Factors Affecting the Implementability of Stock Market Trading Strategies

Brian J. Bushee[*]
University of Pennsylvania

and

Jana Smith Raedy
University of North Carolina

April 2006

Abstract

We examine factors that could mitigate the implementability of stock market trading strategies. We find that price impact adjustments, blockholding constraints, and avoidance of securities with large expected price impacts have large negative effects on portfolio returns for most strategies. Such constraints eliminate significant abnormal returns to the size and return reversal strategies, whereas the cash flow-to-price, return momentum, and post-earnings-announcement drift strategies continue to perform well, as do the book-to-market and operating accrual strategies in some scenarios. Finally, portfolios using short positions perform worse than long-only portfolios due primarily to the increase in stock prices during the sample period.

JEL classification: G10, G11, M41

Keywords: Stock market trading strategies, Portfolio implementability, Short selling

[*] Corresponding author: 1317 Steinberg Hall-Dietrich Hall, 3620 Locust Walk, Philadelphia, PA 19104, 215-898-4872, bushee@wharton.upenn.edu.

We appreciate helpful suggestions from an anonymous reviewer, Bruce Billings, Jennifer Blouin, Gene D'Avolio, Ilia Dichev, Allison Evans, John Hand, Mark Lang, Charles Lee, Rick Morton, Kevin Raedy, Sundaresh Ramnath, Adam Reed, Nancy Rothbard, Doug Shackelford, Hal White, Mike Willenborg, Wendy Wilson, Michelle Yetman, and workshop participants at Pennsylvania State University, University of California-Davis and Darden Graduate School of Business – University of Virginia.

1. Introduction

A substantial body of academic literature provides evidence of stock market trading strategies that generate abnormal returns based on publicly available information (see Kothari, 2001 and Lee, 2001 for reviews of this literature). Some trading strategies have persisted over time despite public knowledge of their existence. This evidence is puzzling considering that the US market is characterized by large institutional investors and hedge fund managers, which have sophisticated research staffs, ready access to capital, and the ability to move prices to the efficient level through their block trades. One possible reason that these profitable strategies seemingly exist is that they are not actually implementable by institutional investors. Sloan (1996) points out that his study does not necessarily imply the existence of unexploited profit opportunities due to the existence of various transactions costs as well as the possibility of price pressures created by trading on the strategy. Holthausen and Larcker (1992) discuss the possibility that the reported returns to their strategy could be exaggerated due to transaction costs as well as other trading constraints such as restrictions on short sales. There is limited evidence that speaks to the question of whether sophisticated market participants can practically implement trading strategies identified by academic researchers.

There are a number of real-world factors that could partially or fully mitigate the ability of sophisticated market participants to implement academic trading strategies. In particular, fund managers must be concerned with unavoidable factors such as explicit transaction costs, the price impact of block trades, and restrictions on short sales. In addition, they face possible constraints due to the legal and regulatory impacts of holding more than a 5 percent stake in a firm, the tax-related incentives to hold an adequately diversified portfolio, and the fiduciary and liquidity impacts of holding penny stocks. While such constraints are avoidable (i.e., a fund can hold more than a 5 percent stake in a firm and can hold penny stocks), doing so imposes other costs on the fund that are difficult to measure, but are nonetheless real. Because of all of these factors, the profitability of trading strategies could be related to the market capitalization of the fund, the number of stocks in the fund's portfolio, the portfolio allocation method, and the frequency with which securities are turned over. This paper investigates the extent to which these realistic investment factors facilitate or restrict the implementation of academic trading strategies by large investment funds.

We examine seven trading strategies: the book-to-market strategy (e.g., Stattman 1980; Rosenberg et al. 1985; Fama and French 1992), the cash flow-to-price strategy (e.g., Fama and French 1996), the return momentum strategy (e.g., Foster et al.1984; Jegadeesh and Titman 1993; Bernard et al. 1997), the operating accrual strategy (Sloan 1996), the return reversal strategy (e.g., DeBondt and Thaler 1985, 1987), the size effect strategy (e.g., Banz 1981; Fama and French 1992), and post-earnings-announcement drift with a fourth quarter reversal (e.g., Jones and Litzenberger 1970; Joy et al. 1977; Latane and Jones 1979; Rendleman et al. 1982; Foster et al.1984; and Bernard and Thomas 1989, 1990). We restrict our focus to these strategies because they are extensively documented by prior research, have been shown to persist over time, and have been shown to be robust to many risk controls and other proposed anomalies (e.g., Bernard and Thomas 1989; Fama and French 1996; Sloan 1996; Raedy 2000).

We intentionally do not explore the effects of risk on the strategies. The purpose of this study is to examine the effects of various real world constraints on the returns to the strategies; thus, examining risk is outside of the scope of the current study. In addition, the effects of risk on these seven strategies have been extensively examined in the extant literature. For example, Fama and French (1996) look at the effects of incorporating a three-factor risk model in assessing various strategies. They include the book-to-market, cash flow-to-price, return momentum, return reversal, and size strategies in their study. Bernard et al. (1997) examine the extent to which various strategies reflect premia for unidentified risk. They include the book-to-market, return momentum, and post-earnings-announcement drift strategies. Sloan (1996) and Mashruwala et al. (2004) study the possibility that the operating accrual strategy is a result of excessive risk. Bernard and Thomas (1989) examine the possibility that post-earnings-announcement drift is really just a premium for additional risk. These are only a few of the many existing studies of the effects of risk on these strategies.

We test the implementability of a given trading strategy by forming a random portfolio of stocks on January 3, 1990. Every trading day thereafter, we sell stocks based on a trading strategy sell list and remove delisted stocks. Then we reinvest the proceeds in stocks on the trading strategy buy list, if possible. We actively manage the portfolio until December 31, 2002. We compare the returns from the trading strategy portfolio to a random benchmark portfolio that starts with the same initial set of stocks, but only buys random firms to replace delisted firms. We estimate 25 iterations for both trading strategy and random portfolios, varying the initial random portfolio and, in the case of the strategies, the order of the buy list. We repeat this approach with appropriate modifications for each of the implementability factors.

We find that the size and return reversal strategies do not perform well in the presence of the various implementability constraints. However, the cash flow-to-price, return momentum, and post-earnings-announcement drift strategies continue to perform well in the presence of all constraints. The book-to-market and operating accrual strategies generate significant positive abnormal returns in some of the scenarios we examine. We find that all of the strategies generate positive abnormal returns in the presence of the restriction against short sales. However, the price impact adjustment and the maximum 5 percent ownership constraint each has a large negative impact on portfolio returns. In general, equally-weighted allocations perform better than value-weighted allocations, highlighting the importance of investing heavily in smaller firms for most trading strategies. Finally, funds with a greater number of stocks and/or a small initial market capitalization generally exhibit higher abnormal returns, suggesting that such funds provide more opportunities to sell trading strategy stocks and reinvest in stocks on the buy list, without incurring greater costs of transacting in larger blocks.

We also examine whether strategies that use short positions are implementable. We find that portfolios with short positions generally yield lower returns than the long-only portfolios across all strategies and a number of sensitivity analyses. The returns to the short selling portfolios are depressed by the sustained increase in stock prices during the sample period. Thus, short positions lose money in an absolute sense and strategies that utilize short positions are not as implementable as long-only strategies. This result helps explain why fewer than 5 percent of funds actually engage in short selling in practice (Almazan et al. 2002).

This paper contributes to the literature examining the implementability of certain trading strategies. Korajczyk and Sadka (2002) examine the robustness of the return momentum strategy to the inclusion of explicit transaction costs and price pressure, modeled as a function of the volume of trade size, and find that the strategy generates significant returns in funds up to capitalizations of $5 billion. Lesmond et al. (2002) find that the return momentum strategy requires transactions in firms that have particularly high transaction costs, raising doubts about the implementability of the strategy. Ali and Trombley (2004) find that the momentum strategy is less (more) profitable for firms that would be expected to have lower (greater) short selling constraints. Chen et al. (2002) examine the effect of price pressures on the book-to-market, size, and momentum strategies. Their price impact model is also a function of the volume of trade size and they attempt to include short sales by adding 10 basis points to the 15 basis point explicit transactions costs they charge to a buy position. They find that the strategies are not implementable in large funds (based on market capitalizations) under these restrictions. Mashruwala et al. (2004) address the question of why the operating accrual anomaly is not arbitraged away. They find that the anomaly is concentrated among stocks with low price and low trading volume, thus indicating that transaction costs could be substantial for this strategy. They also find that the strategy creates excessive exposure to idiosyncratic risk. Kraft et al. (2004) examine the effect of sample selection biases and the treatment of outliers on the operating accrual anomaly. They find that the returns to the accrual anomaly are reduced when these research design issues are corrected.[1] Ball et al. (1995) examine the effect of bid-ask bias on the one-week returns following portfolio formation based on the return reversal strategy. They find that adjusting for this bias substantially reduces the one-week returns to the strategy.

Unlike these papers, we simultaneously examine multiple implementability factors in conjunction with price impact and we investigate seven different trading strategies pervasive in the literature. We use a price impact model that incorporates more information than just the volume of the trade size (such as price, market capitalization, and exchange listing, which are associated with spreads) and we consider additional constraints, such as 5 percent maximum ownership, 10 percent maximum portfolio weight, avoidance of penny stocks, and 5 percent maximum price impact that likely reduce implementability. In addition, we develop a portfolio management strategy that partially takes advantage of the "short positions" without requiring short selling. Moreover, when we introduce short positions, portfolio returns are lower, suggesting that short strategies are not implementable during a period of sustained price

[1] The analyses in our paper are not subject to any of the research design flaws examined by Kraft et al. (2004).

increases. Finally, to obtain a richer picture of the effect of fund size and fund management on the implementability of trading strategies, we allow the market cap of the fund and the number of stocks held to vary jointly with different portfolio allocation schemes.

The paper is organized as follows. The next section provides a discussion of the implementability factors. Section 3 provides a discussion of our data and methodology. Section 4 presents our results and the final section concludes.

2. Implementability Factors

2.1 Unavoidable factors

2.1.1 Explicit trading costs and price pressures related to block trades

The first factors we investigate are explicit trading costs and price pressure costs incurred when block transactions are executed. Prior research on trading strategies generally assumes that stocks can be bought and sold at the CRSP closing price with no transaction costs. However, in order for large funds to trade on a given strategy, they will need to execute block trades, and the implicit price pressure costs of such trades will reduce the returns to the strategy. A number of papers document significant price impacts of large block trades (e.g. Holthausen et al. 1987; Chan and Lakonishok 1993, 1995; Keim and Madhavan 1997). We calculate an adjustment for price pressures and trading costs using the model presented in Keim and Madhavan (1997, table 5).[2] Because trading costs should increase with trade difficulty and spreads and decrease with liquidity, they hypothesize that costs should increase with trade size, inverse price, and exchange listing and decrease with market capitalization. We refer to the combination of explicit

[2] We do not use the models in Chan and Lakonishok (1993, 1995) because they include specific fund manager indicators in their models. We do not use the model in Holthausen et al. (1987) because they did not have the data to determine if the trade was buyer or seller initiated.

transaction costs and price pressures related to block trades as the price impact. For buyer-initiated trades, we estimate the price impact as:

$$\text{Price Impact (\%)} = 1.259 + 0.336*\text{NASDAQ} + 0.092*\text{TRSIZE} - 0.084*\text{MKTCAP} + 13.807*(1/\text{PRICE})$$

For seller-initiated trades, we estimate the price impact as:

$$\text{Price Impact (\%)} = 1.223 + 0.058*\text{NASDAQ} + 0.214*\text{TRSIZE} - 0.059*\text{MKTCAP} + 6.537*(1/\text{PRICE})$$

where:

NASDAQ	= 1 if the stock being traded is listed on NASDAQ and 0 otherwise,
TRSIZE	= ratio of the order size to the market cap of the stock being traded,
MKTCAP	= log of the market capitalization of the stock being traded, and
PRICE	= the price per share of the stock being traded.

