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Securities and Exchange Commission
450 Fifth Street, NW
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To Whom It May Concern:

I am writing to comment on (**File No. S7-29-03; [Release Nos. 33-8349; 34-48952; IC-26313; File No. S7-29-03] RIN 3235-AI94**) the **SEC** ***Concept Release: Request for Comments on Measures to Improve Disclosure of Mutual Fund Transaction Costs***.

Overall, I like the concept release very much, and am very pleased that SEC is paying attention to trading costs of mutual funds. It is clear that SEC has done a thorough job in terms of understanding the problem and related issues.

I am a Ph.D. Candidate in Finance at Boston College. Prior to starting my dissertation in the area of market microstructure and trading costs measurement in particular, I worked for over two years as a Quantitative Trade Analyst in Fidelity's Trading Techniques & Measurement group, which oversees all Fidelity's equity trading. One of my main dissertation advisors is Professor Erik Sirri at Babson College, who was the SEC Chief Economist from 1996 to 1999.

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Attached is my working paper titled "**Measures of Implicit Trading Costs and Buy-Sell Asymmetry**". The focus of the paper is implicit rather than explicit trading costs (commissions). My paper argues that there is no one-size-fits-all solution to the complex problem of trading cost measurement. Different trading cost measures (**Implementation Shortfall** versus **VWAP Cost**) serve very different purposes (**trading costs of investment strategies** versus **execution quality**). I show that Implementation Shortfall, while widely used by both practitioners and academic studies to measure execution quality, mainly captures market movement. Implementation Shortfall is proposed as one of the measures to be disclosed by mutual funds. My paper shows that we need to be very careful about what we are exactly measuring, and how to interpret different results obtained using different measures. My paper also provides a simple explanation for the buy-sell asymmetry phenomenon: mechanical characteristics of measures of implicit trading costs. This finding again shows that pre-trade measures like Implementation Shortfall suffer "natural biases" because they are highly affected by market trend.

If needed, I would be more than happy to explain in more detail my points above and my attached paper. Please do not hesitate to contact me if you have any questions.

Sincerely,

Gang Hu

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Measures of Implicit Trading Costs and Buy-Sell Asymmetry*

Gang Hu**

First Version: December 2002
This Version: January 2004

Abstract

Many previous studies document that institutional buys incur higher implicit trading costs than do sells. Chiyachantana, Jain, Jiang, and Wood (Journal of Finance, forthcoming) find that this widely documented asymmetry is sensitive to the underlying market condition: institutional buys (sells) incur higher implicit trading costs in bullish (bearish) markets. We provide a simple yet previously unexplored explanation for this phenomenon: it is because previous studies use pre-trade benchmark prices to measure implicit trading costs. When a pre-trade measure is used, buys (sells) have higher implicit trading costs during rising (falling) markets. The opposite is true if a post-trade measure is used: sells (buys) have higher implicit trading costs during rising (falling) markets. Both pre-trade and post-trade measures are highly influenced by market movement. On the other hand, during-trade measures are neutral to market movement. Using real institutional trading data, we empirically confirm our predictions. We conclude that buy-sell asymmetry is mainly driven by mechanical characteristics of measures of implicit trading costs. In addition, we emphasize that trading is a double-sided and zero-sum game, and discuss related implications. We further argue that different measures of implicit trading costs serve very different purposes: pre-trade measures are suitable for measuring trading costs of investment strategies, and during-trade measures are suitable for measuring execution quality. We show that a pre-trade measure can be decomposed into a market movement component and a during-trade measure, and empirically the market movement component is the dominant component. Our results cast doubt on previous findings on execution quality that use pre-trade measures, because pre-trade measures mainly capture market movement.

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* My sincerest gratitude goes to Erik Sirri, who provided numerous insights, guidance, encouragement, and support throughout this project. I am extremely grateful to Ani Chitaley at the Fidelity Management & Research Company for his tremendous help in obtaining the necessary data, and many discussions that deepened my understanding of this subject. I thank the Abel/Noser Corporation, especially Gene Noser and Jamie Noser, for generously providing me with the proprietary institutional trading data, and Judy Maiorca and Bruce Stewart for excellent technical assistance. For helpful comments and discussions, I thank Vladimir Atanasov, Pierluigi Balduzzi, Stephen Berkowitz, Jennifer Bethel, Thomas Chemmanur, Wayne Ferson, Evan Gatev, Michael Goldstein, Arun Gorur, Edward Kane, Laurie Krigman, Peter Lert, Yuanzhi Luo, Ananth Madhavan, Alan Marcus, Mark Matthews, Ginger Meng, Jyoti Patel, Jeff Pontiff, Jun Qian, Don Slowik, Phil Strahan, Hassan Tehranian, Wayne Wagner, Mengxin Zhao, and seminar participants at Babson College, Boston College, the Abel/Noser Corporation, and Fidelity Investments. I also thank Sandra Sizer Moore for editorial assistance. All remaining errors and omissions are my own.

