial Economics 57, 355-384.

Kahle, K., 2002. When a buyback isn't a buyback: Open market repurchases and employee options. Journal of Financial Economics 63, 235-261.

McNally, W., Smith, B., 2010. A microstructure analysis of the liquidity impact of open market repurchases. Forthcoming in Journal of Financial Research.

McNally, W., Smith, B., Barnes, T., 2006. The price impacts of open market repurchase trades. Journal of Business Finance and Accounting 33, 735-752.

Miller, J., McConnell, J., 1995. Open-market share repurchase programs and bid-ask spreads on the NYSE: Implications for corporate payout policy. Journal of Financial and Quantitative Analysis 30, 365-382.

Mitchel M., Stafford, E., 2000. Managerial decisions win long-term stock price performance. Journal of Business 73, 287-329.

Newey, W., West, K., 1987. A simple, positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix. Econometrica 55, 703-708.

Oded, J., 2009. "Optimal execution of open-market stock repurchase programs. Journal of Financial Markets 12, 832-869.

Petersen, M., 2009. Estimating standard errors in finance panel data sets: Comparing approaches. Forthcoming in Review of Financial Studies.

Peyer, U., Vermaelen, T., 2009. The nature and persistence of buyback anomalies. Review of Financial Studies 22(4), 1693-1746.

Rau, P., Vermaelen, T., 2002. Regulation, taxes and share repurchases in the United Kingdom. Journal of Business 75, 245-282.

Shumway, T., 1997. The delisting bias in CRSP data. Journal of Finance 52, 327-340.

Stephens, C., Weisbach, M., 1998. Actual share reacquisition in open-market repurchase programs. Journal of Finance 53, 313-333.

Vermaelen, T., 1981. Common stock repurchases and market signaling: An empirical study. Journal of Financial Economics 9, 139-183.

Zhang, H., 2005. Share price performance following actual repurchases. Journal of Banking and Finance 29, 1887-1901.

Appendix A

This Appendix contains an example of a report on actual repurchase filed with the SEC. The reporting firm is Disney (Ticker: DIS) and the reporting is extracted from the 10Q report to the SEC for the period ending on June 30, 2007. Report date is August 1, 2007. The complete report is available at

http://www.sec.gov/Archives/edgar/data/1001039/000119312507168199/d10q.htm

PART II. OTHER INFORMATION (continued)

ITEM 2. Unregistered Sales of Equity Securities and Use of Proceeds

The following table provides information about Company purchases of equity securities that are registered by the Company pursuant to Section 12 of the Exchange Act during the quarter ended June 30, 2007**:**

Period	Total Number of Shares Purchased [1]	Weighted Average Price Paid per Share	Total Number of Shares Purchased as Part of Publicly Announced Plans or Programs	Maximum Number of Shares that May Yet Be Purchased Under the Plans or Programs [2]
April 1, 2007 – April 30, 2007	24,856,354	34.80	24,755,700	86 million
May 1, 2007 – May 31, 2007	14,892,293	35.78	14,793,100	389 million
June 1, 2007 – June 30, 2007	16,108,541	34.44	15,985,800	374 million
Total	55,857,188	34.96	55,534,600	374 million

(1) 322,588 shares were purchased on the open market to provide shares to participants in the Walt Disney Investment Plan (WDIP) and Employee Stock Purchase Plan (ESPP). These purchases were not made pursuant to a publicly announced repurchase plan or program.

(2) Under a share repurchase program implemented effective June 10, 1998, the Company is authorized to repurchase shares of its common stock. On May 1, 2007, following share repurchases made through May 1, 2007, the Company's Board of Directors increased the repurchase authorization to a total of 400 million shares as of that date. The repurchase program does not have an expiration date.

Appendix B - Empirical Methodology

This Appendix includes a detailed description of the methods used in the paper. Section 1 describes the estimation of the covariance matrix in our panel data sample. Section 2 describes the estimation of the Tobit and Probit models including their marginal effects. Section 3 describes the estimation of the VAR (vector auto regression) models used in the paper, their impulse response functions, and the calculation of their confidence intervals.

1. Estimation of the Covariance Matrix

Our sample is a panel data set of 416 firms, with monthly observations over the years 2004–2006. For most of the firms we have 36 monthly observations. Several firms have less than 36 observations due to delisting issues. In the estimation of the covariance matrix of the parameters, we "cluster" by firm and add monthly time dummy variables. For further information about these methods see Petersen (2009).

We exploit the next M-L property to estimate the parameters' covariance matrix:

$$(\theta - \hat{\theta}) = \left(-\sum_{i=1}^{n}\sum_{t=1}^{T_i}\hat{\mathbf{H}}_{it}\right)^{-1}\left\{\sum_{i=1}^{n}\left(\sum_{t=1}^{T_i}\hat{\mathbf{g}}_{it}\right)\right\},$$

where H is the Hessian and g is the gradient.

The variance of the parameters, in all of the models in the paper (specifically: OLS, Probit and Tobit), is estimated by

$$\text{Est.Var}[\hat{\theta}]=[\text{Hessian}]^{-1}\text{Var}[\text{gradient}][\text{Hessian}]^{-1}$$

To take into account the autocorrelation in the firms' residuals, we sum the Hessians and the gradients by firm using

$$\mathbf{H} = \sum_{i=1}^{n}\sum_{t=1}^{T_i}\mathbf{H}_{it}$$
$$\mathbf{g} = \sum_{i=1}^{n}\sum_{t=1}^{T_i}\mathbf{g}_{it}$$

where H is the Hessian and g is the gradient of the specific model. Taking into account that the expectation of the gradient is zero at optimization, the variance of the gradient is estimated as

$$\left\{\sum_{i=1}^{n}\left(\sum_{t=1}^{T_i}\hat{\mathbf{g}}_{it}\right)\left(\sum_{t=1}^{T_i}\hat{\mathbf{g}}_{it}\right)'\right\}.$$

Upon substitution, the asymptotic variance of the parameters with firm cluster is

$$\text{Est.Var}[\hat{\theta}] = \left(-\sum_{i=1}^{n}\sum_{t=1}^{T_i}\hat{\mathbf{H}}_{it}\right)^{-1}\left\{\sum_{i=1}^{n}\left(\sum_{t=1}^{T_i}\hat{\mathbf{g}}_{it}\right)\left(\sum_{t=1}^{T_i}\hat{\mathbf{g}}_{it}\right)'\right\}\left(-\sum_{i=1}^{n}\sum_{t=1}^{T_i}\hat{\mathbf{H}}_{it}\right)^{-1}$$

2. Estimation of Tobit and Probit Models

2.1 Estimation of the Tobit Model

Step 1- Estimating the Model Parameters

We estimate the repurchase equation using the Tobit model (Tables 7 and 8). The Tobit model (also known as "the censored model") is used when the dependent variable is censored at some bound or bounds. The underlying assumption in this model is that there is a continuous variable behind the observed data and the econometrician does not see the "true" continuous variable in the censored area. In our repurchase data the bound is 0. In the months without repurchase we observe 0 and in months with repurchase we observe the repurchase (the underlying continuous variable).