The constant term in both models includes both the intercept, which represents explicit transaction costs, and the coefficient on a technical manager indicator variable, which reflects the extra transaction costs to active portfolio management (Keim and Madhavan 1997).[3]

We expect the price impact adjustment to have the greatest effect on trading strategies that require a large number of trades to execute and on strategies that involve a large number of transactions in small firms.

2.1.2. Short sales

Another issue in the implementation of trading strategies is the use of short sales. Prior literature implicitly assumes that short sales can be transacted in all firms and with no more cost than buyer-initiated trades. D'Avolio (2002) provides a thorough discussion of the market for shorting securities, suggesting that these assumptions are unrealistic for several reasons. First, a stock must be borrowed before it can be shorted. D'Avolio finds that 16 percent of securities are

[3] Keim and Madhavan (1997) estimated separate coefficients for technical managers and index managers based on the presence of both in their sample. Because we are actively managing our portfolio, we include the coefficient on the technical manager indicator and drop the coefficient on the index manager indicator. Also, their model can produce negative price impacts. Thus, we set any price impacts less than 0.1 equal to 0.1.

not available to be borrowed and shorted, many of these in the smallest size decile. Second, the fees to a short sale are greater than those for a buyer-initiated trade due to the cost of borrowing the security. D'Avolio finds that for most securities (91 percent), the cost of borrowing is less than 1 percent per year. However, the other 9 percent have a mean cost of borrowing of 4.3 percent per year.[4] Third, the borrowed stock can be recalled by the lender at any time. D'Avolio finds that 2 percent of securities are recalled in an average month.

Perhaps more important than the questions of the feasibility and costs of short positions, Almazan et al. (2002) report that many mutual funds are prohibited from short selling by their investment policy statements. Specifically, over the 1994-2000 period, 68.9 percent of funds were not permitted to short sell. Of the remaining funds, only 9.8 percent actually did engage in short sales. Thus, only 3 percent of funds engaged in short sale transactions.

Due to the increased costs of short sales and the impermissibility of these transactions by funds, it is not realistic to assume that funds would be able to exploit all of the short-selling possibilities in a strategy. However, a fund could sell any stocks that they already own and invest the proceeds in long positions, producing a zero-investment implementation. Using this notion, we develop a portfolio formation strategy that takes advantage of the "short positions" of the strategies, but does not actually require the fund to engage in short sales. Thus, returns from our approach should be somewhere between the academic returns that reflect unlimited short-selling and the prior work that has only examined the buy side of trading strategies. In the last section, we relax this restriction and explore the implementability of short selling in portfolios.

2.2 Avoidable factors

[4] D'Avolio (2002) reports only the fees paid by the broker to the lender of the stock. The broker typically doubles the fee when transacting with the borrower. Thus, the borrower would likely pay an 8-10 percent fee.

2.2.1. Maximum stake size

We include a constraint on the maximum stake size that a fund can hold in any given security. We limit the fund to a 5 percent ownership stake in any given security. Prior research on trading strategies commonly examines returns to zero-investment portfolios that implicitly represent the investment of one share in each firm. However, funds trying to implement trading strategies would have to invest some portion of their market capitalization into each stock. Thus, the optimal investment in a firm could result in a greater than 5 percent ownership in that firm, especially if a fund manager finds it costly to hold thousands of stocks in the fund's portfolio. Fund managers could be unwilling to take such a position based on the legal and regulatory implications of exceeding a 5 percent ownership stake.

These legal and regulatory implications take two forms. First, if a fund holds 5 percent or more of a security, both the fund and the investee firm are considered affiliated companies according to Section 2(a) of the Investment Company Act of 1940. Affiliated companies are subject to the additional regulations contained in Section 17 of the Act, which subjects the funds' activities to a greater level of regulatory scrutiny. For example, Section 17(j) provides the antifraud provisions for affiliated persons, which are similar to Section 10(b) of the Securities Exchange Act of 1934 (Hazen, 1990). Likewise, Rule 17(j)-1 is the counterpart to Rule 10b-5. Second, if a fund holds more than 5 percent of a given security, it incurs additional costs related to required SEC filings. Pursuant to Rule 13d-1(a), the funds are generally required to file Schedule 13D within 10 days of the acquisition. Thus, for both of these reasons, holding a 5 percent or greater stake in a security imposes substantial additional costs on the investor.[5]

[5] To assess how binding the 5 percent ownership constraint is in practice, we examined the distribution of institutional investor holdings from Spectrum in the 1st quarter of 1990. Overall, 48 percent of institutional investors held at least one stock in which they had a greater than 5 percent stake in the firm. However, Bushee (1998) shows that some institutions intend to take large stakes in firms for corporate governance reasons. Using

We expect that the maximum stake size constraint has the greatest impact on trading strategies that optimally involve large holdings in small firms. This constraint will be particularly important for those strategies that sell large firms to buy small firms, because a fund manager would be unable to reinvest fully the proceeds from the sale of strategy firms into firms on the strategy's buy list. Instead, the fund manager would have to divert some of the sale proceeds to random firms or hold them in cash until another buy opportunity presents itself.

2.2.2. Maximum portfolio weight constraint

We also include a constraint on the maximum percentage of the fund's total assets that can be invested in any one security. We limit this portfolio weight to 10 percent of the fund's total assets. Funds may be unwilling to hold an undiversified portfolio for (at least) two reasons. First, in order for a fund to qualify for advantageous tax status as a pass-through entity it must maintain an adequately diversified portfolio. These maximum portfolio weight restrictions are governed by section 851 of the Internal Revenue Code. There are two levels of restrictions specified in the law. First, with respect to 50 percent of the funds assets, the fund cannot hold more than 5 percent of its total assets in any one issuer. In addition to this restriction, no more than 25 percent of the funds assets can be invested in any one issuer. Thus, in total, these tax-related constraints impose the restriction that a fund may hold 25 percent of its total assets in each of two issuers (for a total of 50 percent). Beyond that, the fund would be constrained to a 5 percent weighting in a given issuer.[6]

---

his classification, we examined only transient institutions, which are high turnover institutions that actively manage their holdings. Among transient institutions, 35 percent held at least one stock with a greater than 5 percent stake in a firm. Among transient funds holding at least one 5 percent stake, the median number of 5 percent holdings was 1 and the median percentage of their portfolio cap in such stocks was 2.7 percent. Thus, while some transient funds hold greater than a 5 percent stake, it is generally a small part of the portfolio.

[6] The Investment Company Act of 1940 has similar criteria to meet the standard of a diversified portfolio. However, the SEC states that "the primary incentive for the maintenance of diversified portfolios stems not from the Act but from the Internal Revenue Code…" (SEC 1966).

In addition to the tax-related portfolio weight constraint, firms are unlikely to maintain a position that is heavily weighted in one security due to the risk considerations inherent in holding a highly undiversified portfolio. In order to determine the portfolio weight constraint for this study, we examined the distribution of holdings of institutional investors in 1990 that are included in the Spectrum database. We computed the maximum weighting in a given security for each institution. The mean of this number across all reporting institutions was 10 percent.[7] We expect that the maximum portfolio weight restriction would have the most effect on a strategy if the strategy relies on large holdings in large firms.

2.2.3. Minimum price constraint

Another avoidable factor that potentially limits the implementability of trading strategies is constraints on penny stock ownership. Funds have incentives to avoid low price-per-share penny stocks because they offer less liquidity, have higher mortality, and exhibit a higher incidence of fraud. Bushee and Leuz (2005) document that low price-per-share stocks are more likely to be traded on the Pink Sheets, where they exhibit larger spreads and lower share turnover than firms quoted on a NASD market. Sequin and Smoller (1997) find that lower-priced stocks have a higher mortality rate than higher-priced stocks, even controlling for market capitalization. Finally, the Penny Stock Reform Act of 1990 was passed in response to the numerous instances of fraud among low price-per-share stocks. We define penny stocks as stocks with a price per share of less than $1, since this definition is used as a requirement for continued listing on the NYSE and NASDAQ.[8] Similar to the maximum stake size constraint, we expect that penny

[7] We also estimated results using a maximum portfolio weight of 20%, which is the 90th percentile. Results were quantitatively similar.

[8] Firms on these markets could have a price of less than $1 on any given day because the listing requirements contain some slack. For example, the NYSE will consider delisting procedures under the minimum price criterion only when the average price over 30 consecutive days is less than $1.

stock constraints will have the greatest impact on trading strategies that involve a large number of trades in small firms.

2.2.4. Maximum price impact

The final avoidable factor we consider is a maximum price impact constraint. If a security purchase were likely to result in a substantial price impact upon trading, it is likely that a fund manager would avoid transacting in the security. Consequently, when this constraint is in effect, we do not transact in any security that is expected (based on the price impact model discussed earlier) to result in a price impact greater than 5 percent. This restriction should lower the price impact of executing the strategy. However, to the extent that this approach requires the substitution of a random firm for a firm on the buy list (i.e., all remaining buy list firms would have high price impact costs), this modification could lower the abnormal returns.

2.3. Fund management characteristics

We test the sensitivity of the abnormal returns generated by the various strategies to several key fund characteristics that can be chosen by portfolio managers. First, we consider the different portfolio allocation schemes a fund can use to implement a trading strategy. Funds could manage their portfolios using equally-weighted investments or value-weighted investments. Equally-weighted allocations will put more money in smaller firms, which may provide more return for dollar of investment in strategies driven by small firm returns, but will be more likely to violate the 5 percent ownership constraint. Value-weighted allocations will put more money in larger firms, which may provide less potential return, but also less price impact. In addition, value-weighted allocations will be more likely to violate the 10 percent portfolio weight constraint. Determining which allocation scheme produces the higher potential for trading strategy returns is an empirical issue, so we consider both alternatives.

Second, we test the sensitivity of the trading strategies to how frequently positions are turned over. In our primary analysis, we assume that securities that have been held for one year are automatically sold when cash is needed to purchase a security from the strategy buy list. However, we also examine the abnormal returns to the strategies when we do not allow this automatic sell feature. We anticipate that returns will be greater when the automatic sell feature is present, since this allows more trading in strategy firms.

