

Mispricing of Dual-Class Shares: Profit Opportunities, Arbitrage, and Trading

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ABSTRACT

This is the first paper to examine the microstructure of how mispricing is created and resolved. We study an easily observable type of mispricing, i.e. dual class-shares with equal cash-flow rights but different prices, and show that a simple trading strategy creates abnormal profits that survive transactions costs and battery of conservative robustness checks. Trade data from TAQ shows that investors shift their trading patterns to take advantage these mispricings. Contrary to common perception, long-short arbitrage plays a minor part in eliminating mispricing. Instead, one-sided trades correct the bulk of the mispricing. We also show that the more liquid share class is, more often than not, responsible for the mispricing. Our findings have implications for the literature on risky arbitrage and asset pricing more generally.

1. Introduction

We examine price discrepancies between dual classes of shares issued by the same company. These price discrepancies can be exploited to provide significant trading profits and therefore appear to represent mispricings or market inefficiencies. A unique contribution of this paper is that we use intraday trade and quote data from TAQ to see how these mispricings arise and how they are corrected.

Each class in our sample of dual class shares is entitled to equal cash flows from the issuing company, but the classes command different numbers of votes per share. Prices of the two classes of shares could differ for rational reasons - the extra votes may have value or the market may value the extra liquidity provided by one class. Nevertheless, we find that significant abnormal returns are produced by the simple trading strategy of buying the cheaper class and shorting the more expensive class when the bid price of one exceeds the ask price of the other by a specified amount. These abnormal returns easily survive trading costs. The long sides of these positions earn abnormal returns by themselves, so these mispricings provide profit opportunities even when there are severe restrictions on short selling.

After establishing that these price discrepancies are mispricings, we examine intraday trade and quote data from TAQ to see how these mispricings arise and how they are eliminated. The most common cause of the mispricing is price pressure moving the active non-voting stock price out of line. This is somewhat counterintuitive - it is usually the most active rather than the least active stock that becomes mispriced. After mispricings arise, we find that purchases of underpriced shares and sales of overpriced ones become more likely to execute at quoted prices - evidence that investors are trying to trade quickly before prices change. We also find that trading volume changes in the expected ways when shares are mispriced. That is, sell volume becomes a larger part of total volume for overpriced shares and buy volume becomes a larger part of total volume for the underpriced class. The changes in volume are particularly clear for the less active voting shares.

Perhaps our most interesting finding is that, contrary to common perception, long-short arbitrage plays only a minor role in correcting mispricing. To measure arbitrage activity, we examine volume from matched trades, defined as the purchase of shares of one class and the sale of the same number of shares of the other class within a minute. Volume from matched sales of

overpriced shares and purchases of underpriced shares increases when the classes are mispriced. The change in volume from matched trades is far less than the change from single-sided trades. We conclude that single-sided trades are more important than arbitrage trades for correcting price discrepancies. This may reflect limits to arbitrage for our sample.

We believe that our findings shed light on price discrepancies between other pairs of similar assets. Siamese twins are shares with equivalent voting rights that trade in different markets.¹ Several researchers, including Rosenthal and Young (1990), Froot and Dabora (1999) and Scruggs (2007), show that the ratio of prices of these shares diverge significantly and for long periods of time from the ratio of their cash flows. Our finding that price discrepancies in dual class shares provide profit opportunities is also similar to findings on pairs trading (see Gatev, Goetzmann, and Rouwenhorst (2007) and Engelberg, Gao, and Jagannathan (2009)). Pairs trading is a statistical arbitrage trading strategy. Pairs are not stocks issued by the same company or stocks with proportional cash flow rights. Instead, pairs are formed from stocks with historically high correlations of returns. If cumulative returns (or normalized prices) diverge, the strategies call for buying the stock with the lower recent return and shorting the stock with the higher recent return. Gatev, Goetzmann, and Rouwenhorst (2007) report annual abnormal returns of 11% from pairs trading. These returns appear to exceed even conservative estimates of transactions costs.

The remainder of the paper proceeds as follows. In Section 2 we discuss dual-class shares. Section 3 describes our sample. In Section 4 we examine whether differences in the prices of dual-class shares represent mispricing. In Section 5 we analyze intraday trade data to see how prices of dual class shares diverge. We study how they converge again in Section 6. A summary of our results is given and conclusions are drawn in Section 7.

2. Dual-Class Shares

A company with dual-class shares has two classes of common stock with different voting rights, or rights to elect different numbers of directors. Dual share classes are usually created to

¹Our work is also related to research on arbitrage opportunities involving portfolios of securities. See Lee, Shleifer, and Thaler (1991), and Pontiff (1996) for work on mispricing of closed-end funds. See Jarrow and O'Hara (1989) on the pricing of Primes and Scores.

guarantee control for founding family members or other insiders who have a minority stake in the company's cash flows. In most cases, corporate charters require cash flows from dividends, liquidations, and other sources to be equal for both classes of shares. In other cases, cash flows for the two classes are required to be in specified proportions.

The trading rules we test later in the paper assume that, when share classes have equal cash flows, a share class with a lower price is underpriced relative to the other class. These are simple rules, not optimal ones. There are good reasons apart from mispricing for price discrepancies. All else equal, voting shares may be more valuable if private benefits accrue to those who control the company through ownership of voting stock (see Lease, McConnell, and Mikkelsen (1983), Zingales (1995) and Nenova (2003)).² Differences in liquidity may also cause prices of dual class shares to diverge (see Smith and Amoako-Adu (1995) and Zingales (1995)). Shares with superior voting rights are typically less liquid. There are often fewer of them outstanding, and they are usually held for long periods of time by investors who wish to retain control of the company. Lower liquidity can explain why shares with superior voting rights sometimes sell for lower prices than shares with inferior votes. If price discrepancies are the result of differences in votes or liquidity, our simple trading rules will not produce abnormal returns.

Casual observation suggests, though, that the value of votes and differences in liquidity are only part of the reason for the price discrepancies between voting and non-voting stock. The value of liquidity and the value of extra votes should be fairly stable on a day to day basis. On the other hand, if mispricing or market inefficiency is behind the differences in dual-class share prices, we would expect the price differences to vary over time. Figure 1a shows the ratio of daily closing bid prices of Comcast voting stock to non-voting stock from 1994 through 1997. Both classes of stock have the same cash flow rights, but only one class has voting rights. For most sample firms, both classes have votes but one has more than the other. For simplicity, in all cases we refer to the class of shares with more votes as voting shares and the class with fewer votes as non-voting stock.

Figure 1a shows the ratio of bid prices of the two share classes varies significantly over 1994 - 1997. In 1994 the bid price of the voting shares is often 1% to 2% below the bid price of the non-voting shares. In 1996 and 1997, the closing bid price of Comcast voting stock often exceeds the

²Christofferson, Geczy, Musto, and Reed (2007) examine the value of votes in the equity loan market and show that votes are usually worth zero.

closing bid price of the non-voting stock by 3% or more. Figure 1b shows the dollar difference between the closing bid price of Comcast voting stock and the ask price of Comcast non-voting shares. There are a number of days in 1996 and 1997 where the bid price of Comcast voting stock exceeds the ask price of the non-voting shares by \$0.50 or more. That is, an unsophisticated investor trading at quoted prices could expect to sell voting shares for at least \$0.50 more than he would pay for non-voting shares. This graph only shows price discrepancies at the close. When intraday data is used, far more trading opportunities present themselves.

Comcast is not a small company. The non-voting shares by themselves would be in the ninth (second largest) size decile of NYSE stocks at the end of 1994 and 1995. They would be in the eighth decile at the end of 1996 and in the largest decile at the end of 1997. The voting shares by themselves would be in the fifth size decile of NYSE stocks at the end of 1994 - 1996. They would be in the sixth decile at the end of 1997. Shares in each class trade every single day over 1994 - 1997. The *minimum* number of trades on any day is 25 for the voting stock and 78 for the non-voting shares.

Figure 2a depicts the ratio of bid prices of voting to non-voting shares for Gray television from 2002 through 2006. Gray Television is a small company (usually first or second decile of NYSE stocks) and the price discrepancies are larger. In late 2002 and early 2003, voting stock sold for at least 10% and as much as 40% more than the non-voting stock. From mid-2004 through 2005, Gray Television voting stock sold at a discount to non-voting shares. The discount was more than 10% on many days. By the end of 2006, the voting stock was again selling at a premium.

Figure 2b uses a solid line to show the daily difference between the closing bid price of the Gray Television voting stock and the closing ask price of the non-voting stock. In 2002 and early 2003, the difference was usually more than \$1, and reached over \$3. This means that if an investor could borrow the voting shares, he could sell them at the bid, use the proceeds to buy non-voting shares with identical cash payouts, and keep at least \$1 per share. The dashed line shows the daily difference between the closing bid price of the non-voting stock and the closing ask price of the voting stock. For most of 2004 and 2005, this value was positive, so an investor could expect to receive more by selling a share of the non-voting stock than he would pay for a share of the voting stock. In many cases this difference was more than \$1. It seems unlikely that greater liquidity is valued this highly.

More generally, if the price discrepancies are due to consistent differences in voting rights or liquidity, prices will not converge and trading rules that attempt to exploit price differences should not produce abnormal returns. We will show that long-short positions that attempt to exploit these price discrepancies earn positive excess returns about 80% of the time. This suggests that in the overwhelming majority of cases, price discrepancies indicate mispricings. So, while our trading rules are not optimal, they do produce abnormal returns and do allow us to study how investors trade in response to mispricings.

3. Sample

We identify all pairs of CRSP stocks that traded at the same time during 1993-2006, had the same first six characters in their Cusip numbers, but had different CRSP perm numbers. After discarding tracking stocks, we are left with an initial sample of 141 pairs of dual-class shares that traded on the New York Stock Exchange (NYSE), American Stock Exchange (Amex), or Nasdaq during 1993 - 2006. We discard pairs without TAQ data and pairs that do not have equal cash flow rights. If there are no times when the price of both classes of shares exceed \$5, we omit that pair of stocks as well. This leaves 100 pairs of dual-class shares. In a handful of cases, there are more than two classes issued by one firm. If there are three classes of stock outstanding at the same time, there are three combinations of two classes and we count them as three pairs of dual-class shares.

The appendix lists each of the pairs of dual-class shares in our sample, along with the dates that both classes trade, the firm SIC code, the NYSE size decile of the voting stock, the NYSE size decile of the non-voting stock, and the number of times the stock pair appears in one of our arbitrage positions. Many of the firms are small, but some are large and well known - they include Brown Forman Distillers, Reader's Digest, Comcast, and Continental Airlines. In total, our rules lead to arbitrage positions in 96 of the 100 pairs of dual-class shares.

A summary description of our sample is provided in Table 1. For each month over 1993 - 2006, we calculate the proportion of stocks listed on the New York Stock Exchange (NYSE), American Stock Exchange (Amex), and Nasdaq. We then average the proportions across the 168 months. Panel A reports that, in an average month, 45.9% of the dual-class shares trade on the NYSE, 17.6% trade on the Amex, and 36.6% trade on Nasdaq. We calculate market capitalizations

for all firms on the CRSP tapes each month over 1993 - 2006. For a firm with dual-class shares, firm size is the sum of the market capitalization of both classes of stock.³ We then divide all firms into deciles each month using NYSE size breakpoints and calculate the average proportion of dual-class shares in each decile across months. Dual-class shares are issued by firms of all sizes. Panel B shows that 22.8% of dual-class firms are in the smallest decile while 5.5% are in the largest decile. Even though most of our sample stocks trade on the Amex or on Nasdaq, over 30% of the firms are above the median size for NYSE stocks.

For brevity, we refer to the share class with fewer votes or that elects fewer members to the board of directors as “non-voting” stock, but, as Panel C shows, only 39% actually have no votes. In most cases, the non-voting stock has fewer votes, with 49% having one vote for every ten of the voting shares. In 20% of the cases, one class of shares elects more directors to the board than does the other class, even if both classes have the same number of votes per share.

One reason why prices of dual-class shares with equal cash flows may differ is differences in liquidity. Table 2 provides statistics on percentage bid-ask spreads and turnover, two measures of liquidity, for voting and non-voting shares. For each firm, we calculate the mean and median closing bid-ask spread for voting and non-voting stock across all days with quotes for both classes of shares. We then calculate cross-sectional percentiles of mean and median spreads for voting and non-voting shares.

Panel A reports cross-sectional percentiles of mean spreads. Ten percent of the voting shares have mean percentage spreads of less than 0.29%, but 50% have mean spreads of 2.05% or more, and ten percent have mean spreads of more than 8.46%. Non-voting shares have narrower spreads. The median of the mean spread for non-voting shares is only 1.05%, while the 90th percentile of mean spreads is just 7.15%. Panel B reports cross-sectional percentiles of individual stock median spreads. The mean of median spreads is 3.13% for voting shares but only 2.04% for non-voting shares. The median of median spreads is 1.81% for voting stock but only 0.82% for non-voting shares. Non-voting shares are cheaper to trade.

Panel C gives the cross-sectional percentiles of mean daily turnover for voting and non-voting stock. Some of the voting shares trade very little. Ten percent of voting shares have mean

³In the table in the appendix, the NYSE size decile is provided for each class of stock.

daily turnover of 0.01% or less. In these cases, some of the shares may turn over frequently, but a large proportion of the outstanding voting shares are held by controlling shareholders who hold positions for long periods. The 25th percentile of turnover for voting shares is 0.04% per day, or about 10% per year. The median turnover for voting stock is 0.12% per day, or about 30% per year. Non-voting shares turn over more frequently. The 25th percentile of turnover for the non-voting shares is 0.14% per day, or about 35% per year. The median turnover for non-voting stock is 0.32% per day, or about 81% per year.