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Measures of Implicit Trading Costs and Buy-Sell Asymmetry

Abstract

Many previous studies document that institutional buys incur higher implicit trading costs than do sells. Chiyachantana, Jain, Jiang, and Wood (Journal of Finance, forthcoming) find that this widely documented asymmetry is sensitive to the underlying market condition: institutional buys (sells) incur higher implicit trading costs in bullish (bearish) markets. We provide a simple yet previously unexplored explanation for this phenomenon: it is because previous studies use pre-trade benchmark prices to measure implicit trading costs. When a pre-trade measure is used, buys (sells) have higher implicit trading costs during rising (falling) markets. The opposite is true if a post-trade measure is used: sells (buys) have higher implicit trading costs during rising (falling) markets. Both pre-trade and post-trade measures are highly influenced by market movement. On the other hand, during-trade measures are neutral to market movement. Using real institutional trading data, we empirically confirm our predictions. We conclude that buy-sell asymmetry is mainly driven by mechanical characteristics of measures of implicit trading costs. In addition, we emphasize that trading is a double-sided and zero-sum game, and discuss related implications. We further argue that different measures of implicit trading costs serve very different purposes: pre-trade measures are suitable for measuring trading costs of investment strategies, and during-trade measures are suitable for measuring execution quality. We show that a pre-trade measure can be decomposed into a market movement component and a during-trade measure, and empirically the market movement component is the dominant component. Our results cast doubt on previous findings on execution quality that use pre-trade measures, because pre-trade measures mainly capture market movement.

Measures of Implicit Trading Costs and Buy-Sell Asymmetry

Many previous studies find that institutional buys incur higher implicit trading costs than do sells (Kraus and Stoll (1972), Holthausen, Leftwich, and Mayers (1987, 1990), Chan and Lakonishok (1993, 1995), and Keim and Madhavan (1996)).[1] In a review paper, Macey and O'Hara (1997) state that "One unambiguous result that emerges from this research is that execution costs of large trades are affected by a wide range of factors. One of the most important is trade direction". Chan and Lakonishok (1993) propose an intriguing information-based explanation for this buy-sell asymmetry phenomenon. Saar (2001) develops an elegant information-based theoretical model to explain this asymmetry. In a very interesting and original study, Chiyachantana, Jain, Jiang, and Wood (Journal of Finance, forthcoming, hereafter CJJW) find that this widely documented asymmetry is sensitive to the underlying market condition. In bullish markets, institutional buys incur higher implicit trading costs than do sells. But in bearish markets, institutional sells incur higher implicit trading costs than do buys. CJJW argue that existing information-based explanations fail to explain the reversal of buy-sell asymmetry during bearish markets. However, CJJW provide very little explanation as to why the underlying market condition is the major driving factor of buy-sell asymmetry. In this study, we provide a previously unexplored explanation for buy-sell asymmetry. This asymmetry is caused by using pre-trade benchmark prices to measure implicit trading costs.

Measures of implicit trading costs can be classified in three categories: pre-trade, during-trade, and post-trade measures, depending on the benchmark prices used. Pre-trade measures use prices prior to the trade, such as the prior day's close, open, last trade, midpoint of bid-ask spread before the trade, etc. During-trade measures use some kind of average price over the trading horizon, typically the volume-weighted average price (VWAP). Post-trade measures use prices after the trade, typically the day's close at the end of the trading horizon.

[1] Implicit trading costs, as opposed to explicit trading costs (commissions, etc.), are trading costs not explicitly paid by investors (imbedded in transaction prices). Implicit trading costs are also frequently referred to as "market impact" or "price impact". For reasons we will discuss later, "market impact" and "price impact" may not be appropriate names for implicit trading costs.