Third, we test the impact on the returns to the trading strategies to different fund sizes, both in terms of market capitalizations and the number of stocks held. Funds with a greater number of securities and/or a smaller capitalization should experience less price impact on trades. The maximum stakeholder constraint should have less impact in funds that invest in a greater number of securities and/or a fund with a smaller capitalization since both of these would involve taking smaller stakes in a given security. In addition, the maximum portfolio weight constraint may have less impact with more securities in the portfolio, but more impact in funds that have smaller market capitalizations. Finally, a greater number of securities increases the likelihood that a fund will hold a strategy stock on the sell list, and hence, increases the opportunities to sell stocks and use the proceeds to purchase stocks from the buy list.

We start with a base case in which a fund uses an equally-weighted portfolio allocation scheme, automatically sells securities that have been held for more than a year if funds are needed to purchase stocks on the strategy buy list, and holds 100 securities with $350 million of initial fund capitalization. The equally-weighted allocation scheme approximates the research design used in most academic anomaly papers and the fund size characteristics are the median values for funds in 1990. We perform sensitivities to the number of securities held by examining portfolios of 50 and 500 stocks and we examine the sensitivity to fund capitalization with initial market capitalizations of $100 million and $3500 million capitalization. These fund sizes are roughly the 10^{th} and 90^{th} percentiles in 1990.

3. Data and Methodology

3.1. Data

We collect data on daily stock returns, delisting returns, trading volume, price, shares outstanding, exchange listing, and market values from the CRSP daily files. These data are also used in the computations of the return momentum and return reversal factors. We obtain data to compute the book-to-market, size, cash flow, operating accrual, and post-earnings-announcement drift factors from the entire set of annual and quarterly Compustat files. See the Appendix for definitions of how each trading strategy factor is computed.

3.2. Trading strategy buy and sell lists

We create our buy and sell list for a given strategy by ranking the factors for that strategy and placing them in ten portfolios based on this ranking, with the largest (smallest) values in the tenth (first) portfolio. We then include the securities in the tenth portfolio on the buy list for the book-to-market (BTM), cash flow-to-price (CP), post-earnings-announcement drift (PEAD), and return momentum (MOM) strategies. We include the securities in the first portfolio on the buy list for the operating accrual (OA), size (SIZE), and return reversal (REV) strategies. The securities in the first (tenth) portfolio are included on the sell list for the BTM, CP, PEAD, and MOM (OA, SIZE, and REV) strategies. We trigger a buy or sell for the BTM, CP, OA and SIZE strategies on the first day of the fifth month after fiscal year end. For the REV strategy, we buy and sell quarterly on the day after the factor return accumulation period. For the MOM strategy, we buy and sell quarterly beginning one month after the factor return accumulation period**.** For PEAD, the securities are placed on the buy/sell lists on the day after the earnings announcement.

In the case of the BTM, CP, OA, SIZE, and PEAD trading strategies, the factors are calculated and placed into portfolios based on their relationship to the prior year's (or quarter's, in the case of PEAD) distribution of the factors to avoid hindsight bias (see Foster et al. 1984; Bernard and Thomas 1989). In the case of the BTM, CP, and OA trading strategies, firm-years are required to have an earnings announcement date on Compustat to ensure that the financial statement data is available on the first day of the fifth month.

3.3. Methodology

Our basic methodology starts with an initial random portfolio of stocks on January 3, 1990. Every trading day, we sell stocks based on a trading strategy sell list and remove any delisted stocks from the portfolio. Then we reinvest the proceeds in stocks on the trading strategy buy list, if possible. Otherwise, we reinvest the proceeds in randomly-selected stocks. We actively manage the portfolio until December 31, 2002. We compare the returns from the trading strategy portfolio to a random benchmark portfolio that starts with the same initial set of stocks, but only buys random firms to replace delisted firms. We repeat this procedure 25 times for both trading strategy and random portfolios.[9] Each iteration starts with a new random portfolio and a new randomly-ordered strategy buy list. We repeat this approach for each trading strategy. Then, we repeat this approach with modifications for each of the implementability factors discussed earlier: price impacts, equal- vs. value-weighting, exclusion of the automatic sale feature, minimum stock price, maximum stake size, maximum portfolio weight, maximum price impact, number of portfolio stocks, and initial fund size.

---

[9] We ran the primary analysis with 100 runs and found similar results that were generally more significant due to the lower standard errors.

3.3.1. Initial random portfolios

We start by specifying the number of stocks to be held in the portfolio and the initial capitalization of the investment portfolio. For the purposes of this section, we will refer to the base case of 100 stocks and a $350 million initial fund size. From the 6,718 stocks listed on the CRSP database as of January 3, 1990, we randomly choose 100 stocks, sampling without replacement.[10] If price or shares outstanding data are missing for the stock, we discard it and select another stock. If applicable, we also screen on a minimum price of $1 at this point.

Once we have selected the 100 stocks, we compute the weighting factor to determine how much of the $350 million initial fund size will be invested in each firm. For equal-weighted portfolios, the weighting factor is 1/n, which would be .01 in this example. For value-weighted portfolios, the weighting factor is

$$MV_i / \sum_{j=1}^{n} MV_j$$

where MV_i is the market value of firm i and n is the number of stocks in the portfolio. The weighting factor is multiplied by the initial fund size to obtain the initial holding in each stock.

If a maximum stake size constraint of 5 percent is in effect, we determine whether any stocks are above this stake size on this date. For each stock above 5 percent, we reduce the stake size to 4 percent and divide the uninvested portion in other portfolio stocks based on the applicable weighting factor.[11] This reinvestment can cause other portfolio stakes to rise above 5 percent, so we iterate until all portfolio stocks are below the minimum stake size. If the

[10] We ran the primary analysis sampling with replacement. These results lead to the same inferences because the number of multiple holdings in the same stock was quite low.

[11] We reduce the stake size to 4 percent, rather than 5 percent, to avoid tripping the stake size constraint whenever the firm makes a repurchase. In the instance where we apply price impact to sales, the costs of having to rebalance frequently to stay below 5 percent can be high. Such rebalancing occurs less frequently when we drop to 4 percent any time the 5 percent stake size will be breeched.

maximum portfolio weight constraint of 10 percent is in effect, we follow a similar iterative procedure, reducing the portfolio weight of any stock over 10 percent to 9 percent.

3.3.2. Daily portfolio returns

Every day, we accumulate the daily stock return (including dividends) for each portfolio stock before executing any buys or sells. This approach forces us to execute all buys and sells at the closing price for the day. To the extent that other market participants are trading based on a strategy during the day, their trades should be reflected in the closing price. If a firm's return is missing for the day, we assume there was zero return. If a firm delists during the day, we use the delisting return from the CRSP delisting array to change the portfolio value of the stock. If the delisting return is missing, and the firm is delisted because of a liquidation or a forced delisting, we assume a delisting return of -100 percent (as in Sloan, 1996). Otherwise, we assume a delisting return of zero.[12]

3.3.3. Daily stock sales and delistings

We next determine whether there are any portfolio stocks that must be sold or removed. All firms that delisted during the day are removed from the portfolio and the proceeds are added to a fund used to replenish portfolio stocks through purchasing activity. Next, we refer to the sell lists for the trading strategy and, if we hold any stocks to be sold on this day, we remove these stocks from the portfolio and add the proceeds to the purchase fund. If there are more potential strategy buys on the date than delists and sells, we sell any recently-acquired random firms. Finally, if there still have not been enough sells to purchase all of the firms on the strategy buy

[12] When we apply the 5 percent maximum stake size and/or 10 percent maximum portfolio weight constraints, we check whether any of our portfolio stocks have exceeded these maximums at this point and make any necessary adjustments. If we are executing the strategy with price impact, we apply the price impact adjustment to both the sale of the excess stake and the reinvestment in other portfolio firms.

list, we automatically sell any stock held for a year. This approach allows for more opportunities to buy strategy firms and reduces the investment in random firms.

In the price impact test, we apply a price impact adjustment to stocks sold before applying the proceeds to the purchase fund. The price impact adjustment is based on the closing price. We do not apply a price impact adjustment to stocks removed due to delistings.

3.3.4. Daily stock purchases

On days when we have money in the purchase fund due to sales or delistings, we purchase stocks to replenish our portfolio to its original size of 100 stocks. We refer to the buy list for the trading strategy to determine whether there are potential strategy stocks to buy. Stocks are eliminated from consideration if price or share data is missing on the day or if a minimum price constraint is in place and the firm's price is less than $1. If we already own a firm on the buy list, we increase our holdings in that firm without adding to the number of stocks held in the portfolio. If there are more potential buys on a given day than there were strategy sales or delistings, we randomly select enough potential buys from the list to exactly replace the number of stocks removed. Any remaining potential buys are kept on the list until the next buy list date before they are removed permanently.

Once we have selected the stocks to buy on a given day, we compute a weighting factor based on the number of buys and on whether we are running an equally-weighted or value-weighted portfolio. For value-weighted portfolios, the weighting factor is based on the closing price. We apply the weighting factor to the money in the purchase fund to determine the investment in each purchase firm. In price impact tests, we apply the price impact adjustment to the purchase based on the closing price. Thus, part of the purchase fund is lost due to price impact costs. If the maximum price impact constraint is in effect, we do not purchase any security that would incur a price impact cost greater then 5 percent.

If we are applying the maximum stake size or portfolio weight constraint and any of the potential purchases would violate the constraint, we reduce the investment to1 percent below the constraint and invest the difference in other purchase firms, iterating until all purchases are within the constraint. In cases where we cannot successfully reinvest the excess that day, we carry the excess money over to subsequent days (interest-free) until it can be reinvested. We apply any price impact adjustment after determining the level of investment that avoids tripping the constraint.

3.3.5. Portfolio iterations

We repeat the daily portfolio returns, daily stock sales and delistings, and daily stock purchases every day until December 31, 2002. We output the total market value of the portfolio at the end of each calendar year, yielding thirteen cumulative return measures. We then compute the geometric average annual return over these thirteen years. We perform 25 runs of this procedure for each trading strategy, starting with a new initial random portfolio for each run and a different random order for the buy list. Finally, we vary this approach based on the implementability factors: price impact, minimum stock price, maximum stake size, maximum portfolio weight, equal- vs. value-weighting, an automatic sell feature, number of portfolio stocks, and initial fund size.

3.4 Random benchmark portfolios

In order to provide a benchmark for assessing whether the raw returns from implementing each trading strategy reflect significant benefits to active portfolio management, we compute the returns for a random benchmark portfolio. We start the benchmark portfolio with the identical set of initial stocks as the trading strategy portfolio and the same initial investment in each. We compute daily returns using the same assumptions as in the trading strategy portfolios. Each day, we remove stocks that delist or must be sold based on the automatic selling factor and place the proceeds in the purchase fund (applying price impact adjustments, if applicable). On days when there is money in the purchase fund, we invest the proceeds in randomly-selected firms to replenish the portfolio to the original number of stocks. Again, any applicable constraints and price impact adjustments are applied to the randomly-selected buy firms. Overall, the only difference between the benchmark and trading strategy portfolio is the lack of the buy and sell lists for the benchmark. We compute abnormal returns for each trading strategy as the difference between the trading strategy portfolio returns and the benchmark portfolio returns at the end of each calendar year.