These differences in liquidity do not usually lead to higher prices for non-voting shares in our sample. Instead, the voting shares typically have higher prices. For each stock and each day, we calculate the difference between the closing bid price of the voting stock and the ask price of the non-voting stock, and the difference between the closing bid price of the non-voting stock and the ask price of the voting stock. We then compute the percentiles of these differences for each firm, and calculate the means of the percentiles across firms.

Panel D reports cross-sectional means of the price differences. If the bid price of each class is always less than the ask price of the other, these differences would always be negative. Instead, we find that voting stock is often more expensive than non-voting stock. On average, the median difference between the bid price of the voting stock and the ask price of the non-voting stock is \$0.13. On average, the 75th percentile of the difference between the bid price of the voting stock and ask price of the non-voting stock is \$0.85, and the 90th percentile of the difference is \$1.76. This indicates that for most firms, for a considerable portion of the time, an investor who owns voting stocks and doesn't reap any of the benefits of control would be better off selling those shares and buying non-voting stock. The bid of the non-voting stock does, on occasion, exceed the ask price of the voting shares. The mean of the 90th percentile of the differences is \$0.42. In these situations, investors are better off selling non-voting shares and buying voting shares.

In some cases, voting shares can be converted into non-voting shares at the holder's request. This minimizes transactions costs and makes it easier and cheaper to exploit underpricing of voting shares. Hence we would expect to see fewer cases where the price of the non-voting shares exceeded the price of the voting shares when the latter was convertible. This is verified in Panel E, which shows the cross-sectional means of price differences for the 29 pairs of stocks with convertible voting shares. As expected, compared to Panel D, we see that the voting stock is more likely to have

a high price relative to the non-voting stock. The bid of the non-voting stock is now less likely to exceed the ask of the voting stock. In Panel F, we report the cross-sectional means of the stock percentiles of price differences when the voting stock is not convertible. Now, on average, 10% of the time the bid of the non-voting stock exceeds the ask price of the voting stock by \$0.59.

The trading rules that we examine in this paper involve buying one class of shares and selling the other. Both positions are then closed out with trades when prices converge. If the voting class is convertible, and it is priced below that non-voting shares, traders could exploit the mispricing with fewer trades. Panels E and F show that underpriced voting stock becomes uncommon when the voting shares are convertible.

4. Do Price Differences Indicate Mispricing? Evidence from Simple Trading Rules

A. The Magnitude of Mispricing

Ultimately, we want to see how mispricings arise, and how investors trade in response to them. First, it is necessary to show that differences in prices of dual class shares are indeed mispricings. Discrepancies in prices of dual-class shares with identical cash flow rights are not necessarily indicative of mispricing. If there are private benefits of control, voting shares could be overpriced relative to non-voting shares, and the mispricing could last indefinitely. In this case, there should be two clienteles for the stock. Investors who are able to extract private benefits of control will hold the voting stock, and others will hold the cheaper non-voting stock. Likewise, more liquid dual-class shares could sell for higher prices than the less liquid class indefinitely. In this case, we would expect the clientele that plans to hold shares for short periods to buy the more expensive and more liquid class, while the clientele that anticipates holding shares for long periods will buy the cheaper and less liquid shares.

On the other hand, if price discrepancies between dual-class shares are indicative of mispricing, the discrepancies should disappear over time. Furthermore, the price discrepancies should provide trading rules that will produce abnormal profits - at least before frictions and trading costs. In this section, we examine the performance of trading rules of the following type: when the bid price of one class of shares exceeds the ask price of the other class by a specified dollar amount,

buy the shares of the cheaper stock at the ask price and sell short the shares of the more expensive stock at the bid price. When the ask price of the sold shares converges to the bid price of the purchased shares, the position is closed by repurchasing the sold shares at the ask price, and selling the purchased shares at the bid price. Note that our trading rules do not necessarily assume that dual-class shares are mispriced when there are price discrepancies. The dual-class shares could be mispriced when there is a price discrepancy. On the other hand, if differences in voting rights or liquidity meant that the classes had different values, they would be mispriced when the prices converge. Our strategy assumes that the share classes are mispriced *either* when there are price discrepancies *or* when the prices have converged.

To simulate the execution of these trading rules, we compare bid and ask prices of the two classes of stocks at the end of each two minute period. If prices diverge enough for the trading rule to trigger the establishment of a position, the buys and sells are assumed to take place at the quoted prices in effect two minutes *later*. Likewise, when prices converge, the trades are assumed to take place at the quotes prevailing two minutes later. If a stock is delisted, or the end of the sample period arrives with the position still open, it is assumed to be closed at the last available prices.

In some ways, our simulations are conservative. It takes far less than two minutes to execute a trade, and prices may move against the arbitrageur over the two minutes.⁴ It is also possible to execute some of these trades within the spread rather than at quoted prices. These quotes are firm - they represent prices where transactions could take place - but trades often occur at better prices. In particular, NYSE trades were often given price improvement during this time. In addition, we only observe prices at the end of two minute intervals. It is likely that we don't even spot many arbitrage opportunities.

Assuming a two minute delay between observing a trading opportunity and trading helps to insure that our apparent mispricings are not due to data errors. In addition, we clean the data in a number of ways to insure that bad data doesn't contaminate our results. Quotes are omitted if a stock's bid price is equal to or greater than its own ask price, or if the ask price is more than four times the bid price. Quotes are also discarded if either the bid or ask price increases or decreases 25% or more in a two minute period. Likewise, quotes are discarded if the bid-to-bid or ask-to-ask

⁴ Bacidore, Ross and Sofianos (2003) find average exposure-to-execution time of 22.5 seconds for NYSE orders in August, 1999. NASDAQ trades through the Small Order Execution System (SOES) had even shorter execution times.

return of one class of shares exceeds the bid-to-bid or ask-to-ask return of the other by 25% or more over two minutes. Observations are also omitted if the bid price of one share class exceeds the bid price of the other by 50% or more. We do not establish or close positions during the first four minutes of the day. Some NYSE or Amex stocks have Nasdaq quotes during the first four minutes that are out of line with quotes that appear once the primary exchange for the stock opens. Finally, we do not open a position if either class of shares has a price under \$5. These stocks are often more difficult to short than other shares, and the short-seller will usually be asked to put up additional cash.

These simulations are not intended to test whether abnormal returns can actually be earned by arbitrageurs. We will look at that later. They are instead intended to test two things. First, whether the price discrepancies indicate that the shares are mispriced relative to each other. Second, whether an investor who was trading anyway, and for whom there was therefore no marginal cost of buying or selling a dual-class share, could profitably exploit information in the price discrepancies.

Table 3 provides median daily turnover, daily dollar volume, and firm size for stocks at the time positions are initiated to exploit price discrepancies. Turnover, defined as the proportion of shares traded, and dollar volume are calculated over the 20 days prior to the date the position is initiated. The sizes of the voting and non-voting share classes are estimated on the day prior to the establishment of the position by multiplying the outstanding shares by the closing price of the stock. The first two rows describe turnover, volume, and size for dual-class shares when trading rules are triggered by price discrepancies of \$0.50 or more. We report statistics separately for cases where the voting stock has the higher price, and instances where the non-voting stock has the higher price. Mispricings of this magnitude are common. Over the 14 year sample period, we find 2,176 opportunities to trade on price discrepancies of \$0.50 or more. In 1,288 or 59.2% of the 2,176 cases, the voting stock is overpriced relative to the non-voting stock. Voting shares turn over about one fourth as frequently as non-voting shares. The median capitalization of voting shares is only about a third as large as the capitalization of the non-voting stock. The combination of low turnover and small capitalizations implies that volume is low for non-voting shares. Median daily dollar volume is almost 20 times larger for non-voting shares than for voting shares.

Results are similar when we look at the characteristics of stocks that would be traded with different price discrepancies as investment triggers. In all cases, voting shares tend to have lower

turnover, lower volume, and smaller size than non-voting shares. In all cases, the long-short position is more likely to consist of a short position in the voting stock than in the non-voting shares.

Table 4 describes abnormal returns earned by the trading rules. The first three rows report results for the rule in which positions are established when the bid price of one share exceeds the ask price of the other by at least 50¢. To calculate returns, we follow Mitchell, Pulvino, and Stafford (2002) and assume that arbitrageurs are required to put up 50% of the value of the long position and 50% of the value of the short position when the arbitrage position is established. Each day, we calculate returns to our open positions using TAQ quotes. Dividends are obtained from CRSP as needed to calculate returns.

For each day over 1993 - 2006, we calculate an equal-weighted average return on all positions established by each rule. We calculate an excess return for the portfolio each day by subtracting the return on one month treasury bills that day. We then regress the excess returns on the market excess returns, the differences between the returns of small and big firms (SMB), the differences between the returns of high and low book-to-market stocks (HML) and the momentum factor. All daily factor returns, along with the returns of one month treasury bills, are obtained from Ken French's website. In effect, we are estimating the abnormal returns earned by an arbitrageur who takes long-short positions in each arbitrage opportunity.

The first row of the table shows the coefficients and intercept from the regression when positions are initiated when the price discrepancy between one stock's bid price and the other's ask price is at least \$0.50. The intercept from this regression is 0.0012, with a robust t-statistic of 10.79. This indicates that the portfolio of long-short positions earns a return of 12 basis points per day (which compounds to 35.3% per year) after adjusting for risk using the three Fama-French factors and momentum. Coefficients on all of the factors are relatively small, as one would expect with long-short positions, and the R^2 for the regression is only 1.2%. The coefficient on the market excess return is actually negative. These positions carry little or no systematic risk.

The positive and significant intercept from this regression has two important implications. First, the price differences between the share classes at least in part represent mispricing. If the difference in votes made one class of shares more valuable than the other, we would expect the difference in prices to be permanent. We wouldn't expect prices to predictably converge. Likewise, we wouldn't expect a difference in prices that is due to differences in liquidity to disappear in a

predictable way.

A second implication of the abnormal returns is that some investors could benefit from trading on these price discrepancies, and their trading should, eventually, bring prices into line even without arbitrage. Investors who are going to buy a stock and bear trading costs anyway would do well to buy dual-class shares that are underpriced relative to the other class. An investor who is going to sell shares from his portfolio would benefit from selling shares that are overpriced relative to the other class of shares. Preferences for buying undervalued shares and selling overvalued shares should bring prices into line eventually even if trading costs and frictions preclude long-short arbitrage trading.

The next row of the table reports coefficients from a regression of the abnormal returns of the long leg of the positions on the Fama-French factors. If short sale restrictions are behind the abnormal returns earned by the long-short positions, we might expect higher priced shares to be overpriced, while shares of the lower priced class may be correctly priced. In this case, we would see abnormal returns to the short leg of the position, but not to the long leg. That is not what we find, however. The intercept from the regression is positive, highly significant, and indicates that the long position earns abnormal returns of six basis points per day (which compounds to 16.3% per year). This finding again raises the question of why the mispricing is not eliminated through normal trading. Investors who are considering buying shares for their portfolio will earn larger risk-adjusted returns by adding shares of underpriced dual-class shares to their portfolios.

As expected for a long position, the coefficient on the market excess return is 0.71, and highly significant. The coefficients on SMB and HML are also positive and significant while the coefficient on the momentum factor is negative. The R^2 of the regression is 0.49. In contrast, the R^2 of the regression of long-short position returns on the four factors is only 0.01.

The next row of the table reports coefficients from the regression of the daily returns of the short positions on the four factors. The intercept coefficient is positive - the more expensive of the dual-class shares are overpriced and shorting them produces abnormal returns of five basis points per day. That the intercept is nearly equal for the regressions for long and short position returns suggests that the share classes are, on average, equally over and underpriced. As expected, the coefficient on the market excess return is negative and highly significant. Coefficients on SMB and HML are also negative and significant, while the coefficient on momentum is positive.

The remainder of the table provides regression estimates for portfolio returns when the positions are initiated when price discrepancies reach \$0.75, \$1.00, or \$2.00. In all cases, and for all subperiods, intercepts are positive and highly significant. Moreover, they are positive and significant for both the long and short legs of the positions. In general, intercepts, and hence daily abnormal returns, decrease as the price discrepancy required to initiate a position increases. As we will see later, positions with larger initial price discrepancies take longer to converge, thus yielding smaller returns per day.⁵

In Table 5, we report coefficients and intercepts for regressions of portfolio returns on the Fama-French factors and momentum, but this time we report them separately for cases where the voting shares are the position's long leg, and cases where the non-voting shares are the long leg of the position. The important result in Table 5 is that abnormal returns are positive and highly significant regardless of whether voting or non-voting shares are held long. This implies two things. First, differences in liquidity do not explain the returns of the arbitrage portfolios. As we have shown, non-voting shares are typically much more liquid than voting shares. If the long-short portfolios consisted of long positions in illiquid voting shares and short positions in liquid non-voting shares, their abnormal returns could be construed as compensation for providing liquidity. This does not appear to be the case though, as abnormal returns are similar regardless of whether the liquid or illiquid shares are held long.

Second, Table 5 provides additional evidence that short-sale restrictions are not responsible for the mispricings. If shares are impossible to borrow, or can only be borrowed at a high cost, the overpriced class of shares may remain overpriced for long periods of time while the other class of shares trades at its true value. Voting shares are typically less liquid and more expensive to short than non-voting shares. Table 5 indicates though that the long-short positions provide abnormal returns regardless of whether the short leg of the position is the difficult to short voting stock or the much easier to short non-voting stock.

