Shedding Light on "Invisible" Costs: Trading Costs and Mutual Fund Performance

Roger Edelen

Roger Edelen is associate professor of finance at the University of California, Davis.

Richard Evans

Richard Evans is assistant professor of business administration at the Darden School of Business, University of Virginia, Charlottesville.

Gregory Kadlec

Gregory Kadlec is the R.B. Pamplin Professor of Finance at Virginia Tech, Blacksburg.

Industry observers have long warned of the "invisible" costs of fund trading, yet evidence that these costs matter is mixed. This is because many studies do not account for the largest trading cost component – price impact. Using portfolio holdings and transaction data, the authors find that funds' annual trading costs are on average larger than their expense ratio and negatively affect performance. They also develop an accurate but computationally simple trade cost proxy—position-adjusted turnover.

The expense ratio is one of the few reliable predictors of mutual fund return performance; and the increasing market share of low-cost index and exchange-traded funds suggests that investors use this information when making investment decisions. However, as noted by John Bogle and other prominent industry observers, the expense ratio captures only the "visible" (i.e., reported) costs of mutual funds. Funds incur a host of "invisible" costs that are less transparent to investors—most notably, the transaction costs associated with changes to portfolio holdings.

In our study, we estimated funds' annual expenditures on trading costs and examined the impact of those costs on fund return performance. Largely following the methodology in Chalmers, Edelen, and Kadlec (1999), we developed a detailed position-by-position measure of funds' annual expenditures on trading costs by using fund portfolio holdings data, transaction-level securities data, and U.S. SEC filings. First, we used quarterly portfolio holdings data to determine each fund's position changes on a stock-by-stock basis. Second, for each position change, we applied an estimate of the cost (brokerage commission, bid–ask spread, and price impact) of trading that amount of that stock in that quarter. Third, we computed each fund's annual expenditure on trading costs by aggregating the costs of all trades for that fund over the year. We applied this approach to our sample of 1,758 domestic equity funds over 1995–2006.

Discussion of findings.

We found that funds' annual expenditures on trading costs (hereafter, aggregate trading costs) were comparable in magnitude to the expense ratio (1.44% versus 1.19%, respectively). Moreover, funds' aggregate trading costs displayed considerably more cross-sectional variation than did expense ratios. For example, the difference in average expense ratio for small-cap growth and large-cap value funds was 0.32 percentage points (1.39% versus 1.07%), whereas the difference in average aggregate trading costs for the same funds was 2.33 percentage points (3.17% versus 0.84%).

The more important question concerns how funds' expenditure on trading costs relates to return performance. If funds are able to recover these costs with superior returns, these expenditures might enhance overall (net) performance. This, however, does not appear to be the case. We found a strong negative relation between aggregate trading cost and fund return performance. **Figure 1** shows the average risk-adjusted performance of the sample, sorted by various fund characteristics. Sorting funds by expenses, fund total net assets, or turnover (the most common trading-cost proxy) yields no consistent pattern of returns. In stark contrast, sorting funds on the basis of their aggregate trading-cost estimate yields a clear monotonic pattern of decreasing risk-adjusted performance as fund trading costs increase. The difference in average annual return for funds in the highest and lowest quintile of aggregate trading cost is –1.78 percentage points.

Given the power of aggregate trading cost in predicting fund performance, widespread availability of this metric would be useful to investment decision makers. Unfortunately, direct estimates of fund trading costs are difficult to come by for reasons of both data availability and computational complexity. Thus, we sought a simpler means of estimating fund trading costs by using readily available data. The most readily available metric to proxy for trading costs, used by both academics and practitioners, is fund turnover.[1] However, the empirical evidence on the relation between fund turnover and return performance is ambiguous. Turnover is negatively related to performance in some studies, positively related to performance in other studies, and unrelated to performance in yet other studies.[2]

We conjectured that the ambiguous relation between turnover and performance is due to the fact that turnover does not account for the differential cost of fund trades—which depends on fund size (i.e., trade size) and stock liquidity (i.e., small cap versus large cap). For example, a $500 million small-cap fund with 50% turnover will have much higher trading costs than a $100 million large-cap fund with 100% turnover, despite the former's lower turnover. Thus, we considered a simple adjustment to turnover that addresses this underlying deficiency. We computed *position-adjusted turnover* by multiplying each fund's turnover by its relative position size. A fund's

[1]A required disclosure of mutual funds, fund turnover is calculated as the minimum of fund purchases and sales over the period divided by the average monthly fund total net assets over the same period.

[2]Some researchers found an insignificant relation between fund performance and turnover (Ippolito 1989; Elton, Gruber, Das, and Hlavka 1993; Chen, Hong, Huang, and Kubik 2004). Others found a significant positive relation (Grinblatt and Titman 1994; Wermers 2000; Chen, Jegadeesh, and Wermers 2000; Kacperczyk, Sialm, and Zheng 2008). Carhart (1997) documented a significant negative relation. Edelen (1999) and Alexander, Cicci, and Gibson (2007) found that fund performance is positively related to discretionary turnover and negatively related to nondiscretionary (flow-driven) turnover.

relative position size is equal to its average position size (total net assets divided by number of holdings) divided by the average position size of all funds in its market-cap category. Relative position size captures the price impact of the fund's trades—the largest component of a fund's trading costs.