4. Results

4.1. Returns with price impacts and constraints on stake size and price

Panel A of Table 1 documents geometric mean annual returns to the trading strategies with no adjustment for price impacts and Panel B reports returns with an adjustment for price impacts. The first column of Table 1 presents results without the maximum stake size, maximum portfolio weight, minimum price, and maximum price impact constraints.[13] The returns to all of the strategies except CP are reduced by the adjustment for price impacts.[14] However, the BTM, CP, MOM, OA, and PEAD strategies continue to generate significant positive abnormal returns even after the price impact adjustment. Neither the SIZE nor REV

---

[13] When we do not apply the 5 percent maximum stake size constraint, we apply a constraint against owning more than 100% of shares outstanding.

[14] The mean price impact for buy (sell) transactions ranges from 3.3% (2.2%) to 8.5% (5.0%) across the strategies. In the case of CP, the price impact adjustment had a greater effect on the benchmark portfolio than on the strategy portfolio, increasing the abnormal returns.

strategies survive the inclusion of the constraint, suggesting that the transaction costs of implementing these strategies far outweigh the "abnormal" returns to the anomaly factor.[15]

The next four columns of Table 1 document returns to the trading strategies with constraints for a maximum stake size of 5 percent, a maximum portfolio weight of 10 percent, a minimum price of $1 and a maximum price impact of 5 percent. The inclusion of the 5 percent stake constraint causes a significant reduction in the returns to all of the strategies. In fact, the BTM, OA, REV, and SIZE strategies do not survive if the portfolios are restricted to own less than 5 percent in any stock, even when no price impact adjustments are made. The inclusion of the 10 percent maximum portfolio weight restriction has no significant impact on the strategies.[16] With the exception of the OA strategy, the inclusion of the $1 minimum price constraint has very little impact on the profitability of the strategies. It does significantly reduce the returns to the OA strategy, indicating that the OA strategy is particularly dependent on low-priced securities. The inclusion of the 5 percent maximum price impact constraint has little effect on the returns to the strategies in the absence of a price impact adjustment. However, with the exception of the SIZE strategy, returns are generally substantially reduced with the inclusion of this restriction when the price impact adjustment is made. This decrease in abnormal returns is not due to a reduction in the raw returns of the trading strategies, but rather a significant increase in the returns to the benchmark portfolios. Overall, when all the constraints are considered jointly, the returns to all of the strategies are reduced. Only in the case of the MOM

[15] We also compute the returns to the PEAD strategy without a fourth-quarter reversal (i.e., the stock is held instead of sold prior the fourth quarter earnings announcement). This strategy should result in less price impact overall, but involves holding the stock through the fourth quarter reversal. Abnormal returns for the PEAD strategy without a reversal are generally significant, though at a lower magnitude than the PEAD strategy with reversal.

[16] This constraint is rarely binding. We check this constraint every trading day, so in a 100-stock portfolio, the constraint is checked over 350,000 times. On average, holdings only violate this constraint around 325 times.

strategy is that reduction not significant. In fact, in the presence of all of the constraints, only the CP, MOM and PEAD strategies survive.[17]

The substantial effect of the stake size constraint can be explained by considering the size of the firms in which the strategies take long and short positions. If the abnormal returns to a strategy are driven primarily by selling shares in large firms and purchasing shares of small firms, then the 5 percent stakeholder constraint will have a significant effect as the fund has to either invest the excess proceeds from selling large firms in random firms or remain uninvested until a future buy opportunity arises. In additional analyses (not reported), we split each buy/sell list into two subsamples, a small firm sample and a large firm sample, based on the median size for that year. We then compute four different returns (unconstrained) for each strategy; large firms in the buy list, small firms in the buy list, large firms in the sell list, and small firms in the sell list. The majority of the returns to the BTM, CP, REV, and SIZE strategies are due to the small firms on the buy list.[18] The PEAD and OA strategy also would benefit from only buying the small firms; however the benefit is not nearly as large as for the other strategies. The MOM strategy primarily benefits from the large firms on the sell list.

4.2. Returns with modifications to fund characteristics

In the prior analyses, we examine a base case that uses an equally-weighted portfolio allocation scheme with 100 securities, $350 million in fund capitalization, and an automatic sell feature. We find that four of the strategies examined do not generate abnormal returns in the

[17] Although the OA strategy does not remain significant in the scenario provided, this is due largely to the final year of the analysis. If we only run the OA strategy through 2001, the average annual abnormal return remains significantly positive, even in the presence of all of the constraints.

[18] For example, in the case of the REV strategy, the annual abnormal returns to the large (small) firms on the buy list are -1% (19%) and the abnormal returns to the large (small) firms on the sell list are -2% (9%). Thus, the returns to an unconstrained REV strategy where only the large (small) firms are sold and small (large) firms are bought would be 21% (-10%). In addition, 86% (81%) of the firms on the buy (sell) list are small (large) firms. It is also the case that the BTM, CP, and REV strategies perform better if, in addition to buying the small firms, you sell the large firms. However, this does not contribute nearly as much to the overall portfolio return.

presence of an adjustment for price impact and the four avoidable constraints: maximum stake, maximum portfolio weight, minimum stock price, and maximum price impact. In this section, we apply the four avoidable constraints and price impact adjustment to all portfolios, and allow the other fund management characteristics to vary. First, a value-weighted portfolio allocation scheme would involve purchasing larger (smaller) shares in large (small) firms and could generate different results because of less sensitivity to the 5 percent stake size constraint, more sensitivity to the 10 percent portfolio weight constraint, and/or less price impact. The second column of Table 2 reports the average annual abnormal returns to value-weighted portfolios. The returns to every strategy are lower in the value-weighted approach. Consequently, it is not the case that any of the trading strategies that are insignificant under an equally-weighted approach become significant with the use of a value-weighted portfolio.

We also examine the choice of *not* automatically selling securities that have been held for one year, but holding them until they are delisted or appear on strategy sell lists. By holding securities, transaction costs will be lower and any return impacts beyond one year will be captured by the strategy. The third column in table 2 reports these results. This approach reduces the abnormal returns in all of the strategies except BTM. Without the automatic sell feature, the funds are very limited in their ability to transact in strategy firms.[19] Thus, some amount of churning is necessary for implementable abnormal returns to trading strategies.

Next, we examine whether the previously-documented insignificant or negative returns to some strategies are driven by the 100-stock portfolios and the $350 million initial market capitalization in the base case. These strategies could be implementable in different size funds because the constraints will have less impact for certain fund sizes. For example, the 5 percent

[19] Notably, without automatic selling, the average trading strategy portfolio has 24% of its stocks in common with the benchmark portfolio after thirteen years, compared to only 0.7% with automatic selling.

stake size constraint should have less impact in funds that invest in a greater number of securities and/or a fund with a smaller capitalization. The fourth through seventh columns of Table 2 report the average annual abnormal returns to portfolios with initial capitalizations of $100 and $3500 million and number of securities held of 50 and 500. Notably, the PEAD and MOM strategies are significant in all cases. The REV strategy is not significant in the base case, or in any of the other fund sizes presented. The SIZE strategy is only significant in the 500 stock portfolio, with an average annual abnormal return of only 1.5 percent. The BTM, CP, and OA strategies perform better with a smaller fund capitalization and with a larger number of securities. These results are consistent with both of these conditions lessening the impact of the 5 percent stake size constraint. In fact, the BTM and OA strategies, although not significant in the base case, are now significant in two out of the five cases examined.

4.3. Cross-sectional regression analysis of trading strategy implementability factors

In the prior sections, we have turned one dial at a time to examine systematically how each implementability constraint either facilitates or restricts the implementation of profitable trading strategies. A drawback to this analysis is that it still only examines a small subset of the possible number of interactions between implementability constraints and fund characteristics. In this section, we expand the analysis by examining all of the possible interactions among our implementability factors. We use a regression framework to examine how each factor contributes to the implementability of profitable trading strategies, *ceteris paribus,* across all possible combinations of factors. This analysis will allow us to determine whether any factor subsumes other factors in affecting implementability.

We first estimate a regression on a sample that includes all 256 possible combinations of the following implementability factors: (1) constraints on maximum stake size, maximum portfolio weights, minimum price, and maximum price impacts (CON), (2) price impact adjustments (PID), (3) value-weighted portfolio allocations (VWD), instead of equally-weighted allocations, (4) portfolios which do and do not automatically sell stocks held for one year (HOLD), (5) portfolios with 50, 200, or 500 stocks (NS50, NS200, NS500) instead of 100 stocks, and (6) portfolios with an initial market cap of \$100 million, \$1,000 million, and \$3,500 million (CAP100, CAP1000, CAP3500), instead of \$350 million. We add the 200 stock and \$1,000 million fund characteristics because these are the mean levels in 1990 (recall that 100 stock/\$350 million is the median and that the other combinations are the 10th and 90th percentiles). We estimate the following regression using average annual abnormal returns and indicator variables for the implementability factors for each iteration of each trading strategy:[20]

$$AAR = \beta_0 + \beta_1 * CON + \beta_2 * PID + \beta_3 * VWD + \beta_4 * ASELL + \beta_5 * NS50 + \beta_6 * NS200 + \beta_7 * NS500 + \beta_8 * CAP100 + \beta_9 * CAP1000 + \beta_{10} * CAP3500 + \varepsilon.$$

We perform 25 of these regressions, each based on a different initial random portfolio and different randomly-ordered buy lists. We report the mean coefficient and significance tests based on standard errors computed from the distribution of the coefficients.

Table 3, Panel A reports the results from these regressions, which are consistent with the results in the earlier section that only looked at modifications to the base case. The constraints for the maximum stake size, maximum portfolio weight, minimum price, and maximum price impact significantly reduce the abnormal returns for all trading strategies except REV and SIZE. The magnitude of the effect of these constraints is particularly substantial for the BTM, CP, OA and PEAD strategies. The price impact adjustment produces a significant decline in returns across all strategies ranging between 0.3 percent and 4.9 percent.

[20] A random portfolio with the same combination of implementability factors is subtracted from each trading strategy return to obtain the abnormal return.

In terms of fund characteristics, the use of a value-weighted, as opposed to an equally-weighted, portfolio allocation mostly produces either no significant difference in returns or significantly smaller returns across the strategies. The abnormal returns to the CP, MOM, OA, SIZE, and PEAD strategies are significantly reduced when a value-weighted allocation is utilized. The REV strategy is the only strategy that is significantly increased with the value-weighted allocation. The hold indicator is significantly negative for every strategy except REV and SIZE, confirming that most strategies require some short-term churning to realize significant positive returns. In the case of REV and SIZE, significant returns can still be earned after one year, making the hold strategy more profitable. The indicators for fund size characteristics reveal that, in general, funds with a greater number of stocks and a smaller initial fund capitalization provide higher returns, *ceteris paribus*, suggesting that such funds provide more opportunities to sell trading strategy stocks without incurring greater costs of transacting in larger blocks.