The remainder of the table presents regression results for the returns of the long and short portfolios when positions are initiated with price discrepancies of \$0.75, \$1.00, and \$2.00. Long positions earn positive abnormal returns regardless of which rule is used. This again suggests that

⁵We have rerun the regressions for each half of the sample period (1993-1999 and 2000 - 2006) and obtained nearly identical results in each subperiod.

mispricing of dual-class shares is not an artifact of short-selling restrictions. For each trading rule, daily abnormal returns of long and short positions are roughly equal. The magnitude of the daily abnormal returns declines from between 11 and 14 basis points to between eight and four basis points as the initial price discrepancy increases from \$0.50 to \$2.00. Prices tend to converge more slowly when the initial difference is large. This is likely because some of these price differences are justified by valuable differences in control rights or liquidity.

We have argued that even without arbitrage trading, the prices of dual-class shares should eventually converge as investors who are purchasing stocks should add underpriced dual-class shares to their portfolios, while investors who are selling stocks out of their portfolios will benefit from selling overpriced dual-class shares. This suggests that it is worthwhile to examine the returns to individual dual-class share positions rather than returns to a strategy of buying all underpriced dual-class shares while selling all overpriced shares.

In Table 6, we report the distribution of returns across all the individual positions formed by purchasing shares of an underpriced dual-class and selling shares of the overpriced class. As before, we initiate a long-short position when the bid price of shares of one class exceeds the ask price of the other by \$0.50, \$0.75, \$1.00, or \$2.00. Execution is delayed by two minutes. Each position is closed when the bid price of the class of shares that had been purchased equals the ask price of the shares that had been sold short.⁶ Trade executions are assumed to be delayed two minutes when positions are closed. All transactions are assumed to take place at the NBBO best bid and ask prices. As before, returns are calculated assuming that investors put up half of the money for the long position and half the money for the short position.

The first row of Table 6 shows that over the sample period, a total of 2,168 price discrepancies occur in which the bid price of the higher priced class of shares exceeds the ask price of the lower priced class of shares by at least \$0.50. Of these, 1,871, or 86.3%, provide profitable trading opportunities. Trades can lose money for two reasons. First, our simulations include a two minute delay between submission and execution of orders. Prices can and do change over these short intervals. Second, if prices have not converged by the time one or both of the share classes is

⁶We replicate the strategy assuming positions are closed when the bid price of the class of shares that had been purchased exceeds the ask price of the shares that had been sold short by \$0.25, and find slightly lower, but still significant, profits.

delisted, we assume positions are closed out at the last CRSP price. Likewise, we assume all positions open at the end of our sample period are closed out at closing prices at the end of 2006. The mean return of the 2,168 trades is 2.58%, and the median is 1.80%.

A bigger issue is whether the price discrepancies converge fast enough to allow abnormal returns to be earned on the money invested in long-short positions. The second row of the table shows the distribution of the returns net of one-month treasury bill returns for the holding period.⁷ Results reported earlier in this paper indicate that there is little or no systematic risk to these long-short positions, so returns net of treasury bill returns can be considered abnormal returns. On average, returns exceed treasury bills over the holding period by 1.80%. The difference is highly significant, with a t-statistic of 9.47. The median difference is 1.52%. Of the 2,168 positions, 80.2%, or 1,739 provide larger returns than treasury bills. Investors who are adding stocks to their portfolio or diminishing their holdings will almost always profit by exploiting price discrepancies for dual-class shares.

There is a wide range of holding periods for different positions. Hence, the next row of Table 6 reports the distribution of returns net of treasury bills per day. The mean is 47 basis points per day, while the median across all 2,168 positions is 17 basis points per day.

The fourth row of Table 6 shows the distribution of holding periods. It would certainly seem that these abnormal returns would provide investors with strong incentives to shed higher priced dual-class shares and to load up on the lower priced shares. Nevertheless, 1,946 or 89.4% of the 2,176 price discrepancies fail to converge the same day. When the initial price discrepancy is \$0.50, the median time to convergence is six days, while the mean is 47.2 days.

This analysis is replicated in the rest of Table 6 using price discrepancies of \$0.75, \$1.00, and \$2.00 as triggers to establish positions. As the initial price discrepancies are increased, the mean and median returns, and returns in excess of treasuries increase. When a \$2.00 price difference is required before initiating a position, the mean return on the position reaches 10.24%, while the mean return net of treasury returns is 7.33%. The proportion of positive returns and positive returns net of treasury returns also increases as larger price discrepancies are required.

The average holding period also increases, though. The 2.68% mean return for the price

⁷Daily treasury bill returns are calculated assuming that one-month treasury bill returns are the same each day of the month. If a position is established or closed during a day, we subtract the interest for the entire day to calculate excess returns.

discrepancy of \$0.50 is earned over an average holding period of 47 days. The 10.24% mean return for the price discrepancy of \$2.00 is earned over an average holding period of 179.2 days. The median daily return in excess of treasury bills falls from 17 basis points for the price discrepancy of \$0.50, to 13 basis points when the initial price discrepancy is \$2.00.

As a whole, the examination of individual position returns indicates that the overwhelming majority of price discrepancies between dual-class shares provide an opportunity to earn a return that exceeds the riskless rate. Price discrepancies provide abnormal returns in more than 80% of the cases. We do not claim that our trading rules maximize profits. Use of limit orders, for example, might improve execution or allow positions to be closed more quickly. It might also be worthwhile to close out positions at a loss if prices do not converge within a few days.⁸ Alternatively, it may be worthwhile to compare relative prices with their historical averages to see if dual-class shares are mispriced.⁹ Nevertheless, our evidence that price discrepancies between dual class shares are indeed mispricing indicate that these price discrepancies can be used to study how mispricings arise and how they are eliminated.

B. Does Dual-class Share Mispricing Allow Arbitrage Profits in Practice?

Thus far, we have shown that a long position in the lower priced class of shares and a short position in the higher priced class of shares produces abnormal returns. This indicates that the price discrepancies are due to mispricing. It also shows that investors who were going to purchase equity anyway will earn abnormal returns by purchasing the lower-priced class of shares. Likewise, investors who were going to sell shares from their portfolio anyway will do well to sell any dual-class shares they own that are overpriced relative to the other class of shares.

It is not clear whether these mispricings allow active investment strategies to generate abnormal returns in practice. We have ignored commissions and costs of borrowing shares. The most important impediment to profiting fully from these mispricings however, may be the inability

⁸Engelberg, Gao and Jagannathan (2009) find that this improves the profitability of pairs trading.

⁹We have not tried any of these trading rules. We have used rules similar to the ones explored in this paper but with percentage price discrepancies rather than dollar price discrepancies. Results are similar, but since we will later use commissions expressed in cents per share, it makes more sense to use dollar price discrepancies as well.

to borrow shares at all. D'Avolio (2002) reports that 16% of the stocks in the CRSP database were unshorable in 2000 - 2001. It seems likely that some of the closely held voting shares in our sample would fit into this group.

Without comprehensive data on the market for borrowing shares for our sample period, it is difficult to say with certainty whether the strategies that we simulate could be profitably employed in practice. Instead, we examine returns to a very conservative strategy of taking unmarginated long positions in underpriced shares. Taking only long positions assures us that a strategy is feasible regardless of restrictions on short selling. By assuming that these long positions are 100% financed by the investor we avoid the possibility of margin calls. We look at profits to these long-only strategies when commissions of 9¢ per share or 5¢ are paid on all transactions. We believe that 9¢ per share especially is a conservative estimate of commissions. Battalio, Jennings and Selway (2001) report that Ebroker and Waterhouse Securities charged retail investors less than 9¢ per share for 2,000 share trades in 1996. Institutional trading costs were lower. Goldstein, Irvine, Kandel, and Wiener (2007) reported average commissions of 7¢ per share for institutional trades in 1993, and 5¢ for institutional trades in 2004.

Each day, we calculate the return on each long position. Commissions are paid on the day a position is opened and on the day that it is closed. The bid-ask spread is assumed to be paid on the day the position is opened. Abnormal returns are then calculated as the intercept from a regression of portfolio returns on the three Fama-French factors and momentum. Results are shown in Table 7.

The first row shows results for equal-weighted portfolios when a \$0.50 price discrepancy triggers trades. The intercept in this regression is 0.00032, indicating that the position earns abnormal returns of 3.2 basis points per day, or about 8% per year. The t-statistic of 2.43 indicates that the abnormal returns are significant when 14 years of data are used. This strategy earns risk-adjusted abnormal returns but is by no means a riskless strategy. There are positive and significant coefficients on each of the three Fama-French factors. The next row of Table 9 provides regression results when a \$0.50 price discrepancy is used to determine long purchases and commissions are 5¢ per share. Abnormal returns increase slightly from 3.2 basis points per day to 3.7 basis points per day. The t-statistics for the intercept increases from 2.43 to 2.82.

The remainder of Table 7 reports abnormal returns on long positions when price discrepancies of \$0.75, \$1.00, or \$2.00 are the thresholds that trigger a purchase. Commissions of

9¢ or 5¢ per share are again paid whenever positions are initiated or closed. In all cases, positive abnormal returns are earned on the long-only positions. They range from 3.1 to 5.0 basis points per day. T-statistics indicate significance at the 5% level in all cases except when a \$2.00 price discrepancy is needed to initiate a position and commissions are 9¢ per share. In this case, the t-statistic is 1.94.

If there are no short sale restrictions, the best way to profit from the mispricings of dual-class shares is by taking simultaneous long positions in the underpriced class and short positions in the overpriced class. With short sale restrictions, at a minimum, an investor can attempt to profit from mispricings by taking unlevered long positions in underpriced shares. Table 7 indicates that statistically significant abnormal returns could be earned with this strategy. Remember also that this is a conservative strategy. It might be worthwhile to margin these long positions and simultaneously short ETFs which represent the broad market. This would allow more leverage without an increase in riskiness. It may also be possible to use limit orders to secure better execution than we assume.

It appears that profits can be earned in practice from trading on price discrepancies in dual class shares, but some caveats are in order. We examine 14 years of data to detect statistically significant abnormal returns. Would a sophisticated investor have known this was a profitable strategy in 1993 or 2000? It's not clear. In addition, our strategy involves checking prices every two minutes. It takes a lot of time and work to pursue these strategies. Returns from buying underpriced dual-class shares could just be reasonable compensation for an investor's efforts. Then there is the issue of scale. On average, there are 29.6 positions open on a day when the \$0.50 price discrepancy is used as a trigger. Under optimistic scenarios, only a few million dollars could be invested in these positions. That's not enough for most hedge funds.

5. How Prices Diverge

We have provided strong evidence that either price discrepancies between dual class shares (or their subsequent convergence) represent mispricing, or a market inefficiency. We next study how these mispricings arise by examining quotes and trades around the time that prices diverge. With the advent of decimalization in 2001, characterizations of trades as buyer or seller initiated became much less accurate. In addition, decimalization led to more order splitting, making it far more

difficult to determine the size of an order and see if it was part of a long-short strategy. Hence, in studying how prices diverge, and how they later converge, we use data only from 1993-2000.

Prices of dual class shares can diverge in two ways. We define asynchronous price adjustment as a price discrepancy that occurs when one share class changes in price, and is eliminated when the price of the other class changes in the same way. This type of mispricing arises if information gets incorporated more quickly into the price of one share class than the other. We define price pressure as a price discrepancy that is created when the price of one class changes and is eliminated when the price change is reversed. In general, mispricings fall into one category, but it is possible for them to fall into two. This occurs if the price of one share class changes and the convergence occurs as result of prices of both classes move back toward each other.

Panel A of Table 8 presents the results by market value tercile, and Panel B presents the results by volume tercile. Size is the sum of the daily sum of the market values of both types of shares, using number of shares outstanding and end of day prices from CRSP. Volume is the total number of shares traded in both classes on a particular day, also from CRSP. Terciles are computed annually and assigned each day. For example, the first number in Panel A shows that, for the largest firms and in situations where the voting became overpriced, 21.73 percent of mispricings occurred when the price of the voting class changed and the price of the non-voting class followed with a lag. Throughout the table, the proportions in each category are usually above 20 percent, which shows that no one cause of mispricing dominates.¹⁰ In general, price discrepancies occur most often because the non-voting stock changes price. When a price discrepancy arises because the price of the non-voting shares changes, it is usually from price pressure. The general lesson to be drawn from this is that more frequently traded shares, which most consider to be efficiently priced, can actually be more susceptible to mispricing from price pressure than infrequently traded shares. At the same time though, when one share class incorporates information more quickly than the other, it is usually the active, non-voting shares that move first.

We use the binomial model to test whether these proportions could have arisen by chance if all of the types of mispricing were equally likely. Price pressure on the non-voting stock is more

¹⁰The total percentage is somewhat larger than one because some mispricings fit into both the price pressure and asynchronous adjustment categories. This occurs if the price of one stock changes, and the discrepancy is eliminated partly by a reversal of the original price change, and partly by an adjustment by the lagging class.

common than would be expected if all the sources of mispricing were equally likely. Price pressure on the voting stock and asynchronous price adjustment with the voting stock leading are less common than expected if all types of mispricing were equally likely.

We next examine trading just prior to prices diverging. We obtain trading data from TAQ for each of the classes of stock from 1993 to 2000. The sample ends in 2000 because the Lee and Ready (1991) algorithm that we use to sign trades does a poor job following decimalization.¹¹ We categorize each trade as a buy (buyer initiated) or sell (seller initiated) using the Lee and Ready algorithm. We identify potential long-short arbitrage trades by matching buys in one class of stock with sells of the same number of shares of the other class of stock that occur within one minute. For example, a buy of 1,000 shares from the voting class may be part of a long-short arbitrage strategy if there is a 1,000 share sell of the non-voting class within 60 seconds. Of course, many of the trades matched in this way will actually be independent trades made by different investors rather than a part of an arbitrage strategy. Hence, we calculate the proportion of buys of non-voting shares that can be matched with sell of voting shares, and the proportion of sells of non-voting shares that can be matched with buys of voting shares during times there is no mispricing. We don't expect matched trades to be particularly interesting around the time that prices diverge, but of course we are very interested in their role in bringing about convergence.^{12,13}

For each stock and class, we calculate the proportion of all volume from unmatched buys, matched buys, unmatched sells, and matched sells for the base case of no mispricing. We then calculate the proportion of volume from these trade types on days when prices diverge. We use all trades up to and including the trades which cause prices to diverge. We do not use a minimum price discrepancy here, as in testing the trading rules, but define a price discrepancy as the bid price of one class exceeding the ask price of the other. We compute abnormal volume as the difference between

¹¹ See, for example, Barber, Odean, and Zhu (2006).