As with our aggregate trading cost measure, our simplified proxy is consistent with microstructure theory regarding determinants of trading costs and is strongly negatively related to fund performance. As Figure 1 shows, the difference in average annual return for funds in the highest and lowest quintiles of position-adjusted turnover is –1.92 percentage points. Overall, our results suggest that trading costs are an important determinant of fund performance, and our simple proxy for trading costs can be used by investors and researchers alike.

Data

Our initial sample included 3,799 open-end domestic equity mutual funds[3] over 1995–2006 with quarterly portfolio holdings data from Morningstar. We applied three constraints to arrive at our final sample. First, because we had only transaction-level data necessary for estimating the trading costs of domestic equities, we restricted our sample to funds with at least 90% domestic equity. Second, we eliminated the first three years of each fund's data because incubated funds have upwardly biased returns (Evans 2010). Finally, as in previous studies, we excluded sector funds and funds with less than $20 million in total net assets (TNA). Our final sample comprised 1,758 funds, with an average of 578 in a given quarter.

Table 1 reports summary statistics for fund size, turnover, and risk-adjusted performance in our sample. To calculate risk-adjusted fund performance, we used a four-factor model:

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[3]In our analysis, we aggregated all the various classes of the fund into a single fund observation.

$$\left(R_{i,t}-R_t^{TBill}\right)=\alpha_i+\beta_i^{HML}\left(R_t^{Mkt}-R_t^{TBill}\right)+\beta_i^{SMB}R_t^{SMB} \\ +\beta_i^{HML}R_t^{HML}+\beta_i^{Mom}R_t^{Mom}+\varepsilon_{i,t}. \tag{1}$$

The model includes four return factors: the market (Mkt), market-cap (SMB = small minus big), and book-to-market (HML = high minus low) factors proposed by Fama and French (1993), plus the momentum factor (Mom) proposed by Carhart (1997). Because the number of funds tended to be larger in later years, we first computed estimates within each quarter and then averaged across quarters to avoid skewing the data toward later years. Sample statistics on fund size (TNA), turnover, and performance were typical of other studies.

Methodology: Aggregate Trading Cost (Fastidiously Measured)

Using a comprehensive treatment of available data to assess trading costs directly, we first examined quarterly portfolio holdings data to determine position changes on a stock-by-stock basis for each fund quarter. We then applied an estimate of the brokerage commission, bid–ask spread, and price impact for each position change. We aggregated these cost estimates for all trades (more precisely, quarterly portfolio changes) made by the fund over the year to obtain our fastidious estimate of annual trading costs.

Trading Volume.

We estimated trading volume on a stock-by-stock basis from changes in quarterly portfolio holdings adjusted for stock splits and stock mergers. One limitation of using quarterly portfolio holdings to infer trades is the slippage that occurs when a stock is bought and sold between disclosure dates. To minimize the incidence of such missed trades, we excluded observations in which the time between reported holdings was more than 100 days. For approximately 76% of our sample, we had the total purchases and sales volume from the SEC Form N-SAR filings and could thus track slippage. Using these data, we found that changes in portfolio holdings capture an average (median) of 82% (86%) of actual fund trading volume. Therefore, in our descriptive statistics for trading volume, we applied a linear scaling factor of 1.2 (1/82%) to the trading volume inferred from quarterly holdings. Using this adjustment, we estimated an average annual trading volume of 177% of TNA for the whole sample.

Brokerage Commissions.

Brokerage commissions are payments made to brokerage firms for executing trades. We obtained data on the funds' overall brokerage commissions, paid quarterly, from N-SAR reports filed with the SEC. We then prorated these aggregate brokerage commissions down to individual trades according to a statistical model that relates commissions to characteristics of the fund and its trades.[4] Where a matched N-SAR filing was not found, brokerage data were unavailable. In those cases, we estimated the missing brokerage commissions by using the statistical model that relates brokerage commissions to fund and trade characteristics. Thus, for each position change, we had an estimate of the associated percentage brokerage commission, which reflects either a proration of directly observed commissions or the typical commission for a trade of that nature.

As **Table 2** shows, this interpolation affects only 24.1% of the observations and commission costs represent less than 20% of trading costs. Hence, the noise introduced by this scheme is likely immaterial. Nevertheless, in untabulated results, we repeated the main analyses in our study without using this interpolation scheme and found no qualitative difference.

Bid–Ask Spread.