To obtain a clearer picture of the impact of investment per stock, we replace the separate indicators for number of stocks and initial fund capitalization with indicators based on the initial investment per stock, defined as the initial fund capitalization divided by the number of stocks. The LOWINVEST (HIGHINVEST) indicator represents all funds with initial investments of less (greater) than $2 million ($10 million) per stock; these levels are chosen to divide the distribution into three equal parts. For example, funds with 50 stocks and a market capitalization of $3500 million would be in the HIGHINVEST category. Panel B of Table 3 presents the results of these regressions. For all of the trading strategies, abnormal returns are higher for low initial investment portfolios and lower for high initial investment portfolios.[21]

[21] We also ran this regression including two controls for risk; (1) the difference in the average beta between the strategy and benchmark portfolios and (2) the difference in the average standard deviation of returns between the

4.4. Sensitivity analyses

4.4.1. Sensitivities to research design choices

We perform a number of sensitivity analyses to examine the robustness of our results to various research design choices. These analyses are reported in Table 4 and are modifications of the base case, which is the equally-weighted, 100-stock, $350 million initial capitalization portfolio with the inclusion of the automatic sell feature, price impact adjustments, and the set of four avoidable constraints: maximum stake size, maximum portfolio weight, minimum price, and maximum price impact. Panel A (B) reports returns based on an unconstrained (constrained) portfolio without (with) an adjustment for price impact.

First, we investigate whether our results are driven by starting the trading strategy on January 3, 1990. The second column of table 4 presents average annual abnormal returns (based on eleven years) to a portfolio that is formed on January 2, 1992. The choice of start date does not affect our inferences for the results in panel A. The choice of start date only affects the OA and REV strategies in panel B. The returns to the OA strategy are increased to 2.6 percent and the returns to the REV strategy are increased to 2.4 percent.

We also examine the method used to buy firms off the strategy buy lists. Instead of a random ordering of purchases, as in our primary analyses, we first purchase the security with the highest measure of the strategy variable and use this order for all 25 iterations. For example, in the case of the BTM (SIZE) strategy, our first purchase would be the security with the largest book-to-market ratio (smallest size). The third column of table 4 reports that implementing the strategies with an ordered buy list has very little effect on the results of the analysis. In the

strategy and benchmark portfolios. While both of these variables are significant in every strategy, they do not affect the inferences of the reported regression results.

unconstrained case, the SIZE strategy is no longer significant. In the unconstrained case the OA strategy is significantly positive, whereas it is insignificant in the base case.

In our main results, we constrain the portfolio to maintain the same number of stocks throughout the time period examined. To assess the impact of this assumption, we estimate the results allowing the number of stocks in the portfolio to increase over time. Over the 1990-2002 period, the mean number of stocks in institutional investor portfolios increased by about 10 stocks per year; although the median number of stocks only increased by about one stock per year. We estimate our results allowing the number of stocks to grow by 10 stocks per year from the initial starting point for our base case and report the results in the fourth column of Table 4. In all instances, strategies that generated significant positive returns continued to do so with the growth in the number of stocks. In two cases (the constrained BTM and OA strategies) the returns are now significantly positive as opposed to the insignificant returns in the base case.

The final sensitivity we perform is that we buy all firms on the strategy buy list; thus, allowing the portfolios to have an unlimited number of stocks. Since we continue to fix the initial fund capitalization at $350 million, this greatly reduces the stake size in most holdings. As the last column of Table 4 shows, the BTM and OA strategies are now significantly positive in the constrained scenario analysis.

Overall, these results indicate that the CP, MOM and PEAD strategies remain profitable under many possible scenarios. The SIZE strategy is not significant under any of the scenarios and the REV strategy is only significantly positive under one scenario. While both the BTM and the OA strategies appeared not to be implementable in the results discussed earlier, these sensitivities indicate that they may indeed be profitable under certain conditions.

4.4.2 Sensitivity to short selling restriction

In our primary analyses, we do not allow short sale transactions because almost 70 percent of funds are prohibited from short selling per their investment policy statements (Almazan et al. 2002). Moreover, only approximately 3 percent of all funds actually engage in any short transactions and Richardson (2003) finds no evidence of short sellers trying to implement the accrual anomaly. Given the potential for higher profits from short selling, it is puzzling that more funds do not engage in short transactions. It is possible that the higher transaction costs, potential for recall, increased riskiness, and/or the recent bull market have made short selling an undesirable method for implementing trading strategies. We perform an analysis that allows short positions with real-world constraints to try to provide some evidence on why short strategies are so rare.

Our basic approach is as follows. Similar to our long-only approach, we endow the fund manager with an initial random portfolio of 100 stocks and an initial capitalization of $350 million. Whenever there is money available (due to delistings, strategy sales, automatic sales, closed short positions, or daily collateral cash flows), the proceeds are used to post collateral for short positions in stocks on the strategy sell list. To borrow a stock, the fund must post cash collateral equal to 102 percent of the market value of the stock (D'Avolio 2002). We assume the fund immediately sells the security for the market value and uses the proceeds to purchase firms on the buy list. In the price impact tests, we charge the fund with the explicit transaction and price impact costs for both of these transactions.

Every day, the necessary collateral value is reassessed based upon 102 percent of the daily market value of the security. If the market value of the borrowed stock has increased (decreased), the fund pays cash to (receives cash from) the lender. In addition, the fund receives from the lender interest on the posted collateral less the fee charged by the lender (this is called the “rebate”). Any daily positive cash flow received from the reduction in collateral or rebate is used to fund new strategy shorts or buys. If none are available, it is reinvested in the long positions. Any daily cash shortfall from increases in collateral is satisfied by proportionally reducing the investments in the long positions.

We close the short position if the firm delists, if the stock is recalled, if the short position has suffered cumulative losses greater than 10 percent of the initial market value, or if the position has been held for a year. To close the short position, we must sell enough long positions to generate sufficient cash to purchase the shorted stock on the market (in the constrained analysis, we apply transaction costs and price pressure on both market transactions). This shorted stock is returned to the lender in exchange for the collateral.

We must make a number of assumptions in order to include real world constraints on the short sale transactions. We allow up to 100 separate short positions consistent with our parameters in the long position of the strategy.[22] When a security shows up on the sell list, we first determine if the security is available to be shorted and how much can be shorted (i.e., the “loan supply”). Following D’Avolio’s (2002) results, we compute loan supply as 75 percent of standardized institutional ownership. If the loan supply exceeds 2 percent of shares outstanding, we cap the short position at 2 percent because D’Avolio (2002) finds that the average *aggregate* short interest is approximately 2 percent. Although arbitrary, it is unlikely that one investor would take a short position larger than the “normal” aggregate short position held by the market.

To compute the rebate paid by the lender on the daily collateral balance, we use the federal funds rate as the interest rate paid by the lender. The fee charged by the lender is security specific. There are two loan market regimes, general collateral and specials. D’Avolio (2002)

[22] While we base the number of securities held in the long position on the median of existing funds, we have less guidance on the appropriate number of short positions to hold since only 3 percent of funds actually hold any short positions at all. Thus, we perform various sensitivity analyses on this choice.

reports that approximately 90 percent of stocks fall in the general collateral regime for which the average fee charged to the intermediary broker is 20 basis points. However, the broker generally charges a markup that approximately doubles the fee to the borrower, so we charge 40 basis points for general collateral stocks. Securities that are on special have much higher fees. D'Avolio reports fees to the broker of 4.3 percent; we use 10 percent as the ultimate fee charged to the borrower.[23] We use four variables—institutional ownership, IPO, size, and turnover—to determine if the security would be in the special regime. We use the regression coefficients in D'Avolio (2002) to calculate the probability that the security is on special and we assume the securities in the top 10 percent based on our probability model are in the special regime (D'Avolio finds that roughly 10 percent of securities are in the special regime). The fees are stated in terms of annual rates, but are paid on a daily basis.

Once we have a short position, we check it daily to determine whether it would be recalled by the lender. D'Avolio (2002) finds that daily turnover (daily volume/shares outstanding) and intra-day volatility (the difference in the daily high and low prices, divided by the closing price) are strong predictors of recalls. D'Avolio finds that 1 percent of positions are recalled on a given date, so we choose levels of daily turnover (17 percent) and intra-day volatility (16 percent) to produce a 1 percent recall rate.

Because a fund could suffer an unlimited loss from a short position, we assume that a fund manager would close out the short position when it has lost a certain amount of money. The manager must watch losses carefully because, to close a position, there must be enough investment on the long side to fund the repurchase of the shorted shares. Lacking guidance of

[23] D'Avolio (2002) reports that some specials have "negative rebates" in which the fee is greater than the interest paid on the collateral. Brokers often pay negative rebates on some portion of their loan supply to meet loan demand, but charge a blended rate to the borrowers. We use the 10 percent fee to account for any possible effect of negative rebates.

when a fund manager would abandon a short position, we arbitrarily assume that the manager will close a position when it resulted in cumulative negative cash flows in excess of 10 percent of the initial market value of the position. Finally, we allow the short position to be maintained for a full year absent a recall, delisting, or large loss.[24]

As a benchmark for computing abnormal returns, we use the same random, long-only portfolios used in the long-only analysis. A fund manager with money to invest is faced with a choice of either investing in the market index (i.e., random firms) or a trading strategy. However, it does not seem reasonable that a fund manager would consider shorting random firms; they would only short-sell strategy firms. Thus, it would be unrealistic to create a benchmark portfolio that shorts random firms and invests the proceeds in long firms.

Table 5 presents the average annual abnormal returns to the strategies implemented with short selling. Panel A reports the returns to the unconstrained, no price impact adjustment scenarios and panel B reports the returns to the scenarios that include a price impact adjustment and the four avoidable constraints. The first (second) column reports the returns to the base case portfolio that does not (does) allow short selling. The returns are consistently lower when short selling is allowed. The only exceptions are the SIZE and PEAD strategies in the unconstrained and constrained cases, respectively. However, short-selling only increases the returns by about 1% annually in these cases.

We report sensitivity analyses on the base case assumptions in Table 5. We allow transactions in specials (column 3), allow unlimited losses (column 4), and take positions up to the size of the loan supply (column 5). In all three sensitivities, for both the unconstrained and

[24] While Reed (2002) shows that the median loan length is 3 days, this does not imply that the median short position is only held for 3 days. Firms engaged in short transactions will rotate from lender to lender, thus closing out individual loans frequently, but maintaining the short position. We also ran this analysis reversing the position after half a year. Results were quantitatively similar.

the constrained portfolios, the returns are either generally unaffected or are substantially lower than in the base short-selling case. We also ran the analysis without any real world constraints, thus allowing unlimited short positions in all securities, removing any fees, and ignoring recalls. The abnormal returns to this scenario are still generally no greater than those of the base case (not reported).[25] Thus, the finding that portfolios with short positions generate smaller abnormal and raw returns than long-only portfolios is likely not driven by our assumptions.

