



# Errors in estimating share repurchases<sup>☆</sup>

Monica L. Banyl<sup>a</sup>, Edward A. Dyl<sup>b</sup>, Kathleen M. Kahle<sup>b,\*</sup>

<sup>a</sup> McIntire School of Commerce, University of Virginia, United States

<sup>b</sup> Eller College of Management, University of Arizona, United States

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## ABSTRACT

We examine the accuracy of various estimates of firms' repurchases of common stock used in earlier studies, and find high error rates in the most commonly used estimators. We also find that the procedure used to estimate open market share repurchases can significantly impact results. The Compustat-based measure, which is the most accurate, deviates from the actual number of shares repurchased by more than 30% in about 16% of the cases. We conclude that many studies should be revisited now that the SEC mandates disclosure of precise information about share repurchases in Forms 10-Q and 10-K.

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## 1. Introduction

We examine the accuracy of estimates of the number of shares repurchased used in earlier studies of common stock repurchases. These estimates use information from either Compustat or the Center for Research in Security Prices (CRSP), so the data are readily available. To our knowledge, no other study examines the accuracy of these common proxies for open market share repurchases. An understanding of the methods used to estimate share repurchases and their biases is important because the inferences drawn from studies of share repurchases may depend on the accuracy of the estimates used.

Share repurchases in general, and open market share repurchases in particular, are an increasingly important payout method for U.S. firms. Table 1 summarizes the frequency of share repurchase announcements reported in Securities Data Company's (SDC) Mergers & Acquisitions database by type of repurchase. Firms use one of four methods to repurchase shares: open market purchases; fixed-price tender offers; Dutch auction tender offers; and privately negotiated purchases. Of the 15,496 share repurchases announced in SDC from 1985–2004, 84% were open market purchases. The total announced value of these open market repurchases was \$1.8 trillion, which is 89% of the total value of all share repurchases. Moreover, the importance of open market repurchases is increasing. Since 1996, open market purchase programs account for 88% of all announced repurchases programs, and the announced value of these open market purchases is over 93% of the total reported value of repurchase programs. This trend has not gone unnoticed. Numerous recent studies examine the extent to which open market repurchases substitute for dividends (Fenn and Liang, 2001; Guay and Harford, 2000; Grullon and Michaely, 2002; Kahle, 2002).

The sources of data used in academic studies of share repurchases vary over time and by paper. Table 2 lists select papers in finance and accounting that examine share repurchases, categorized according to the sources of the repurchase data used in the paper. Early

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\* Corresponding author. University of Arizona, Eller College of Management, 1130 E. Helen St., Tucson AZ 85721-0108, United States. Tel.: +1 520 621 17489; fax: +1 520 621 1261.

E-mail address: [kkahle@eller.arizona.edu](mailto:kkahle@eller.arizona.edu) (K.M. Kahle).

**Table 1**

Summary of share repurchases, 1985–2004

| Year  | Total share repurchases |                 | Open market purchases |                 | Privately negotiated purchases |                 | Fixed-price tender offers |                 | Dutch auction tender offers |                 |
|-------|-------------------------|-----------------|-----------------------|-----------------|--------------------------------|-----------------|---------------------------|-----------------|-----------------------------|-----------------|
|       | Number                  | Value (\$ mil.) | Number                | Value (\$ mil.) | Number                         | Value (\$ mil.) | Number                    | Value (\$ mil.) | Number                      | Value (\$ mil.) |
| 1985  | 226                     | \$34,754        | 124                   | \$15,587        | 57                             | \$3,973         | 39                        | \$14,071        | 6                           | \$1,123         |
| 1986  | 250                     | \$32,112        | 170                   | \$20,116        | 50                             | \$4,434         | 22                        | \$5,520         | 8                           | \$2,043         |
| 1987  | 849                     | \$55,635        | 768                   | \$46,021        | 37                             | \$3,618         | 39                        | \$4,797         | 5                           | \$1,198         |
| 1988  | 344                     | \$43,197        | 236                   | \$29,367        | 59                             | \$2,863         | 27                        | \$3,728         | 22                          | \$7,240         |
| 1989  | 658                     | \$66,697        | 486                   | \$57,053        | 103                            | \$3,467         | 50                        | \$1,693         | 19                          | \$4,484         |
| 1990  | 959                     | \$35,759        | 791                   | \$28,918        | 104                            | \$3,149         | 55                        | \$2,859         | 9                           | \$834           |
| 1991  | 447                     | \$19,112        | 296                   | \$14,294        | 98                             | \$3,321         | 51                        | \$810           | 2                           | \$688           |
| 1992  | 591                     | \$35,257        | 462                   | \$30,862        | 82                             | \$1,563         | 40                        | \$1,199         | 7                           | \$1,633         |
| 1993  | 617                     | \$36,840        | 472                   | \$33,867        | 79                             | \$1,550         | 62                        | \$851           | 4                           | \$572           |
| 1994  | 938                     | \$63,130        | 788                   | \$58,543        | 88                             | \$1,110         | 54                        | \$2,772         | 8                           | \$705           |
| 1995  | 988                     | \$85,637        | 850                   | \$70,714        | 92                             | \$13,563        | 38                        | \$470           | 8                           | \$890           |
| 1996  | 1,256                   | \$153,392       | 1,123                 | \$140,247       | 73                             | \$8,951         | 40                        | \$2,606         | 20                          | \$1,587         |
| 1997  | 1,192                   | \$162,678       | 1,007                 | \$144,447       | 113                            | \$11,537        | 43                        | \$3,089         | 29                          | \$3,606         |
| 1998  | 1,726                   | \$218,577       | 1,628                 | \$207,817       | 62                             | \$3,931         | 15                        | \$4,328         | 21                          | \$2,501         |
| 1999  | 1,346                   | \$141,612       | 1,261                 | \$134,250       | 47                             | \$2,376         | 21                        | \$1,814         | 17                          | \$3,172         |
| 2000  | 773                     | \$166,277       | 691                   | \$146,919       | 33                             | \$2,338         | 30                        | \$14,363        | 19                          | \$2,657         |
| 2001  | 651                     | \$155,536       | 558                   | \$148,092       | 49                             | \$5,316         | 30                        | \$1,643         | 14                          | \$485           |
| 2002  | 472                     | \$119,470       | 366                   | \$111,601       | 58                             | \$5,460         | 37                        | \$1,624         | 11                          | \$784           |
| 2003  | 489                     | \$93,162        | 388                   | \$87,514        | 51                             | \$2,439         | 36                        | \$1,765         | 14                          | \$1,444         |
| 2004  | 528                     | \$236,711       | 466                   | \$222,697       | 34                             | \$8,773         | 18                        | \$1,330         | 10                          | \$3,911         |
| Total | 15,300                  | \$1,955,548     | 12,931                | \$1,748,929     | 1,369                          | \$93,732        | 747                       | \$71,332        | 253                         | \$41,555        |

Source: Securities Data Corporation (SDC). SDC reports multiple announcements of the same repurchase program from different sources. We report only the first fixed-price tender offer or first Dutch auction tender offer announcement in a year for each firm in a given calendar year to minimize over-counting. Open market purchases and privately negotiated purchases are examined simultaneously, and only the first of either of these in a given year is included. If a company announces both an open market purchase and a privately negotiated purchase on the same day, it is coded as an open market purchase. This procedure understates the dollar value of repurchases when firms announce an increase in repurchases later in the year. Open market purchases may include some direct purchases from private parties.

studies rely on *Wall Street Journal* announcements of share repurchases, while more recent studies identify repurchases from SDC and estimate the number of shares repurchased using either CRSP or Compustat data. Although the accuracy of the repurchase estimates is peripheral to the purpose of these academic studies, the respective discussions of the benefits and drawbacks of the measures used indicate that researchers are aware that the estimates are subject to measurement errors. The recent availability of precise repurchase information allows us to test the accuracy of the repurchase proxies used in earlier studies. Current research practices may misstate the number of announced share repurchase programs due both to the way SDC collects and reports information and to the variety of repurchase program structures used by firms (i.e. explicit expiration dates versus open-ended programs). We also examine the sources of measurement error in commonly used Compustat- and CRSP-based estimates of the number of shares repurchased, especially for firms with high stock option exercises or firms using the retirement method to record treasury purchases.

Using a hand-collected sample of 958 firms, we compare the actual number of shares repurchased (as reported in SEC filings) to CRSP- and Compustat-based estimates of the number of shares repurchased.<sup>1</sup> We find that both annual and quarterly Compustat purchases of common stock are good measures of actual repurchases in the sense that the proportion of extremely inaccurate data points is low.<sup>2</sup> We also examine how the redemption of stock options affects the accuracy of the estimates. Kahle (2002) and Bens et al. (2003) find that firms with high option use often issue and repurchase shares simultaneously, so errors caused by repurchases overlapping with share distributions are greater for these firms. Compustat purchases of common stock is the only measure of repurchases that is not offset by concurrent stock issues, so it is the most accurate measure of repurchases for firms with high option redemption.

Previous research often uses announcements reported in the SDC database to identify firms repurchasing shares. Consequently, we examine how comprehensive SDC coverage is, and find many instances where publicly announced share repurchase programs are not reported by SDC. The Compustat measures provide fairly accurate estimates of actual *total* share repurchases for firms with SDC coverage, but they are less accurate in capturing a firm's *open market* repurchases.

Finally, we report the results of regressions of actual repurchases versus estimated repurchases on variables used in earlier studies to determine if the errors in the estimates affect research outcomes. We find that actual repurchases are significantly related to options exercised, but only the estimate based on Compustat purchases of common stock reveals this relation. These findings further highlight that the share repurchase measure used is important, especially for firms with high option exercises.

Our results are important to academic researchers. Recent regulatory changes to Rule 10b-18 of the Securities Exchange Act of 1934 require that companies make quarterly disclosures of actual share repurchases and average prices paid. Firms must also

<sup>1</sup> In a prior version of this paper, we used a hand-collected sample of Fortune 500 firms between 1996 and 1998 and collected repurchase information from the Statement of Cash Flows, Statement of Stockholders' Equity, and/or the Management's Discussion and Analysis. The new share repurchase disclosures are required for fiscal years beginning after December 2003. Our current sample utilizes these new disclosures and includes both large and small firms; our main findings remain consistent with the findings reported in the earlier version of this paper.

<sup>2</sup> Compustat purchases of common stock are defined as Compustat annual data item #115 minus changes in the value of preferred stock.