We argue that buy-sell asymmetry is mainly driven by mechanical characteristics of measures of implicit trading costs. When a pre-trade measure is used, buys (sells) have higher implicit trading costs during rising (falling) markets. The opposite is true when a post-trade measure is used. Sells (Buys) have higher implicit trading costs during rising (falling) markets. Both pre-trade and post-trade measures are highly influenced by market movement. On the other hand, during-trade measures are neutral to market movement. Figure 1 summarizes our main predictions on buy-sell asymmetry.

		Measures of Implicit Trading Costs		
		Pre-Trade Measures	**During-Trade Measures**	**Post-Trade Measures**
Market Condition	↑	**Buys > Sells** (Cell 1)	**Buys ≈ Sells** (Cell 3)	**Buys < Sells** (Cell 5)
	↓	**Buys < Sells** (Cell 2)	**Buys ≈ Sells** (Cell 4)	**Buys > Sells** (Cell 6)

Figure 1. Summary of Main Predictions on Buy-Sell Asymmetry. This figure summarizes our main predictions on buy-sell asymmetry for different measures of implicit trading costs during both rising and falling markets separately. For example, "Buys > Sells" in cell 1 means that if we use pre-trade measures of implicit trading costs, then during rising markets, the implicit trading costs for buys should be higher than sells.

Most previous studies fall into cell 1 in Figure 1. One of the main contributions of CJJW is the discovery of cell 2 in Figure 1. One of the main contributions of this study is the identification of the other four cells in Figure 1 (cells 3, 4, 5, and 6), and perhaps more importantly, the reason for buy-sell asymmetry, mechanical characteristics of measures of implicit trading costs. Using real institutional trading data, we confirm our predictions in Figure 1.

We emphasize that trading is a double-sided and zero-sum game. Trading is a double-sided game because for any transaction to take place, there must be both a willing buyer and a willing seller. Therefore, any transaction has to be both a buy and a sell at the same time. There are two dimensions to the zero-sum game nature of trading. The first dimension of zero-sumness is a direct implication of the double-sidedness of trading. It applies to all implicit trading cost measures. The second dimension of zero-sumness is a feature of using the average as the benchmark. It applies to VWAP Cost in the context of trading execution quality measurement, and similarly to the alpha in the context of investment performance measurement. Figure 2 summarizes implications of the double-sided and zero-sum game nature of trading, under the hypothetical scenario that we have a complete trading database that includes all transactions from all market participants.[2]

		Side	**Measures of Implicit Trading Costs**		
			Pre-Trade Measures	**VWAP Cost**	**Post-Trade Measures**
Market Condition	↑	**All**	**0**	**0**	**0**
		Buys	$+ C_1$	**0**	$- C_2$
		Sells	$- C_1$	**0**	$+ C_2$
	↓	**All**	**0**	**0**	**0**
		Buys	$- C_1'$	**0**	$+ C_2'$
		Sells	$+ C_1'$	**0**	$- C_2'$

Figure 2. Trading is a Double-Sided and Zero-Sum Game – What if We Have a Complete Trading Database? This figure summarizes our predictions for different measures of implicit trading costs during both rising and falling markets separately for all, buys, and sells. The hypothetical scenario here is that we have a complete trading database that includes all transactions from all market participants (buy-side institutional investors, sell-side brokers, individual investors, market makers, and specialists, etc.). C_1, C_2, C_1', and C_2' are all positive. C_1 ($- C_1'$) is the trading value-weighted market-wide return measured from the pre-trade benchmark price to the VWAP, with the VWAP in the denominator, during rising (falling) markets. C_2 ($- C_2'$) is the trading value-weighted market-wide return measured from the VWAP to the post-trade benchmark price, with the VWAP in the denominator, during rising (falling) markets.

[2] Chan and Lakonishok (1993) state "Berkowitz, Logue, and Noser (1988) interpret the price impact in relation to the volume-weighted average price as a measure of execution cost. Using this benchmark, the dollar-weighted average impact is very small, at 0.02%. Similar values are obtained if the calculation of the volume-weighted price excludes the trade under consideration, or if the simple average price is used as the benchmark. Indeed, the simple average impact is slightly negative, which would imply, under the interpretation of Berkowitz, Logue, and Noser (1988), a negative execution cost on average for purchases!" As is clear in their use of the exclamation point, the authors seem to be surprised to find that aggregate VWAP Cost is very small and can be negative. Their results are not surprising, because VWAP Cost has zero-sums for all, buys, and sells (see Figure 2). There is nothing wrong with a negative implicit trading cost. It means that it is a gain instead of a loss.