In several estimations we use time and firm dummy variables as controls to capture the within-firm variability. In these cases we still cluster the residual by firm, using the procedure described in Item 1 of this Appendix. Clustering reduces the *t*-statistics of the parameters in our estimations.

Step 2 - Estimation of the Tobit Model Marginal Effects

After estimating the parameters, we estimate the marginal effects to estimate the effect of the explanatory variables on the dependent variable. For the Tobit model, the marginal effects are estimated at the mean of the explanatory variables by

$$MARGINAL = \frac{\partial \mathbf{E}[y \mid \overline{\mathbf{x}}]}{\partial \overline{\mathbf{x}}} = \Phi(\hat{\boldsymbol{\beta}}'\overline{\mathbf{x}} / \sigma) \times \hat{\boldsymbol{\beta}}$$

Because the marginal effects are a function of the estimated parameters, we estimate the variance of the marginal effects using the Delta method, which is a first-order Taylor expansion. The formula is

$$\left[\frac{\partial \text{MRG}}{\partial \theta}\right]' \left[\text{Est.Var}(\theta)\right] \left[\frac{\partial \text{MRG}}{\partial \theta}\right]$$

where MRG are the marginal effects $\Phi(\hat{\boldsymbol{\beta}}'\overline{\mathbf{x}} / \sigma) \times \hat{\boldsymbol{\beta}}$.

2.2 Estimation of the Probit Model Parameters and Marginal Effects

After estimating the Tobit model, we proceed to estimate the probability for a repurchase using the Probit model (Table 7 Panel 7B). In the estimation of the Probit model, the dependent variable *Rep/Size* assumes the value of 1 in repurchase months and the value of 0 otherwise. As in the Tobit model, we use time and firm dummy variables as control variables in several cases, and cluster by firm.

The marginal effects of the Probit model are estimated at the mean of the explanatory variables by

$$MARGINAL = \frac{\partial \mathbf{E}[y \mid \overline{\mathbf{x}}]}{\partial \overline{\mathbf{x}}} = \left[\phi\left(\hat{\boldsymbol{\beta}}' \overline{\mathbf{x}}\right) \right] \hat{\boldsymbol{\beta}}$$

As in the Tobit model, the Delta method is used to estimate the variance of the marginal effect.

3. Estimation of the Impulse Response of the VAR (Vector-Auto-Regression) Models

3.1 The VAR Equations and Parameter Estimation

We estimate a bivariate VAR model. The dependent variables in the system are *Ret* and *Rep/Size*. In each equation of the system (one for *Ret* and one for *Rep/Size*) we include three lags of each dependent variable. The model equations are defined by the next system:

$$Rep/Size_t = \alpha_1 + \sum_{i=1}^{3} \gamma_{1i} Rep/Size_{t-i} + \sum_{i=1}^{3} \beta_{1i} RET_{t-i} + \varepsilon_{1t}$$

$$RET_t = \alpha_2 + \sum_{i=1}^{3} \gamma_{2i} Rep/Size_{t-i} + \sum_{i=1}^{3} \beta_{2i} RET_{t-i} + \varepsilon_{2t}$$

When constructing the VAR model, the contemporaneous relation between the dependent variables is basically in the covariance matrix of the residuals. Because contemporaneous causality cannot be inferred statistically, the economist must decide which dependent variable "causes" the other. This decision is independent of which impulse response is investigated. Given the results in Table 7, that repurchase activity tends to follow a negative shock to return, and that the contemporaneous relation with the return is negative, we assumed that the return triggers the repurchase (although it is also possible that repurchases impact the return, which is also suggested by our results). For robustness we constructed the model under the opposite assumption that the repurchase rather than the return drives the results. The impulse responses resulting under this alternative assumption are qualitatively similar.

As discussed above, repurchase is a censored dependent variable. As using the OLS specification for the repurchase equation may yield inaccurate results, we estimate two versions of a bivariate VAR model. In the first version we estimate both *Ret* and *Rep/Size* in the OLS model. In this way we ignore the fact that *Rep/Size* is censored. In the second version *Ret* is estimated by the OLS model and *Rep/Size* is estimated by the Tobit model. We denote version one as OLS-VAR and version two as Tobit-VAR. The results are qualitatively similar. For brevity the results of the OLS-VAR are not reported in this paper.

3.2 The Impulse Response Function Update

After estimating the models we estimate the impulse response function by sequentially updating the equations, based on the shocks to the system (a shock of 1 std.) and the estimated parameters. The shocks are given by the Cholesky decomposition of the residuals' covariance matrix. For the Tobit-VAR model we update the Tobit equation using $\partial \mathbf{y} = \Phi(\hat{\boldsymbol{\beta}}' \mathbf{X} / \sigma) \times \hat{\boldsymbol{\beta}} \times \partial \mathbf{x}$ based on the information concerning the

explanatory variable. If our model includes time and firm dummy variables, updating is performed without these dummy variables, because they are used exclusively as controls. In the updating procedure, the terms of the previous update are considered observed data rather than latent variables. Due to the nature of the repurchase variable, 0 or positive outcome, if the update outcome for rep/size is negative, it is set to 0. We did not encounter any such negative outcomes in the updates.

3.3 Confidence Intervals for the Impulse Response Function

The standard errors and confidence intervals of the impulse response are estimated by simulation (see Hamilton, 1994, pp. 336-337). We simulated 100,000 rounds. In each round we estimate the impulse response based on the draw of the new set of the parameters. The draw is based on the estimated parameters and their covariance matrix.

To estimate the joint covariance matrix of the parameters from both equations of the VAR system, once again we use the M-L properties:

$(\theta - \hat{\theta}) = \left(-\sum_{i=1}^{n}\sum_{t=1}^{T_i}\hat{\mathbf{H}}_{it}\right)^{-1}\left\{\sum_{i=1}^{n}\left(\sum_{t=1}^{T_i}\hat{\mathbf{g}}_{it}\right)\right\}$, where H is the Hessian and g is the gradient.

The partition of the covariance matrix of the parameters from each equation K is given by

$$\text{Est.Var}[\hat{\theta}k] = \left(-\sum_{i=1}^{n}\sum_{t=1}^{T_i}\hat{\mathbf{H}}\mathbf{k}_{it}\right)^{-1}\left\{\sum_{i=1}^{n}\left(\sum_{t=1}^{T_i}\hat{\mathbf{g}}\mathbf{k}_{it}\right)\left(\sum_{t=1}^{T_i}\hat{\mathbf{g}}\mathbf{k}_{it}\right)'\right\}\left(-\sum_{i=1}^{n}\sum_{t=1}^{T_i}\hat{\mathbf{H}}\mathbf{k}_{it}\right)^{-1}$$

The partition of the covariance matrix of the parameters between equations 1 and 2 is given by

$$\text{Est.Covar}[\hat{\theta}1,\hat{\theta}2] = \left(-\sum_{i=1}^{n}\sum_{t=1}^{T_i}\hat{\mathbf{H}}\mathbf{1}_{it}\right)^{-1}\left\{\sum_{i=1}^{n}\left(\sum_{t=1}^{T_i}\hat{\mathbf{g}}\mathbf{1}_{it}\right)\left(\sum_{t=1}^{T_i}\hat{\mathbf{g}}\mathbf{2}_{it}\right)'\right\}\left(-\sum_{i=1}^{n}\sum_{t=1}^{T_i}\hat{\mathbf{H}}\mathbf{2}_{it}\right)^{-1}.$$

These expressions allow us to estimate the entire covariance matrix of the equations' parameters even if one model is an OLS model and the second is a non-linear model such as the Tobit model.