The effective bid–ask spread is the absolute-value difference between the price at which a stock trades and its most recent quote midpoint. This difference indicates the minimal cost of trading one share. Using transaction prices and bid–ask quotes from the NYSE Trade and Quote (TAQ) database, we

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[4]Edelen, Evans, and Kadlec (2012) used a similar model. The details of our brokerage commission model are provided in Appendix A.

computed the average effective spread for each stock in each quarter (see Appendix A for the details of this calculation). For each quarterly position change in each fund, we allocated a cost (percentage of dollars traded) equal to the effective spread estimate for the corresponding stock and quarter.

Price Impact.

In addition to paying brokerage commissions and bid–ask spreads, institutions face an even larger cost in the price impact of their trades. A large position change typically involves dozens—if not hundreds—of separate trades that take place over perhaps several days. Price impact refers to the fact that every time a purchase is made, the next bid–ask quote tends to be a little higher, and every time a sale is made, the next bid–ask quote tends to be a little lower. Thus, when a mutual fund acquires a position, it generally pays an increasingly higher price for each incremental purchase. The magnitude of the price impact depends on the size of the position change. Following Hasbrouck (2009), we estimated the price impact coefficient, λ_{it}, for stock i in quarter t from the following time-series regression of changes in quote midpoints on the square root of signed trading volume, using all nonoverlapping 15-minute intervals in the quarter:

$$\Delta M_{itp} = \lambda_{it}\sqrt{V_{itp}} + U_{itp}, \tag{2}$$

where ΔM_{itp} is the change in midpoint of the bid–ask quotes and V_{itp} is the signed trading volume for stock i in quarter t over interval p. Following Lee and Ready (1991), we signed the trades by using the quote midpoint preceding the trade. The median estimate of λ_{it} is 0.00004, which implies that a trade of 5,000 shares (the median quarterly change in shares held) has a price impact of 28 bps.[5]

[5]As noted in Hasbrouck (2009), estimates of price impact have extreme observations that seem implausible. For example, the 99th percentile for our estimate of λ_{it} is 0.0007, which implies

Note that applying these price impact coefficients to quarterly position changes yields a *proxy* for the cumulative price impact of the fund's trades. Position changes are usually executed over multiple trades, which accumulate price impact at a rate that may be greater or less than the Hasbrouck square root specification. Indeed, researchers have used other functional forms, such as a log transformation (Edelen and Gervais 2003). However, our approach represents a first-order attempt to incorporate trade size into the price impact component of per unit cost.

Aggregate Trading Cost.

Our fastidious measure of aggregate trading cost involves multiplying the per unit cost of each trade (quarterly portfolio change) for each fund in each quarter times the dollar value of the trade and summing across all trades for the fund quarter.

Methodology: Position-Adjusted Turnover (Simplified)

While comprehensive, our aggregate trading-cost measure is difficult to estimate given the substantial data and computational requirements, which make it inaccessible to individuals and, indeed, to most academic studies. In contrast, turnover—defined as the minimum of fund purchases and sales divided by TNA—is widely available because funds are required to disclose it in their semi-annual fund filings. However, turnover is limited in that it does not give any consideration to per unit cost. Thus, we explored a simplified hybrid approach that adjusts turnover on the basis of estimated variations in per unit cost.

We first computed the average dollar value of each portfolio holding (a statistic that we called the fund quarter's *position size*) by dividing the fund's TNA by the number of stocks in the portfolio. Intuitively, aggregate trading cost should depend on the size of *changes* in position rather than position size. The

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that a trade of 5,000 shares has a price impact of 5%. Thus, we truncated all estimates of λ_{it} above the 95th percentile.

two are highly correlated (0.88), however, and position size is much simpler to compute—instead of changes to the portfolio, only the fund's TNA and the total number of holdings are required. Ascertaining position-adjusted turnover involves the following three-step computation: (1) Calculate the average position size for the fund by dividing the fund's TNA by its total number of holdings, (2) compute the percentile rank of the fund's average position size relative to all other funds in a given market-cap category (i.e., small, mid, or large) in a given quarter, and (3) take the product of this percentile and the fund quarter's turnover to obtain the position-adjusted turnover.

Estimates of Aggregate Trading Cost

Table 2 reports the buildup of our estimates of funds' aggregate trading costs (columns 1–7), as well as a comparison of those costs with the expense ratio (columns 8 and 9). Column 1 shows the average annual trading volume (buys plus sells), as a percentage of TNA, for various fund subsets. The next four columns present the three components of per unit trading cost—brokerage commission, bid–ask spread, and price impact—plus their sum (column 5). Columns 6 and 7 present the mean and standard deviations of the combined aggregate trading-cost estimates, reflecting both the volume and per unit cost of the funds' trades, summed across all changes in quarterly portfolio holdings (annualized).

First, let us consider per unit costs. In Table 2 (column 5), we can see that the average per unit trading cost is 80 bps (one-way). Price impact dominates in both magnitude and variation across categories, although spread, the other market component, also varies materially. In general, per unit trading costs are strongly related to the market capitalization of stocks (small, mid, large) but not to style (i.e., growth/value). For example, the average per unit trading cost of large-cap funds is 48 bps, and the average per unit trading cost of small-cap funds is 153 bps. Fund size (TNA) plays a role in trading costs, because estimated per unit trading costs are more than 30 bps higher for large funds than for small funds.