¹² We replicate all of our tests using a broader definition of matched trades that are matched by size, time and opposite share class only and not necessarily by the trade sign assigned by the Lee and Ready (1991) algorithm. This definition would catch arbitrage trades even if the trade direction of one or both trades is misclassified. Results are similar for all tables involving matched trades.

¹³ We replicate our tests after deleting all dates when poison pills come into effect or are amended, and all periods with proxy fights. The results do not change.

the proportion of trades that fit into these categories when there are discrepancies in the prices of dual-class shares and the proportion in the base case. We do this separately for each stock and calculate means and t-statistics cross-sectionally. Results are shown in Table 9.

The first eight rows of the table report changes in volume of voting shares on days when prices diverge. The first row of the table provides the change in the proportion of voting stock volume from unmatched sell orders. The column marked “All” provides results when trades of all sizes are considered. Here we see that the proportion of voting stock volume from unmatched sell trades is, on average, 6.6% higher than normal prior to the voting stock becoming underpriced. So, if unmatched sells normally make up 50% of the volume in voting stock, they make up 56.6% before the voting becomes underpriced. Similarly, two rows below, the value of -0.068 indicates that unmatched buy orders of voting stock decreases by 6.8% before the voting stock becomes underpriced. Other rows report average abnormal trading volume in voting shares before the voting stock becomes overpriced, and in non-voting stock before it becomes over or underpriced. In each case, the abnormal volume is as expected - there is an increase in buy volume for the class that becomes overpriced and an increase in sell volume for the class that becomes underpriced. Abnormal volume from matched trades is small. Matched trades can be indicative of long-short arbitrage, and we wouldn't expect arbitrage to move prices out of line.

Succeeding columns of the table show abnormal volume by trade size categories of less than 500 shares, 500 to 2,000 shares, and more than 2,000 shares. Abnormal volume from trades in all trade size categories and both share classes seem to move prices out of line.

6. How Prices Converge

We next examine how trading in dual-class shares is affected by mispricing. We hope to accomplish two things by looking at trades. First, we want to provide additional confirmation that price discrepancies represent real mispricing and not just differences in value caused by differences in liquidity or voting rights. Second, we want to know what causes the convergence of stock prices. Are prices driven back into line by textbook long-short arbitrage trades, or simply by bargain hunters who buy cheap shares? We would like to know if trades in the less active and less liquid voting shares eliminate mispricings, or whether trades in the non-voting shares are more important.

We first see if investors recognize price discrepancies as fleeting profit opportunities and trade accordingly. Investors who can trade patiently often succeed at trading within the quoted spread. On the other hand, investors who want to ensure that their trades execute quickly usually submit market orders that execute at quoted prices. We test the urgency of traders by examining the proportion of trades that occur at the quotes.

Table 10 reports the proportion of trades that we type as buys and sells that occur at quoted prices. For each firm, we calculate the proportion of buys and sells of each class that occur at the quotes when the voting (non-voting) shares are overpriced and when there is no mispricing. We then average the percentages across stocks and calculate t-statistics using the cross-sectional standard deviations. Panel A presents the results for the non-voting shares broken down by trade size. In this table, the smart trades that go against the mispricing are in italics. The first row of the table reveals that the proportion of non-voting sell orders that execute at the quoted prices is higher when the non-voting class is overpriced than when there is no mispricing. This holds for all trade sizes and for both matched and unmatched trades. For example, 67.1% of unmatched sells of 500 to 2,000 non-voting shares execute at quoted prices when there is no mispricing. When the non-voting shares are overpriced relative to the voting shares, 78.4% of 500 to 2,000 share sells take place at the quoted bid. The last row of Panel A provides the proportion of buy orders of non-voting stock that take place at quoted prices when the non-voting shares are underpriced. For every trade size category, and for both matched and unmatched trades, the proportion of buy orders that execute at the quoted ask price is greater when the non-voting shares are underpriced than when they are priced correctly. As a whole, Panel A shows that trades of non-voting shares reveal a greater sense of urgency when the non-voting shares are mispriced and the trades exploit that mispricing.

Panel B reports the mean percentage of voting share trades taking place at quoted prices with and without mispricing. The first row of the table reveals that the proportion of sales that take place at the quoted bid price is greater when voting stock is overpriced than when it is not mispriced. This holds true for all trade sizes and for both matched and unmatched trades. The difference is statistically significant in each case except for matched trades of less than 500 shares.

The last row of panel B reports the mean proportion of buys that take place at the quoted ask price when voting shares are underpriced. For all trade sizes and for both matched and unmatched trades, the proportion of buys of voting shares that take place at the ask is significantly higher when

the voting shares are underpriced than when they are correctly priced. In some cases the results are quite striking. When there is no mispricing, 42.5% of matched buys of voting shares take place at the quoted ask price. When the voting shares are underpriced, on average, 81.1% of matched buys of voting shares occur at the quoted as price.

To summarize, Table 10 shows that when non-voting shares are underpriced, a higher proportion of buy orders take place at the quoted ask price than when there is no mispricing. When they are overpriced, a higher proportion of sell orders execute at the bid price than when there is no mispricing. The same pattern is revealed for trades of voting shares. This is consistent with investors trading urgently in order to avoid missing an opportunity when there is mispricing. An alternative explanation would be that perhaps spreads are narrower or there are fewer counterparties besides the market maker willing to trade between the quotes when there is mispricing, and that trades therefore are more likely to execute at the quotes. These explanations would imply, however, that all trades are more likely to execute at quoted prices, not just trades that could profit from the mispricing. A careful look at Table 10 shows that the foolish trades that buy overpriced shares or sell underpriced ones are, for most but not all size categories, somewhat more likely to execute at quoted prices than when there is no mispricing. The differences are much weaker, however, and less likely to be significant than the differences between the likelihoods that smart trades will execute at quotes when stocks are or are not mispriced. In some cases, as with small unmatched purchases of overpriced voting stock, the proportion of foolish trades that execute at quotes actually declines.

In Table 11, we examine how signed trading volume is affected by mispricing. As in Table 9, we calculate the proportion of trading volume from unmatched buys, unmatched sells, matched buys and matched sells for each stock when there is no mispricing. For convenience, the last column of the table designates trade type as “Smart” or “Dumb.” Smart trades buy undervalued shares or sell overvalued ones. Dumb trades buy overpriced shares or sell underpriced ones. If investors exploit mispricing, changes in the proportion of volume should be positive for smart trades and negative for dumb ones.

The first eight rows of the table present results for trades of voting shares. In general, when voting shares are underpriced, they are less likely to be sold and more likely to be bought. When overpriced they are more likely to be sold and less likely to be purchased. The column labeled “All” presents results when trades of all sizes are included. When voting shares are underpriced,

unmatched volume from sales declines 13.9%. So, for example, if unmatched sales account for 50% of the voting class volume when there is no mispricing, they would account for 36.1% of the volume of voting shares when the voting shares are underpriced. Sales of voting shares that can be matched with buy trades in non-voting stock, and hence may be part of a long-short arbitrage strategy, make up 0.8% less of total voting share volume when the voting shares are underpriced. The next two rows report changes in buy volume of voting shares when the voting shares are underpriced. The proportion of total volume in voting shares from unmatched buy trades is 10.5% greater when the voting shares are underpriced than for the base case. The t-statistic of 4.04 indicates that this increase in buy volume is highly significant. Matched buy orders make up 4.2% more of the total volume in voting shares when the voting shares are underpriced. The t-statistic of 4.40 indicates that volume from matched buys of voting shares and sells of non-voting shares increases significantly when the voting shares are underpriced. It is interesting that this significant increase in matched trades occurs when the relatively liquid non-voting stock is shorted, and the more difficult to short voting stock is purchased.

To summarize, these results suggest that when voting stock is underpriced, investors attempt to take advantage of mispricing through their trades of voting shares. Buy orders become a larger proportion of the volume while sell orders become a decreasing proportion. By far, the biggest change in the proportion of trades comes from unmatched trades. One-sided trades seem to be more important than arbitrage trades in moving prices toward equilibrium levels.

The next four rows report abnormal trading volume for voting shares when the voting shares are overpriced. There is more sell volume from matched trades than when there is no mispricing. Unmatched sell volume increases by 1.7% of the total volume, but the difference is not statistically significant. A potential explanation for why the results are weaker when voting shares are overpriced is that it may be more difficult to sell shares of voting stock short than to short non-voting shares. Both matched and unmatched buy volume decreases for the voting shares when that class is overpriced.

The next eight rows of the table present results for volume of non-voting shares. Results are weak. For the most part, there is little change in buy or sell volume of non-voting shares when there is mispricing. When all trades are considered together, there are two exceptions. When non-voting shares are overpriced, there is a decrease in unmatched sales that is marginally significant. This

change is of the opposite sign to what is expected - smart trades have decreased with mispricing. The next line shows that matched trades involving selling non-voting stock increase when the non-voting stock is overpriced. The arbitrage trades go in the right direction.

We would not expect trades of all sizes to be equally likely to come from traders who are trying to exploit mispricings. Barclay and Warner (1993) show that most price changes are due to medium-size trades, which they define as between 1,000 and 9,900 shares. Similarly, Chakravarty (2001) finds that medium-size trades, which he defines as 500 to 9,900 shares, explain most of the cumulative price changes for NYSE stocks. These results suggest that it is the medium-size trades that are used by informed traders. They may use medium-size trades in an attempt to conceal their information through “stealth trading.” Alternatively, they may use medium-size trades because they need to trade quickly and quoted depths are of medium-size.¹⁴ For Nasdaq stocks, it could mean trading 1,000 shares, the maximum number that could be executed automatically through the small order execution system or SOES (see Harris and Schultz (1997)).

In the other columns of Table 11, results are broken down by small, medium and large trades. Small trades are less than 500 shares, medium-size trades are from 500 to 2,000 shares, and large trades are defined as more than 2,000 shares. Looking first at voting shares, we see that results are strongest for the 500 - 2,000 share trades. Proportions of trades in every category are significantly different from their proportions when there is no mispricing. Furthermore, each change is in the direction to be expected if investors were trading to eliminate mispricing. For example, when voting shares are underpriced, the proportion of their volume of 500 to 2,000 share trades from unmatched sales declines 14.4%. When voting is overpriced, the proportion of volume from unmatched sales of 500 - 2,000 voting shares increases 3.5%. Volume from trades of less than 500 shares also seems to change in the expected directions, but not as consistently. Unmatched volume of voting shares from large trades changes in the right direction when the voting shares are underpriced, but for the most part large trades are not affected much by mispricing.

When trades of non-voting stock are broken down by trade size, results remain weak, with some of the marginally significant results being of the wrong sign. When the trades of the 500 to

¹⁴Informed traders, or smart traders, *prefer* to trade larger amounts (See Easley and O’Hara (1987)) and may break up orders. It is limitations on the size of trades that can be executed immediately or the effort to disguise information that leads smart investors to use medium-size trades.

2,000 share size that is preferred by informed investors are examined, volume changes usually have the expected signs. Results are statistically significant in three cases for medium-size trades.

There are several conclusions to be drawn from Table 11. First, investors' trading patterns change significantly and in the expected way when dual-classes of shares are mispriced relative to each other. This indicates that investors believe that the price discrepancies do indeed represent mispricing, and they attempt to exploit these mispricings. Second, while both matched and unmatched trades change in the expected ways, the total change in volume from unmatched trades far exceeds the total change from matched trades. This suggests that arbitrage trades may not be very important for eliminating mispricings. One-sided trades that involve buying underpriced shares or selling overpriced shares may be more important. Third, mispricing has its biggest impact on trading in voting shares. It is possible that trading in non-voting shares is dominated by uninformed noise traders, and their trading is less affected by mispricing than the trading of the smarter, better informed investors who trade voting shares. It is also possible that results are clearer for voting stock because there is less noise trading in these shares. Finally, trades of 500 - 2,000 shares are particularly strongly affected by mispricing. These are the medium-sized trades that other researchers have found to be most likely to be informed.

We next examine abnormal trading volume on days where mispriced share classes converge. These results are shown in Table 12. Our methodology is similar to that of Table 11. For each firm and class, we calculate the proportion of total volume from trades of each type (matched/unmatched, buy/sell) on days with mispricing but before the mispricing is eliminated. We then subtract the proportion of volume from trades of each type that occur during periods with no mispricing. We then average across firms and calculate t-statistics from the cross-sectional standard deviation of firm proportion changes.

When all trade sizes are considered together, buys of underpriced stock increase and sales of overpriced share decrease regardless of which share class is underpriced. Here, changes in volume are significant for both share classes. Of more interest is that the change in the volume from unmatched share trades greatly exceeds the change in the volume from matched share trades. Prices converge because investors separately buy underpriced shares and sell overpriced ones. Long-short arbitrage is much less important, perhaps because of limits to arbitrage in our sample. The popular view that arbitrage is needed to eliminate mispricing is just not true.