In the OLS case (the usual VAR model) the estimation is straightforward and yields the familiar expression, $\Sigma \otimes (X'*X)^{-1}$, where Σ is the covariance matrix between the equations' residuals and X is the matrix of the explanatory variables.

3.4 Technical Note about the Covariance Matrix with Time and Firm Dummy Variables

As mentioned above, in order to estimate the confidence intervals of the impulse response function, we must draw a new set of parameters using the parameters' covariance matrix. When 450 dummy variables are included, such a draw is technically impossible. To circumvent this problem, after calculating the clustered covariance matrix, we make a draw from the partial covariance matrix, which is the partition of the covariance matrix that includes only the updated variable parameters.

Table 1: Sample Statistics of the 470 Firms in the Sample

Panel 1A reports the sample statistics of the complete sample of 470 firms. *Mean* is the average of the firm-level averages, *Median* is the median of the firm-level averages, and *Std.* is the standard deviation of the firm-level averages. *Firm Size* is the firm market capitalization, calculated as the outstanding shares multiplied by the CRSP price at the end of the previous month. *Dividend Yield* is the monthly dollar value of the firm's ordinary dividend (taken from CRSP) as a percentage of the firm's market capitalization in the previous month. *Ret* is the monthly stock return, and *Alpha* is the monthly abnormal return calculated using a four-factor model that is based on the three Fama-French factors and the Carhart (1997) momentum factor, and is calculated out of sample following Brennan et al. (1998). The variables *Ret* and *Alpha* are adjusted for delisting following Shumway (1997). *Market Volume* is the monthly market dollar volume of trade in the stock, calculated as the sum over the month of the stock's daily market dollar volume. The daily market dollar volume, in turn, is calculated as the daily stock trade volume times the end of day price based on the CRSP data.
Panel 1B provides statistics of repurchasing vs. non-repurchasing firms. Columns (1)-(3) report statistics only for the 416 firms that reported repurchase transactions during the sample period 2004-2006, and Columns (4)-(6) report statistics for the remaining 54 firms that did not repurchase any shares during the sample period.

Panel 1A: Sample Statistics – Complete Sample

	470 firms (full sample)		
	(1)	**(2)**	**(3)**
	Mean	***Median***	***Std***
***Firm Size* ($millions)**	22,268	10,745	38,939
***Dividend Yield* (monthly)**	0.13%	0.11%	0.12%
***Ret* (monthly)**	1.11%	1.09%	1.48%
***Alpha* (monthly)**	-0.18%	-0.06%	1.57%
***Market Volume* ($millions)**	2,671	1,489	3,765

Panel 1B Sample Statistics – Repurchasing vs. Non-Repurchasing Firms

	416 firms with repurchase transaction			**54 firms with no repurchase transaction**			***Difference in means***	***t*-stat of difference in means**	**Wilcoxon of difference in means**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**
	Mean	***Median***	***Std***	***Mean***	***Median***	***Std***			
***Size* ($millions)**	23,543	11,747	39,899	12,159	5,943	29,005	11,384	2.52	4.58
***Dividend Yield* (monthly)**	0.14%	0.12%	0.12%	0.10%	0.03%	0.13%	0.04%	1.97	2.74
***Ret* (monthly)**	1.16%	1.11%	1.27%	0.66%	0.98%	2.56%	0.50%	1.43	1.22
***Alpha* (monthly)**	-0.08%	0.00%	1.34%	-0.95%	-0.56%	2.67%	0.87%	2.33	3.16
***Market Volume* ($millions)**	2,753	1,555	3,749	2,053	967	3,865	700	1.31	3.18

Table 2 - Statistics of Repurchase Activity for the 416 Repurchasing Firms

This table reports the statistics of the repurchase activity during the sample period, based on a total of 8,501 non-zero monthly repurchase observations reported by the 416 firms that repurchased shares during the sample period. *Repurchase Volume* is the monthly dollar value repurchased, calculated as the monthly quantity of shares repurchased in the month multiplied by the monthly average repurchase price reported on the 10Q or 10K form. *Market Volume Given Repurchase* is market dollar volume of the trade in the stock in repurchase months calculated as the sum over the month of the stock's daily market dollar volume. (The monthly volume in Table 2 is different from the monthly volume reported in Table 1 because here we consider repurchase months only, whereas Table 1 includes all months independent of a repurchase). The daily market volume, in turn, is calculated as the daily stock trade volume times the end of day price based on the CRSP data. *Repurchase/Market Volume* is the repurchase dollar value as a percentage of the dollar volume of trade in the stock in the repurchase months. (This ratio is not Row 1 divided by Row 2 because the average of the ratio is not the ratio of the average). *Rep/Size* is the monthly dollar value of the firm's repurchase as a percentage of the firm's market capitalization in the previous month. *Mean* is the average of the 8,501 observations, *Median* is the median of the 8,501 observations, and *Std.* is the standard deviation of the 8,501 observations.

	(1)	**(2)**	**(3)**
	Mean	***Median***	***Std***
***Repurchase Volume* (\$millions)**	104	27	251
***Market Volume Given Repurchase* (\$millions)**	3,244	1,725	4,604
Repurchase/Market Volume	3.3%	1.9%	4.6%
Rep/Size	0.41%	0.22%	0.64%

Table 3 – Liquidity Statistics of Repurchasing vs. Non-Repurchasing Months

This table reports liquidity statistics of the sample of repurchase months vs. non-repurchase months. For each firm we calculate the average of the characteristic in the repurchase months and in the non-repurchase months and then calculate the difference. *HBAS* is the half bid-ask spread as a percentage, calculated in each month as the average of the daily closing bid and ask quotes from CRSP. *MktVol* is the average monthly dollar volume of trade in the stock on the market in millions of dollars. We include only firms with repurchase months and non-repurchase data; Of the sample of 416 firms, 394 firms had both repurchase months and non-repurchase months.

The table reports the averages of *HBAS* and *MktVol* for all months in Row (1), for repurchase months in Row (2), and for non-repurchase months in Row (3). The difference in the averages between repurchase months and non-repurchase months and the statistical significance of the difference are also reported (calculated as a paired sample). The *p*-values and *t*-statistics are reported in Rows (5) and (6) of the table, respectively. Rows (7) to (10) report the results of a binomial test of the relation between repurchase and liquidity. For each of the variables, *HBAS* and *MktVol* we report the number of firms for which the difference between the average value of the variable in repurchase months less the average value of the variable in non-repurchase months is negative, and the number of firms for which this difference is positive. The statistical significance of the difference is confirmed with a binomial distribution test, assuming equal chances for positive and negative outcomes.