**Table 2**

Prior research on share repurchases

| Source of repurchase information                | Reference                                                                                                                                                                                                                                                                    |
|-------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Announcement sources</i>                     |                                                                                                                                                                                                                                                                              |
| Wall Street Journal and Dow Jones News          | Barclay and Smith (1988)<br>Comment and Jarrell (1991)<br>DeAngelo et al. (2000)<br>Denis (1990)<br>Ikenberry et al. (1995)<br>Vermaelen (1981)                                                                                                                              |
| SDC                                             | Billet and Xue (2007)<br>Gong et al. (2008)<br>Grullon and Michaely (2002)<br>Guay and Harford (2000)<br>Jagannathan and Stephens (2003)<br>Lie (2005)<br>Massa et al. (2007)                                                                                                |
| <i>Data sources and repurchase proxies</i>      |                                                                                                                                                                                                                                                                              |
| Decreases in shares outstanding from CRSP:      | Guay and Harford (2000)<br>Jagannathan et al. (2000)<br>Stephens and Weisbach (1998)                                                                                                                                                                                         |
| Changes in Treasury Stock from Compustat:       | Bagwell and Shoven (1989)<br>Bens et al. (2002)<br>Fama and French (2001)<br>Fenn and Liang (2001)<br>Stephens and Weisbach (1998)                                                                                                                                           |
| Decreases in shares outstanding from Compustat: | Stephens and Weisbach (1998)                                                                                                                                                                                                                                                 |
| Purchases of common stock from Compustat:       | Bens et al. (2003)<br>Billet and Xue (2007)<br>Chan et al. (2004)<br>Dittmar (2000)<br>Gong et al. (2008)<br>Grullon and Michaely (2002, 2004)<br>Jagannathan and Stephens (2003)<br>Jagannathan et al. (2000)<br>Kahle (2002)<br>Lie (2005)<br>Stephens and Weisbach (1998) |
| Actual repurchases from Form 10-K:              | Bens et al. (2003)                                                                                                                                                                                                                                                           |

This table lists select papers that examine share repurchases, categorized according to the source of the repurchase announcement or data.

provide details on their program announcement dates, program size, approved methods of share acquisitions (i.e. open market, privately negotiated purchases, etc.), and expiration date of the program, if any. Thus, since 2004, researchers have access to accurate reporting of monthly share repurchase activity for all public firms. Our finding that Compustat- and CRSP-based estimates of repurchases are frequently inaccurate highlights the need to re-examine the results of earlier studies of share repurchases in light of the accurate repurchase data now available in SEC Forms 10-Q and 10-K.

The remainder of this paper is organized as follows. Section 2 discusses a firm's obligation to report repurchase activities and several issues that limit the accuracy of the commonly used data sources to reflect repurchase program activities. Section 3 describes our sample and discusses the various CRSP- and Compustat-based measures of share repurchases. Section 4 examines the accuracy of these estimates of repurchases. Section 5 concludes.

## 2. Repurchase reporting and data sources

Issuer repurchases of equity securities are regulated by the SEC under the Securities Exchange Act of 1934 (Exchange Act),<sup>3</sup> which makes it unlawful for firms to use share repurchases to manipulate stock prices. Rule 10b-18 of the Exchange Act outlines specific requirements for repurchases to receive Safe Harbor protection from price manipulation claims. Until 2004, the Exchange Act did not require disclosure of actual repurchases, although most firms provided this information in either the footnotes of the financial

<sup>3</sup> The safe harbor under Rule 10b-18 was amended in November 2003 (effective December 2003). Firms must now disclose quarterly the number of shares repurchased, the average repurchase price, and whether the repurchase was part of a publicly announced open market repurchase program. Our sample takes advantage of the extensive disclosures under this new rule.

statements, the Management's Discussion and Analysis section, or the statement of stockholders' equity. Since most databases do not extract this information from the firms' Form 10-Ks, however, researchers had to estimate the number of shares repurchased.

Stephens and Weisbach (1998) discuss various estimates of actual repurchases using CRSP and Compustat data, and subsequent researchers have attempted to improve the accuracy of these estimates. Jagannathan et al. (2000) examine whether monthly decreases in shares outstanding from CRSP or purchases of common and preferred stock reported in Compustat more accurately reflect actual repurchases. They find that the CRSP measure understates actual repurchases, while the Compustat measure overstates them, but their final sample contains only 35 firms with both CRSP and Compustat data available and includes a number of outliers. Grullon and Michaely (2002) and Kahle (2002) adjust Compustat purchases of common and preferred stock by removing changes in the value of preferred stock to better measure purchases of common stock; more recently, Massa et al. (2007) ignore the preferred stock adjustments, stating that preferred stock activity is an insignificant portion of a firm's share repurchase activity. Fama and French (2001) adjust the Stephens and Weisbach (1998) measure of changes in the dollar value of treasury stock to account for firms that retire treasury shares. However, the main focus of these papers is not the accuracy of the share repurchase measures per se, which remains an open question.

The new Exchange Act disclosures require firms to provide the dates, duration, and sizes of their active share repurchase programs. Previously, researchers relied on the *Wall Street Journal* or SDC to provide information about open market repurchase announcements.<sup>4</sup> There are several problems with SDC data, however. The first problem is an artifact of the way SDC gathers and reports information about share repurchases. SDC obtains announcements of share repurchases from a variety of sources, so it may double-count a single announcement if it appears in different sources on different days. For example, SDC may include two observations for a program announcement reported by the wire services on one day and appearing in *The Wall Street Journal* on the following day. We mitigate this problem in Table 1 by reporting only the first repurchase announcement in a given calendar year for each firm in the sample. This procedure understates the value of a repurchase program, however, if a firm announces subsequent repurchase programs or addendums to existing programs later in the same year. Second, SDC reports announcements of new programs, amended programs, and shares actually repurchased under existing programs; it is not always clear which is which. Additionally, many firms announce blanket share repurchase authorizations that provide managers with approval for a variety of methods to acquire shares, including open market repurchase transactions and privately negotiated repurchase programs<sup>5</sup>; it is not clear whether SDC differentiates these announcements from firms announcing pure open market repurchase programs.

Finally, SDC does not provide comprehensive coverage of all firms that announce repurchase programs or that repurchase shares. The Exchange Act requires firms to obtain board of director approval for repurchase programs, but it does not require that firms publicly announce these repurchase programs. Although both the NYSE and NASDAQ require listed companies to issue press releases when they establish buyback programs, it is not clear that every such press release is reported in the media or picked up by SDC. Further, some types of repurchases are not part of an established program and are not publicly announced. The most common example is the "non-cash" repurchase, which is often approved as part of a firm's equity compensation plan and occurs when employees use shares of stock to satisfy the tax withholding obligations or to pay exercise prices related to their stock options.

Overall, SDC announcements of repurchases do not include all repurchase programs, are poor predictors of the number of shares that will be repurchased by a firm, and are not inclusive of all repurchase authorizations. The CRSP- and Compustat-based estimates of share repurchases used in current research may not accurately account for all of the intricacies of the individual firm programs. The following section includes a discussion of the specific measures used in recent research and comments on the inaccuracies of these measures.

### 3. Data and methodology

#### 3.1. Sample selection

The 2003 revisions to the Exchange Act require firms to disclose all share repurchases in their quarterly and annual reports. These disclosures must include the number of shares repurchased (monthly number and average repurchase price) and whether the purchases are made under a publicly announced plan or program.<sup>6</sup> Appendix A shows the fourth quarter disclosure of DST Systems. DST repurchased 4.3 million shares during the quarter, but almost 2% were acquired from employees in conjunction with stock option exercises. As required, DST provides details on its repurchase program, including the program approval date and the extent of the repurchase plan. This detail is important as academic research often assumes that only programs announced within the past two years remain active (Stephens and Weisbach, 1998; Lie, 2005; and Gong et al., 2008 for example).<sup>7</sup>

We hand collect data on actual 2004 share repurchases from the quarterly and annual disclosures required under the revised Rule 10b-18 disclosures. Because this procedure is time consuming, we limit our sample to non-financial, December year-end firms

<sup>4</sup> Stephens and Weisbach (1998) investigate whether firms actually follow through with the repurchase announcements reported by SDC.

<sup>5</sup> Common verbiage for repurchase announcements includes the following phrase: The share repurchases could be made at the direction of management through transactions in the open market and/or privately negotiated transactions, including the use of options, futures, swaps and accelerated share repurchase contracts.

<sup>6</sup> A "public" program could encompass authority for open market transactions, tender offers, or privately negotiated transactions such as accelerated share repurchase agreements.

<sup>7</sup> In our sample, the oldest, active program was announced in December 1989 (Liz Claiborne—2004 repurchases of \$120 million) and several large, actively repurchasing firms like General Electric and Coca-Cola made \$1.9 billion and \$1.8 billion of share repurchases under programs announced in 1994 and 1996, respectively.