Pioneered by Perold (1988), most previous studies on trading costs use pre-trade measures. Berkowitz, Logue, and Noser (1988) first introduce a during-trade measure that uses the VWAP as the benchmark price.[3] VWAP Cost is very widely used by practitioners. Schwartz and Steil (2002) find that Chief Investment Officers rank VWAP performance well above other criteria for evaluating how well their traders handle their orders. However, there seems to be much confusion on which measure is the right measure to use, and how to interpret different results obtained by using different measures. We address these issues in this study.

There is no one-size-fits-all solution to the complex problem of trading cost measurement. Many different research questions can be asked about the same trading process. A natural question is how good is the execution quality? Macey and O'Hara (1997) review and analyze the legal and economic aspects of the duty of best execution. Conrad, Johnson, and Wahal (2001) study the impact of soft-dollar arrangements on brokers' execution quality for institutional investors. Conrad, Johnson, and Wahal (2003) study whether alternative trading systems provide better execution. Another interesting question is what are the trading costs of investment strategies? Keim (2003), Korajczyk and Sadka (2003), and Lesmond, Schill, and Zhou (2003) study the robustness of momentum profits to trading costs. These two classes of research questions are very different in nature, and they call for different trading cost measures.

We argue that different implicit trading cost measures serve very different purposes. Pre-trade measures are suitable for measuring trading costs of investment strategies (in a typical institutional trading process, this is the trading cost from the portfolio manager's point of view). During-trade measures (VWAP Cost) are suitable for measuring execution quality (whether the buy-side trader or the sell-side broker did a good job or not). The philosophy behind using VWAP Cost to measure trading

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[3] VWAP Cost also appears in several other studies. Goldstein, Irvine, Kandel, and Wiener (2003) study VWAP Cost when examining brokerage commissions. Chakravarty, Panchapagesan, and Wood (2002), and CJJW justify their inclusion of VWAP Cost by citing its popularity among practitioners. Domowitz, Glen, and Madhavan (2001) use a different during-trade benchmark, the mean of the day's high, low, open, and close prices (HLOC). HLOC can be viewed as an approximation of the VWAP. HLOC is considerably easier to compute, and hence especially useful in international markets where high quality intraday trading data are not readily available. Harris (1998) analyzes and discusses how the choice of performance benchmarks affects a trader's decisions regarding trading strategies. Madhavan (2002) discusses various strategies used by practitioners to achieve the VWAP. Konishi (2002) derives a static optimal execution strategy of a VWAP trade.

execution quality is very much the same philosophy behind using the alpha to measure investment performance. Post-trade measures are sometimes used by index funds for controlling tracking errors relative to the close (Madhavan (2002)).

We relate different implicit trading cost measures through decompositions. For example, Prior Close Cost (a pre-trade measure) can be decomposed into two components, Market Movement Cost Prior Close to VWAP and VWAP Cost (a during-trade measure). Therefore, VWAP Cost can be viewed as Prior Close Cost controlling for stock-specific during-trade market movement. A few other studies also realize the need to control for market movement, even though the distinction between trading costs of investment strategies and execution quality is not made explicit. CJJW and Keim (2003) control for market-wide during-trade market movement by subtracting market index return measured over the trading horizon from pre-trade measures. This measure shares some common properties with post-trade measures, because the market index return is measured from Prior Close to Close. Also, this measure does not control for stock-specific during-trade market movement.

We empirically show that the market movement component (Market Movement Cost Prior Close to VWAP) is the dominant component of Prior Close Cost. For example, when we use trade packages as the unit of observation and regress Prior Close Cost onto its two components separately, we get an R-square of 90.4 percent for Market Movement Cost Prior Close to VWAP, and an R-square of only 5.7 percent for VWAP Cost. This result is rather striking. We can approximate Prior Close Cost with very high accuracy without even knowing the institutional investor's execution price. This result shows that Prior Close Cost is a poor measure of execution quality, because it is overwhelmingly dominated by market movement. Many previous studies use Prior Close Cost, or a variation of such, and interpret their results as findings on execution quality. Our findings cast doubt on such interpretations.