		HBAS	***MktVol***
(1)	**All Months**	0.0372	2667.8
(2)	**Repurchase Months**	0.0363	2710.0
(3)	**Non-Repurchase Months**	0.0380	2625.6
(4)	**Difference (3)-(2)**	-0.0016	84.4400
(5)	***p*-value of Difference (3)-(2)**	0.000	0.144
(6)	**t-statistic of Difference (3)-(2)**	-3.65	1.46
(7)	**# Negative**	253 (64%)	159 (40%)
(8)	**#Positive**	141 (36%)	235 (60%)
(9)	**N**	394 (100%)	394 (100%)
(10)	**Binomial Tests – *p*-value**	< 0.0001	< 0.0001

Table 4: Repurchasing Firms' Characteristics: Dependency on Firm Size

This table reports the repurchasing firms' characteristics and the dependency of these characteristics on firm size. We sort the 416 firms that had repurchase activity during the sample period into three equally sized groups by firm size. Firm size is the average market capitalization over the repurchase months for each firm, and market capitalization is calculated as the number outstanding shares times the CRSP price at the end of the previous month. Starting with Panel 4A, *Firm Size Range* is the range of firm sizes in the group. The small-firm group includes firms with market capitalization in the range \$0.5-\$7.6 billion. The medium-sized firm group includes firms with market capitalization in the range \$7.6-\$18 billion, and the large-firm group includes firms with market capitalization in the range \$18-\$357 billion. Each of the reported variables is calculated equally weighted for each firm over monthly data, and then equally weighted over the firms in the group. *Average Size* is the average firm market capitalization in each group in \$ billion. *ReptoMktVol* is the average repurchase dollar value as a percentage of the dollar volume of trade in the stock in the repurchase months in each group. *HBAS* is the half bid-ask spread as a percentage, calculated in each repurchase month as the average of the daily closing bid and ask quotes from CRSP. *RetStd* is the standard deviation of the return, calculated for each month as the standard deviation of the daily returns within the month. *Number of Analysts* and *Dispersion of Analysts* are, respectively, the number of analysts covering the firm, and the dispersion of their quarterly earnings forecast, normalized by the forecast mean, and calculated based on monthly updates of forecasts from IBES. Continuing in Panel 4B, *RepFreq* is the repurchase frequency measured as the ratio between the number of months in which the firm reported repurchase activity and the total number of months in which the firm appears in the sample. For example, if a firm has only 20 months of data in the sample period, and this firm repurchased in 10 out of these 20 months, the repurchase frequency is 50%. *Rep/Size* is the monthly dollar value of the firm's repurchase as a percentage of the firm's previous month market capitalization. *Dividend Yield* is the monthly dollar value of the firm's ordinary dividend (taken from CRSP) as a percentage of the firm's previous month market capitalization. *Total Payout Yield* is the sum of *Repurchase/Size* and *Dividend Yield*. *Repurchase Payout Ratio* is the average of the firms' annual dollar value of repurchase (calculated from monthly data) as a percentage of the firms' annual earnings (data item #18, Income before Extraordinary Items from Compustat). *Dividend Payout Ratio* and *Total Payout Ratio* are calculated similarly. With the exception of *ReptoMktVol* and *HBAS* (Panel 4A), which are calculated based on 8,501 repurchase months, all variables are calculated based on the complete sample of 14,669 observations (months with and without repurchase).

Panel 4A Firm Characteristics: Dependency on Firm Size

Firm Size Group	# of Firms in Size Group	*Firm Size Range* (billions)	*Average Size* (billions)	*HBAS*	*Ret Std*	*Number of Analysts*	*Dispersion of Analysts*
Small-Firm Group	139	\$0.5-7.6	\$4.5	0.046%	1.59%	11.80	0.16
Medium-Sized Firm Group	138	\$7.6-18	\$12.2	0.034%	1.42%	14.49	0.08
Large-Firm Group	139	\$18-357	\$54.9	0.028%	1.32%	19.06	0.08
All Firms	416	\$0.5-357	\$23.9	0.036%	1.44%	15.09	0.11
Difference Large less Small			50.3	-0.018%	-0.28%	7.26	-0.08
***t*-stat of difference**			10.26	7.37	4.85	9.34	2.00
Wilcoxon of difference			14.39	9.07	4.22	8.13	4.04

Panel 4B Payout Characteristics: Dependency on Firm Size

Firm Size Group	# of Firms in Size Group	*Rep Freq*	*ReptoMktVol*	*Rep/Size*	*Dividend Yield*	*Total Payout Yield*	*Repurchase Payout Ratio*	*Dividend Payout Ratio*	*Total Payout Ratio*
Small-Firm Group	139	47%	3.7%	0.249%	0.122%	0.371%	0.52	0.18	0.70
Medium-Sized Firm Group	138	57%	3.0%	0.219%	0.142%	0.361%	0.49	0.33	0.82
Large-Firm Group	139	69%	3.3%	0.231%	0.148%	0.379%	0.50	0.30	0.0
All Firms	416	58%	3.3%	0.233%	0.137%	0.370%	0.50	0.27	0.77
Difference Large less Small		0.22	-0.37%	-0.018%	0.026%	0.008%	-0.03	0.12	0.09
***t*-stat of difference**		6.73	1.21	0.75	1.86	0.35	0.44	3.07	1.34
Wilcoxon of difference		6.37	0.65	0.32	2.68	0.42	0.55	3.57	1.46

Table 5: The Difference between Repurchase Price and Market Price

This table reports averages and *t*-statistics of the *Diff* measure by firm size. This measure is defined as the average monthly price paid by the firm less the average monthly market price, divided by the average monthly market price (in %). The average monthly market price input for *Diff* is the value-weighted average of the CRSP end-of-day market price, weighted by the daily trade volume. The measure is winsorized around the 1% tails of its distribution. We partition the sample into equal-size groups by firm size: small firms, medium-sized firms, and large firms. The first row of the table reports the *Diff* measure for the small-firm group. In Column (1), *Diff* average is the equally weighted average of the group's *Diff* averages, each firm's *Diff* average being calculated equally weighted over the firm's monthly *Diff* observations. In Column (3), *Diff* average is the equally weighted average of the group's repurchase observations of *Diff*. The next rows report the results for the medium-sized firm group and large-firm group in a similar manner. We then report the significance of the difference between small-firm group and the large-firm group. For completeness we also report the results for the complete sample (416 firms and 8,501 observations) at the bottom of the table. All *t*-statistics (in parentheses) are calculated based on clustering by firm and time, following Petersen (2009, Eq. 16).