**Table 3**

Sample descriptive statistics

|                               | All firms |            |          | Repurchasing firms |            |            | SDC firms |            |            |
|-------------------------------|-----------|------------|----------|--------------------|------------|------------|-----------|------------|------------|
|                               | N         | Mean       | Med      | N                  | Mean       | Med        | N         | Mean       | Med        |
| Total                         |           |            |          |                    |            |            |           |            |            |
| MV <sub>t-1</sub>             | 958       | \$6717.9   | \$1402.9 | 520                | \$10,399.8 | \$2168.9   | 165       | \$13,377.0 | \$2403.8   |
| Total share repurchases (\$M) | 958       | \$134.5    | \$0.4    | 520                | \$247.9    | \$35.1     | 165       | \$432.9    | \$97.7     |
| % shares outstanding          | 958       | 0.0159     | 0.0002   | 520                | 0.030      | 0.018      | 165       | 0.047      | 0.040      |
| % OMR shares outstanding      | 958       | 0.0118     | 0.0000   | 520                | 0.022      | 0.011      | 165       | 0.040      | 0.033      |
| Options / shares outstanding  | 958       | 0.0182     | 0.0135   | 520                | 0.019      | 0.015      | 165       | 0.024      | 0.021      |
| Quartile 1                    |           |            |          |                    |            |            |           |            |            |
| MV <sub>t-1</sub>             | 240       | \$553.5    | \$548.8  | 95                 | \$563.4    | \$574.0    | 23        | \$588.2    | \$595.8    |
| Total share repurchases (\$M) | 240       | \$7.2      | \$–      | 95                 | \$18.3     | \$5.4      | 23        | \$31.4     | \$19.4     |
| % shares outstanding          | 240       | 0.012      | 0.000    | 95                 | 0.031      | 0.009      | 23        | 0.043      | 0.032      |
| % OMR shares outstanding      | 240       | 0.007      | 0.000    | 95                 | 0.017      | 0.001      | 23        | 0.036      | 0.028      |
| Options / shares outstanding  | 240       | 0.023      | 0.014    | 95                 | 0.020      | 0.017      | 23        | 0.031      | 0.028      |
| Quartile 2                    |           |            |          |                    |            |            |           |            |            |
| MV <sub>t-1</sub>             | 239       | \$1002.6   | \$961.6  | 110                | \$1005.8   | \$981.9    | 29        | \$994.5    | \$913.8    |
| Total share repurchases (\$M) | 239       | \$13.3     | \$–      | 110                | \$28.9     | \$9.6      | 29        | \$45.7     | \$27.0     |
| % shares outstanding          | 239       | 0.013      | 0.000    | 110                | 0.027      | 0.012      | 29        | 0.043      | 0.032      |
| % OMR shares outstanding      | 239       | 0.008      | 0.000    | 110                | 0.017      | 0.007      | 29        | 0.035      | 0.024      |
| Options / shares outstanding  | 239       | 0.017      | 0.013    | 110                | 0.020      | 0.018      | 29        | 0.029      | 0.028      |
| Quartile 3                    |           |            |          |                    |            |            |           |            |            |
| MV <sub>t-1</sub>             | 240       | \$2350.3   | \$2210.8 | 131                | \$2404.9   | \$2286.0   | 50        | \$2292.1   | \$2092.2   |
| Total share repurchases (\$M) | 240       | \$41.2     | \$0.6    | 131                | \$75.6     | \$45.6     | 50        | \$113.1    | \$94.6     |
| % shares outstanding          | 240       | 0.017      | 0.000    | 131                | 0.032      | 0.022      | 50        | 0.050      | 0.041      |
| % OMR shares outstanding      | 240       | 0.014      | 0.000    | 131                | 0.027      | 0.017      | 50        | 0.043      | 0.038      |
| Options / shares outstanding  | 240       | 0.019      | 0.014    | 131                | 0.022      | 0.017      | 50        | 0.025      | 0.018      |
| Quartile 4                    |           |            |          |                    |            |            |           |            |            |
| MV <sub>t-1</sub>             | 239       | \$23,009.3 | \$9597.7 | 184                | \$26,786.3 | \$10,468.1 | 63        | \$32,543.5 | \$10,044.8 |
| Total share repurchases (\$M) | 239       | \$477.3    | \$98.5   | 184                | \$619.9    | \$237.6    | 63        | \$1011.5   | \$374.5    |
| % shares outstanding          | 239       | 0.021      | 0.011    | 184                | 0.028      | 0.021      | 63        | 0.045      | 0.032      |
| % OMR shares outstanding      | 239       | 0.018      | 0.006    | 184                | 0.024      | 0.018      | 63        | 0.041      | 0.031      |
| Options / shares outstanding  | 239       | 0.014      | 0.011    | 184                | 0.015      | 0.012      | 63        | 0.018      | 0.014      |

"All firms" includes December year-end, non-financial firms with market capitalization at 12/31/03 in excess of \$400 million, who filed four quarterly and annual reports with the SEC in 2004. "Repurchasing firms" report share repurchases of any type in their 2004 Form 10-K and Form 10-Q filings. SDC firms are repurchasing firms which SDC indicates made share repurchase announcements during either 2004 or 2003. Size quartiles are based on MV<sub>t-1</sub> which is the market capitalization (in \$millions) at 12/31/03. *Total Share Repurchases* is the dollar amount (in \$millions) of share repurchases (of all types) reported in the SEC filings for 2004. *% Shares Outstanding* is the ratio of total shares repurchased in 2004 to common shares outstanding at 12/31/03. *% OMR Shares Outstanding* is the ratio of shares repurchased under publicly announced programs, excluding tender offers and privately negotiated transactions to common shares outstanding at 12/31/03. *Options / Shares Outstanding* is the ratio of employee stock options exercised to common shares outstanding at the end of 2004.

(the first companies to report four consecutive quarters under the revised Rule 10b-18 rules) with 2003 market capitalizations of at least \$400 million.<sup>8</sup> We record quarterly repurchases, program dates and sizes, new program announcements, and the percentage of shares repurchased through publicly announced programs. The detail of these disclosures allows us to parse out actual open market repurchases (OMRs) from other share repurchases. We also obtain data on employee stock options outstanding, exercised, and granted during the year from the Form 10-Ks.

Finally, we require that the firm have data available from CRSP and Compustat, although we do not require sufficient data to calculate every repurchase measure used by earlier studies. The measures of repurchases we examine include: (a) monthly decreases in shares outstanding from CRSP, (b) annual and quarterly decreases in shares outstanding from Compustat, (c) increases in the dollar value and number of shares of Treasury stock, (d) Compustat purchases of common stock, and (e) changes in Treasury stock, adjusted for firms that use the retirement method to record repurchases. Our final sample consists of 958 individual firms.

Table 3 provides descriptive statistics of our sample. The mean (median) market capitalization of our firms is \$6.72 billion (\$1.40 billion). Of the 958 firms, 520 firms repurchase shares during 2004 and 361 of these firms make OMRs.<sup>9</sup> If we split the repurchasing sample into quartiles, the means and medians within each quartile is roughly the same as the overall sample. The distribution of repurchasing firms is skewed toward the largest quartiles, however, making the overall mean and median higher for firms that actually repurchase relative to the whole sample. The median shares repurchased as a percentage of shares outstanding is higher in the upper two quartiles. We also examine SDC firms, defined as firms that SDC indicates made share repurchase

<sup>8</sup> To place this in context, Ken French's web site indicates that in December, 2003, less than 20% of NYSE firms had market capitalizations below \$400 million. If we place our sample into quintiles based on his breakpoints, our sample covers firms in each quintile, but is dominated by firms in the second (36%) and third (22%) quintiles. However, the distribution of our SDC covered firms relative to our entire sample closely mimics the distribution of all SDC firms to the Compustat Universe.

<sup>9</sup> Thus 69% of repurchasing firms repurchase through OMRs. Recall from Table 1 that 84% of SDC repurchase announcements from 1985–2004 were OMR repurchases. However, SDC does not pick up repurchases related to option exercises, which results in an overstatement of the fraction of repurchasing firms making OMRs.

announcements during either 2003 or 2004. SDC does not appear to discriminate by size: SDC captures between 24–37% of the repurchasing firms within each size quartile.<sup>10</sup> SDC does seem to discriminate based on repurchase activity, however. Within each quartile, firms covered by SDC repurchase a significantly greater percentage of shares outstanding and the percentage of open market repurchases is also higher than in repurchasing firms as a whole.

### 3.2. Measures of share repurchases

Earlier studies use a variety of different CRSP- and Compustat-based measures of share repurchases. In this section, we describe the five most common procedures for estimating share repurchases and discuss the potential problems or biases associated with each measure.

#### 3.2.1. CRSP decreases in shares outstanding

The most straightforward estimate of the number of shares repurchased by a firm is the decrease in shares outstanding reported by CRSP, adjusted for other activities that affect the number of shares outstanding, such as stock dividends and stock splits. We do not offset monthly decreases in shares outstanding with increases in other months because increases can occur for a variety of reasons—including new stock issues, the distribution of shares to employee benefit plans, or the exercise of stock options. Since these increases are unrelated to repurchase activity and bias repurchase estimates downward, we record monthly increases in shares outstanding as a zero decrease. If repurchases and distributions of shares occur in the same month, however, they will offset each other, and the monthly decrease in CRSP shares outstanding will understate actual shares repurchased. Although new stock issues are infrequent events for most firms, the exercise of stock options by employees is not, so this measure is most likely understated for firms with significant employee stock options activity.

#### 3.2.2. Compustat decreases in shares outstanding

Our second measure of share repurchases is simply the decrease (if any) in shares outstanding reported in the quarterly and/or annual Compustat databases. The use of quarterly or annual data instead of monthly data increases the likelihood that repurchases and distributions occur within the same period and offset each other. Thus, we expect the Compustat share measures will understate actual repurchases more severely than the monthly CRSP data.

#### 3.2.3. Compustat purchases of common stock

Stephens and Weisbach (1998) use quarterly Compustat information on the net dollars spent on repurchases and retirements of the firm's own securities to measure share repurchases. Since the repurchase price for these shares is not known, they assume that the firm purchases the shares either at the lowest price or the average monthly closing price during the quarter. Using the low price likely overstates the actual number of shares repurchased. Stephens and Weisbach note that the repurchase figure from Compustat “is an aggregate of all security repurchases and retirements during the quarter” (p. 320), which overstates repurchases of common stock by including the amount spent on the retirement or redemption of preferred stock and/or the conversion of preferred into common stock. Unlike the previous measures, Compustat's purchases of common and preferred stock is usually not offset by either concurrent sales of stock through equity offerings or option exercises.<sup>11</sup> Consequently, this measure is less affected by employee option exercises than the previous measures.

Several papers adjust for the aggregation of common and preferred stock information. Both Grullon and Michaely (2002) and Kahle (2002) subtract decreases in the value of preferred stock from the Compustat annual purchase measure to reduce the overestimation of common stock repurchases for preferred stock activities.<sup>12</sup> We also adjust purchases of common and preferred stock for any decrease in the value of preferred stock; we further assume that the repurchase price is the average monthly closing price during the fiscal year. Henceforth, we refer to this measure as annual Compustat purchases of common stock.

Stephens and Weisbach (1998) examine quarterly, rather than annual, purchases of common and preferred stock.<sup>13</sup> An advantage to using quarterly data is that it more precisely identifies the time of the repurchase and, thus, more precisely estimates the actual repurchase price. For the quarterly measures, we assume that the stock repurchases occur at the average monthly closing price during the quarter. As in the annual measure, we adjust for changes in preferred stock during the quarter and cumulate across quarters to get a yearly measure. We refer to this measure as quarterly Compustat purchases of common stock.

<sup>10</sup> When we examine only firms that make open market repurchases, we find that SDC covers 45% of the firms in the first quartile, 39% of the firms in the second quartile, 50% of the firms in the third quartile, and 46% of the firms in the fourth quartile.

<sup>11</sup> Firms themselves occasionally net share repurchases and issuances in their cash flow statements. In these instances, Compustat reports a netted figure either in annual data item #108 (sale of common and preferred stock) or in annual data item #115 (purchase of common and preferred stock), and a combined data code in the other. For example, IBM engages in significant share repurchases annually. In 2004, the firm reported OMR repurchases of \$7.3 billion. Compustat, however, picks up their netted common stock information, reported in the statement of cash flows, of \$6.5 billion, which would cause a researcher to understate share repurchases by over 10%.

<sup>12</sup> Even this action does not fully alleviate potential measurement errors. Compustat nets ESOP adjustments with the preferred stock data item which, depending on the direction of the ESOP transactions, may overstate or understate a firm's repurchase activity. More recently, researchers elect to eliminate all firms repurchasing less than 1% of common stock, believing that since the incidence of preferred stock and ESOP activities is low, the 1% threshold will eliminate these firms (see Dittmar, 2000; Gong et al., 2008; and Lie, 2005).