To provide another point of comparison, we obtained per unit cost estimates for 2004 from Plexus Consulting Group, a consultant on institutional trading costs. Our estimates for large-, mid-, and small-cap funds in 2004 were 23, 34, and 66 bps, respectively, versus the Plexus estimates of 42, 51, and 89 bps. Although our per unit cost estimates are somewhat lower, they capture variations across market-cap categories well. One possible reason for the discrepancy in levels is the square root specification of Equation 2, which may understate the cumulative effects of price impact because an overall change in position is executed over multiple waves of trading. Our evidence from using position-adjusted turnover supports that conjecture.

We computed aggregate trading costs (columns 6 and 7), per fund quarter, by adding up, trade by trade, the product of trade size and the estimated per unit cost for each trade. We then annualized that figure. Aggregate trading costs average 144 bps a year, which is somewhat higher than the average expense ratio of 119 bps. However, the variation in aggregate trading costs across categories is substantially greater than the variation in expense ratios. For example, estimated trading costs range from 61 bps (large-cap blend funds) to 317 bps (small-cap growth funds), whereas the corresponding average expense ratios range from 98 bps to 139 bps.

Table 2 highlights the importance of considering both per unit costs and trading volume in forming trading-cost proxies. For instance, large-cap growth funds have higher average trading volume than do small-cap value funds (187% versus 150%) but a substantially lower aggregate trading cost (97 bps versus 229 bps), which suggests a counterintuitive *negative* relation between trading volume and aggregate trading cost. Likewise, small funds (TNA < median) trade more than large funds but have a lower estimated aggregate trading cost. Both examples point to the tendency to trade more when per-unit trading costs are relatively low. This can lead to a positive relation between turnover and fund returns even if trading does not add value, because high turnover funds may have *lower* aggregate trading costs.

Evaluation of Proxies: Consistency with Microstructure Theory

We then evaluated these two trading-cost proxies—and turnover—on the basis of how effectively they line up with portfolio characteristics that both microstructure theory and economic intuition suggest should influence trading costs. In general, a proper measure of trading costs is expected to relate negatively to the average share price, market capitalization, and trading volume of the individual stocks in the fund's portfolio and relate positively to the fund's trading volume and trade size.[6] Thus, we regressed each trading-cost proxy on these five fund characteristics to assess how well each conforms to the predictions of microstructure theory.

The results are summarized in **Table 3**. We used the technique of Fama and MacBeth (1973) for all regressions, though we present both univariate and multivariate results. Our Fama–MacBeth regressions involved a cross-section of funds over many quarters. Rather than pooling all the data and running one regression, we ran a separate regression for each quarter, which determined the cross-sectional relation among the funds for that quarter. This approach yielded 44 estimates, one for each quarter. We then averaged these 44 quarterly estimates to obtain the final estimate, which helped avoid (1) overweighting later periods owing to the increasing number of fund observations over time and (2) distorted *t*-statistics owing to cross-correlation of returns. Because the 44 quarterly coefficients might exhibit time-series correlation that incorrectly inflates *t*-statistics, we used the procedure of Newey and West (1987) to correct the *t*-statistics.

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[6]See, for example, Demsetz (1968); Stoll (1978a, 1978b); Glosten and Milgrom (1985); Kyle (1985).

To alleviate multicollinearity concerns, we present a univariate specification, in which the relation between each of the three proxies (Panels A, B, and C of Table 3) is related to each characteristic in five separate regressions. Conversely, to highlight the marginal relations while controlling for cross-correlations across characteristics, we also present a multivariate specification, in which the relation to all five characteristics is estimated in a single regression (one for each of three trading-cost proxies in Panels A, B, and C). The first three characteristics are at the stock level: Market Cap is the average of the log market capitalization of stock holdings, Stock Volume is the average of median daily share volume across stock holdings over the previous quarter, and 1/Price is the inverse of the average log share price of stock holdings. The last two are at the fund level: Fund Volume is the quarterly trading volume as a fraction of TNA, and Trade Size is the average dollar trade size. We do not present the coefficient estimates, just their *t*-statistics. The sign below each *t*-statistic indicates the predicted sign. Estimates that align with the predicted sign with at least 95% confidence are labeled "Yes" for consistency. Statistically significant contrary results are labeled "No."