It is also interesting that changes in volume for both classes are larger and more significant when the class is underpriced than when it is overpriced. This suggests mispricing has a larger impact on volume when the mispricing is exploited by taking a long position or avoiding selling rather than by taking short positions or avoiding buying. Costs and difficulties of selling short, along with the fact that few investors hold a particular stock make it easier to take advantage of underpricing than overpricing.¹⁵

7. Summary and Conclusions

We examine the prices of dual-classes of shares issued by the same company that differ in votes but have identical cash flow rights. It is surprisingly common for the bid price of one class of shares to exceed the ask price of the other. Using our sample of 100 pairs of dual-class shares with equal cash flow rights, we find 2,168 separate cases over 1993 - 2006 where the bid price of one class of shares exceeded the other by at least \$0.50. More than 80% of these price discrepancies provided returns after bid-ask spreads that exceeded the returns on treasury bills. An arbitrage strategy that involves shorting the overpriced shares and buying shares in the underpriced class earns abnormal returns of 12 basis points per day net of the bid-ask spread. This suggests that the price discrepancies we document are due to mispricing of the shares.

It seems unlikely that abnormal returns of this magnitude could be earned in practice. In some cases it may have been very expensive to borrow shares to short the overpriced stock, and in some cases it may have been impossible to borrow the shares at all. Without comprehensive data on the equity lending market, we cannot determine how much could be earned on these price discrepancies in practice. Nevertheless, it seems likely that some profits could be earned. A simulated strategy of buying the underpriced shares at the ask price without margin and paying commissions of 9¢ per share on each trade. This conservative strategy still produces significant abnormal returns of three basis points per day, or about 7.5% per year.

Attainable abnormal returns of this magnitude seem reasonable. This strategy is by no means riskless. Using the four-factor model, the portfolio of long-only positions earns positive abnormal

¹⁵ This agrees with work by Miller (1977) and subsequent empirical work suggesting that short sale restrictions exacerbate mispricing

returns, but loads significantly on the market risk premium, the small firm premium, and the value premium. In addition, this strategy requires effort on the part of the investor. We assume that prices are checked for discrepancies every two minutes throughout the trading day. The abnormal returns could be considered compensation for the effort required to monitor prices, or for setting up systems to monitor them automatically.

Our use of intraday TAQ data allows us to delve more deeply into how mispricings arise and how they are eliminated than does prior research. We classify the mispricings into those that are caused by price pressure and those caused by one share class leading the other class. We find that the non-voting share class often responds more quickly to information than does the voting class. The most common cause of mispricing though, is price pressure that moves the non-voting shares. This finding goes against the commonly held belief that more liquid securities are less likely to be mispriced.

Once a mispricing arises, we find the trading volume in underpriced shares shifts from sales to purchases while trading volume in overpriced shares shifts away from buys and into sells. This is additional evidence that the price discrepancies we document are mispricing rather than differences in the true values of the share classes, and that investors attempt to exploit the mispricing. In addition, we find that the urgency of trading, as measured by the number of trades that occur at the quotes, increases during periods of mispricing. Furthermore, the increase in urgent trades is concentrated in those trades that buy the cheaper shares or sell the more expensive class.

We usually think of long-short arbitrage as the means by which relative value mispricings are corrected. Arbitrage, however, does not seem to be an important factor in eliminating dual-class share mispricing. Matched trades, our proxy for arbitrage trades, account for little of the change in trading when dual-class shares are mispriced. One-sided purchases of underpriced shares and sales of overpriced shares seem far more important for moving prices back into line. Our findings suggest that the role of arbitrage in reducing mispricing has been overstated in the finance and economics literature. Mispricing can be and is corrected by intelligent investors through independent purchases of underpriced securities and sales of overpriced securities.

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Table 1
A Description of the Dual-class Shares Sample

The proportion of stocks listed on each exchange and the proportion in each NYSE size decile is calculated each month. Time series averages are then calculated across the 168 months from January 1993 through December 2006. A total of 100 pairs of dual-class shares appear in the sample at least one month. New York Stock Exchange size decile breakpoints are calculated monthly.

Panel A. Time-series mean proportion of dual class shares listed on each exchange.

New York Stock Exchange	American Stock Exchange	Nasdaq
45.9%	17.6%	36.6%

Panel B. Time-series mean proportion of dual-class firms in each NYSE size decile.

Small	2	3	4	5	6	7	8	9	Large
22.8%	14.0%	14.1%	10.3%	8.7%	6.5%	6.0%	7.1%	5.1%	5.5%

Panel C. Ratio of non-voting to voting shares votes.

0	0-0.1	0.1	0.1-1	1
39%	6%	49%	8%	7%

Panel D. Directors elected by each class.

One class elects more directors	Same
20%	80%

Table 2

The distributions of percentage spreads and turnover for voting and non-voting shares. For each stock, the mean and median spreads are calculated across trading days. We then calculate the cross-sectional mean, 10th percentile, 25th percentile, median, 75th percentile, and 90th percentile of individual stock means and medians. For each stock, the distribution of daily stock turnover is calculated. Cross-sectional means of the percentiles are then calculated for voting and non-voting shares. Cross-sectional distributions of individual stock daily mean and median dollar volume and number of trades are also computed.

	Mean	10%	25%	Median	75%	90%
Panel A. Cross-Sectional Percentiles of Stock Mean Spreads						
Voting Shares	3.55%	0.29%	0.81%	2.05%	5.15%	8.46%
Non-Voting Shares	2.40%	0.23%	0.48%	1.05%	3.42%	7.15%
Panel B. Cross-Sectional Percentiles of Stock Median Spreads						
Voting Shares	3.13%	0.22%	0.68%	1.81%	4.31%	7.71%
Non-Voting Shares	2.04%	0.11%	0.33%	0.82%	3.05%	5.49%
Panel C. Cross-sectional Percentiles of Daily Stock Turnover						
Voting Shares	0.25%	0.01%	0.04%	0.12%	0.36%	0.59%
Non-Voting Shares	0.50%	0.06%	0.14%	0.32%	0.59%	0.98%
Panel D. Cross-Sectional Means of Individual Stock Percentiles						
Bid _{Vote} - Ask _{NonVote}	\$0.22	-\$1.11	-\$0.52	\$0.13	\$0.85	\$1.76
Bid _{NonVote} - Ask _{Vote}	-\$0.96	-\$2.60	-\$1.59	-\$0.79	-\$0.13	\$0.42
Panel E. Cross-Sectional Means of Individual Stock Percentiles, Voting is Convertible						
Bid _{Vote} - Ask _{NonVote}	\$0.46	-\$0.79	-\$0.35	\$0.15	\$0.95	\$2.36
Bid _{NonVote} - Ask _{Vote}	-\$1.40	-\$3.42	-\$1.94	-\$0.97	-\$0.43	-\$0.06
Panel F. Cross-Sectional Means of Individual Stock Percentiles, Voting is not Convertible						
Bid _{Vote} - Ask _{NonVote}	\$0.14	-\$1.23	-\$0.58	\$0.12	\$0.81	\$1.54
Bid _{NonVote} - Ask _{Vote}	-\$0.80	-\$2.29	-\$1.47	-\$0.72	-\$0.02	\$0.59

Table 3.**Median turnover, dollar volume, and market capitalization for voting and non-voting stock at the time when arbitrage positions are established.**

Daily turnover and daily dollar volume are estimated over the 20 trading days before the arbitrage position is established. Size is the market capitalization of the class of stock - not the firm. It is estimated by multiplying the closing price of the shares by the number of shares outstanding the day before the arbitrage position is established. Volume, shares outstanding, and closing prices are from CRSP.

	Median Daily Turnover			Median Daily Volume (\$000's)		Median Capitalization (\$millions)	
	Number	Non-Voting	Voting	Non-Voting	Voting	Non-Voting	Voting
Vote - NonVote > \$0.50	1,288	0.0020	0.0004	931.2	50.3	436	138
NonVote - Vote > \$0.50	888	0.0023	0.0005	1,468.4	71.8	565	159
Vote - NonVote > \$0.75	807	0.0020	0.0004	861.3	53.6	415	129
NonVote - Vote > \$0.75	498	0.0023	0.0005	1,560.4	69.8	558	137
Vote - NonVote > \$1.00	562	0.0021	0.0005	861.3	58.0	405	128
NonVote - Vote > \$1.00	309	0.0022	0.0006	1,522.9	81.6	526	116
Vote - NonVote > \$2.00	244	0.0017	0.0005	552.6	56.9	317	110
NonVote - Vote > \$2.00	103	0.0023	0.0006	1,783.6	126.9	635	239

Table 4.
Regressions of daily excess returns of the long-short positions in dual-class shares on Fama-French factors and momentum.

Long-short positions are initiated with a two-minute delay when the bid price of one class of shares exceeds the ask price by \$0.50, \$0.75, \$1.00, or \$2.00. Positions closed with a two-minute delay when ask price of purchased stock is equal to or greater than the bid price of the sold stock. Equal-weighted portfolios of the long legs and of the short legs of all open long-short positions are formed each day, and the excess returns of these long portfolios and short portfolios are regressed on the Fama-French factors and momentum. Excess returns are calculated by subtracting the one month treasury bill return from the portfolio return. Heteroskedasticity-consistent t-statistics are shown in parentheses.

	Intercept	$R^{Mkt} - R^f$	SMB	HML	Mom.	R^2
Bid - Ask > \$0.50	0.0012 (10.79)	-0.0769 (-4.04)	-0.0632 (-2.68)	-0.0448 (-1.52)	0.0354 (1.99)	0.0121
Long Leg Only	0.0006 (5.45)	0.7113 (46.91)	0.4605 (21.22)	0.3657 (13.75)	-0.1242 (-7.58)	0.4904
Short Leg Only	0.0005 (4.83)	-0.7225 (-39.31)	-0.4805 (-20.26)	-0.3790 (-12.25)	0.1464 (7.76)	0.5176
Bid - Ask > \$0.75	0.0010 (8.56)	-0.0756 (-3.84)	-0.0606 (-2.52)	-0.0430 (-1.40)	0.0291 (1.56)	0.0103
Long Leg Only	0.0005 (4.30)	0.7249 (46.55)	0.4704 (21.35)	0.3674 (13.12)	-0.1337 (-7.80)	0.4824
Short Leg Only	0.0004 (3.67)	-0.7264 (-36.12)	-0.4819 (-19.44)	-0.3735 (-11.30)	0.1476 (7.49)	0.4975
Bid - Ask > \$1.00	0.0008 (6.83)	-0.0771 (-4.16)	-0.0555 (-2.38)	-0.0242 (-0.84)	0.0309 (1.75)	0.0123
Long Leg Only	0.0004 (3.18)	0.7350 (45.48)	0.4805 (21.33)	0.3735 (13.31)	-0.1373 (-8.02)	0.4730
Short Leg Only	0.0003 (2.81)	-0.7326 (-39.43)	-0.4835 (-20.00)	-0.3576 (-11.61)	0.1537 (8.34)	0.5086
Bid - Ask > \$2.00	0.0007 (5.54)	-0.1068 (-5.85)	-0.0888 (-3.61)	-0.0232 (-0.78)	0.0475 (2.63)	0.0203
Long Leg Only	0.0003 (2.32)	0.7736 (42.35)	0.4872 (18.25)	0.4093 (12.97)	-0.1508 (-7.86)	0.4265
Short Leg Only	0.0003 (2.30)	-0.7872 (-43.00)	-0.5175 (-18.97)	-0.3909 (-12.57)	0.1797 (9.64)	0.5041

Table 5.**Regressions of daily excess returns on Fama-French factors and momentum for long-short positions in dual-class shares when voting or non-voting shares are held long.**

Long-short positions are initiated with a two-minute delay when the bid price of the non-voting (voting) class of shares exceeds the ask price of the voting (non-voting) shares by \$0.50, \$0.75, \$1.00, or \$2.00. Positions are closed with a two-minute delay when ask price of purchased stock is equal to or greater than the bid price of the sold stock. Equal-weighted portfolios of all open long-short positions are formed each day, and the excess returns of these portfolios are regressed on the Fama-French factors and momentum. Excess returns are calculated by subtracting the one month treasury bill return from the portfolio return. Robust t-statistics are shown in parentheses.

	Intercept	$R^{Mkt} - R^f$	SMB	HML	Mom.	R^2
Bid - Ask > \$0.50						
Long Non-Voting	0.0011 (7.86)	0.0180 (0.72)	-0.0112 (-0.38)	-0.0026 (-0.06)	0.0242 (1.06)	0.0011
Long Voting	0.0014 (9.54)	-0.2776 (-10.97)	-0.1322 (-4.19)	-0.1140 (-3.11)	0.0468 (1.97)	0.0250
Bid - Ask > \$0.75						
Long Non-Voting	0.0010 (6.80)	0.0202 (0.79)	-0.0034 (-0.11)	-0.0016 (-0.04)	0.0114 (0.48)	0.0007
Long Voting	0.0009 (6.27)	-0.2816 (-10.83)	-0.1396 (-4.22)	-0.1161 (-3.00)	0.0590 (2.34)	0.0740
Bid - Ask > \$1.00						
Long Non-Voting	0.0008 (5.64)	0.0251 (1.06)	0.0173 (0.60)	0.0217 (0.55)	0.0101 (0.45)	0.0007
Long Voting	0.0007 (4.07)	-0.2959 (-10.45)	-0.1605 (-4.79)	-0.1040 (-2.55)	0.0596 (2.45)	0.0762
Bid - Ask > \$2.00						
Long Non-Voting	0.0008 (5.11)	-0.0007 (-0.03)	-0.0297 (-0.95)	0.0367 (0.87)	0.0282 (1.23)	0.0014
Long Voting	0.0004 (2.01)	-0.3175 (-10.31)	-0.1658 (-4.50)	-0.1184 (-2.58)	0.0681 (2.55)	0.0640

Table 6.**The distribution of holding period excess returns across long-short positions.**

Long-short positions are initiated with a two-minute delay when the bid price of one class of shares exceeds the ask price by \$0.50, \$0.75, \$1.00, or \$2.00. This table describes the distribution of holding period returns, returns net of treasury bills, and holding periods. Positions are closed with a two minute delay when the ask price of purchased stock is equal to or greater than the bid price of the sold stock.