<sup>13</sup> Quarterly purchases of common and preferred stock, as reported by Compustat (quarterly data item #93), actually measures purchases year-to-date. The number reported for the third quarter cumulates all purchases in quarters one, two, and three, and the number reported for the fourth quarter is identical to the annual value.

### 3.2.4. Changes in treasury stock

Stephens and Weisbach (1998) also examine the quarterly change in the dollar value of treasury stock as a measure of share repurchases. This treasury stock measure suffers from several problems. First, repurchase prices are not known. Second, treasury share repurchases and share distributions can overlap in the same period. Thus, like estimates using decreases in shares outstanding, this measure is biased for firms that repurchase and issue treasury stock in the same period.<sup>14</sup> Third, many companies are prohibited by state corporate laws from maintaining treasury stock accounts. These companies record repurchases as retirements to the common stock accounts; the change in treasury stock measure identifies these firms as having zero repurchases. A final source of bias for this measure occurs when firms accept shares of stock as payment for stock compensation transactions (i.e., when employees return newly redeemed shares to the firm to pay the exercise prices). In these instances, the Compustat change in treasury shares overstates open market share repurchases. Given these issues, the (quarterly) treasury stock estimate of share repurchases has more potential sources of bias than either the decrease in shares outstanding reported by CRSP or the Compustat purchases of common stock measure.

We measure changes in treasury shares using four different methods. First, following Stephens and Weisbach (1998), we divide the quarterly change in the value of treasury stock by (1) the average monthly closing price or (2) the lowest price reported during the quarter. Our third measure uses annual changes in treasury stock divided by the average closing price. Finally, we calculate the increase in treasury shares using annual Compustat data item #87; this item is not available in the quarterly data. The advantage of this last measure is that it does not require a repurchase price. Since repurchases increase the treasury accounts, we ignore decreases in the treasury accounts (e.g., due to reissues or retirements). Thus, analogous to our measures of decreases in shares outstanding reported by CRSP or Compustat, when a firm reports a decrease in treasury stock, we record a value of zero for that observation.

### 3.2.5. Fama–French changes in treasury stock

Fama and French (2001) note that most researchers treat all repurchases as non-cash dividends. However, share repurchases do not substitute for dividends when (i) repurchased stock is reissued to employee stock ownership plans or as stock options or (ii) repurchased stock is reissued in a merger. They assert that annual changes in treasury stock more accurately estimate repurchases that are dividend substitutes because treasury stock captures the cumulative effect of share repurchases and subsequent reissues, while remaining unaffected by new stock issues (SEOs). In addition, some firms retire acquired shares directly from the capital accounts rather than increase a treasury stock account. Fama and French measure these repurchases as the greater of the difference between purchases and sales of common and preferred stock (data item #115–data item #108) or zero.

Two potential downward biases can result from using the Fama–French method. First, as with the previous treasury stock measures, the Fama–French measure understates repurchases when firms purchase and retire treasury shares in the same year but do not use the retirement method.<sup>15</sup> Second, the Fama–French procedure understates repurchases whenever Compustat misidentifies the retirement method firms. Fama and French (2001) note that Compustat does not consistently identify the firms which use the retirement method. They adjust for this deficiency by assuming that a firm uses the retirement method in any year in which Compustat annual footnote #45 indicates that the retirement method is used. We use the annual reports to identify firms using the retirement method and examine the degree to which Compustat truly under-reports its use. We consider a firm as using the retirement method when it records share repurchases as direct reductions in common stock, additional paid in capital, or retained earnings, even if the firm reports a non-zero treasury stock balance.<sup>16</sup> Using this approach, we identify 143 repurchasing firms that use the retirement method. Only 12 of these firms are designated by Compustat as using the retirement method.

Since our purpose is to evaluate the accuracy of commonly used repurchase proxies and not to discuss the dividend properties of the repurchases, we use a modified version of the Fama–French method in our analysis that is more consistent with our other measures of share repurchases. In particular, for firms that do not use the retirement method we use the maximum of zero and the change in treasury stock; for retirement method firms, we use the maximum of zero and annual Compustat purchases of common stock. Note that this procedure is identical to the definition of our measure of Compustat purchases of common stock in section 3.2.3. Since we want to use data available in CRSP and Compustat to estimate repurchases, we use the Fama–French procedure to identify retirement method firms. Thus, our main proxy only considers the 12 firms identified by the Fama–French procedure as retirement method firms.

## 4. Results

This section presents our findings regarding the accuracy of the CRSP- and Compustat-based measures of yearly stock repurchases for firms that actually repurchase shares during a particular year. In addition, we divide our sample according to both

<sup>14</sup> The most common reason for reissuing treasury stock is the exercise of employee stock options. However, other events, such as mergers, could also result in shares being reissued.

<sup>15</sup> For example, in 2004 AutoNation retired \$318.4 million of treasury shares while it repurchased \$236million in new treasury shares in the open market. Because the firm does not use the retirement method, Fama and French would report the maximum of zero and change in treasury stock. In this particular case, they would report zero, thereby ignoring AutoNation's repurchase. However, Compustat data item #115 properly captures the treasury repurchases. We find sixteen other sample companies also retired treasury stock during the year.

<sup>16</sup> We find that seven repurchasing firms maintain treasury stock accounts but still report share repurchases as reductions in the common stock accounts. The Fama–French repurchase measure does not consider this possibility.

**Table 4**

Actual versus estimated share repurchases for repurchase estimators

| Repurchase measure                                                                | N   | Mean ratio<br>of estimated<br>to actual | Median ratio<br>of estimated<br>to actual | Percent of estimate off by more than: |       |       |       |       |
|-----------------------------------------------------------------------------------|-----|-----------------------------------------|-------------------------------------------|---------------------------------------|-------|-------|-------|-------|
|                                                                                   |     |                                         |                                           | 10%                                   | 20%   | 30%   | 40%   | 50%   |
| Panel A: all repurchasing firms where actual shares repurchased>0                 |     |                                         |                                           |                                       |       |       |       |       |
| CRSP decrease in monthly shares out                                               | 520 | 2.347*                                  | 0.531***                                  | 89.40                                 | 79.42 | 70.38 | 64.62 | 59.04 |
| Compustat decrease in shares out (annual)                                         | 520 | 0.237***                                | 0.000***                                  | 97.12                                 | 92.31 | 86.54 | 80.38 | 75.38 |
| Compustat decrease in shares out (q)                                              | 520 | 1.427                                   | 0.486***                                  | 90.19                                 | 81.54 | 68.46 | 60.96 | 53.08 |
| Compustat purchases of common (annual)                                            | 505 | 1.623                                   | 0.942***                                  | 47.78                                 | 31.35 | 24.81 | 22.88 | 21.92 |
| Compustat purchases of common (q)                                                 | 520 | 1.293                                   | 0.968***                                  | 34.04                                 | 28.27 | 26.15 | 24.42 | 23.27 |
| Increase in treasury shares (annual)                                              | 520 | 0.440***                                | 0.000***                                  | 72.11                                 | 69.81 | 66.15 | 63.86 | 60.77 |
| Increase in treasury stock (annual, avg. close)                                   | 520 | 0.466***                                | 0.280***                                  | 79.81                                 | 69.42 | 63.46 | 59.23 | 56.54 |
| Increase in treasury stock (q, avg close)                                         | 520 | 0.582***                                | 0.575***                                  | 68.85                                 | 61.92 | 57.50 | 52.31 | 50.38 |
| Increase in treasury stock (q, low price)                                         | 520 | 0.666***                                | 0.544***                                  | 76.92                                 | 64.23 | 58.27 | 54.42 | 51.73 |
| Modified Fama–French                                                              | 518 | 0.487***                                | 0.373***                                  | 78.46                                 | 68.08 | 61.54 | 57.31 | 54.62 |
| Panel B: actual versus estimated share repurchases for high- and low-option firms |     |                                         |                                           |                                       |       |       |       |       |
| Options below the median                                                          |     |                                         |                                           |                                       |       |       |       |       |
| CRSP decrease in monthly shares out                                               | 260 | 3.023*                                  | 0.695***                                  | 85.38                                 | 75.38 | 64.23 | 58.08 | 53.85 |
| Compustat decrease in shares out (annual)                                         | 260 | 0.314***                                | 0.019***                                  | 94.62                                 | 86.15 | 76.92 | 70.38 | 65.38 |
| Compustat decrease in shares out (q)                                              | 260 | 3.740                                   | 0.579***                                  | 85.77                                 | 76.54 | 61.54 | 54.62 | 48.08 |
| Compustat purchases of common (annual)                                            | 252 | 2.408                                   | 0.942***                                  | 46.54                                 | 35.38 | 27.69 | 25.77 | 24.62 |
| Compustat purchases of common (q)                                                 | 260 | 1.764                                   | 0.972***                                  | 36.54                                 | 30.00 | 28.46 | 26.92 | 25.77 |
| Increase in treasury shares (annual)                                              | 260 | 0.467***                                | 0.000***                                  | 74.62                                 | 72.69 | 66.92 | 65.00 | 61.54 |
| Increase in treasury stock (annual, avg. close)                                   | 260 | 0.500***                                | 0.066***                                  | 81.92                                 | 71.54 | 65.38 | 60.38 | 57.69 |
| Increase in treasury stock (q, avg close)                                         | 260 | 0.651***                                | 0.517***                                  | 73.08                                 | 64.23 | 59.23 | 55.00 | 51.54 |
| Increase in treasury stock (q, low price)                                         | 260 | 0.746*                                  | 0.534***                                  | 78.85                                 | 65.38 | 61.54 | 56.15 | 53.46 |
| Modified Fama–French                                                              | 259 | 0.515***                                | 0.282***                                  | 81.15                                 | 70.77 | 63.85 | 58.85 | 56.15 |
| Options above the median                                                          |     |                                         |                                           |                                       |       |       |       |       |
| CRSP decrease in monthly shares out                                               | 260 | 1.671                                   | 0.402***                                  | 93.46                                 | 83.46 | 76.54 | 71.15 | 64.23 |
| Compustat decrease in shares out (annual)                                         | 260 | 0.160***                                | 0.000***                                  | 99.62                                 | 98.46 | 96.15 | 90.38 | 85.38 |
| Compustat decrease in shares out (q)                                              | 260 | 0.625**                                 | 0.330***                                  | 95.00                                 | 88.46 | 78.85 | 70.77 | 62.31 |
| Compustat purchases of common (annual)                                            | 253 | 0.842***                                | 0.944***                                  | 48.85                                 | 27.31 | 21.92 | 20.00 | 19.23 |
| Compustat purchases of common (q)                                                 | 260 | 0.822***                                | 0.964***                                  | 31.54                                 | 26.54 | 23.85 | 21.92 | 20.77 |
| Increase in treasury shares (annual)                                              | 260 | 0.413***                                | 0.000***                                  | 69.62                                 | 66.92 | 65.38 | 62.69 | 60.00 |
| Increase in treasury stock (annual, avg. close)                                   | 260 | 0.433***                                | 0.337***                                  | 77.69                                 | 67.31 | 61.54 | 58.08 | 55.38 |
| Increase in treasury stock (q, avg close)                                         | 260 | 0.514***                                | 0.643***                                  | 64.62                                 | 59.62 | 55.77 | 49.62 | 49.23 |
| Increase in treasury stock (q, low price)                                         | 260 | 0.586***                                | 0.613***                                  | 75.00                                 | 63.08 | 55.00 | 52.69 | 50.00 |
| Modified Fama–French                                                              | 259 | 0.459***                                | 0.416***                                  | 75.77                                 | 65.38 | 59.23 | 55.77 | 53.08 |