	***Diff* average based on 416 Firms' *Diff* averages**		***Diff* average based on 8,501 Repurchase Observations**	
	(1)	**(2)**	**(3)**	**(4)**
	***Diff* average**	**N**	***Diff* average**	**N**
***Diff* by Firm Size**				
Small-Firm Group	-0.416	139	-0.286	2,229
	[4.18]		[3.98]	
Medium-Sized Firm Group	-0.024	138	-0.05	2,762
	[0.38]		[0.93]	
Large-Firm Group	-0.010	139	-0.00	3,440
	[0.18]		[0.14]	
Small Firm less Large Firm Group: *t*-stat of *Diff*	-3.61		-3.25	
Small Firms less Large *Firm* Group : Wilcoxon of *Diff*	-3.62		-4.85	
***Diff* of Complete Sample**	-0.149	416	-0.095	8,501
	[3.39]		[1.86]	

Table 6: Regression Analysis of the Difference between Repurchase Price and Market Price

This table reports the results of the panel regression of the *Diff* measure on different explanatory variables. The analysis is based on 8,501 non-zero repurchase observations. *Diff* is defined as the average monthly price paid by the firm less the average monthly market price, divided by the average monthly market price (in %). The average monthly market price input for *Diff* is the value-weighted average of the CRSP end-of-day market price, weighted by the daily trade volume. The measure is winsorized around the 1% tails of its distribution. *LnSize* is the natural log of the firm's market capitalization, calculated as the outstanding number of shares times the CRSP price at the end of the previous month. *HBAS* is the half bid-ask spread as a percentage, calculated in each month as the average of the daily closing bid and ask quotes from CRSP. *HBAS(t-1)* is the 1-month lag of *HBAS*. *RepFreq* is the ratio between months with repurchase to total months that the firm appears in the sample. *RetStd(t-1)* is the 1-month lag of the standard deviation of the return, the standard deviation of the return being calculated for each month as the standard deviation of the daily returns within the month. *Rep/Size* is the ratio between the monthly repurchase dollar value and the firm's previous month's market capitalization. *ReptoMktVol* is the ratio between the monthly repurchase dollar value of trade in the stock and the monthly market dollar volume of trade in the stock. The *t*-statistics (in parentheses) are calculated based on clustering by firm and time dummy variables.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Intercept	-1.159	-1.569	-1.162	-1.586	-1.484	-1.457	-1.491
	[3.65]	[4.29]	[3.66]	[4.36]	[3.98]	[3.92]	[4.04]
LnSize	0.098	0.123	0.072	0.097	0.095	0.092	0.096
	[3.56]	[4.12]	[2.42]	[3.04]	[2.97]	[2.87]	[3.02]
HBAS(t-1)		3.987		4.150	4.225	4.129	4.263
		[2.17]		[2.25]	[2.25]	[2.21]	[2.31]
RepFreq			0.335	0.347	0.324	0.318	0.325
			[2.26]	[2.36]	[2.17]	[2.13]	[2.19]
RetStd(t-1)					-0.07	-0.06	-0.069
					[1.36]	[1.22]	[1.38]
Rep/Size					0.050		0.065
					[1.06]		[0.67]
ReptoMktvol						0.532	-0.238
						[0.96]	[0.21]
Adjusted - R^2	1.54%	1.65%	1.65%	1.77%	1.74%	1.73%	1.73%

Table 7: Determinants of Monthly Repurchases – Tobit and Probit Regression Results

This table reports the determinants of monthly repurchase activity using the Tobit and Probit models. The analysis is based on 14,669 observations (months with and without repurchases). Panel 7A presents the Tobit model results and Panel 7B presents the Probit model results. Both panels report the marginal effects of the estimation, estimated at the mean of the explanatory variables. The dependent variable is the monthly fraction of shares repurchased *Rep/Size*, measured as the ratio between the repurchase dollar value in month *t* and the previous month market capitalization. *Ret* is the return in month *t* adjusted for delisting, following Shumway (1997). *HBAS* is the half bid-ask spread as a percentage, calculated in each month as the average of the daily closing bid and ask quotes from CRSP. *HBAS(t-1)* is the 1-month lag of *HBAS*. Lags of the other variables are indicated in a similar manner. All regressions include time and firm dummy variables, and the *t*-statistics (in parentheses) are clustered by firm. See Appendix B for the estimation of the models' marginal effects and calculation of their *t*-statistics.

Panel 7A: Marginal Effects of the Tobit Model

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Ret	-0.001		-0.001						-0.002	-0.002
	[2.63]		[2.77]						[3.28]	[3.57]
HBAS		-0.513	-0.538							-0.764
		[2.07]	[2.18]							[3.36]
HBAS(t-1)				-0.113			-0.117			
				[0.33]			[0.35]			
Rep/Size(t-1)					0.124		0.123	0.116	0.116	0.116
					[6.64]		[6.72]	[6.65]	[6.65]	[6.66]
Rep/Size(t-2)								0.014	0.014	0.014
								[1.72]	[1.74]	[1.76]
Rep/Size(t-3)								0.056	0.057	0.057
								[4.45]	[4.49]	[4.44]
Ret (t-1)						-0.004	-0.004	-0.004	-0.004	-0.004
						[6.29]	[6.35]	[6.68]	[6.67]	[7.03]
Ret(t-2)								-0.002	-0.002	-0.002
								[4.20]	[4.34]	[4.74]
Ret(t-3)								-0.001	-0.001	-0.001
								[1.26]	[1.50]	[1.70]

Panel 7B: Marginal Effects of the Probit Model

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Ret	-0.003		-0.003						-0.003	-0.004
	[3.73]		[4.17]						[4.03]	[4.65]
HBAS		-1.032	-1.106							-1.354
		[2.73]	[2.87]							[3.51]
HBAS(t-1)				-0.821			-0.837			
				[2.20]			[2.27]			
Rep/Size(t-1)					0.161		0.160	0.153	0.153	0.152
					[5.66]		[5.79]	[5.73]	[5.73]	[5.83]
Rep/Size(t-2)								0.019	0.020	0.020
								[1.83]	[1.88]	[1.89]
Rep/Size(t-3)								0.082	0.083	0.083
								[4.90]	[4.97]	[4.94]
Ret (t-1)						-0.003	-0.003	-0.003	-0.003	-0.004
						[3.95]	[3.84]	[3.91]	[3.90]	[4.50]
Ret(t-2)								-0.002	-0.002	-0.002
								[2.54]	[2.71]	[3.14]
Ret(t-3)								0.000	0.000	-0.001
								[0.18]	[0.50]	[0.78]