Initial Difference	Variable	Mean	T-Statistic	10 th Percentile	25 th Percentile	50 th Percentile	75 th Percentile	90 th Percentile	Number of Positions	Number > 0
\$0.50	Return	2.58%	(14.42)	-0.36%	0.83%	1.80%	3.35%	6.13%	2,168	1,871
	Return - Tbills	1.80%	(9.47)	-1.46%	0.38%	1.52%	3.01%	5.48%	2,168	1,739
	Ret - Tbills Per Day	0.47%	(3.90)	-0.04%	0.02%	0.17%	0.55%	1.41%	2,168	1,739
	Holding Days	47.2		0	2	6	24	89	2,168	1,946
\$0.75	Return	3.82%	(13.29)	0.08%	1.42%	2.87%	4.71%	8.29%	1,304	1,177
	Return - Tbills	2.66%	(8.69)	-1.51%	0.77%	2.27%	4.09%	7.19%	1,304	1,085
	Ret - Tbills Per Day	0.58%	(3.00)	-0.02%	0.03%	0.17%	0.53%	1.43%	1,304	1,085
	Holding Days	71.1		1	3	11	42	161	1,304	1,201
\$1.00	Return	4.70%	(11.49)	0.17%	1.90%	3.75%	5.89%	9.62%	873	793
	Return - Tbills	3.14%	(7.21)	-1.94%	0.96%	2.95%	5.10%	8.30%	873	725
	Ret - Tbills Per Day	0.55%	(1.90)	-0.02%	0.02%	0.14%	0.45%	1.20%	873	725
	Holding Days	96.2		1	6	18	68	236	873	829
\$2.00	Return	10.24%	(8.96)	2.05%	4.35%	7.34%	11.33%	17.89%	350	327
	Return - Tbills	7.33%	(6.09)	-2.68%	2.04%	5.62%	9.30%	17.09%	350	294
	Ret - Tbills Per Day	0.58%	(0.83)	-0.01%	0.02%	0.13%	0.41%	1.04%	350	294
	Holding Days	179.2		4	15	52	195	475	350	341

Table 7.**Abnormal returns on long-only positions without margins.**

When the bid price of one class of shares exceeds the ask price of the other by \$0.50, \$0.75, \$1.00, or \$2.00, shares in the cheaper stock are purchased with a two minute delay. No money is borrowed, the arbitrageur is instead assumed to pay 100% of the stock price. Commissions of 9¢ (or 5¢) per share are assumed to be paid when shares are purchased and when they are sold. Equal dollar amounts are assumed to be invested in each long position. The daily excess returns of the equal-weighted portfolio of long positions are then regressed on the Fama-French factors and momentum. Excess returns are calculated by subtracting the one month treasury bill return from the portfolio return. Heteroskedasticity-consistent t-statistics are reported in parentheses.

		Intercept	$R^{Mkt} - R^f$	SMB	HML	Mom.	R^2
Bid - Ask > \$0.50	9¢ per share commissions	0.00032 (2.43)	0.7110 (37.00)	0.4532 (16.19)	0.3626 (12.17)	-0.1241 (-6.92)	0.3967
	5¢ per share commissions	0.00037 (2.82)	0.7104 (36.97)	0.4531 (16.20)	0.3620 (12.19)	-0.1248 (-6.98)	0.3979
Bid - Ask > \$0.75	9¢ per share commissions	0.00035 (2.58)	0.7244 (37.89)	0.4662 (16.82)	0.3639 (11.88)	-0.1391 (-7.31)	0.3900
	5¢ per share commissions	0.00039 (2.83)	0.7240 (37.86)	0.4662 (16.82)	0.3633 (11.88)	-0.1396 (-7.36)	0.3908
Bid - Ask > \$1.00	9¢ per share commissions	0.00031 (2.16)	0.7325 (36.00)	0.4702 (16.25)	0.3633 (11.61)	-0.1450 (-7.69)	0.3717
	5¢ per share commissions	0.00034 (2.33)	0.7325 (35.95)	0.4701 (16.24)	0.3637 (11.65)	-0.1452 (-7.72)	0.3726
Bid - Ask > \$2.00	9¢ per share commissions	0.00034 (1.94)	0.7724 (34.07)	0.4789 (14.20)	0.4065 (11.97)	-0.1650 (-7.89)	0.3108
	5¢ per share commissions	0.00050 (2.89)	0.7725 (34.11)	0.4780 (14.18)	0.4068 (12.00)	-0.1646 (-7.88)	0.3113

Table 8. Types of mispricing.

Mispricing periods are classified into four types. We define asynchronous price adjustment as a mispricing that occurs when one share class moves, and later the other class moves in the same direction, eliminating the mispricing. We define price pressure as a mispricing that arise when one class moves, and then the mispricing is eliminated by the same share class moving in the opposite direction. Mispricings can fall into more than one category. Size is daily market value of both classes of shares in CRSP, and Volume is total daily volume in both types of shares from CRSP. Tercile cutoffs are computed each year using all the firm days in that year. Each day, the firm is compared to the tercile cutoffs and a tercile is assigned. A signify greater than the average proportion at the 1 and 5 percent levels is denoted by a ++ or + respectively, and - - and - signify less than the average proportion at the 1 and 5 percent significance levels.

Panel A: By Market Value Tercile

Mispricing	Size	Asynchronous Price Adjustment		Price Pressure	
		Voting Leads	Non-Voting Leads	Voting Moved	Non-Voting Moved
Voting becomes overpriced	Big	0.2173 ⁻	0.2718	0.2515 ⁻	0.3633 ⁺⁺
	Medium	0.1939 ⁻	0.2919 ⁺⁺	0.2215 ⁻	0.3914 ⁺⁺
	Small	0.2101 ⁻	0.2837	0.2006 ⁻	0.3906 ⁺⁺
Non-Voting becomes overpriced	Big	0.2337 ⁻	0.2834	0.2218 ⁻	0.3725 ⁺⁺
	Medium	0.1603 ⁻	0.3660 ⁺⁺	0.1962 ⁻	0.3915 ⁺⁺
	Small	0.2564	0.2770	0.2014 ⁻	0.3988 ⁺⁺

Panel B: By Volume Tercile

Mispricing	Volume	Asynchronous Price Adjustment		Price Pressure	
		Voting Leads	Non-Voting Leads	Voting Moved	Non-Voting Moved
Voting becomes overpriced	High	0.2177 ⁻	0.2683	0.2524 ⁻	0.3608 ⁺⁺
	Medium	0.1961 ⁻	0.3119 ⁺⁺	0.2105 ⁻	0.4040 ⁺⁺
	Low	0.1741 ⁻	0.2850	0.1928 ⁻	0.4198 ⁺⁺
Non-Voting becomes overpriced	High	0.2407 ⁻	0.2831	0.2239 ⁻	0.3658 ⁺⁺
	Medium	0.1813 ⁻	0.3334 ⁺⁺	0.1941 ⁻	0.4180 ⁺⁺
	Low	0.1546 ⁻	0.4005 ⁺⁺	0.1639 ⁻	0.4005 ⁺⁺

Table 9. Abnormal volume on days when prices diverge.

Days when prices diverge are defined as days where 1) the ask price of each share class exceeded the bid price of the other share class at the previous day's close and 2) during the day prices diverged so that the bid price of shares of one class exceeded the ask price of shares of the other class at the close. We consider only trades leading up to the price divergence on that day.

Class	Mispricing	Buy/ Sell	Match	N	All	T-stat	<500 Shares	T-stat	[500,2000] Shares	T-stat	>2000 Shares	T-stat	
Voting		Sell	No	64	0.066	(2.24)	0.050	(1.52)	0.073	(2.34)	0.109	(2.07)	
			Yes	64	0.010	(0.77)	-0.006	(-1.24)	0.019	(1.17)	-0.007	(-0.74)	
	Voting Becomes Underpriced	Buy	No	64	-0.068	(-2.34)	-0.051	(-1.62)	-0.088	(-2.76)	-0.088	(-1.74)	
			Yes	64	-0.008	(-2.60)	0.007	(0.45)	-0.004	(-1.03)	-0.015	(-6.69)	
	Voting	Sell	No	72	-0.105	(-4.34)	-0.107	(-3.78)	-0.108	(-4.12)	-0.111	(-2.78)	
			Yes	72	-0.005	(-1.50)	-0.005	(-1.33)	0.000	(0.01)	-0.015	(-3.89)	
		Voting Becomes Overpriced	Buy	No	72	0.102	(4.14)	0.104	(3.73)	0.091	(3.44)	0.133	(3.22)
				Yes	72	0.009	(1.29)	0.007	(0.89)	0.017	(1.78)	-0.006	(-1.19)
Non- Voting		Sell	No	63	-0.080	(-3.08)	-0.102	(-3.35)	-0.089	(-3.58)	-0.064	(-1.59)	
			Yes	63	-0.003	(-2.33)	0.001	(0.28)	0.000	(0.10)	-0.007	(-3.55)	
	Non-voting Becomes Overpriced	Buy	No	63	0.086	(3.37)	0.101	(3.31)	0.087	(3.59)	0.073	(1.81)	
			Yes	63	-0.002	(-1.82)	0.000	(0.20)	0.001	(0.57)	-0.002	(-1.05)	
	Non-voting	Sell	No	73	0.096	(4.56)	0.054	(2.65)	0.081	(4.56)	0.080	(2.87)	
			Yes	73	0.000	(0.08)	0.001	(0.30)	0.005	(1.45)	-0.006	(-2.00)	
		Non-voting Becomes Underpriced	Buy	No	73	-0.094	(-4.52)	-0.058	(-2.90)	-0.088	(-5.28)	-0.070	(-2.46)
				Yes	73	-0.002	(-1.54)	0.002	(0.75)	0.002	(1.02)	-0.005	(-3.66)

Table 10. Percentage of trades occurring at quoted prices.

This table provides the proportion of all trades that occur at inside bid or ask quotes. A *+++*, *++* or *+* signify greater than the no-mispricing proportion at the 1, 5 and 10 percent levels. “Smart” trades, in italics, include purchases of underpriced shares and sales of overpriced shares.

Panel A. Non-Voting Shares

		Unmatched Trades			Matched Trades		
		< 500	500 - 2,000	> 2,000	< 500	500 - 2,000	> 2,000
Nonvoting Overpriced	<i>Sell</i>	<i>0.769⁺</i>	<i>0.784⁺⁺⁺</i>	<i>0.772⁺⁺⁺</i>	<i>0.715</i>	<i>0.785⁺⁺⁺</i>	<i>0.741</i>
	<i>Buy</i>	<i>0.675</i>	<i>0.704⁺⁺</i>	<i>0.728⁺⁺⁺</i>	<i>0.650</i>	<i>0.650</i>	<i>0.651⁺</i>
No Mispricing	Sell	0.710	0.671	0.664	0.687	0.588	0.700
	Buy	0.689	0.656	0.598	0.631	0.628	0.492
Nonvoting Underpriced	Sell	0.720	0.686	0.665	0.641	0.682 ⁺⁺	0.635
	<i>Buy</i>	<i>0.739⁺⁺</i>	<i>0.729⁺⁺⁺</i>	<i>0.681⁺⁺⁺</i>	<i>0.683</i>	<i>0.748⁺⁺⁺</i>	<i>0.661⁺⁺</i>

Panel B. Voting Shares

		Unmatched Trades			Matched Trades		
		< 500	500 - 2,000	> 2,000	< 500	500 - 2,000	> 2,000
Voting Overpriced	<i>Sell</i>	<i>0.728⁺⁺</i>	<i>0.746⁺⁺⁺</i>	<i>0.687⁺⁺</i>	<i>0.630</i>	<i>0.751⁺⁺⁺</i>	<i>0.634⁺⁺</i>
	<i>Buy</i>	<i>0.701⁺⁺</i>	<i>0.670⁺⁺⁺</i>	<i>0.655⁺⁺</i>	<i>0.637⁺⁺</i>	<i>0.633⁺⁺</i>	<i>0.675⁺⁺⁺</i>
No Mispricing	Sell	0.682	0.622	0.608	0.607	0.534	0.463
	Buy	0.640	0.607	0.564	0.590	0.546	0.425
Voting Underpriced	Sell	0.657	0.674 ⁺	0.636	0.578	0.619 ⁺	0.628 ⁺
	<i>Buy</i>	<i>0.758⁺⁺⁺</i>	<i>0.804⁺⁺⁺</i>	<i>0.653⁺⁺</i>	<i>0.685⁺⁺</i>	<i>0.748⁺⁺⁺</i>	<i>0.811⁺⁺⁺</i>

Table 11.

Abnormal trading volume when shares are mispriced.

For each firm, we calculate the proportion of all volume in each share class from matched buys, matched sells, unmatched buys and unmatched sells for the base case of no mispricing. We then compute abnormal volume as the difference between the proportion of trades in these categories when there is mispricing and the baseline proportion. Cross-sectional means are presented, and cross-sectional t-statistics are in parentheses.