Generally, the fastidious aggregate trading-cost measure aligns well with economic intuition. The coefficient sign is always as predicted, with confidence typically exceeding 99.9%, the exception being the market-cap regressor in the multivariate regression. Position-adjusted turnover also aligns well with economic intuition and theory regarding trading costs, though not quite as robustly as the fastidious measure. The exception is the coefficient on liquidity (Stock Volume). In contrast, turnover does not align well with theoretical determinants of trading costs. In 5 out of 10 cases, the estimate is either contrary to prediction (multivariate) or not reliably aligned with the prediction (univariate). The offending cases concern the liquidity (Stock Volume and 1/Price) of the stock and the size of the fund's trades. Presumably, these results highlight the endogenous nature of trading; funds that face higher per unit costs are expected to trade less. This endogeneity appears to substantially undermine turnover's effectiveness as a trading-cost proxy. The evidence in Table 3, however, provides a substantial basis for concluding that both the fastidious aggregate trading cost and the position-adjusted turnover simplification meaningfully proxy for trading costs.

Returns

Having considered the degree to which one can reasonably expect trading-cost proxies to capture trading costs, we then examined their association with fund performance. We considered both a univariate relation to demonstrate the dominant effects and a multivariate analysis that more precisely captures the incremental effects of trading costs. In both cases, our analysis was predictive—that is, we related the trading-cost proxy to future fund returns.

The univariate analysis is presented in Figure 1. For each quarter, we sorted funds into quintiles on the basis of five different ranking variables and then computed the average one-quarter-ahead abnormal return within each quintile. The figure presents the time-series average of these quarterly averages. The first three sort variables are turnover and two commonly used fund characteristics: expenses and fund size (TNA). The last two are our trading-cost measures: fastidious aggregate trading cost and the simplified position-adjusted turnover.

Sorting fund performance by aggregate trading cost or position-adjusted turnover clearly identifies a net negative impact of trading costs on performance. Indeed, Figure 1 indicates that either measure provides a powerful and monotonic sort on future fund performance. In contrast, turnover, expenses, and fund size each yield an ambiguous, or u-shaped, relation to future returns. In these cases, the sorting appears to be somewhat useful, but it is not nearly as clean or convincing as the sorts with our two trading-cost measures.

Although the univariate analysis in Figure 1 presents a clear picture, confounding cross-effects may be distorting or driving the relations. Therefore, we repeated the analysis in a multivariate regression context to ensure robustness (**Table 4**). We considered a variety of specifications (columns 1–5), but the dependent variable in each case was the one-quarter-ahead, four-factor, risk-adjusted fund return net of expenses. All explanatory variables were lagged observations. As in Table 3, we used the Fama–MacBeth (1973) regression procedure.

We used lagged independent variables both to obtain a predictive analysis and to avoid concerns of reverse causality. This approach is important for two reasons. First, fund flows exhibit a well-documented tendency to chase past returns. Because cross-sectional variations in flows generate cross-sectional variations in trading, the concurrent relation between trading volume (or trading costs) and return performance is positively biased (Edelen 1999). Second, many studies have documented a positive correlation between institutional trading and a stock's prior return performance (see, e.g., Griffin, Harris, and Topaloglu 2003; Lipson and Puckett 2010). This lag dependence of trading on past returns can cause a positive bias between trading volume and fund returns if the relation is concurrent, particularly at a quarterly frequency.

Table 4 reports the regression results. The first regression (column 1) confirms the general finding in the literature that turnover is not statistically reliably related to fund returns. Although the coefficient estimate is negative, the *t*-statistic is insignificant (–1.0). The second regression (column 2) examines aggregate trading cost. Note that the scale of this variable is much different from that of turnover—hence, the smaller coefficient. However, the estimate is statistically significant at conventional levels, indicating that trading costs indeed negatively predict fund abnormal returns (i.e., the average fund does not recover trading costs by way of superior stock selection). This result contrasts with turnover (where no reliable relation is seen) because aggregate trading cost incorporates the per unit cost of each trade. As demonstrated earlier (Table 2), per unit costs can run counter to the volume of trade. Because turnover focuses only on the latter, it misses an important determinant of trading costs.

Column 3 of Table 4 presents the return-regression analysis of position-adjusted turnover. Position-adjusted turnover is an interaction of turnover and a proxy for the per unit cost of trade in a given fund quarter. Hence, we included turnover as a separate explanatory variable to specify the regression properly. The interpretation of the statistically significant negative coefficient of position-adjusted turnover is that the performance effect of trading costs is high for funds that hold relatively large positions and trade frequently (i.e., high turnover). In contrast, when the fund holds relatively small positions, the performance effect of trading costs is immaterial. Recall from Table 3 that position-adjusted turnover lines up well with theoretical determinants of trading costs, lending confidence to the view that the evidence does indeed pertain to trading costs.

The remaining two regressions in Table 4 (columns 4 and 5) provide an analysis of the robustness of the various trading-cost proxies to alternative specifications. In particular, rather than interacting the various per unit cost and activity measures, we separately included each component as a stand-alone explanatory variable. In each case, the significance of the trading-cost proxy's explanatory power is lost. For instance, comparing Regression 4 with Regression 2 or Regression 5 with Regression 3, we can identify a statistically reliable detrimental effect on performance only when per unit costs and trading volume are considered jointly.