In order to examine the interactions between allocation schemes, fund sizes, and the constraints, we ran several regressions, similar to those discussed in section 4.3. Panel A of table 6 reports the results of a regression that includes indicator variables for the price impact adjustment, the avoidable constraints (maximum stake size, maximum portfolio weight, minimum price, and maximum price impact constraints), the use of a value-weighted portfolio, and the LOWINVEST and HIGHINVEST indicators. All portfolios included in this regression allow short sale transactions. The results for the short-selling portfolios are generally consistent with the portfolios that do not allow short selling (table 3, panel B). Both the avoidable constraints and the price impact adjustment decrease returns. Also, the value-weighted portfolios either perform worse than the equally-weighted portfolios (with the exception of REV). The median and low investment portfolios tend to outperform the high investment portfolios.

In panel B of table 6, we include long-only and short selling portfolios in one regression. Again, the inclusion of constraints, price impact adjustments, value-weighting, and high investments in individual securities all generally lower the returns to the strategies. The abnormal returns to the CP and MOM strategies are significantly reduced when the portfolio allows short sale transactions, whereas returns to the REV and SIZE strategies are significantly

[25] This result is consistent with Geczy et al. (2002), which shows that the imposition of fees, both general collateral and specials, do not significantly reduce the return to the short position in the SIZE, MOM, and BTM strategies.

increased. However, the latter result is largely driven by the strategies with do not include a price pressure adjustment.

Overall, we find that allowing a portfolio to short sell actually reduces both the raw and abnormal returns to the strategies. These results contradict the findings of academic strategies and this contradiction stems from different assumptions about the appropriate benchmark. The returns to the short positions presented in prior literature are market-adjusted. Thus, to find positive abnormal returns from a short position, it is not necessary that the shorted firms decline in market value, just that they gain value at a rate slower than the market as a whole. We computed the academic returns to the strategies over this time period and confirmed that the raw returns to the short position were negative (i.e. the firms were increasing in value) for every strategy. In reality, funds are generally compared to a long market index, not to an index that assumes the market portfolio is shorted. Thus, a fund manager would only engage in shorts if they were profitable in an absolute sense. The sustained bull market of the 1990's, along with the higher transaction costs and risks of short selling, likely account for the absence of observed short selling by funds. In such a market, long-only strategies are far more implementable than long-short strategies.

5. Conclusions

This study examines whether seven trading strategies that have been pervasive in the academic literature can be implemented by funds facing real-world constraints on their buying and selling activities. We consider multiple implementability factors, including explicit transaction costs, the price impact of block trades, incentives to hold less than a 5 percent stake in a firm, incentives to hold less than a 10 percent portfolio weight in a given security, incentives to avoid penny stocks, and incentives to avoid transacting in securities that generate large price impacts. We also develop a portfolio formation strategy that takes advantage of the "short positions" of the strategies, but does not actually require the fund to engage in short sales. In addition, we analyze the sensitivities of the strategies to various fund characteristics, such as value-weighted versus equally-weighted portfolio allocations, an automatic sell feature, initial fund capitalizations, and the number of stocks held in the portfolio.

We find that all of the strategies generate positive abnormal returns in the presence of the restriction against short sales. We also find that price impact adjustments, constraints on holding more than a 5 percent ownership in any portfolio firm, and restrictions on transacting in securities that are expected to incur a greater than 5 percent price impact each has a large negative impact on portfolio returns. In general, equally-weighted allocations perform better than value-weighted allocations, highlighting the importance of investing heavily in smaller firms for most trading strategies. We also find that funds with a greater number of stocks and/or a small initial market capitalization generally exhibit higher abnormal returns, suggesting that such funds provide more opportunities to sell trading strategy stocks and reinvest in stocks on the buy list, without incurring greater costs of transacting in larger blocks. Finally, we find that portfolios that engage in short positions generally perform worse than long-only portfolios due primarily to the sustained increase in stock prices during the sample period.

In terms of the trading strategies, the cash flow-to-price, return momentum, and post-earnings-announcement drift strategies generate positive abnormal returns after including all of the implementability constraints. In addition, the evidence suggests that these three trading strategies could be implemented across a broad range of realistic situations. While the operating accrual strategy is not profitable in the base case scenario, it is implementable in a wide range of other scenarios. We also find that the book-to-market strategy is not profitable under the base case scenario, but is implementable across some scenarios, although not as many as the operating accrual strategy. Finally, we find that the positive abnormal returns to the size and return reversal strategies are largely eliminated in the presence of price impact adjustments and constraints of holding more than a 5 percent stake in a firm. Thus, these two strategies do not appear implementable under a reasonable set of realistic implementability constraints.

We should note that we only examine a limited number of approaches to actively managing a portfolio. It is possible that for some of the strategies that we found were not implementable, there could be modifications that would make them profitable. For example, modifications such as borrowing money at some interest rate to buy all strategy firms if funds are not available from sales, starting with smaller fund sizes, or expanding the buy and sell lists beyond extreme deciles may lead to implementable approaches. However, our point is not say that certain academic trading strategies could *never* be implemented, but rather to show that some trading strategies are significantly adversely affected by some basic implementability constraints.

More importantly, our results show that some strategies survive these implementability constraints. Again, we have not considered all possible implementability constraints. For example, we rely on an empirical model of price impact to proxy for bid-ask spread effects because spread data is not generally available. However, the magnitude of the abnormal returns from the strategies that do survive our basic implementability constraints are sufficiently large to cast doubt on whether any additional, second-order constraints could prevent the implementation of these strategies. Thus, our results suggest that future research on behavioral explanations, rather than implementation explanations, will likely provide more fruitful avenues for investigating why market participants do not exploit certain market anomalies.

APPENDIX
COMPUTATION OF STRATEGY FACTORS

Book-to-market strategy (BTM): The book-to-market ratio is calculated as book equity (Compustat annual data item 60) divided by market equity (Compustat annual data items 25 * 199), measured at the end of the fiscal year.

Cash flow-to-price strategy (CP): The cash flow/price ratio is equal to actual annual earnings less preferred dividends (Compustat annual data item 237) plus depreciation and amortization (Compustat annual data item 14) all divided by the market value of equity (Compustat annual data items 25 * 199) at the end of the year (see Fama and French 1996).

Return momentum strategy (MOM): The factor for this strategy is a one-quarter cumulative abnormal return ending on November 30, February 28, May 31, and August 31. Abnormal returns are calculated as market-adjusted returns, consistent with Bernard et al. (1997).

Operating accrual strategy (OA): Operating accruals are defined as the change in current assets (Compustat annual data item 4) minus the change in cash (Compustat annual data item 1) minus the change in current liabilities (Compustat annual data item 5) plus the change in debt included in current liabilities (Compustat annual data item 34) plus the change in income taxes payable (Compustat annual data item 71) minus depreciation and amortization (Compustat annual data item 14). This number is then scaled by total assets (Compustat annual data item 6). This is identical to the calculation in Sloan (1996).

Return reversal strategy (REV): The factor for this strategy is a five-year cumulative abnormal (market-adjusted) return ending on December 31, March 31, June 30, and September 30, consistent with DeBondt and Thaler (1985).

Size effect (SIZE): Size is measured as the market value of equity (Compustat annual data items 25 * 199) as of the end of the fiscal year.

Post-earnings-announcement drift (PEAD): This strategy is based on standardized unexpected earnings. Unexpected earnings are computed as the difference in actual earnings (Compustat quarterly data item 69) and expected earnings where expected earnings are based on the Foster (1977) model. Unexpected earnings are scaled by the market value of common equity (Compustat quarterly data items 61 * 14) at the end of the fiscal quarter to arrive at standardized unexpected earnings.

References

Ali, A., and M. Trombley. 2004. Short sale constraints and momentum in stock returns. Working paper, University of Arizona.

Almazan, A., K. Brown, M. Carlson, and D. Chapman. 2004. Why constrain your mutual fund manager? *Journal of Financial Economics* 73 (August): 289-321.

Ball, R, S.P. Kothari, C. Wasley. 1995. Can we implement research on stock trading rules? *The Journal of Portfolio Management* 21 (Winter): 54-63.

Banz, R. 1981. The relationship between return and market value of common stocks. *Journal of Financial Economics* 9 (March): 3-18.

Bernard, V., and J. Thomas. 1989. Post-earnings-announcement drift: delayed price response or risk premium? *Journal of Accounting Research* 27 (Supplement): 1-36.

Bernard, V. and J. Thomas. 1990. Evidence that stock prices do not fully reflect the implications of current earnings for future earnings. *Journal of Accounting and Economics* 13 (December): 305-341.

Bernard, V., J. Thomas, and J. Wahlen. 1997. Accounting-based stock price anomalies: separating market inefficiencies from risk. *Contemporary Accounting Research* 14 (Summer): 89-136.

Bushee, B. 1998. The influence of institutional investors on myopic R&D investment behavior. *The Accounting Review* 73 (July): 305-333.

Bushee, B. and C. Leuz. 2005. Economic consequences of SEC disclosure regulation: evidence from the OTC bulletin board. *Journal of Accounting and Economics* : In press. .

Chan, L. and J. Lakonishok. 1993. Institutional trades and intraday stock price behavior. *Journal of Financial Economics* 33 (April): 173-200.

Chan, L. and J. Lakonishok. 1995. The behavior of stock prices around institutional trades. *Journal of Finance* 50 (September): 1147-1174.

Chen, Z., W. Stanzl, M. Watanabe. 2002. Price impact costs and the limit of arbitrage. Working paper, Yale University.

D'Avolio, G. 2002. The market for borrowing stock. *Journal of Financial Economics* 66 (November/December): 271-306.

DeBondt, W. and R. Thaler. 1985. Does the stock market overreact? *Journal of Finance* 40 (July): 793-808.

DeBondt, W. and R. Thaler. 1987. Further evidence of investor overreaction and stock market seasonality. *Journal of Finance* 42 (July): 557-582.

Fama, E. and K. French. 1992. The cross-section of expected stock returns. *Journal of Finance* 47 (June): 427-465.

Fama, E. and K. French. 1996. Multifactor explanations of asset pricing anomalies. *The Journal of Finance* 51 (March): 55-84.

Foster, G., C. Olsen, and T. Shevlin. 1984. Earnings releases, anomalies, and the behavior of security returns. *The Accounting Review* 59 (October): 574-603.

Geczy, C., D. Musto, and A. Reed. 2002. Stocks are special too: an analysis of the equity lending market. *Journal of Financial Economics* 66: 241-269.

Hazen, T. 1990. Treatise on the law of securities regulation. West Publishing Co., St. Paul, Minnesota.

Holthausen, R.and D. Larcker. 1992. The prediction of stock returns using financial statement information. *Journal of Accounting and Economics* 15: 373-411.

Holthausen, R., R. Leftwich, and D. Mayers. 1987. The effect of large block transactions on security prices. *Journal of Financial Economics* 19: 237-267.