Class	Mispricing	Buy/ Sell	Match	N	All	T-stat	<500 Shares	T-stat	[500,2000] Shares	T-stat	>2000 Shares	T-stat	Trade
Voting	Voting Underpriced	Sell	No	73	-0.139	(-5.01)	-0.162	(-5.97)	-0.144	(-5.81)	-0.097	(-2.23)	Dumb
			Yes	73	-0.008	(-2.71)	-0.002	(-0.66)	-0.010	(-2.64)	-0.008	(-1.57)	Dumb
		Buy	No	73	0.105	(4.04)	0.136	(5.13)	0.094	(4.07)	0.098	(2.34)	Smart
			Yes	73	0.042	(4.40)	0.028	(3.44)	0.060	(4.62)	0.006	(1.21)	Smart
	Voting Overpriced	Sell	No	77	0.017	(1.06)	0.014	(0.87)	0.035	(2.16)	0.031	(1.17)	Smart
			Yes	77	0.016	(2.76)	0.017	(2.93)	0.015	(2.52)	0.006	(0.76)	Smart
		Buy	No	77	-0.029	(-1.78)	-0.033	(-2.12)	-0.044	(-2.66)	-0.033	(-1.23)	Dumb
			Yes	77	-0.004	(-2.70)	0.001	(0.40)	-0.006	(-2.69)	-0.004	(-2.01)	Dumb
Non-Voting	Non-voting Overpriced	Sell	No	71	-0.052	(-2.43)	-0.009	(-0.42)	-0.029	(-1.28)	-0.031	(-1.15)	Smart
			Yes	71	0.027	(1.82)	0.007	(1.79)	0.033	(2.16)	-0.001	(-0.18)	Smart
		Buy	No	71	0.026	(1.27)	-0.002	(-0.09)	-0.004	(-0.17)	0.035	(1.32)	Dumb
			Yes	71	-0.001	(-0.32)	0.004	(1.87)	0.000	(0.02)	-0.003	(-1.27)	Dumb
	Non-voting Underpriced	Sell	No	77	-0.006	(-0.40)	-0.022	(-1.46)	-0.018	(-1.74)	0.008	(0.37)	Dumb
			Yes	77	-0.003	(-1.51)	0.004	(1.48)	-0.002	(-1.00)	-0.006	(-1.91)	Dumb
		Buy	No	77	0.007	(0.48)	0.012	(0.81)	0.015	(1.47)	-0.003	(-0.13)	Smart
			Yes	77	0.002	(1.44)	0.007	(2.65)	0.005	(3.30)	0.001	(0.53)	Smart

Table 12. Abnormal volume on days when prices converge

Days when prices converge are defined as those where 1) the bid price of one class of shares exceeded the ask price of the other class at the close on the previous day and 2) at the close the ask price of each share class was at least as great as the bid price of the other class. We consider only trades before the convergence.

Class	Mispricing	Buy/ Sell	Match	N	All	T-stat	<500 Shares	T-stat	[500,2000] Shares	T-stat	>2000 Shares	T-stat	Trade
Voting	Voting Underpriced	Sell	No	63	-0.239	(-6.90)	-0.207	(-4.90)	-0.241	(-7.00)	-0.088	(-1.59)	Dumb
			Yes	63	-0.001	(-0.17)	0.003	(0.38)	0.006	(0.60)	-0.017	(-4.13)	Dumb
		Buy	No	63	0.205	(5.61)	0.178	(4.09)	0.181	(4.67)	0.115	(2.07)	Smart
			Yes	63	0.035	(2.33)	0.026	(2.40)	0.053	(2.40)	-0.010	(-2.82)	Smart
	Voting Overpriced	Sell	No	71	0.088	(3.29)	0.064	(2.70)	0.059	(1.99)	0.095	(2.13)	Smart
			Yes	71	0.016	(2.14)	0.030	(2.16)	0.017	(2.22)	0.004	(0.36)	Smart
		Buy	No	71	-0.097	(-3.63)	-0.090	(-4.12)	-0.070	(-2.41)	-0.088	(-2.08)	Dumb
			Yes	71	-0.007	(-1.96)	-0.003	(-0.79)	-0.006	(-1.58)	-0.011	(-1.89)	Dumb
Non- Voting	Non-voting Overpriced	Sell	No	60	0.037	(1.66)	0.032	(1.11)	0.053	(1.92)	0.024	(0.84)	Smart
			Yes	60	0.009	(1.49)	0.012	(1.55)	0.017	(1.98)	-0.007	(-1.58)	Smart
	Buy	No	60	-0.045	(-2.04)	-0.052	(-1.84)	-0.071	(-2.87)	-0.011	(-0.37)	Dumb	
		Yes	60	-0.001	(-0.51)	0.008	(1.68)	0.001	(0.58)	-0.006	(-2.86)	Dumb	
	Non-voting Underpriced	Sell	No	69	-0.109	(-5.03)	-0.071	(-2.94)	-0.147	(-8.11)	-0.088	(-2.80)	Dumb
			Yes	69	-0.003	(-1.38)	-0.000	(-0.00)	0.001	(0.49)	-0.005	(-2.03)	Dumb
Buy	No	69	0.107	(4.89)	0.063	(2.60)	0.138	(7.53)	0.096	(3.03)	Smart		

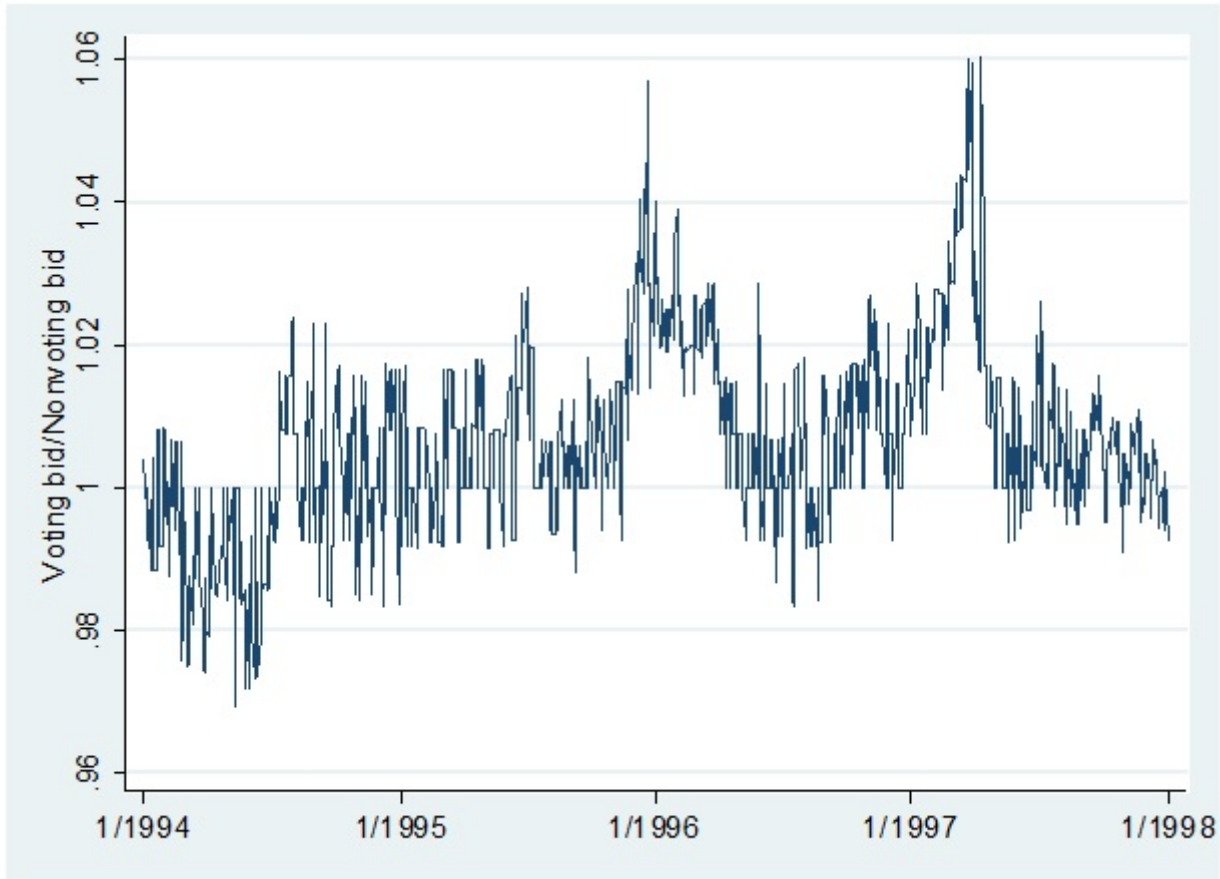


Figure 1a. Ratios of the closing bid price of Comcast voting stock to the bid price of Comcast non-voting stock.

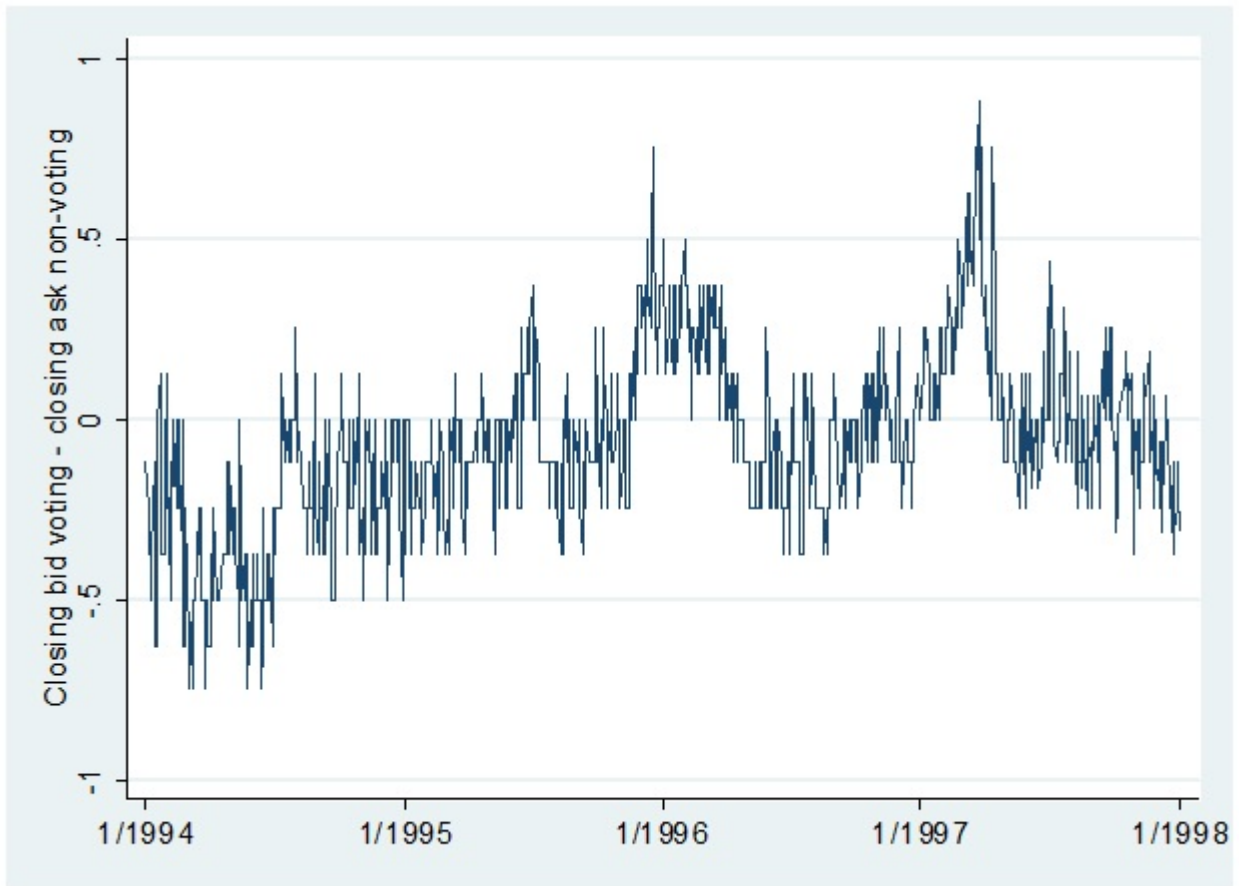


Figure 1b.

Differences between the closing bid price of Comcast voting stock and the closing ask price of Comcast non-voting stock.

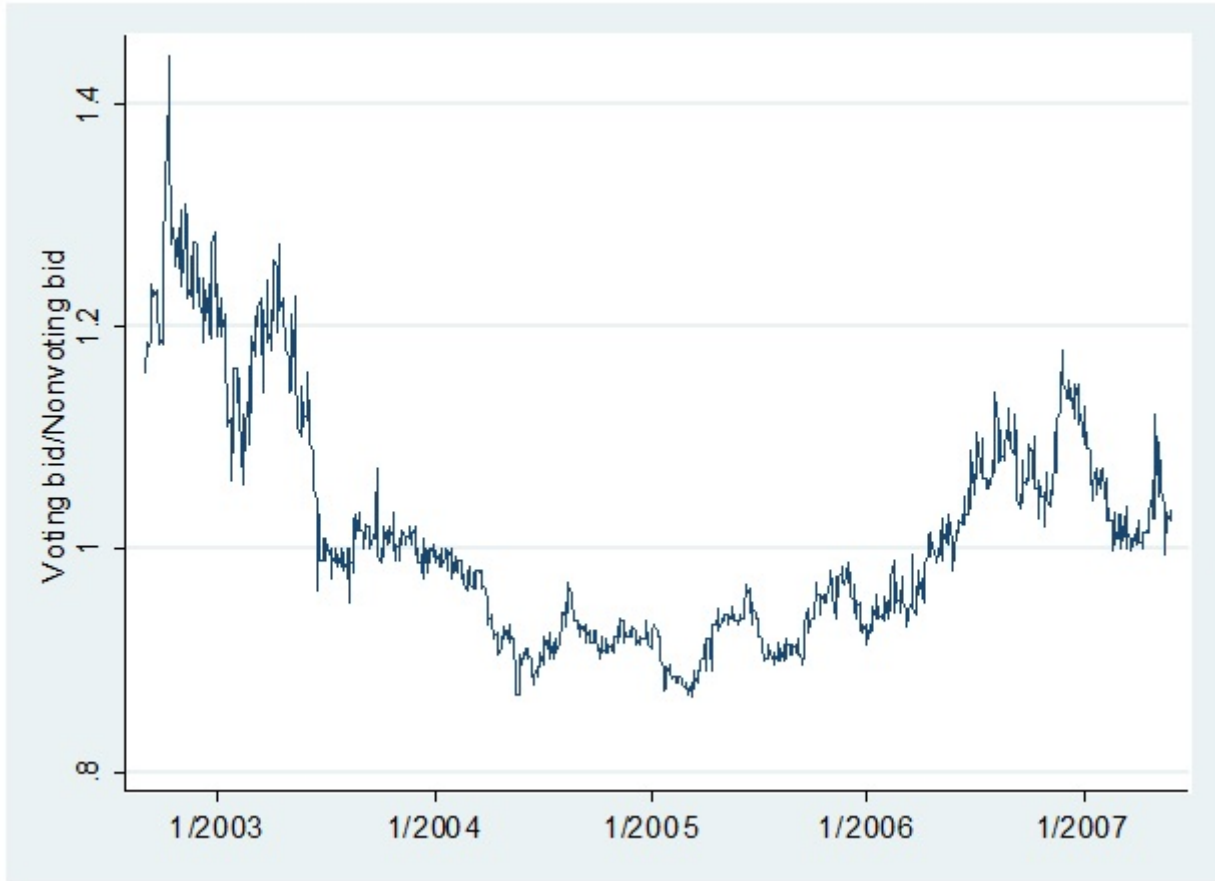


Figure 2a.