The message of Table 4 is that an effective trading-cost proxy must account for both trade volume and per unit trading costs *interacted*. Taken literally, as in the fastidious aggregate trading-cost measure, this approach involves substantial data and computational requirements. Position-adjusted turnover, however, offers a simple approximation that appears to provide a highly effective substitute for the fastidious calculations. Moreover, it also offers an intuitive interpretation: The return impact of trading is negligible when a fund's relative position size is small, but it is substantial and negative when a fund's relative position size is large. Overall, we conclude that so-called invisible trading costs have a material and negative effect on fund returns.

Conclusion

Contrary to the literature, our results suggest that invisible trading costs have a detrimental effect on fund performance that is at least as material as that of the (visible) expense ratio. However, the commonly used proxy of turnover fails to identify this effect statistically reliably because it does not jointly consider trading volume and per unit costs. Assessing turnover on the basis of consistency with market microstructure considerations confirms this interpretation: Turnover fails to line up with microstructure theory. But because our fastidiously constructed aggregate trading-cost estimate accounts for both per unit costs and trading activity, it aligns well with microstructure theory. Unfortunately, it is computationally infeasible except in a large-scale study such as this one. To address this issue, we offer a simple alternative that performs well. This alternative—position-adjusted turnover, or turnover multiplied by a measure of the fund's average position size relative to peer funds—is both effective and easy to compute.

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2006 ReFlow Symposium, 2006 Investment Management Consultants Association Conference, 2006 ICI Small Fund Conference, and 2005 Plexus Group Conference.

Appendix A. Computing Brokerage Commissions and Effective Spreads

In this appendix, we describe the steps that we took to estimate both brokerage commissions and effective bid–ask spreads for the funds in our sample.

Brokerage Commissions

Although we estimated price impact and bid–ask spreads from trade-level data on the underlying securities held by the mutual funds, our estimates of brokerage commissions came from each fund's semi-annual N-SAR filing. The full details of the brokerage commission database that we used are given in Edelen, Evans, and Kadlec (2012).

Each fund's semi-annual N-SAR filing contained data on total brokerage commission payments and the dollar value of purchases and sales associated with those commissions. To compute the brokerage commission rate, we took the quotient of brokerage commissions and the sum of fund purchases and sales for the 75.9% of the sample for which we had N-SAR filing data (19,306 out of 25,423 quarterly fund observations). Because of the limited availability of commission data, we modeled the determinants of commissions for the matched portion of our sample and then used the coefficients from that model to extrapolate commission rates for those funds without N-SAR data. The coefficients from this regression model are shown in **Table A1**.

The dependent variable in the regression is the brokerage commission rate. The independent variables are the fund's expense ratio, the natural log of fund and family size, the natural log of the average price of the shares traded, and an indicator variable for whether the fund is sold with a load. The coefficients of fund size and fees are positive, consistent with previous research (see Livingston and O'Neal 1996; Edelen, Evans, and Kadlec 2012). Commissions decrease with fund family size, consistent with economies of scale or greater bargaining power on the part of fund families. Not surprisingly, the most statistically significant regressor is the average price of the shares traded by the fund. Commissions are related to the price of the stocks traded because they are generally a fixed charge per share traded, which would account for the negative coefficient of this variable.

Using these regression coefficients, we estimated commission rates for those funds without commission data. The adjusted R^2 of the estimation regression (13%) suggests a fairly high degree of noise in the extrapolation. After omitting brokerage commissions from the aggregate trading-cost measure and after removing all observations with missing N-SAR data, we reran the performance regressions, and the (unreported) results were qualitatively unchanged.

Effective Spreads

We estimated the volume-weighted average effective spread, VWS_{it}, for stock i in quarter t, using all valid transactions k during the quarter, as follows:

$$VWS_{it} = \sum_{k=1}^{K}\left(\left|\frac{P_{ik} - M_{ik-}}{M_{ik-}}\right| V_{ik} \Big/ \sum_{k=1}^{K} V_{ik}\right),$$

where P_{ik} is the transaction price, M_{ik-} is the midpoint of the bid–ask quotes immediately preceding transaction k, and V_{ik} is the number of shares traded. After computing the spread for each stock in each quarter, we allocated a bid–ask spread cost (percentage of dollars traded) to each quarterly position change for all funds by using the average effective spread for each stock in each quarter.

In estimating effective spreads, we used only valid data—that is, only BBO eligible (best bid and offer) quotes from the primary exchange, excluding batched or out-of-sequence trades. We also removed data entry errors (e.g., transposed or dropped digits) by eliminating quotes in which the spread exceeds 20% of the stock price or $2 (whichever is greater) or the transaction reverses by more than $10 within three trades. We used the time-stamp adjustment of Lee and Ready (1991).