Table 8: Impulse Responses of Repurchase and Return in Firm-Size Groups

This table reports VAR (vector auto regression) analysis results. The analysis is based on 14,669 observations (months with and without repurchases). Panel 8A reports the cumulative impulse response of repurchase to a negative one-standard-deviation shock in return, controlling for firm size; Panel 8B reports the cumulative impulse response of return to a positive one-standard-deviation shock in repurchase, controlling for firm size. The repurchase variable considered in all models is *Rep/size,* the ratio between the repurchase dollar value in month *t* and the previous month market capitalization. We use two different measures for return: *Alpha*, the monthly abnormal return, calculated using a four-factor model that is based on the three Fama-French factors and the Carhart (1997) momentum factor (calculated out of sample, following Brennan et al., 1998) and *Ret,* the return in month *t*. The variables *Alpha* and *Ret* are adjusted for delisting, following Shumway (1997). We sort all 416 firms into three equal-size groups, based on the firms' average market capitalization over the sample period: small firms, medium-sized firms, and large firms. For each size group we then estimate a Tobit-VAR model, i.e., a VAR model in which the return equation (*Ret* or, alternatively, *Alpha*) is estimated using an OLS model and the *Rep/Size* equation is estimated using a Tobit model. The models are estimated with three lags of *Rep/Size* and three lags of return (*Alpha* or, alternatively, *Ret*). We report the results only for the small-firms and large-firms groups. In Panel 8A, Columns (1) and (2) report the impulse response of *Rep/Size* to a negative one-standard-deviation shock in *Alpha* for small firms and large firms, respectively, and Columns (3) and (4) report the impulse response of *Rep/Size* to a negative one-standard-deviation shock in *Ret* for small firms and large firms, respectively. In Panel 8B, Columns (1) and (2) report the impulse response of *Alpha* to a positive one-standard-deviation positive shock in *Rep/Size* for small firms and large firms, respectively, and Columns (3) and (4) report the impulse response of *Ret* to a positive one-standard-deviation shock in *Rep/Size* for small firms and large firms, respectively. All VAR models include time and firm dummy variables, and the *t*-statistics of the impulse response function are adjusted for clustering. The *t*-statistics are reported at the bottom of the panels, and are calculated using a simulation of 100,000 draws. A detailed description of the VAR models and the simulation used appears in Appendix B.

Panel 8A - Cumulative Response of *Rep/Size* to Negative Shocks in *Alpha* and *Ret*

	Rep/Size to Alpha		*Rep/Size to Ret*	
	(1)	(2)	(3)	(4)
Period	**Small Firms**	**Large Firms**	**Small Firms**	**Large Firms**
t	0.00%	0.00%	0.01%	0.00%
t+1	0.16%	0.12%	0.06%	0.02%
t+2	0.18%	0.16%	0.09%	0.03%
t+3	0.27%	0.22%	0.11%	0.03%
t+4	0.29%	0.25%	0.11%	0.03%
t+5	0.30%	0.25%	0.12%	0.03%
t+6	0.30%	0.26%	0.12%	0.03%
t+7	0.30%	0.26%	0.12%	0.03%
t+8	0.31%	0.27%	0.12%	0.03%
t+9	0.31%	0.27%	0.12%	0.03%
t+10	0.31%	0.27%	0.12%	0.03%
t+11	0.31%	0.27%	0.12%	0.03%
t+12	0.31%	0.27%	0.12%	0.03%
t+13	0.31%	0.27%	0.12%	0.03%
t+14	0.31%	0.27%	0.12%	0.03%
t+15	0.31%	0.27%	0.12%	0.03%
Response T0-T15	0.306%	0.266%	0.117%	0.033%
t-statistic *T0-T15*	2.78	4.80	4.09	2.57

Panel 8B - Cumulative Response of *Alpha* and *Ret* to a Positive Shock in *Rep/Size*

	Alpha to Rep/Size		*Ret to Rep/Size*	
	(1)	(2)	(3)	(4)
Period	**Small Firms**	**Large Firms**	**Small Firms**	**Large Firms**
t	0.00%	0.00%	0.00%	0.00%
t+1	-0.05%	-0.15%	-0.02%	-0.14%
t+2	0.37%	-0.31%	0.39%	-0.25%
t+3	0.58%	-0.15%	0.65%	0.01%
t+4	0.59%	-0.13%	0.67%	0.05%
t+5	0.61%	-0.13%	0.68%	0.05%
t+6	0.62%	-0.13%	0.68%	0.06%
t+7	0.62%	-0.13%	0.69%	0.07%
t+8	0.62%	-0.13%	0.69%	0.07%
t+9	0.62%	-0.12%	0.69%	0.07%
t+10	0.62%	-0.12%	0.69%	0.07%
t+11	0.62%	-0.12%	0.69%	0.07%
t+12	0.62%	-0.12%	0.69%	0.07%
t+13	0.62%	-0.12%	0.69%	0.07%
t+14	0.62%	-0.12%	0.69%	0.07%
t+15	0.62%	-0.12%	0.69%	0.07%
Response T0-T15	0.624%	-0.124%	0.693%	0.075%
t-statistic *T0-T15*	2.07	-0.63	2.45	0.38

Table 9: Alphas and Returns based on Repurchase Portfolio

This table reports the average *Alpha* and return on portfolios that are long repurchasing firms and short non-repurchasing firms. Every month we construct a portfolio in which we buy all firms that repurchased in the previous month and short all firms that did not, and hold the position for different horizons. The portfolios are repurchase value weighed using the variable *Rep/Size* (measured as the ratio between the reported monthly repurchase volume in month *t* and the market value of the firm at the end of month *t-1,* calculated using CPSP) for the firms that we buy, and equally weighted for the firms that we short. *Alpha* is the monthly abnormal return, calculated using a four-factor model that is based on the three Fama-French factors and the Carhart (1997) momentum factor, and where *Alpha* is calculated as out-of-sample alpha, following Brennan et al. (1998). Return is the return in month *t*. Return and *Alpha* are adjusted for delisting, following Shumway (1997). Panel 9A reports the average cumulative *Alpha* and return of portfolios formed for different horizons. The first row in Panel 9A reports average cumulative *Alphas*. In this row, Column (1) reports the average *Alpha* of 1-month portfolios, i.e., the average monthly *Alpha* when each portfolio is constructed at the beginning of the month and sold at the end of the month. For example, at the beginning of February 2004 we buy all firms that reported a repurchase in January 2004, and short all other firms, and hold this portfolio until the end of February 2004. Column (2) reports the average 2-month *Alphas* of portfolios that are constructed each month and held for two months. For example, at the beginning of February 2004 we buy all firms that reported a repurchase in January 2004, and short all other firms, and hold this portfolio until the end of April 2004. Columns (3) to (7) are constructed in the same manner for horizons of 3, 4, 5, 12 and 24 months. We then partition the firms into three equal-size groups according to their average size over the sample period. The second and third rows in Panel 9A report the average cumulative *Alphas* for the small-size firms and the large-size firms, respectively (results for the medium-sized firms are not reported). The next part of Panel 9A reports average cumulative returns in a similar manner. The *t*-statistics in Panel 9A are in parentheses and are corrected for serial correlation in the residuals following Newey-West (1987). Panel 9B reports the average *Alpha* and return of the small-firm group firms in the sample, for portfolios that are constructed as follows. At the beginning of *t*+2 we buy all firms that had a repurchase during the month *t,* and short all other firms. The portfolio is held for one month and then sold. Each month a portfolio is constructed and the panel reports the average *Alpha* and return of these portfolios. For example, at the beginning of March 2004 we buy all firms that reported a repurchase in January 2004, and short all other firms, and hold this portfolio until the end of March 2004. Column (1) of Panel 9B reports the average *Alpha* of these portfolios and Column (2) reports the average return of these portfolios.