Data are for firms that actually repurchased shares. Actual yearly repurchases are collected from companies' 10-Qs and 10-Ks. Increase in treasury shares is the maximum of zero or the increase in the number of treasury shares during the year. Increase in treasury stock is the maximum of either zero or the increase in the dollar value of treasury stock during the year, divided by either the average closing price or the low price during the year (quarter). Compustat purchases of common is the maximum of zero or Compustat purchases of common and preferred minus any decreases in the par value of preferred stock. The modified Fama–French measure is the change in treasury stock when a firm does not use the retirement method and purchases of common and preferred when the firm does use the retirement method. Annual (q) indicates that the Compustat annual (quarterly) tapes are used to calculate the variables. \*, \*\*, and \*\*\* indicate a value that is significantly different from 1.0 at the 0.10, 0.05 and 0.01 levels, respectively.

In Panel B, options are measured as options exercised during 2004 divided by shares outstanding. In calculating the median options exercised, only firms with positive actual shares repurchased are used.

the level of stock options exercised and whether or not there is a SDC announcement of a repurchase program and test the robustness of the repurchase estimators across these subsamples.

Our primary measure of accuracy for each estimation procedure is the median ratio of estimated shares repurchased to actual shares repurchased. Using actual repurchases as the denominator illustrates how well each estimator measures actual repurchases. A ratio of 1.0 indicates an observation for which the estimate exactly equals actual share repurchases; a ratio above (below) 1.0 indicates that the estimator overstates (understates) share repurchases. In addition to testing whether the means and medians of the ratios equal 1.0, we also examine the extent of the inaccuracies across the entire sample by identifying the proportion of observations where a particular estimate is off by  $\pm 10\%$ ,  $\pm 20\%$ , and so forth, up to  $\pm 50\%$  of the number of shares that were actually repurchased.

Panel A of Table 4 reports the ratios of the estimated to actual repurchases for all of the repurchasing firms. All median measures<sup>17</sup> of estimated to actual repurchases are significantly different from 1.0 based on a Wilcoxon signed-rank test, although this result may be influenced by the skewness of the distributions. The medians range from a low of 0.00 for both Compustat annual decreases in shares outstanding and increase in annual treasury shares to a high of 0.94 and 0.97 for annual and quarterly Compustat purchases of common stock, respectively. Although, on average, Compustat purchases of common stock measures share

<sup>17</sup> Although the mean measures are included in the table, the variation in them may be driven by outliers which are often caused by errors in public databases. Rather than delete observations which include information, we focus our discussion on the median firm while still assessing the accuracy of the individual observations in columns 5–8.

repurchases most accurately, 34% of the quarterly and 48% of the annual observations over or understate actual repurchases by at least 10%. This level of accuracy is far better than that of the other estimates, however. CRSP misstates 89% (59%) of observations by at least 10% (50%). As expected, the treasury stock measures significantly understate actual repurchases, most likely due to overlapping treasury reissues and the exclusion of the retirement method firms. At least two-thirds of these measures are misstated by at least 10%, and 55% of the annual treasury stock measures are misstated by more than 50%. The Fama–French method attempts to overcome this underestimation by substituting cash flow information for firms using the retirement method. However, as noted in section 3.2.5, Compustat severely under-reports the number of firms using the retirement method. The Fama–French corrections for the treasury stock firms do not improve the measure by much, if at all, as half of the observations still misstate actual repurchases by 50% or more. Overall, Panel A of Table 4 indicates that some proxies are better than others; however, no estimate of share repurchases completely overcomes measurement errors and possible biases. The following subsections examine how option activity and SDC coverage affect the accuracy of these measures.

#### 4.1. Effect of options

The level of employee stock options at a firm may affect the accuracy of estimates of shares repurchased. Kahle (2002) and Bens et al. (2003) provide evidence that, in the 1990s, firms repurchased shares in order to fund employee stock option exercises and avoid the dilution of EPS that would result from issuing new shares. Thus, firms with high option use are more likely to repurchase shares. Since the exercise of stock options can bias some of the CRSP- and Compustat-based estimates of repurchases, we categorize firms as High or Low Option firms based on whether the proportion of stock options exercised relative to total shares outstanding is above (High Option) or below (Low Option) the sample median.<sup>18</sup> Both the CRSP and Compustat measures of decreases in shares outstanding understate actual repurchases to the extent that repurchases and distributions occur during the same period. Netting share repurchases and distributions poses less of a problem if researchers use CRSP monthly data rather than Compustat quarterly or annual data. However, even using monthly data, the overlap of repurchases and distributions may be problematic for firms where employees exercise large numbers of options. Similarly, estimates using increases in treasury shares or treasury stock are distorted for high stock option firms if the firm settles the stock options with treasury stock rather than new issues of common stock. Compustat purchases of common stock is least likely to net share purchases and distributions, so it is likely to be a better estimate repurchases for High Option firms.

Panel B of Table 4 compares the accuracy of the repurchase proxy measures between the Low and High Option firms. The median ratios of estimated to actual repurchases continue to remain significantly different from 1.0 for all repurchase proxy measures. Consistent with Bens et al. (2003) and Kahle (2002), actual repurchases are higher in firms with greater option use (results not tabulated) and as predicted, the increased motive to reissue common stock decreases the accuracy of the repurchase estimates. The worst performing measure – annual Compustat decreases in shares outstanding – estimated 2% (0%) of the actual repurchases for the median Low (High) Option firm. All of the CRSP and Compustat estimates of decreased shares outstanding are more accurate when the options are low; for High Option firms, over 93% of the estimates misstate actual repurchases by at least  $\pm 10\%$ , and 62% of the observations misstate actual repurchases by  $\pm 50\%$  or more. The bias caused by the netting of repurchased and reissued shares for firms with high stock compensation activity is severe.

The treasury stock measures appear more accurate for the High Option firms; however, this result is misleading, especially given the dismal performance of this proxy to capture share repurchases for all firms. The annual increase in treasury shares for the median High (Low) Option firm is 0 (0), due to the use of the retirement method and the high frequency of share retirements and stock compensation issuances. The Modified Fama–French measures do not improve the accuracy of these measures, probably because Compustat substantially understates the number of firms using the retirement method. Thus, if researchers use treasury accounts to estimate repurchase activity, they will capture less than half of all repurchasing firms.<sup>19</sup>

As in Panel A of Table 4, both annual and quarterly Compustat purchases of common stock continue to be the most accurate estimates of repurchases; the median ratios of estimated to actual are at least 0.94 and appear, as expected, unaffected by option activity. However, for both the high and the low option sample, nearly one-half (one-third) of the annual (quarterly) measures are misstated by more than  $\pm 10\%$  and nearly one-fifth of the measures are misstated by more than  $\pm 50\%$ .

The results in Table 4 show that all of the measures underestimate actual share repurchases, and even more so when stock option use is high. Although no CRSP- or Compustat-based estimate of share repurchases is without measurement issues, Compustat purchases of common stock is the most accurate measure of share repurchases for both High and Low option firms.

#### 4.2. SDC coverage of repurchase announcements

SDC announcements are frequently used to identify firms that repurchase shares.<sup>20</sup> Although firms are not required to announce share repurchase programs to satisfy the safe harbor provisions of SEC Rule 10b-18, doing so may protect firms from liability under the stock price anti-manipulation provisions of the Securities and Exchange Act.<sup>21</sup> In addition, the NYSE and Nasdaq

<sup>18</sup> To determine the median fraction of options exercised to shares outstanding, we use all firms making share repurchases.

<sup>19</sup> A researcher using any treasury stock measure could also introduce regional biases into his sample as the ability to use a treasury stock account is usually permitted or prohibited by state corporate laws.

<sup>20</sup> See Billet and Xue (2007), Gong et al. (2008) or Lie (2005), for example.

<sup>21</sup> See Jagannathan et al. (2000), pp. 358–359.

**Table 5**

Analysis of repurchase program announcements

| Panel A: share repurchase program information                          |  |                                  |          |                                  |
|------------------------------------------------------------------------|--|----------------------------------|----------|----------------------------------|
| Share repurchase programs (Source: SEC filings)                        |  | All firms                        |          | Repurchasing firms               |
| No current program                                                     |  | 445                              |          | 94                               |
| OMR program                                                            |  | 496                              |          | 409                              |
| Other <sup>a</sup>                                                     |  | 17                               |          | 17                               |
|                                                                        |  | 958                              |          | 520                              |
| 2004 reported program announcements <sup>b</sup> (Source: SEC Filings) |  | All firms                        |          | Repurchasing firms               |
| None                                                                   |  | 721                              |          | 296                              |
| Announcement of:                                                       |  |                                  |          |                                  |
| New program                                                            |  | 128                              |          | 116                              |
| Extension to existing program                                          |  | 62                               |          | 61                               |
| More than one new program or extension                                 |  | 45                               |          | 45                               |
| Reactivation of old program                                            |  | 2                                |          | 2                                |
| Total                                                                  |  | 237                              |          | 224                              |
|                                                                        |  | 958                              |          | 520                              |
| Panel B: SDC coverage of OMR firms                                     |  |                                  |          |                                  |
|                                                                        |  | Repurchase sample                |          | SDC covered firms                |
| All firms                                                              |  | 958                              |          | 181                              |
| Less: firms making no Repurchases                                      |  | (438)                            |          | (14)                             |
| Less: privately negotiated transactions                                |  |                                  |          | (2)                              |
| Repurchasing firms                                                     |  | 520                              |          | 165                              |
| Less: firms making no OMR repurchases                                  |  | (159)                            |          | (10)                             |
| OMR firms                                                              |  | 361                              |          | 155                              |
|                                                                        |  | Non-covered firms <i>n</i> = 206 |          | SDC covered firms <i>n</i> = 155 |
|                                                                        |  | Mean                             | Median   | Mean                             |
|                                                                        |  |                                  |          | Median                           |
| MV <sub><i>t</i>-1</sub>                                               |  | \$10,157                         | \$2485   | \$13,351                         |
| Market to book <sub><i>t</i>-1</sub>                                   |  | 1.97*                            | 1.52**   | 2.27                             |
| OMR %                                                                  |  | 0.023***                         | 0.018*** | 0.043                            |
| RP %                                                                   |  | 0.026***                         | 0.020*** | 0.047                            |
|                                                                        |  |                                  |          | 0.036                            |

SDC covered firms are firms with SDC repurchase announcements in 2003 or 2004.  $MV_{t-1}$  is the firm capitalization at the end of 2003 (in millions). Market-to-Book measures firm capitalization. OMR % is the number of shares repurchased on the open market during 2004 to shares outstanding at the end of 2003. RP % is the number of shares repurchased (by any means except privately negotiated programs or tender offers) to shares outstanding at the end of 2003. \*, \*\*, and \*\*\* indicates a value that is significantly different from 1.0 at the 0.10, 0.05 and 0.01 levels, respectively. Median comparisons are made using the Wilcoxon signed-rank test.