Ratios of the closing bid price of Grey Television voting stock to the bid price of Grey Television non-voting stock.

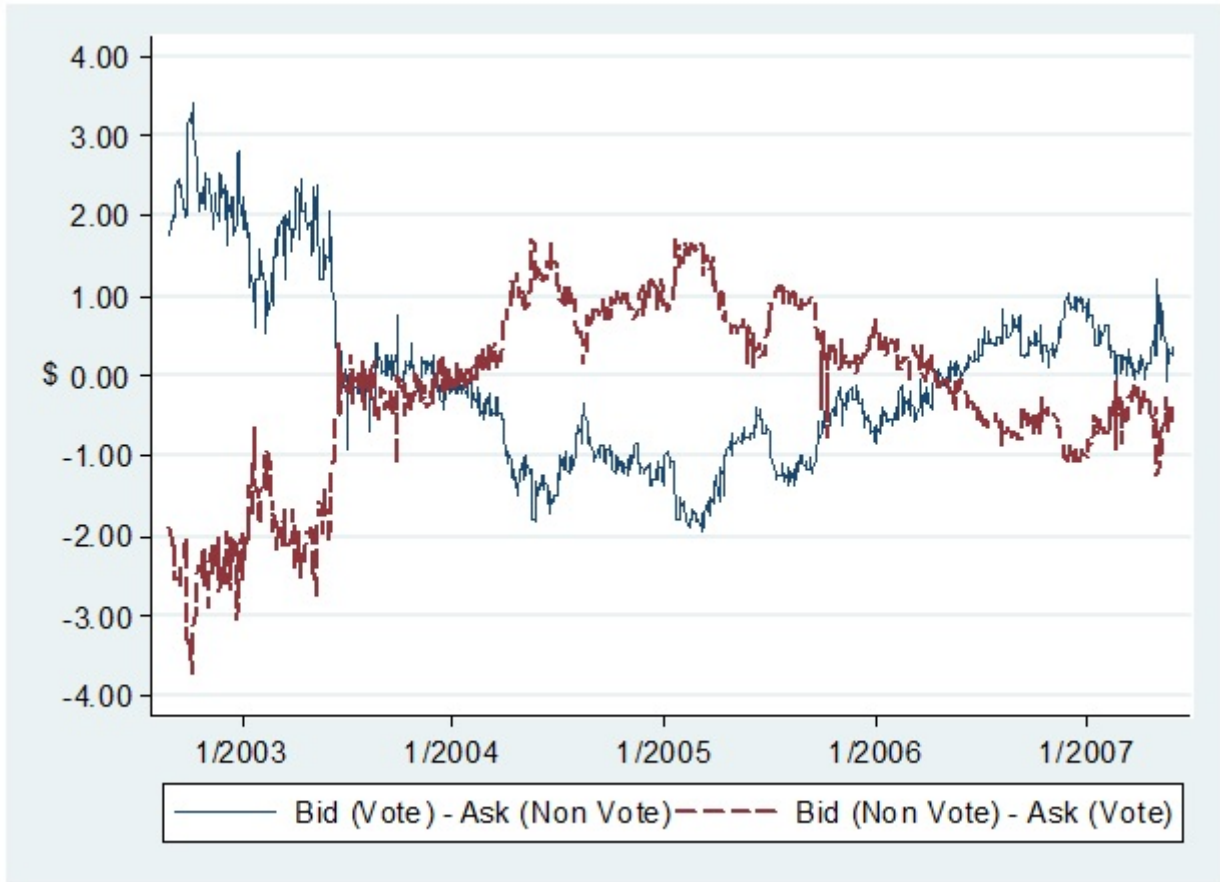


Figure 2b.
Differences in prices of Grey Television voting and non-voting shares.

Appendix

Firm names and SIC codes are the most recent available from CRSP. Each month, both voting and non-voting shares are assigned to NYSE size deciles. The table presents the time-series mean of the deciles across the months when both classes traded. The number of arbitrage positions are the total initiated when price discrepancies are \$0.50, \$0.75, \$1.00, or \$2.00. If a firm has more than two classes of shares, more than one pair is listed.

Name	First Date	Last Date	SIC Code	Voting Size Decile	Non-Voting Size Decile	Number Arb. Positions
Brown Forman	1/1993	12/2006	2084	6.80	7.35	369
Constellation Brands	1/1993	12/2006	2084	2.20	5.82	276
Baldwin and Lyons	1/1993	12/2006	6330	1.00	2.48	228
P H I Inc	1/1993	12/2006	4520	1.00	1.05	206
Hubbell Inc	1/1993	12/2006	3644	3.24	6.93	210
Forest City Enterp.	1/1993	12/2006	6512	3.23	4.65	174
Methode Electronics	1/1993	1/2004	3678	1.00	4.30	164
John Wiley & Sons	1/1993	12/2006	2731	2.10	4.94	143
Tecumseh Products	1/1993	12/2006	3580	2.52	4.40	140
Jones Intercable	1/1993	3/2000	4840	1.62	4.37	139
Kelly Services	1/1993	12/2006	7361	1.03	2.91	125
E X X	11/1994	12/2006	3621	1.00	1.00	119
Penn Engineering	5/1996	5/2005	3452	1.00	2.08	117
Reader's Digest	1/1993	12/2002	2731	4.72	8.11	107
Sequa Corp	1/1993	12/2006	3724	1.93	2.92	104
Aaron Rents	1/1993	12/2006	7359	1.05	2.77	94
Crawford	1/1993	12/2006	6411	2.80	2.66	89
Moog Inc.	1/1993	12/2006	3494	1.00	2.65	87
Continental Airlines	9/1993	1/2001	4512	3.24	6.34	80
Crown Central	1/1993	3/2001	2911	1.28	1.30	77
Bio Rad Labs	1/1993	12/2006	8731	1.38	3.55	69
First Commerce Banc	10/1993	6/2000	6020	1.02	2.51	65
Marsh Supermarkets	1/1993	9/2006	5410	1.00	1.00	64
Nelson Thomas	1/1993	6/2006	2731	1.00	2.25	61

Name	First Date	Last Date	SIC Code	Voting Size Decile	Non-Voting Size Decile	Number Arb. Positions
American Maize	1/1993	11/1995	2046	2.91	1.03	57
Watsco	1/1993	12/2006	5075	1.00	2.88	57
Telecommunications	8/1995	3/1999	4841	5.23	9.28	53
Comcast	1/1993	11/2002	4840	9.37	5.59	52
Waddell & Reed	11/1998	4/2001	6799	5.60	5.70	52
Molson Coors	2/2005	12/2006	2082	1.04	8.00	51
Benihana	1/1993	12/2006	5810	1.00	1.00	47
Bandag	1/1993	12/2006	3011	3.62	3.60	46
Telecommunications	1/1993	3/1999	4841	7.26	9.99	45
Neiman Marcus	10/1999	10/2005	5311	4.50	5.47	44
Seneca Foods	9/1995	12/2006	2033	1.00	1.00	42
Florida East Coast	10/2000	9/2003	4011	3.94	3.94	40
Heico Corp.	4/1998	12/2006	3724	1.62	1.50	40
Radio One	6/2000	12/2006	4832	2.35	4.72	40
Curtiss Wright	11/2000	5/2005	3728	2.14	3.17	39
Plymouth Rubber	1/1993	1/2005	3069	1.00	1.00	39
Jo Ann Stores	8/1995	11/2003	5949	1.87	1.71	37
Playboy	1/1993	12/2006	4841	1.05	2.37	36
J.M. Smucker	1/1993	8/2000	2033	3.51	3.40	35
Rush Enterprises	7/2002	12/2006	5511	1.00	1.04	35
Gartner Inc	7/1999	7/2005	8741	2.76	4.43	32
Oriole Homes	1/1993	2/2003	1531	1.00	1.00	31
Associated Group	12/1994	1/2000	4810	4.25	4.23	29
T C I Satellite	12/1996	4/1999	4890	1.00	2.96	27
Fedders	9/1994	3/2002	3585	1.46	1.37	23
Liberty Homes	1/1993	5/2004	2452	1.00	1.00	23

Name	First Date	Last Date	SIC Code	Voting Size Decile	Non-Voting Size Decile	Number Arb. Positions
Fredericks Hollywood	11/1993	9/1997	5621	1.00	1.00	21
Turner Broadcasting	1/1993	10/1996	4833	8.49	7.40	16
Gray Television	9/1996	12/2006	4833	1.27	1.83	16
Spinnaker Inds	8/1996	11/2001	2672	1.17	1.13	16
Conoco	8/1999	10/2001	1311	9.81	8.69	15
Stevens Intl	1/1993	7/1999	3555	1.00	1.00	14
Triarc Cos.	9/2003	12/2006	2086	1.85	2.80	13
Infousa	10/1997	10/1999	7330	2.42	2.38	12
McData	8/2000	12/2006	3572	3.69	2.13	12
Premier Radio	1/1996	6/1997	7920	1.00	1.12	12
Federal Agricultural	1/1994	12/2006	6159	1.00	1.71	11
Telecommunications	9/1997	3/1999	4840	5.00	9.06	11
Sport Chalet	9/2005	12/2006	5941	1.00	1.00	9
Wackenhut	1/1993	5/2002	7381	1.09	1.83	9
Dairy Mart	1/1993	2/2000	5411	1.00	1.00	8
Base Ten Systems	1/1993	5/1998	7372	1.00	1.03	8
ID T Corp	6/2001	12/2006	4813	2.25	4.24	8
Liberty Media	5/2006	12/2006	4841	2.00	9.00	8
Molex	1/1993	12/2006	3670	7.48	7.05	8
Pilgrim's Pride	8/1999	11/2003	2015	2.75	1.39	8
Gamestop	11/2004	12/2006	5734	3.69	4.19	8
Freescale Semicond	7/2004	12/2006	3674	8.25	7.00	7
Discovery Holding	7/2005	12/2006	4841	1.00	7.17	6
Reading Intl	1/2000	12/2006	6513	1.00	1.00	6
Tronox	3/2006	12/2006	2816	1.40	1.00	6

Name	First Date	Last Date	SIC Code	Voting Size Decile	Non-Voting Size Decile	Number Arb. Positions
CCH Inc	1/1993	1/1996	2730	4.08	4.03	5
Roses Stores	1/1993	4/1995	5310	1.08	1.12	5
All American Comm.	12/1995	11/1997	7810	1.13	1.04	4
Comcast Corp	11/2002	12/2006	4840	10.00	10.00	4
Greenwich Air Serv.	11/1993	8/1997	3720	2.19	2.75	4
Hechinger	1/1993	9/1997	5210	1.70	2.98	4
Lennar Corp	4/2003	12/2006	1521	5.16	8.27	4
Liberty Media	8/2001	5/2006	4813	6.04	10.00	4
M I P S Technologies	6/2000	11/2003	3674	2.54	2.10	4
Telephone & Data Sys	5/2005	12/2006	4813	6.00	6.00	4
Reinsurance Group	6/1998	9/1999	6311	6.87	2.87	4
Sportmart	9/1994	1/1998	5990	1.35	1.10	4
Wang Laboratories	1/1993	9/1993	3574	1.00	2.25	4
D E P Corp.	1/1993	11/1996	2840	1.00	1.00	3
N P C International	1/1993	8/1995	5810	1.84	1.68	3
Blockbuster Inc.	10/2004	12/2006	7822	1.85	2.78	2
Viacom	1/2006	12/2006	4841	6.00	10.00	2
American Fructose	1/1993	2/1993	2046	2.00	2.00	1
Everest & Jennings	1/1993	11/1993	3842	1.00	1.00	1
Freeport McMoran	7/1995	5/2002	1021	6.11	7.15	1
McRae Inds	1/1993	12/2005	3577	1.00	1.00	1
Agere Systems	6/2002	5/2005	3674	6.06	5.66	0
C B S Corp	1/1993	12/2006	4833	8.22	9.83	0
Liberty Media	5/2006	12/2006	4841	2.00	9.00	0
United Foods	1/1993	9/1999	2037	1.00	1.00	0