Panel 9A – Cumulative *Alpha* and Return of Repurchase Portfolios

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	N
Time period	***t*+1**	**t+1 to t+2**	**t+1 to t+3**	**t+1 to t+4**	**t+1 to t+5**	**t+1 to t+12**	**t+1 to t+24**	
Average Cumulative Alpha								
All Firms	-0.139	0.133	0.481	0.408	0.466	0.371	-0.427	416
	[0.89]	[0.64]	[1.92]	[1.14]	[1.26]	[0.45]	[0.63]	
Small-Firm Group	0.211	1.063	1.402	1.651	1.645	2.047	0.480	139
	[0.84]	[3.01]	[3.57]	[3.44]	[2.77]	[1.01]	[0.28]	
Large-Firm Group	-0.279	-0.479	-0.268	-0.817	-0.832	-0.858	-1.891	139
	[1.14]	[1.16]	[0.47]	[1.03]	[0.85]	[0.40]	[1.03]	
Average Cumulative Return								
All Firms	-0.115	0.085	0.405	0.286	0.329	0.108	-1.899	416
	[0.64]	[0.40]	[1.62]	[0.83]	[0.80]	[0.17]	[2.11]	
Small-Firm Group	0.078	0.716	0.922	1.112	1.062	1.177	-2.008	139
	[0.26]	[1.77]	[1.84]	[1.77]	[1.33]	[0.73]	[2.22]	
Large-Firm Group	-0.230	-0.421	-0.213	-0.894	-0.982	-1.222	-3.982	139
	[0.97]	[1.01]	[0.36]	[1.07]	[0.94]	[0.45]	[1.24]	

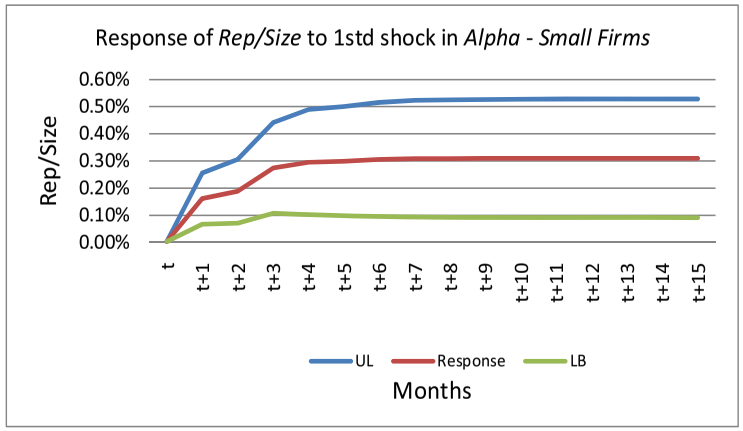
Panel 9B – *Alpha* and Return of a 1-month Repurchase Portfolio Using a 2-Month-Lag Investment in the Small-Firms Strategy

	Alpha (1)	Return (2)	N
Time Period	***t*+2**	***t*+2**	
Small Firm Average	0.916	0.725	139
	[2.84]	[1.98]	

Figure 1: Impulse Response of Repurchase to a Negative Shock in Return - Small Firms vs. Large Firms

This figure depicts the impulse response of repurchase to a negative shock in return, for the small firms and large firms in our sample, using a Tobit-VAR model, as reported in Panel 8A of Table 8. We sort the firms in the sample into three equally-sized groups by firm size. We present the impulse responses only for the small-firm and the large-firm groups. The variable we use for repurchase is *Rep/Size*, repurchase in month *t* normalized by firm size in month *t*-1. We use two measures of return. The first measure is *Alpha*, the monthly abnormal return in month *t*, calculated using a 4-factor model that is based on the three Fama-French factors and the Carhart (1997) momentum factor. *Alpha* is calculated out of sample following Brennan et al. (1998). The second measure we use is *Ret*, the naïve return in month *t*. The variables *Alpha* and *Ret* are adjusted for delisting following Shumway (1997). Graphs 1A and 1B depict the impulse response of *Rep/Size* to a negative one-standard-deviation shock in *Alpha*, for small firms and large firms, respectively. Graphs 1C and 1D depict the impulse response of *Rep/Size* to a negative one-standard-deviation shock in *Ret*, for small firms and large firms, respectively. In all graphs, the middle line represents the impulse response, and the upper and lower lines represent 5% confidence intervals, calculated using a simulation of 100,000 draws (see Hamilton 1994, pp. 336-337), adjusted for clustering. The models are estimated using three lags of *Rep/Size* and three lags of return (*Alpha* or, alternatively, *Ret),* and time and firm dummy variables. A detailed description of the VAR model estimation and the impulse response calculation appears in Appendix B.

1A



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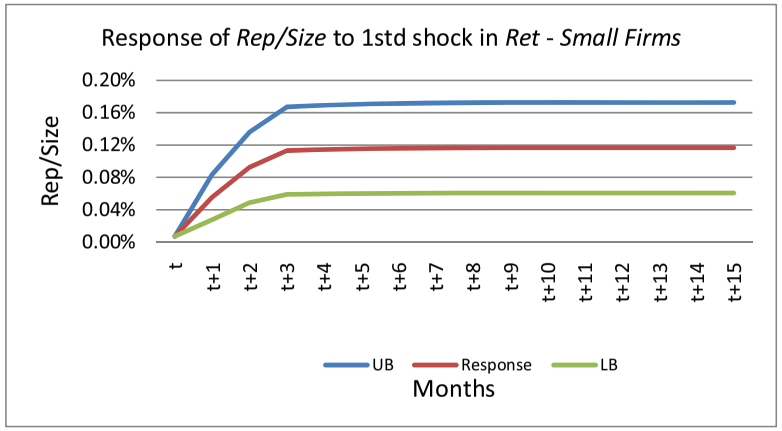

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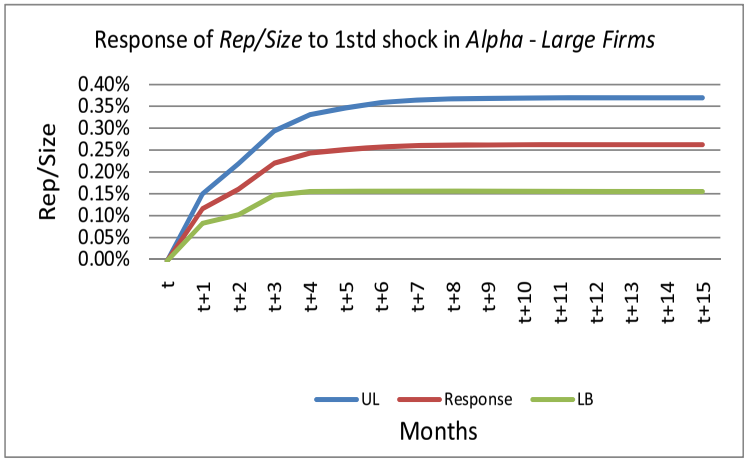