<sup>a</sup> Other includes two Dutch auction repurchases, 13 private placements and two dividend reinvestment plans (DRIPs).

<sup>b</sup> Tender offer and privately negotiated transactions are excluded.

require listed companies to issue a press release when they establish buyback program, so most firms probably announce their intention to repurchase shares. Firms must now disclose on a quarterly basis both the number of shares repurchased *and* whether the purchase activity is part of a publicly announced repurchase program, a surprising requirement in light of the perception that most repurchases are part of announced programs.

Panel A of Table 5 shows information from the SEC filings of our sample firms. Of the 958 firms in our sample, 520 actually repurchase shares in 2004 and 94 make their repurchases outside of publicly announced programs.<sup>22</sup> Although 409 of the repurchasing firms have open market repurchase programs in place, only 361 of these firms purchase shares under the program in 2004; the remaining 48 have OMR programs in place, but their 2004 repurchases do not include open market repurchases. An additional 17 firms make repurchases through Dutch auctions, private placements, or DRIPs. Only 224 of the 520 repurchasing firms announce new OMR repurchase programs or make extensions to existing programs during 2004. Thus, even if SDC covers all program announcements, a researcher using SDC to identify firms actively repurchasing in a given year would capture at most 43% of our sample. We find that the actual SDC capture rate is far less than 100%; only 119 of the 224 announcements are captured in the database.

If SDC does not systematically exclude program announcements, then a researcher's use of SDC should not affect his results. In Panel B of Table 5 we use a methodology common in accounting and finance research to identify a sample of OMR repurchasing firms. We pull all announcements from SDC for 2003 and 2004, to simulate a two year announcement window, which provides us with 181 program announcements. Fourteen of these firms make no repurchases during the year, and we eliminate two SDC announcements that are privately negotiated transactions and are coded incorrectly in SDC.<sup>23</sup> This leaves us with an SDC sample of

<sup>22</sup> Most, but not all, of these firms accepted shares in lieu of cash from employees to cover tax withholdings and exercise costs for employee stock compensation redemptions.

<sup>23</sup> Although a researcher using SDC would not identify the error without further research, we decided to eliminate these observations so we could evaluate how well SDC identifies actively repurchasing firms.

**Table 6**

Evaluation of Compustat statement of cash flow proxies

| Measure                                                                                                            | N   | Mean    | Median   | Percent of estimate off by more than: |       |       |       |       |
|--------------------------------------------------------------------------------------------------------------------|-----|---------|----------|---------------------------------------|-------|-------|-------|-------|
|                                                                                                                    |     |         |          | [10%]                                 | [20%] | [30%] | [40%] | [50%] |
| Panel A: ratio of estimate to actual for all positive proxy observations                                           |     |         |          |                                       |       |       |       |       |
| Ratio of proxy to all repurchases (\$)                                                                             |     |         |          |                                       |       |       |       |       |
| Compustat purchases of common (q)                                                                                  | 443 | 1.484   | 1.000**  | 18.14                                 | 14.97 | 14.06 | 12.93 | 11.79 |
| Compustat purchases of common (annual)                                                                             | 427 | 1.946   | 1.000**  | 11.48                                 | 9.13  | 7.96  | 7.03  | 6.56  |
| Ratio of proxy to OMR repurchases (\$)                                                                             |     |         |          |                                       |       |       |       |       |
| Compustat purchases of common (q)                                                                                  | 353 | 2.137** | 1.000**  | 17.97                                 | 13.31 | 12.46 | 11.05 | 9.63  |
| Compustat purchases of common (annual)                                                                             | 351 | 2.665*  | 1.000*** | 13.11                                 | 9.97  | 9.12  | 8.26  | 7.69  |
| Panel B: All observations where proxy measures (\$) > 1% of prior year market capitalization                       |     |         |          |                                       |       |       |       |       |
| Ratio of proxy to all repurchases (\$)                                                                             |     |         |          |                                       |       |       |       |       |
| Compustat purchases of common (q)                                                                                  | 290 | 1.000   | 1.000    | 7.96                                  | 5.88  | 4.84  | 4.15  | 3.46  |
| Compustat purchases of common (annual)                                                                             | 289 | 1.019   | 1.000    | 5.19                                  | 3.46  | 2.42  | 2.08  | 1.73  |
| Ratio of proxy to OMR repurchases (\$)                                                                             |     |         |          |                                       |       |       |       |       |
| Compustat purchases of common (q)                                                                                  | 263 | 1.942** | 1.000**  | 14.83                                 | 12.17 | 11.41 | 9.89  | 8.75  |
| Compustat purchases of common (annual)                                                                             | 263 | 1.943** | 1.000*** | 12.17                                 | 9.51  | 8.75  | 7.98  | 7.22  |
| Panel C: all observations with SDC coverage of program announcements and positive actual share repurchase activity |     |         |          |                                       |       |       |       |       |
| Ratio of proxy to all repurchases (\$)                                                                             |     |         |          |                                       |       |       |       |       |
| Compustat purchases of common (q)                                                                                  | 160 | 1.041   | 1.000    | 10.06                                 | 8.81  | 7.55  | 6.92  | 5.03  |
| Compustat purchases of common (annual)                                                                             | 157 | 1.080   | 1.000    | 5.73                                  | 5.10  | 3.18  | 2.55  | 1.91  |
| Ratio of proxy to OMR repurchases (\$)                                                                             |     |         |          |                                       |       |       |       |       |
| Compustat purchases of common (q)                                                                                  | 150 | 1.526   | 1.000    | 14.67                                 | 12.67 | 12.00 | 10.67 | 8.00  |
| Compustat purchases of common (annual)                                                                             | 148 | 1.598   | 1.000    | 10.81                                 | 8.78  | 7.43  | 6.76  | 5.41  |

Data are for firms that actually repurchased shares. Actual yearly repurchases are collected from companies' required disclosures made in Form 10-K and 10-Q SEC filings. Compustat purchases of common is the maximum of zero or Compustat purchases of common and preferred minus any decreases in the par value of preferred stock. "All Repurchases" include share repurchases made in or out of a publicly announced program. "OMR Repurchases" include only in-program share repurchases made on the open market. Columns (2) and (3) show the mean and median ratio of estimated repurchases to actual repurchases for each measure. A firm is designated as having an SDC program announcement if SDC covers an announcement made in either 2003 or 2004. Extreme Compustat measures (1%, 99%) are deleted. \*, \*\*, and \*\*\* indicate a value that is significantly different from 1.0 at the 0.10, 0.05 and 0.01 levels, respectively.

165 firms that researchers could conclude are firms with active open market research programs. However, ten of these firms do not make OMR repurchases in 2004. Again, a researcher could not cull out these firms without examining the SEC filings; we choose to eliminate these firms, however, because our goal is to determine whether relying on SDC to identify OMRs biases results. Our procedure yields 155 firms covered by SDC out of the 361 firms which make OMR repurchases in 2004.

We compare the SDC covered firms to the non-SDC firms on market capitalization, market to book, and repurchase percentages and find somewhat surprising results. With such a low capture rate, we expected a bias in terms of firm size; however, this is not the case. Though similar in size, the SDC firms report higher market-to-book ratios ( $p < 0.05$ ). The mean (median) percentage of OMRs to market capitalization made by the SDC covered firms is 4.3% (3.3%) which is significantly different ( $p < 0.01$ ) from the mean (median) percentage of 2.3% (1.8%) repurchased by the non-SDC firms.

We next examine how the sample selection procedure affects the precision of the repurchase estimates, focusing on the two most accurate estimators—Compustat quarterly and annual purchases of common stock. Further, to improve the precision of the estimates, we calculate the Compustat proxies as the median ratio of the estimated *dollar* value of shares repurchased to the actual *dollar* value of shares repurchased.<sup>24</sup> Additionally, we eliminate extreme outlying observations in the Compustat proxies by trimming at the 1% and 99% levels of our independent variables. Because of the detail provided in the SEC disclosures, we can also examine how effectively the commonly used proxies capture firms' actual *open market* repurchasing behavior.

Table 6 summarizes the ratio of estimated to actual repurchases for three subsamples common in earlier studies. The first, reported in Panel A, includes only firms reporting non-zero Compustat purchases proxies. While 520 firms actually repurchase shares in 2004, the Compustat quarterly (annual) measures only pick up 443 (427) of these observations. The use of the repurchase dollar amount rather than estimated shares repurchased improves the accuracy of both Compustat measures over the performance reported earlier in Table 4. However, 18% (12%) of the quarterly Compustat proxies are still misstated by  $\pm 10\%$  ( $\pm 50\%$ ), while 11% (7%) of the annual Compustat estimates are misstated by  $\pm 10\%$  ( $\pm 50\%$ ). The next rows show the ratio of the estimated to actual *open market* repurchases detailed in the filings. The assumption that these estimates identify only firms making open market share repurchases overstates the true OMR sample by 90 firms. Even if one could cull out the non-program firms, the quarterly (annual) Compustat proxy still misstates *open market* share repurchases by  $\pm 10\%$  for 18% (13%) of the sample firms.