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Author Online Summary

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We developed a detailed position-by-position measure of funds’ annual expenditures on trading costs by using fund portfolio holdings data, transaction-level securities data, and U.S. SEC filings. First, we used quarterly portfolio holdings data to determine each fund’s position changes on a stock-by-stock basis. Second, for each position change, we applied an estimate of the cost (brokerage commission, bid–ask spread, and price impact) of trading that amount of that stock in that quarter. Third, we computed each fund’s annual expenditure on trading costs by aggregating the costs of all trades for that fund

over the year. We applied this approach to our sample of 1,758 domestic equity funds over 1995–2006.

We found that funds' annual expenditures on trading costs (i.e., aggregate trading cost) were comparable in magnitude to the expense ratio (1.44% a year versus 1.19%, respectively). Moreover, there was considerably more variation in fund trading costs than in expense ratios. For example, the difference in average expense ratio for small-cap growth and large-cap value funds was 0.32 percentage points (1.39% versus 1.07%), whereas the difference in average aggregate trading costs for the same funds was 2.33 percentage points (3.17% versus 0.84%).

The more important question concerns how funds' expenditures on trading costs relate to return performance. We found a strong negative relation between aggregate trading cost and fund return performance. Sorting funds by expenses, fund total net assets, or turnover (the most common trading-cost proxy) yielded no consistent, monotonic pattern of returns. In stark contrast, sorting funds on the basis of their aggregate trading-cost estimate yielded a clear monotonic pattern of decreasing risk-adjusted performance as fund trading costs increase. The difference in average annual return for funds in the highest and lowest quintiles of aggregate trading cost was –1.78 percentage points.

Given the power of aggregate trading cost in predicting fund performance, it would be a useful tool for investment decision makers. Unfortunately, these direct estimates of fund trading costs are difficult to come by for reasons of both data availability and computational complexity. The most readily available metric to proxy for trading costs, used by both academics and practitioners, is fund turnover. However, the empirical evidence on the relation between fund turnover and return performance is ambiguous. We conjectured that this ambiguity is due to the fact that turnover does not account for the differential cost of fund trades—which depends on fund size (i.e., trade size) and stock liquidity (i.e., small cap versus large cap). For example, a $500 million small-cap fund with 50% turnover will have much higher trading costs than a $100 million large-cap fund with 100% turnover, despite the former's lower turnover.

To address this underlying deficiency, we propose a simple adjustment to turnover. In particular, we compute "position-adjusted turnover" by multiplying each fund's turnover by its relative position size. A fund's relative position size is equal to its average position size (total net assets divided by number of holdings) divided by the average position size of all funds in its market-cap category. Relative position size captures the price impact of the fund's trades—the greatest component of a fund's trading costs. We found that this simplified proxy has power similar to that of our more fastidious measure. The difference in average annual return for funds in the highest and lowest quintiles of position-adjusted turnover was –1.92 percentage points. Overall, our results suggest that trading costs are an important determinant of fund performance, and we offer a simple proxy for trading costs that can be used by investors and researchers alike.

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Table 1. Summary Statistics for Mutual Fund Sample, 1995–2006

	Turnover		Total Net Assets ($ millions)		Four-Factor Model		
Fund Group	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Obs.
All	82.4%	6.6%	1,525.1	343.0	–1.77%	3.74%	25,423
Small cap							
Value	58.1%	16.0%	445.1	155.2	–1.09%	7.85%	1,034
Blend	71.8	16.6	523.9	148.1	–1.71	5.66	1,956
Growth	118.5	20.5	587.2	161.1	–3.41	8.25	3,186
Mid cap							
Value	70.4%	12.6%	1,287.7	720.8	–1.20%	6.31%	1,554
Blend	71.0	15.9	1,020.3	469.8	–0.53	6.15	1,803
Growth	122.1	14.5	1,104.5	301.5	–2.27	9.32	3,642
Large cap							
Value	65.2%	7.5%	2,183.4	876.4	–1.61%	5.05%	2,893
Blend	52.2	8.2	2,412.5	674.8	–1.50	3.74	4,925
Growth	89.3	9.8	1,851.5	653.6	–2.00	5.64	4,430
Large TNA	76.7%	5.8%	2,877.3	666.2	–2.09%	3.82%	12,742
Small TNA	88.0	11.8	163.7	33.0	–1.44	3.89	12,681

Notes: This table reports the mean and standard deviation of sample funds' turnover, total net assets, and annualized four-factor alphas (Carhart 1997), calculated over the quarter (Months 0 to 2) by using betas estimated over the previous 36 months (Months –36 to –1). "Obs." stands for number of observations.