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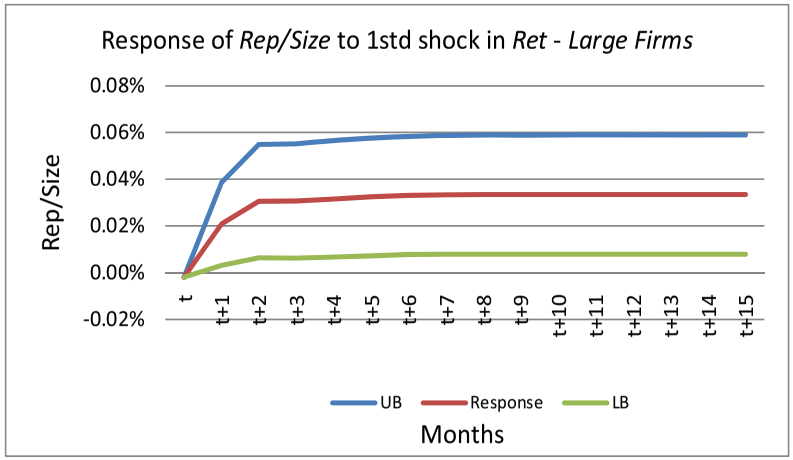
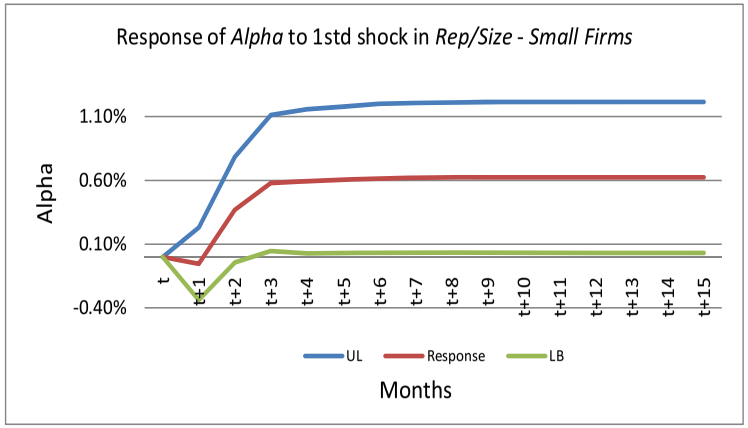


Figure 2: Impulse Response of Stock Return to a Positive Shock in Repurchase - Small Firms vs. Large Firms

This figure depicts the impulse response of return to a positive shock in repurchase, for the small firms and large firms in our sample, using a Tobit-VAR model, as reported in Panel 8B of Table 8. We sort the firms in the sample into three equally-sized groups by firm size. We present the impulse responses only for the small-firm and the large-firm groups. We use two measures of return. The first measure is *Alpha*, the monthly abnormal return in month *t*, calculated using a 4-factor model that is based on the three Fama-French factors and the Carhart (1997) momentum factor. *Alpha* is calculated out of sample following Brennan et al. (1998).The second measure we use is *Ret*, the naïve return in month *t*. The variable we use for repurchase is *Rep/Size*, repurchase in month *t* normalized by firm size in month *t*-1. The variables *Alpha* and *Ret* are adjusted for delisting following Shumway (1997). Graphs 2A and 2B depict the impulse response of *Alpha* to a positive one-standard-deviation shock in *Rep/Size*, for small firms and large firms, respectively. Graphs 2C and 2D depict the impulse response of *Ret* to a positive one-standard-deviation-shock in *Rep/Size*, for small firms and large firms, respectively. In all graphs, the middle line represents the impulse response, and the upper and lower lines represent 5% confidence intervals, calculated using a simulation of 100,000 draws (see Hamilton, 1994, pp. 336-337), adjusted for clustering. The models are estimated using three lags of *Rep/Size* and three lags of return (*Alpha* or, alternatively, *Ret),* and time and firm dummy variables. A detailed description of the VAR model estimation and the impulse response calculation appears in Appendix B.

2A



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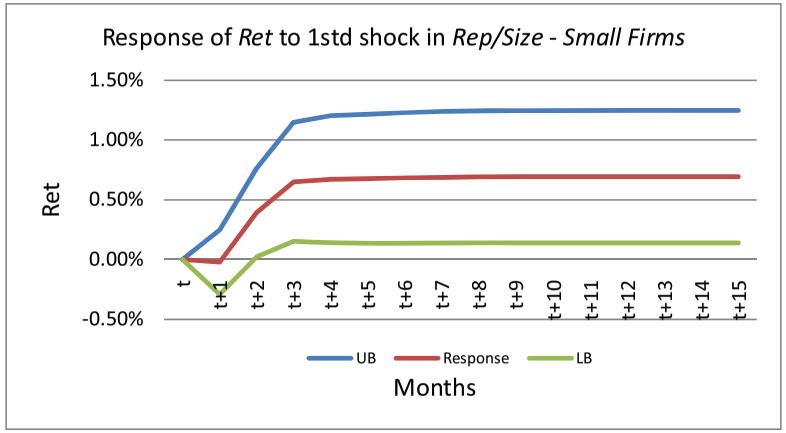

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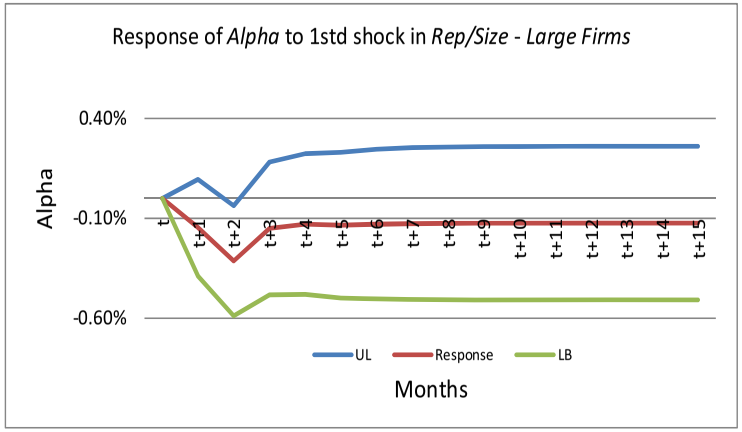

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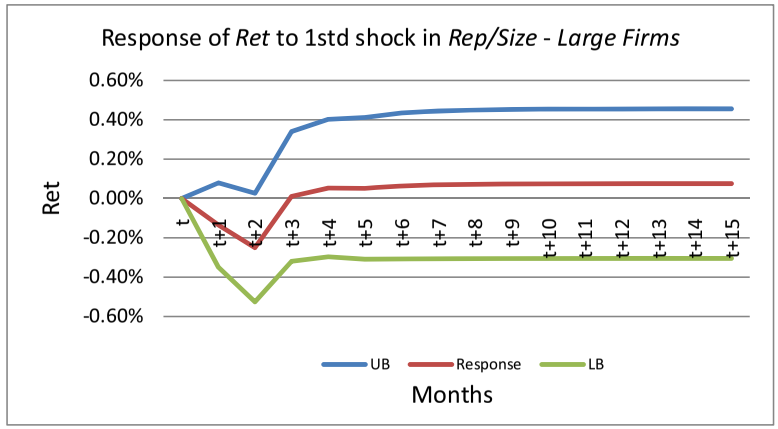

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