Jegadeesh, N. and S. Titman. 1993. Returns to buying winners and selling losers: implication of stock market efficiency. *Journal of Finance* 44 (March): 135-148.

Jegadeesh, N. and S. Titman. 2001. Profitability of momentum strategies: an evaluation of alternative explanations. *Journal of Finance* 56, 699-720.

Jones, C. and R. Litzenberger. 1970. Quarterly earnings reports and intermediate stock price trades. *Journal of Finance* 30 (March): 143-148.

Joy, O., R. Litzenberger, and R. McEnally. 1977. The adjustment of stock prices to announcements of unanticipated change in quarterly earnings. *Journal of Accounting Research* 15 (Autumn): 207-225.

Keating, E., T. Lys, and R. Magee. 2003. Internet downturn: finding valuation factors in Spring 2000. *Journal of Accounting and Economics* 34 (January): 189-236.

Keim, D. and A. Madhavan. 1995. Anatomy of the trading prices: empirical evidence on the behavior of institutional traders. *Journal of Financial Economics* 37 (March): 371-398.

Keim, D. and A. Madhavan. 1997. Transactions costs and investment style: an inter-exchange analysis of institutional equity trades. *Journal of Financial Economics* 46 (December): 265-292.

Korajczyk, R. and R. Sadka. 2004. Are momentum profits robust to trading costs? *Journal of Finance* 59 (June): 1039-1082.

Kothari, S.P. 2001. Capital market research in accounting. *Journal of Accounting and Economics* 31 (September): 105-231.

Kraft, A., A. Leone, and C. Wasley. 2004. Research design issues and related inference problems underlying tests of the market pricing of accounting information. Working paper, University of Rochester.

Latane, H. and C. Jones. 1979. Standardized unexpected earnings - 1971-1977. *Journal of Finance* 34 (June): 717-724.

Lee, C. 2001. Market efficiency and accounting research: A discussion of "Capital market research in accounting" by S.P. Kothari. *Journal of Accounting and Economics* 31 (September): 233-253.

Lesmond, D., M. Schill, and C. Zhou. 2004. The illusory nature of momentum profits. *Journal of Financial Economics* 71 (February): 349-380.

Mashruwala, C., S. Rajgopal, and T. Shevlin. 2004. Why is the accrual anomaly not arbitraged away?. Working paper, University of Washington.

Raedy, J. 2000. A reconciliation of stock market anomalies. Working paper, University of North Carolina.

Reed, A. 2003. Costly short-selling and stock price adjustment to earnings announcements. Working paper, University of North Carolina.

Richardson, S. 2003. Earnings quality and short sellers. *Accounting Horizons* 17 (Supplement): 49-61.

Rosenberg, B., K. Reid, and R. Lanstein. 1985. Persuasive evidence of market inefficiency. *Journal of Portfolio Management* 11 (Spring): 9-17.

Securities and Exchange Commission (SEC). 1966. Report of the U.S. Securities and Exchange Commission on the Public Policy Implications of Investment Company Growth.

Sequin, P. and M. Smoller. 1997. Share price and mortality: An empirical evaluation of newly listed NASDAQ stocks. *Journal of Financial Economics* 45: 333-363.

Sloan, R. 1996. Do stock prices fully reflect information in accruals and cash flows about future earnings? *The Accounting Review* 71 (July): 289-315.

Stattman, D. 1980. Book value and stock returns. *The Chicago MBA: A Journal of Selected Papers* 4:25-45.

Table 1
Average annual abnormal returns to trading strategies with and without constraints

Panel A: No price impact adjustment

Strategy	No constraints	Maximum Stake Constraint Only	Maximum Portfolio Weight Constraint Only	Minimum Price Constraint Only	Maximum Price Impact Constraint Only	All Constraints
Book-to-Market	.095*	.001†	.096*	.101*	.093*	.004†
Cash flow-to-Price	.117*	.038*†	.119*	.103*	.116*	.044*†
Return Momentum	.060*	.044*††	.061*	.058*	.066*	.051*
Operating Accruals	.069*	-.009†	.079*	.036*†	.056*	.004†
Return Reversals	.051*	-.019†	.056*	.048*	.061*	.020*††
Size	.016**	-.085†	.017**	.034*	.022*	-.046†
PEAD	.105*	.058*†	.106*	.094*	.103*	.061*†

Panel B: Price impact adjustment

Strategy	No constraints	Maximum Stake Constraint Only	Maximum Portfolio Weight Constraint Only	Minimum Price Constraint Only	Maximum Price Impact Constraint Only	All Constraints
Book-to-Market	.077*†	.011†	.068*†	.071*††	.044*†	-.012†
Cash flow-to-Price	.125*	.046*†	.126*	.085*†	.086*†	.039*†
Return Momentum	.058*	.040*†	.060*	.046*	.031*†	.048*
Operating Accruals	.028*†	-.009†	.019**†	.011†	.001†	.008†
Return Reversals	-.109†	-.029†	-.095†	-.023†	-.114†	-.012†
Size	-.160†	-.078†	-.161†	-.026†	-.059†	-.062†
PEAD	.072*†	.049*†	.072*†	.055*†	.068*†	.047*†

*, ** Significantly positive at the 1%, 5% level, respectively
†, †† Significantly less than unconstrained strategies that are not adjusted for price impacts (the first column of panel A) at the 1%, 5% level, respectively

This table presents mean annual average abnormal returns from 25 actively-managed portfolios based on each trading strategy, with price impact, maximum (5%) stake size, maximum (10%) portfolio weight, minimum ($1) price, and maximum (5%) price impact constraints as indicated. See the Appendix for definitions of the trading strategies. We form random portfolios of stocks on January 3, 1990. Every trading day thereafter, we sell stocks based on a trading strategy sell list and remove delisted stocks. Then we reinvest the proceeds in stocks on the trading strategy buy list, if possible. Otherwise, we reinvest the proceeds in randomly-selected stocks. We compute average annual abnormal returns over a thirteen year period by comparing the returns from the trading strategy portfolio through 2002 to a random benchmark portfolio that starts with the same initial set of stocks, but only buys random firms to replace delisted firms. All portfolios use an equally-weighted allocation scheme, include an automatic sell feature, hold 100 securities throughout, and start with an initial capitalization of $350 million. These fund size characteristics represent the median value for all institutional investors during the first quarter of 1990.

Table 2
Sensitivity of average annual abnormal returns to modifications of portfolio management choices

Strategy	Base Case	Modifications: Value-weighted	No auto-sell feature	$100 M Cap	$3500 M Cap	50 stocks	500 stocks
Book-to-Market	-.012	-.031	.000	.037*	-.008	-.079	.037*
Cash flow-to-Price	.039*	.034*	.007*	.066*	-.002	-.029	.050*
Return Momentum	.048*	.045*	-.008	.042*	.037*	.031*	.042*
Operating Accruals	.008	.006	.005	.036*	-.037	-.054	.029*
Return Reversals	-.012	-.014	-.010	.006	-.011	-.051	-.039
Size	-.062	-.076	-.036	-.054	-.027	-.099	.015*
PEAD	.047*	.044*	.009**	.054*	.063*	.049*	.056*

*, ** Significantly positive at the 1%, 5% level, respectively

This table presents mean annual average abnormal returns from 25 actively-managed portfolios based on each trading strategy, with price impact, maximum (5%) stake size, maximum (10%) portfolio weight, minimum ($1) price, and maximum (5%) price impact constraints included in all portfolios. See the Appendix for definitions of the trading strategies. We form random portfolios of stocks on January 3, 1990. Every trading day thereafter, we sell stocks based on a trading strategy sell list and remove delisted stocks. Then we reinvest the proceeds in stocks on the trading strategy buy list, if possible. Otherwise, we reinvest the proceeds in randomly-selected stocks. We compute average annual abnormal returns over a thirteen year period by comparing the returns from the trading strategy portfolio through 2002 to a random benchmark portfolio that starts with the same initial set of stocks, but only buys random firms to replace delisted firms. The base case portfolios use an equally-weighted allocation scheme, include an automatic sell feature, hold 100 securities throughout, and start with an initial capitalization of $350 million. The base case is modified in each column by changing only the fund characteristic provided in the column heading. For example, the "$100 M Cap" column uses the base case assumptions except with an initial market cap of $100 million instead of $350 million.

Table 3
Regressions of average annual abnormal returns on indicators for implementability factors

Panel A: Model with separate indicators for number of stocks and initial fund capitalization

$AAR = \beta_0 + \beta_1 * CON + \beta_2 * PID + \beta_3 * VWD + \beta_4 * HOLD + \beta_5 * NS50 + \beta_6 * NS200 + \beta_7 * NS500 + \beta_8 * CAP100 + \beta_9 * CAP1000 + \beta_{10} * CAP3500 + \varepsilon.$

	Implementability Factors										
Strategy	Intercept	CON	PID	VWT	HOLD	NS50	NS200	NS500	CAP100	CAP1000	CAP3500
Book-to-Market	.063*	-.041*	-.011*	-.001	-.024*	-.018*	.011*	.012*	.013*	-.008*	-.017*
Cash flow-to-Price	.082*	-.029*	-.003*	-.012*	-.044*	-.008*	.004*	-.004*	.009*	-.009*	-.018*
Return Momentum	.054*	-.002**	-.006*	-.011*	-.050*	-.006*	.000	.002**	.002	-.002	-.003*
Operating Accruals	.028*	-.010*	-.011*	-.007*	-.013*	-.008*	.000	.003**	.006*	-.006*	-.010*
Return Reversals	.009*	.004*	-.049*	.004*	.015*	-.008*	-.002	-.006*	.005*	-.004**	-.008*
Size	-.038*	.015*	-.040*	-.016*	.009*	-.006*	.017*	.036*	.008*	-.007*	-.010*
PEAD	.087*	-.010*	-.023*	-.010*	-.051*	-.003**	-.001	.001	.003*	-.001	-.004*

Panel B: Model with indicators for average dollar per stock initially invested (initial fund capitalization divided by number of stocks)

$AAR = \beta_0 + \beta_1 * CON + \beta_2 * PID + \beta_3 * VWD + \beta_4 * HOLD + \beta_5 * LOWINVEST + \beta_6 * HIGHINVEST + \varepsilon.$

	Implementability Factors						
Strategy	Intercept	CON	PID	VWT	HOLD	LOWINVEST	HIGHINVEST
Book-to-Market	.060*	-.041*	-.011*	-.001	-.024*	.021*	-.017*
Cash flow-to-Price	.077*	-.029*	-.003*	-.012*	-.044*	.009*	-.015*
Return Momentum	.053*	-.002**	-.006*	-.011*	-.050*	.003*	-.005*
Operating Accruals	.026*	-.010*	-.011*	-.007*	-.013*	.005*	-.012*
Return Reversals	.002	.004*	-.049*	.004*	.015*	.009*	-.003**
Size	-.032*	.015*	-.040*	-.016*	.009*	.024*	-.013*
PEAD	.085*	-.010*	-.023*	-.010*	-.051*	.005*	-.001