Table 2. Descriptive Statistics for Aggregate Trading Cost, 1995–2006

	Trading Volume	Per Unit Trading Costs							Aggregate Trading Cost: Volume × Per Unit Cost		Expense Ratio	
Fund Group	Mean	Commissions	+	Bid–Ask Spread	+	Price Impact	=	Per Unit Cost	Mean	Std. Dev.	Mean	Std. Dev.
	1	2		3		4		5	6	7	8	9
All	177%	0.14%		0.13%		0.53%		0.80%	1.44%	0.64%	1.19%	0.05%
Small cap												
Value	150	0.17		0.29		1.18		1.64	2.29	1.09	1.28	0.11
Blend	168	0.17		0.28		1.04		1.49	2.32	1.09	1.20	0.11
Growth	229	0.16		0.28		1.07		1.51	3.17	1.47	1.39	0.08
Mid cap												
Value	162	0.14		0.10		0.46		0.70	1.13	0.59	1.15	0.11
Blend	164	0.15		0.12		0.63		0.90	1.44	0.88	1.22	0.07
Growth	226	0.14		0.15		0.60		0.89	1.87	1.04	1.34	0.09
Large cap												
Value	159	0.13		0.07		0.33		0.52	0.84	0.41	1.07	0.08
Blend	130	0.13		0.07		0.23		0.42	0.61	0.35	0.98	0.07
Growth	187	0.12		0.07		0.29		0.48	0.97	0.51	1.23	0.06
Large TNA	168	0.14		0.13		0.71		0.98	1.69	0.82	1.08	0.06
Small TNA	187	0.14		0.13		0.36		0.62	1.19	0.47	1.30	0.04

Table 3. Trading-Cost Proxies Regressed on Microstructure-Related Fund Characteristics, 1995–2006

	Five Univariate Regressions					One Multivariate Regression				
Regressor	Market Cap	Stock Volume	1/Price	Fund Volume	Trade Size	Market Cap	Stock Volume	1/Price	Fund Volume	Trade Size
A. Dependent variable = aggregate trading cost										
Coefficient *t*-statistic	–6.9	–9.0	8.3	7.2	4.4	–3.0	–1.8	7.3	6.9	6.8
Predicted sign	–	–	+	+	+	–	–	+	+	+
Consistent?	Yes**	Yes**	Yes**	Yes**	Yes**	Yes*	—	Yes**	Yes**	Yes**
B. Dependent variable = position-adjusted turnover										
Coefficient *t*-statistic	–6.2	0.1	2.2	16.8	8.5	–15.1	16.1	–5.7	13.5	14.0
Predicted sign	–	–	+	+	+	–	–	+	+	+
Consistent?	Yes**	—	Yes*	Yes**	Yes**	Yes**	No**	No**	Yes**	Yes**
C. Dependent variable = turnover										
Coefficient *t*-statistic	–6.6	–0.9	3.1	13.9	–0.3	–13.1	14.56	–5.4	14.9	–4.1
Predicted sign	–	–	+	+	+	–	–	+	+	+
Consistent?	Yes**	—	Yes*	Yes**	—	Yes**	No**	No**	Yes**	No**

Notes: The predicted signs come from the microstructure literature. Consistency refers to a statistically significant alignment between the estimate and the prediction.

*Significant at the 5% level.

**Significant at the 1% level.

Table 4. Regression of Performance on Trading-Cost Proxies, 1995–2006
(t-statistics in parentheses)

Variables	Dependent Variable: Four-Factor Alpha				
	Regression 1	Regression 2	Regression 3	Regression 4	Regression 5
Turnover[a]	–4.7		1.1		–4.6
	(–1.0)		(1.4)		(–1.0)
Aggregate trading cost		–0.4			
		(–2.0)			
Position-adjusted turnover (turnover × relative position size)[b]			–1.5		
			(–2.4)		
Trade volume[a]				–4.3	
				(–1.6)	
Per unit trading cost				–0.3	
				(–0.5)	
Relative position size[a]					1.1
					(1.9)
Expenses	–1.2	–1.2	–1.2	–1.1	–1.3
	(–2.3)	(–1.8)	(–2.1)	(–1.8)	(–2.3)
Log TNA[a]	–4.9	–4.5	–3.1	–4.8	–6.0
	(–3.5)	(–3.4)	(–1.9)	(–2.8)	(–3.7)
Log family TNA[a]	1.4	1.3	1.3	1.4	1.5
	(1.5)	(1.3)	(1.3)	(1.4)	(1.6)

[a]The coefficient is multiplied by 1,000 for scaling purposes.

[b]The coefficient is multiplied by 100 for scaling purposes.

Table A1. Brokerage Commissions Regression Model, 1995–2006
(*t*-statistics in parentheses)

Variables	Brokerage Commission
Expenses	2.4
	(6.3)
Log TNA	0.3
	(2.8)
Log family TNA	–0.3
	(–3.9)
Log average share price traded	–6.1
	(–11.2)
Load ID (= 1 if load fund)	0.2
	(0.1)

Figure 1. Performance Sorts on Turnover, Expenses, Total Net Assets, Aggregate Trading Costs, and Position-Adjusted Turnover, 1995–2006

Notes: The sorts on turnover and expenses are based on the annual turnover and expense ratio data from CRSP. The sort on total net assets is based on the fund's total net assets from the previous quarter as reported by CRSP.