We next examine estimates based on Compustat purchases of common stock using a sample selection procedure similar to those in Gong et al. (2008), Lie (2005), and Dittmar (2000). (Recall that this estimator includes purchases of both common and

<sup>24</sup> Studies such as Lie (2005) and Dittmar (2000) use the dollar value of share repurchase activity to market capitalization to gauge the extent of the firm's repurchase activity. Using the repurchase dollar amount eliminates the need to rely on fluctuating stock prices to estimate the number of shares repurchased. When we replicate the panels of Table 6 using the estimate of shares repurchased, the accuracy of the Compustat proxies decreases significantly and the median values reported are less than 1.00 (results untabulated).

**Table 7**

Regressions of estimates on actual repurchases

|                                      | Panel A. Entire repurchase sample |                    |                    |                    |                    | Panel B. Firms with SDC coverage |                    |                    |                    |                    |
|--------------------------------------|-----------------------------------|--------------------|--------------------|--------------------|--------------------|----------------------------------|--------------------|--------------------|--------------------|--------------------|
|                                      | (1)                               | (2)                | (3)                | (4)                | (5)                | (6)                              | (7)                | (8)                | (9)                | (10)               |
| Intercept                            | 0.0113<br>(0.0001)                | 0.0195<br>(0.0001) | 0.0019<br>(0.0007) | 0.0022<br>(0.0001) | 0.0167<br>(0.0001) | 0.0222<br>(0.0001)               | 0.0312<br>(0.0001) | 0.0029<br>(0.0001) | 0.0032<br>(0.0002) | 0.0286<br>(0.0001) |
| CRSP decrease in monthly shares out  | 0.7711<br>(0.0001)                |                    |                    |                    |                    | 0.6608<br>(0.0001)               |                    |                    |                    |                    |
| Increase in treasury shares (annual) |                                   | 0.6785<br>(0.0001) |                    |                    |                    |                                  | 0.6537<br>(0.0001) |                    |                    |                    |
| Purchases of common (annual)         |                                   |                    | 1.0095<br>(0.0001) |                    |                    |                                  |                    | 0.9772<br>(0.0001) |                    |                    |
| Purchases of common (quarterly)      |                                   |                    |                    | 0.9983<br>(0.0001) |                    |                                  |                    |                    | 0.9723<br>(0.0001) |                    |
| Modified Fama–French (annual)        |                                   |                    |                    |                    | 0.8113<br>(0.0001) |                                  |                    |                    |                    | 0.6930<br>(0.0001) |
| N                                    | 520                               | 520                | 505                | 520                | 518                | 165                              | 165                | 165                | 165                | 165                |
| Adjusted R <sup>2</sup>              | 0.587                             | 0.259              | 0.935              | 0.934              | 0.332              | 0.567                            | 0.370              | 0.973              | 0.964              | 0.426              |

The dependent variable is yearly repurchases from company 10-Ks. The independent variables are the different measures of share repurchases, as defined in Section 3.2. Panel A includes all firm-years in our sample. Panel B includes only those firm-years for which a repurchase was reported in SDC in either the year of or the year prior to the actual repurchases.

preferred stock.) These studies assume that the volume of preferred stock activity is low, and so eliminating firms with Compustat purchases of common stock less than 1% of market capitalization reduces the likelihood of a confounded repurchase estimate. The results reported in Panel B of Table 6 include the 290 firms reporting 2004 Compustat purchases of common stock in excess of 1% of 2003 market capitalization. The accuracy of the estimates is improved over the results reported in Panel A. For the quarterly estimate, only 8% (3%) of the proxy measures misstate actual share repurchases by  $\pm 10\%$  ( $\pm 50\%$ ); for the annual estimate, the corresponding numbers are 5% (2%). However, the procedure identifies only 290 of the repurchasing firms and 263 of the OMR firms. Recall from Table 3 that the true number of repurchasing (OMR) firms is 520 (361), so while this sample selection procedure improves accuracy, it only identifies 73% of the OMR firms.

Earlier studies assume that SDC announcements of repurchases provide a comprehensive list of repurchasing firms. As we show in Table 5, however, this is not the case. Panel C of Table 6 reports the accuracy of the Compustat stock purchases estimates for the SDC firms, the identification of which is detailed in Table 5. As in Panel B, the Compustat-based estimates provide accurate estimates of actual share repurchases for the subsample. The misidentification of repurchasing firms could pose problems if a study involves matched samples of repurchasing and non-repurchasing firms, however. As shown in Table 5, SDC appears to identify firms engaging in high volumes of share repurchase activities but fails to capture almost 60% of OMR firms repurchasing smaller, yet still meaningful, proportions of common stock outstanding.

In summary, the annual or quarterly Compustat purchases of common stock measure provides the best estimate of repurchases. The ratio of estimated to actual repurchases is closest to one, and the estimate is the most accurate for the individual observations, especially for firms with high stock option use. However, one should not assume either that Compustat estimates of share repurchases capture *open market* repurchases or that SDC provides a comprehensive list of repurchase announcements.

#### 4.3. Regression analyses

In this section, we use regression analysis to further examine the accuracy of the measures of share repurchases. Although the univariate results indicate that the Compustat purchases of common stock measures are the most accurate measures of share repurchases, the differences between the various measures could be sufficiently minor that they do not matter in a multivariate setting. If the choice of repurchase proxy measure does not affect a researcher's results, it does not matter which measure he uses. We examine this issue by replicating some previous research regarding the determinants of share repurchases.

Table 7 reports the results of regressing the estimates that perform best in Table 4 on actual repurchases to examine the goodness of fit. Panel A of Table 7 considers the entire sample. The estimates have coefficients ranging between 0.68 and 1.01, and the R-squares range from 0.259 to 0.935. The highest coefficient and R-square is from the regression of annual Compustat purchases of common stock on actual repurchases; this outcome is consistent with the results in Table 4 that show that this measure misstates actual repurchases less frequently than the other measures. Panel B of the table contains only observations where the repurchases are announced in SDC. The coefficients on the estimates decrease slightly relative to the entire sample, indicating that the estimates are worse for the SDC firms. Although the coefficients on annual and quarterly Compustat purchases of common stock decrease to 0.98 and 0.97, respectively, the reported R-squares increase to 0.97 and 0.96 respectively. The next best measure, CRSP decreases in monthly shares outstanding, has a coefficient of 0.66 and an R-square of only 0.57.

We next examine how well the CRSP- and Compustat-based measures proxy for actual repurchases as the dependent variable in a regression. Table 8 examines the determinants of share repurchases, using actual repurchases as well as the most accurate estimates. The independent variables include the ratio of options exercised to shares outstanding, the ratio of total debt to assets, the log of the book value of assets, the ratio of the market value to the book value of assets, free cash flow (as defined by Lehn and Poulsen, 1989), and the stock return during the year.

**Table 8**

Determinants of share repurchases

| Dependent variable                              | Intercept          | Options/shares     | Debt/assets         | Log assets          | Market-to-book assets | Free cash flow     | Stock return        | Adj. R <sup>2</sup> |
|-------------------------------------------------|--------------------|--------------------|---------------------|---------------------|-----------------------|--------------------|---------------------|---------------------|
| <i>Panel A: all repurchasing firms (N=465)</i>  |                    |                    |                     |                     |                       |                    |                     |                     |
| Actual repurchases                              | 0.0239<br>(0.0081) | 0.4831<br>(0.0001) | −0.0052<br>(0.5338) | 0.0000<br>(0.9841)  | −0.0027<br>(0.0234)   | 0.0309<br>(0.0532) | −0.0227<br>(0.0001) | 0.055               |
| CRSP decrease in monthly shares out             | 0.0362<br>(0.0001) | 0.1071<br>(0.2097) | −0.0075<br>(0.7194) | −0.0015<br>(0.0957) | −0.0027<br>(0.0195)   | 0.0278<br>(0.0703) | −0.0176<br>(0.0018) | 0.021               |
| Compustat purchases of common (annual)          | 0.0185<br>(0.0348) | 0.4460<br>(0.0001) | −0.0082<br>(0.3104) | 0.0005<br>(0.5575)  | −0.0026<br>(0.0248)   | 0.0335<br>(0.0305) | −0.0205<br>(0.0003) | 0.051               |
| Compustat purchases of common (quarterly)       | 0.0177<br>(0.0413) | 0.4402<br>(0.0001) | −0.0111<br>(0.1653) | 0.0007<br>(0.4754)  | −0.0024<br>(0.0382)   | 0.0368<br>(0.0167) | −0.0222<br>(0.0001) | 0.055               |
| <i>Panel B: open market firms (N=323)</i>       |                    |                    |                     |                     |                       |                    |                     |                     |
| Actual repurchases                              | 0.0141<br>(0.1365) | 0.5539<br>(0.0001) | 0.0028<br>(0.7341)  | 0.0011<br>(0.2480)  | −0.0031<br>(0.0097)   | 0.0455<br>(0.0154) | −0.0235<br>(0.0003) | 0.092               |
| CRSP decrease in monthly shares out             | 0.0384<br>(0.0003) | 0.1501<br>(0.2164) | 0.0006<br>(0.9447)  | −0.0015<br>(0.1912) | −0.0036<br>(0.0073)   | 0.0327<br>(0.1143) | −0.0184<br>(0.0100) | 0.021               |
| Compustat purchases of common (annual)          | 0.0193<br>(0.0448) | 0.5324<br>(0.0001) | 0.0031<br>(0.7134)  | 0.0009<br>(0.3816)  | −0.0035<br>(0.0043)   | 0.0310<br>(0.1025) | −0.0203<br>(0.0019) | 0.083               |
| Compustat purchases of common (quarterly)       | 0.0201<br>(0.0395) | 0.5181<br>(0.0001) | −0.0007<br>(0.9355) | 0.0009<br>(0.3988)  | −0.0034<br>(0.0063)   | 0.0355<br>(0.0645) | −0.0223<br>(0.0008) | 0.077               |
| <i>Panel C: firms with SDC coverage (N=150)</i> |                    |                    |                     |                     |                       |                    |                     |                     |
| Actual repurchases                              | 0.0506<br>(0.0182) | 0.3682<br>(0.0986) | 0.0153<br>(0.3856)  | −0.0004<br>(0.8571) | −0.0078<br>(0.0014)   | 0.0562<br>(0.1328) | −0.0250<br>(0.0781) | 0.067               |
| CRSP decrease in monthly shares out             | 0.0607<br>(0.0052) | 0.0010<br>(0.9965) | 0.0092<br>(0.6049)  | −0.0019<br>(0.3767) | −0.0083<br>(0.0007)   | 0.0542<br>(0.1497) | −0.0163<br>(0.2529) | 0.021               |
| Compustat purchases of common (annual)          | 0.0464<br>(0.0282) | 0.3253<br>(0.1389) | 0.0140<br>(0.4207)  | 0.0000<br>(0.9880)  | −0.0082<br>(0.0006)   | 0.0624<br>(0.0910) | −0.0223<br>(0.1104) | 0.074               |
| Compustat purchases of common (quarterly)       | 0.0460<br>(0.0306) | 0.3160<br>(0.1525) | 0.0116<br>(0.5080)  | 0.0001<br>(0.9495)  | −0.0076<br>(0.0017)   | 0.0570<br>(0.1243) | −0.0243<br>(0.0837) | 0.058               |

This table shows parameter estimates from regressing share repurchases and estimated repurchases on variables previously found to be important in determining share repurchases. The sample is limited to firms that actually repurchase shares. Options/shares are options exercised during 2004 divided by shares outstanding. Debt/assets are long-term debt plus debt in current liabilities, divided by book value of assets. Free cash flow is defined as in [Lehn and Poulsen \(1989\)](#). Stock return is the cumulative return during the year, calculated using CRSP monthly data. Debt/assets, log assets, and market-to-book value of assets are all calculated as of the prior fiscal year-end. *P*-values are in parentheses.