*, ** Significantly positive at the 1%, 5% level, respectively

This table reports the mean coefficients from regressions of average annual abnormal returns (AAR) from trading strategy portfolios on indicators for various implementability factors and fund characteristics over 25 portfolio runs. We estimate runs on 256 different combinations of implementability factors. We form random portfolios of stocks on January 3, 1990. Every trading day thereafter, we sell stocks based on a trading strategy sell list and remove delisted stocks. Then we reinvest the proceeds in stocks on the trading strategy buy list, if possible. Otherwise, we reinvest the proceeds in randomly-selected stocks. We compute average annual abnormal returns over a thirteen year period by comparing the returns from the trading strategy portfolio through 2002 to a random benchmark portfolio that starts with the same initial set of stocks, but only buys random firms to replace delisted firms. The indicator variables are defined as: CON = 1 if the portfolio includes maximum (5%) stake size, maximum (10%) portfolio weight, minimum ($1) price, and maximum (5%) price impact constraints and 0 otherwise; PID = 1 if the portfolio includes a price impact adjustment and 0 otherwise; VWD = 1 if the portfolio is value-weighted and 0 if equal-weighted; HOLD = 1 if the portfolio does not include an automatic sell feature and 0 otherwise; NS50 (NS200) [NS500] = 1 if the fund holds 50 (200) [500] stocks and 0 if 100 stocks; CAP100 (CAP1000) [CAP3500] = 1 if the fund has an initial capitalization of $100 ($1000) [$3500] million and 0 if $350 million; LOWINVEST (HIGINVEST) = 1 if the average initial investment per stock is less than $2 million (greater than $10 million).

Table 4
Sensitivity of average annual abnormal returns to research design choices

Panel A: Unconstrained with no price impact adjustment

		Modifications			
Strategy	Base Case	1992 Start Date	Buys based on strategy variable	Allow growth in portfolio	Buy all firms on list
Book-to-Market	.095*	.108*	.092*	.096*	.083*
Cash flow-to-Price	.117*	.094*	.133*	.119*	.093*
Return Momentum	.060*	.066*	.024*	.062*	.070*
Operating Accruals	.069*	.077*	.081*	.057*	.068*
Return Reversals	.051*	.068*	.084*	.047*	.024*
Size	.016**	.017*	.001	.026*	.079*
PEAD	.105*	.097*	.191*	.112*	.115*

Panel B: Constrained with price impact adjustment

		Modifications			
Strategy	Base Case	1992 Start Date	Buys based on strategy variable	Allow growth in portfolio	Buy all firms on list
Book-to-Market	-.012	.005	-.014	.039*	.055*
Cash flow-to-Price	.039*	.041*	.033*	.058*	.048*
Return Momentum	.048*	.045*	.029*	.047*	.064*
Operating Accruals	.008	.026*	.025*	.019*	.040*
Return Reversals	-.012	.024*	-.008	-.001	-.033
Size	-.062	-.071	-.071	-.044	-.051
PEAD	.047*	.044*	.098*	.054*	.062*

*, ** Significantly positive at the 1%, 5% level, respectively

This table presents mean annual average abnormal returns from 25 actively-managed portfolios based on each trading strategy. Panel A reports returns to portfolios that are not adjusted for price impacts and are not constrained by stakeholder size, portfolio weight, minimum price, or maximum price impact constraints. Panel B reports returns to portfolios that are adjusted for price impacts and are constrained by stakeholder size, portfolio weight, minimum price, or maximum price impact constraints. All the portfolios use an equally-weighted allocation scheme, hold 100 securities throughout, and start with an initial capitalization of $350 million. See the Appendix for definitions of the trading strategies. We form random portfolios of stocks on January 3, 1990. Every trading day thereafter, we sell stocks based on a trading strategy sell list and remove delisted stocks. Then we reinvest the proceeds in stocks on the trading strategy buy list, if possible. Otherwise, we reinvest the proceeds in randomly-selected stocks. In the base case, we compute average annual abnormal returns over a thirteen year period by comparing the returns from the trading strategy portfolio through 2002 to a random benchmark portfolio that starts with the same initial set of stocks, but only buys random firms to replace delisted firms. The base case is modified in each column by changing only the fund characteristic provided in the column heading. "1992 start date" changes the initial portfolio formation date from January 3, 1990 to January 2, 1992. "Buys base on strategy variable" replaces the random purchases off the buy list with an ordered purchase approach, based on the magnitude of the strategy variable. "Allow growth in portfolio" allows a 10 stock per year growth in portfolio size as opposed to the base case which allows no growth. "Buy all firms on list" purchases each firm that is on the buy list, even if it results in many stocks in the portfolio.

Table 5
Average annual abnormal returns to trading strategies that include short selling

Panel A: Unconstrained with no price impact adjustment

Strategy	Base Case – no short selling	Base Case – with short selling	Modifications: Allow transactions in special securities	Modifications: Allow unlimited losses	Modifications: Allow short positions greater than 2%
Book-to-Market	.095*	.079*	.055*	.076*	.080*
Cash flow-to-Price	.117*	.095*	.097*	.089*	.092*
Return Momentum	.060*	.035**	.052*	.035*	.036*
Operating Accruals	.069*	.030*	.034*	.039*	.033*
Return Reversals	.051*	.028**	.002	.008	.025**
Size	.016**	.028*	.012**	.001	.009
PEAD	.105*	.100*	.099*	.078*	.097*

Panel B: Constrained with price impact adjustment

Strategy	Base Case – no short selling	Base Case – with short selling	Modifications: Allow transactions in special securities	Modifications: Allow unlimited losses	Modifications: Allow short positions greater than 2%
Book-to-Market	-.012**	-.037*	-.059*	-.029*	-.068*
Cash flow-to-Price	.039*	.028*	.020*	.033*	.024*
Return Momentum	.048*	.006	.032*	.010	.004
Operating Accruals	.008	-.005	-.010**	.001	-.012*
Return Reversals	-.012**	-.032*	-.044*	-.096*	-.041*
Size	-.062*	-.210*	-.247*	-.032*	-.226*
PEAD	.047*	.055*	-.052*	.040*	-.009

*, ** Significantly positive at the 1%, 5% level, respectively

This table presents mean annual average abnormal returns from 25 actively-managed portfolios based on each trading strategy. Panel A reports returns to portfolios that are not adjusted for price impacts and are not constrained by stakeholder size, portfolio weight, minimum price, or maximum price impact constraints. Panel B reports returns to portfolios that are adjusted for price impacts and are constrained by stakeholder size, portfolio weight, minimum price, or maximum price impact constraints. All the portfolios use an equally-weighted allocation scheme, hold 100 securities throughout, and start with an initial capitalization of $350 million. See the Appendix for definitions of the trading strategies. We form random portfolios of stocks on January 3, 1990. Every trading day thereafter, we sell stocks based on a trading strategy sell list and remove delisted stocks. We also take short positions based upon certain constraints. We reinvest the proceeds from the sale of stocks in the trading strategy buy list, if possible. Otherwise, we reinvest the proceeds in randomly-selected stocks. We compute average annual abnormal returns over a thirteen year period by comparing the returns from the trading strategy portfolio through 2002 to a random benchmark portfolio that starts with the same initial set of stocks, but only buys random firms to replace delisted firms. The short selling base case allows short selling assuming that positions are not taken in firms that we predict to be on special, that positions are reversed when a 10 percent loss has been incurred, and the magnitude of the short position is limited to 2 percent of the outstanding shares. Otherwise, it is the same as the base case without short selling. The additional three columns alter these assumptions, one at a time.

Table 6
Regressions of average annual abnormal returns to short selling portfolios on indicators for implementability factors

Panel A: Model with only short selling portfolios

AAR = $\beta_0 + \beta_1$ * CON + β_2 * PID + β_3 * VWD + β_4* LOWINVEST + β_6 * HIGHINVEST + ε.

	Implementability Factors					
Strategy	Intercept	CON	PID	VWT	LOWINVEST	HIGHINVEST
Book-to-Market	.085*	-.056*	-.027*	.000	.021*	-.023*
Cash flow-to-Price	.073*	-.029*	-.007*	-.024*	.014*	-.020*
Return Momentum	.041*	-.007	-.008*	-.020*	-.001	-.003
Operating Accruals	.038*	-.020*	-.021*	-.014*	.009*	-.013*
Return Reversals	.094*	-.077*	-.107*	.043*	.001	-.043*
Size	.082*	-.071*	-.089*	-.007**	-.014*	-.051*
PEAD	.093*	-.019*	-.013*	-.026*	-.003*	.001

Panel B: Model with portfolios that do and do not include short sale transactions

AAR = $\beta_0 + \beta_1$ * CON + β_2 * PID + β_3* SSELL + β_4 * VWD + β_5 * LOWINVEST + β_6 * HIGHINVEST + ε.

	Implementability Factors						
Strategy	Intercept	CON	PID	SSELL	VWT	LOWINVEST	HIGHINVEST
Book-to-Market	.077*	-.063*	-.021*	.006*	.000	.027*	-.026*
Cash flow-to-Price	.091*	-.044*	-.006*	-.013*	-.020*	.014*	-.024*
Return Momentum	.060*	-.004	-.007*	-.022*	-.019*	.001	-.007**
Operating Accruals	.042*	-.023*	-.020*	-.001	-.014*	.008*	-.020*
Return Reversals	.026*	-.014**	-.092*	.034*	.019*	.006*	-.005*
Size	.001	-.002	-.079*	.029*	-.012*	.010*	-.021*
PEAD	.094*	-.017*	-.019*	-.004	-.021*	.002	-.003

*, ** Significantly positive at the 1%, 5% level, respectively

This table reports the mean coefficients from regressions of average annual abnormal returns (AAR) from trading strategy portfolios on indicators for various implementability factors and fund characteristics over 25 portfolio runs. We estimate runs on 24 (48) different combinations of implementability factors in panel A (B). We form random portfolios of stocks on January 3, 1990. Every trading day thereafter, we sell stocks based on a trading strategy sell list and remove delisted stocks. We also take short positions based upon certain constraints. We reinvest the proceeds from the sale of stocks in the trading strategy buy list, if possible. Otherwise, we reinvest the proceeds in randomly-selected stocks. We compute average annual abnormal returns over a thirteen year period by comparing the returns from the trading strategy portfolio through 2002 to a random benchmark portfolio that starts with the same initial set of stocks, but only buys random firms to replace delisted firms. The indicator variables are defined as: CON = 1 if the portfolio includes maximum (5%) stake size, maximum (10%) portfolio weight, minimum ($1) price, and maximum (5%) price impact constraints and 0 otherwise; PID = 1 if the portfolio includes a price impact adjustment and 0 otherwise; VWD = 1 if the portfolio is value-weighted and 0 otherwise; LOWINVEST (HIGINVEST) = 1 if the average initial investment per stock is less than $2 million (greater than $10 million); SSELL = 1 if the portfolio includes short sale transactions.