Our choice of explanatory variables is based on earlier research as follows. *Options/Shares*—[Kahle \(2002\)](#) and [Fenn and Liang \(2001\)](#) document that options affect the buyback decision. *Debt/Assets*—[Bagwell and Shoven \(1989\)](#) find that highly levered firms are less likely to repurchase, perhaps due to either financial distress or agency costs of free cash flow. *Log Assets*—larger firms have lower financing costs, and thus can afford to repurchase more, so size is used in previous studies to proxy for financing costs. *Market-to-book value*—firms with greater investment opportunities, as reflected in the market-to-book ratio, are less likely to repurchase stock if the payout is designed to reduce agency costs of free cash flow. *Free cash flow*—[Guay and Harford \(2000\)](#) and [Jagannathan et al., \(2000\)](#), show that repurchases depending on a firm's cash flow situation. *Stock return*—[Stephens and Weisbach \(1998\)](#) find a negative relation between stock performance and repurchases, which is consistent with firms purchasing undervalued shares.

The first row of Panel A of [Table 8](#) reports the regression results for all repurchasing firms. Actual repurchases are positively related to options and free cash flow, and negatively related to the market-to-book ratio and stock return. The adjusted *R*-square of this regression is 0.055. Estimated repurchases based on annual and quarterly Compustat purchases of common stock are also positively and significantly related to options exercised, but the CRSP measure is not. This result confirms the conclusion that the estimate based on Compustat purchases of common stock is the only measure that is not severely biased for High Option firms. All of the repurchase estimators are negatively and significantly related to the market-to-book value of assets and stock return as well as positively related to free cash flow. Size is not significant in any of the models in Panel A; however, given the descriptive statistics in [Table 3](#), which indicate that small firms repurchase shares in a similar proportion to large firms, this result is not surprising.

Panel B of [Table 8](#) reports the regression results for firms making open market repurchases. As in Panel A, actual OMRs are positively related to stock options and free cash flow and negatively related to the market-to-book ratio and stock return. The adjusted *R*-square increases from 0.055 in Panel A to 0.092 in Panel B, so these characteristics are more descriptive of OMRs. The Compustat-based estimates show similar results, although the free cash flow variable is less significant (not significant) for the quarterly (annual) measure, perhaps due to netting of non-common stock transactions. Keep in mind that researchers using these estimates cannot easily separate open market repurchases from all other repurchases. The CRSP-based estimate is not significantly related to either stock options or free cash flow, so using this measure could lead to incorrect inferences about the true determinants of open market repurchases.

Finally, Panel C includes only the firms with SDC coverage in 2003 or 2004. Actual repurchases are still positively related to stock options, but only marginally ( $p < 0.10$ ). The market-to-book ratio and stock return retain their negative relation with actual share repurchases, but free cash flow is no longer significant. The Compustat estimates fail to identify any significant relation

between stock options and share repurchases and only find a negative relation between the market-to-book ratio and share repurchases. This result is surprising since many earlier studies rely on SDC to identify repurchasing and open market repurchasing firms. The SDC firms are clearly not representative of repurchases by the general population of firms.

The results in Table 8 indicate that the method used to estimate repurchases matters in empirical research. In particular, the sign and significance of the independent variables can change depending on the estimator. Researchers should also consider how they identify the repurchasing firms (i.e., SDC versus Compustat). To summarize, repurchase measurement issues and sample selection can affect a researcher's conclusions.

## 5. Conclusion

Almost all studies of open market share repurchases have used data from either CRSP or Compustat to estimate the number of shares repurchased. We use new disclosures required by the SEC to examine the accuracy of these various estimates of share repurchases. Overall, Compustat purchases of common stock is the best estimate of actual repurchases. However, we find that employee stock options affect the accuracy of all of the estimates of share repurchases. High option firms are likely to both repurchase and issue shares during the same year (or quarter), and all of the estimates of repurchases underestimate actual repurchases for high option firms. Most of the estimates are better for low option firms. Regression analysis indicates that this bias is important. Compustat purchases of common stock is the only estimate that detects the positive relation between repurchases and options exercised that is observed in the actual repurchase data.

We also categorize our data according to whether or not a firm's repurchase announcement is reported by SDC. Although SDC does not appear to exclude repurchase announcements based on size, it does include firms that repurchase a higher proportion of shares outstanding than the overall population of repurchasers. In addition, SDC both understates the number of open market repurchasing firms and provides a sample of repurchasing firms that do not share the same characteristics as non-SDC firms.

Since recent regulatory changes to Rule 10b-18 of the Exchange Act increase disclosures of actual share repurchase activities, including monthly shares repurchased, average repurchase prices, and specific repurchase program details, researchers no longer need to estimate share repurchases. Future research should revisit earlier studies to see if the results continue to hold over time and in the light of more accurate information.

## Appendix A. Example 10-K disclosure of DST Systems

### Appendix A.1. Stock repurchases

The following table sets forth information with respect to shares of Company common stock purchased by the Company during the quarter ended December 31, 2004.

| Period                 | Total number of shares purchased | 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 |
|------------------------|----------------------------------|------------------------------|----------------------------------------------------------------------------------|--------------------------------------------------------------------------------|
| October 1–October 31   | 2264 <sup>a</sup>                | \$38.92                      | 0                                                                                | 10,033,500 <sup>b</sup>                                                        |
| November 1–November 30 | 1,623,370 <sup>a</sup>           | \$47.87                      | 1,600,000                                                                        | 8,433,500 <sup>b</sup>                                                         |
| December 1–December 31 | 2,651,109 <sup>a</sup>           | \$50.24                      | 2,600,000                                                                        | 5,833,500 <sup>b</sup>                                                         |

<sup>a</sup>For the three months ended December 31, 2004, the Company purchased, in accordance with the 1995 Stock Option and Performance Award Plan, 76,743 shares of its common stock for participant income tax withholding in conjunction with stock option exercises, as requested by the participants. These purchases were not made under the publicly announced repurchase plans or programs. Of these shares, 2264 shares were purchased in October, 23,370 shares were purchased in November and 51,109 shares were purchased in December.

<sup>b</sup>On February 26, 2004, the Company's Board of Directors authorized a stock repurchase plan allowing but not requiring the repurchase of up to 6 million shares of Company common stock in open market and private transactions during the period beginning March 1, 2004 through February 28, 2007. On October 19, 2004, the Company's Board of Directors authorized an additional 5.5 million share repurchase to the plan. On December 31, 2004, the Company had approximately 5.8 million remaining shares to be purchased under this plan.

## References

- Bagwell, L., Shoven, J., 1989. Cash distributions to shareholders. *Journal of Economic Perspectives* 3, 129–140.
- Barclay, M., Smith, C., 1988. Corporate payout policy: cash dividends versus open-market repurchases. *Journal of Financial Economics* 22, 61–82.
- Bens, D., Nagar, V., Wong, M., 2002. Real investment implications of employee stock option exercises. *Journal of Accounting Research* 40, 359–393.
- Bens, D.A., Nagar, V., Skinner, D.J., Wong, M.H.F., 2003. Employee stock options, EPS dilution, and stock repurchases. *Journal of Accounting & Economics* 36, 51–90.
- Billet, M., Xue, H., 2007. The takeover deterrent effect of open market share repurchases. *Journal of Finance* 62 (4), 1827–1850.
- Chan, K., Ikenberry, D., Lee, I., 2004. Economic sources of gain in stock repurchases. *Journal of Financial and Quantitative Analysis* 39, 461–479.
- 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.
- DeAngelo, H., DeAngelo, L., Skinner, D., 2000. Special dividends and the evolution of dividend signaling. *Journal of Financial Economics* 57, 309–354.
- Denis, D., 1990. Defensive changes in corporate payout policy: share repurchases and special dividends. *Journal of Finance* 45, 1433–1456.
- Dittmar, A., 2000. Why do firms repurchase stock? *Journal of Business* 73, 331–355.
- Fama, E.F., French, K.R., 2001. Disappearing dividends: changing firm characteristics or lower propensity to pay? *Journal of Financial Economics* 60, 3–43.
- Fenn, G., Liang, N., 2001. Corporate payout policy and managerial stock incentives. *Journal of Financial Economics* 60, 45–72.
- Gong, G., Louis, H., Sun, A.X., 2008. Earnings management and firm performance following open-market repurchases. *Journal of Finance* 63 (2), 947–986.
- Grullon, G., Michaely, R., 2002. Dividends, share repurchase, 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, 385–415.
- Ikenberry, D., Lakonishok, J., Vermaelen, T., 1995. Market underreaction to open market share repurchases. *Journal of Financial Economics* 39, 181–208.
- Jagannathan, M., Stephens, C., 2003. Motives for multiple open-market repurchase programs. *Financial Management* 32, 71–91.
- Jagannathan, M., Stephens, C.P., Weisbach, M.S., 2000. Financial flexibility and the choice between dividends and stock repurchases. *Journal of Financial Economics* 57, 355–384.
- Kahle, K.M., 2002. When a buyback isn't a buyback: open market repurchases and employee options. *Journal of Financial Economics* 63, 235–261.
- Lehn, K., Poulsen, A., 1989. Free cash flow and stockholders gains in going private transactions. *Journal of Finance* 44, 771–788.
- Lie, E., 2005. Operating performance following open market share repurchase announcements. *Journal of Accounting and Economics* 39, 411–436.
- Massa, M., Rehman, Z., Vermaelen, T., 2007. Mimicking repurchases. *Journal of Financial Economics* 84 (3), 624–666.
- Stephens, C.P., Weisbach, M.S., 1998. Actual share reacquisitions in open-market repurchase programs. *Journal of Finance* 53, 313–333.
- Vermaelen, T., 1981. Common stock repurchases and market signaling. *Journal of Financial Economics* 9, 139–183.