To summarize, first, we provide a new explanation for the widely documented buy-sell asymmetry phenomenon. Second, we emphasize that trading is a double-sided and zero-sum game, and discuss related implications. Third, we argue that different measures of implicit trading costs serve different purposes. Fourth, we empirically show that Prior Close Cost mainly captures market movement.

The remainder of this study is organized in four sections. Section I discusses various issues related to trading cost measurement and our empirical methodology. Section II describes the data. Section III discusses our empirical results, and Section IV concludes.

I. Methodology

A. Typical Institutional Trading Process

Figure 3 depicts a typical institutional trading process. This process starts with the portfolio manager (PM) making investment decisions, which stock to buy or sell, and the quantity to be traded. Then the PM sends the order to a trader inside the same institutional investor. The PM also specifies a trading horizon, which is usually a trading day. The trading horizon can also be shorter than a trading day, or it can span multiple trading days. Since many institutions in our sample do not provide intraday time stamps, we mainly analyze daily frequency in our empirical analysis. As for the multiday issue, we follow Chan and Lakonishok (1995) to construct trade packages.

The trader's job is to execute the order within the trading horizon and get the best price possible. The trader makes trading decisions, for example, when to trade during the trading horizon, which trading venue to use (ECNs versus traditional brokers), which broker to use, and how to interact with the broker. The trader then sends the order to a broker. The trader can also break up the order and only send part of the order to a broker, or send pieces of the order to multiple brokers. Given instructions from the trader, the broker also makes trading decisions. Finally, the order is executed and printed on an exchange.

[Insert Figure 3 about here]

B. Measures of Implicit Trading Costs

We focus on implicit trading costs in this study. We also include statistics on explicit trading costs (commissions) in our empirical results. Commissions can serve as compensation for non-trading related services, for example, as "soft dollars" for research provided by brokers to institutional investors (Conrad, Johnson, and Wahal (2001)). Measures of implicit trading costs take the following common form:[4]

$$\text{Implicit Trading Cost} \equiv \text{Side} * \frac{\text{Execution Price}(P_E) - \text{Benchmark Price}}{\text{Execution Price}(P_E)} \quad (1)$$

$$\text{where Side} = \begin{cases} 1, \text{for buys} \\ -1, \text{for sells} \end{cases}, \text{ and Benchmark Price} \equiv \begin{cases} P_{pre}, \text{for pre-trade measures} \\ \text{VWAP, for during-trade measures} \\ P_{post}, \text{for post-trade measures} \end{cases}$$

As Figure 3 shows, P_E denotes the institutional investor's execution price. Different implicit trading cost measures use different benchmark prices. P_{pre} denotes the pre-trade benchmark price. Following most previous studies, we use Prior Close as P_{pre} in our empirical study.[5] Prior Close is the closing price on the day prior to the trading horizon. For a multiday package, Prior Close is the closing price on the day prior to the first day of the package. The during-trade benchmark price, VWAP, is the volume-weighted average price of all available market transactions during the trading horizon. Even though the designation VWAP says nothing about the time frame, it is often being thought of as equivalent to the daily VWAP. However, the VWAP can be defined for any time frame, intraday, daily or multiday. We analyze both the daily VWAP and the multiday VWAP empirically. P_{post} denotes the post-trade benchmark price. We use Close, the closing price of the trading horizon, as P_{post}. For a multiday package, Close is the closing price on the last day of the package. We analyze three implicit trading cost measures in detail empirically, Prior Close Cost, VWAP Cost, and Close Cost.[6]

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[4] Most previous studies use the benchmark price instead of the execution price in the denominator, even though no clear reason is provided for the choice. Either way, it will not make a big difference in terms of empirical results. We prefer to use the execution price in the denominator because: 1) most importantly, the decompositions later will hold exactly only if we use the execution price in the denominator; 2) it makes it easier to compare results obtained using different measures, because they all have the same denominator; 3) it makes it more convenient to compute the corresponding dollar trading cost (simply multiply the implicit trading cost by the dollar principal traded).

[5] We also tried using Open, the opening price of the trading horizon, as P_{pre}, and all results are qualitatively similar to results obtained by using Prior Close as P_{pre}. To save space, we do not report results using Open as P_{pre}.

[6] One of the criticisms of VWAP Cost is that the institution investor's own trades are part of the benchmark. We do not believe this is a problem. After all, we have a similar problem when we evaluate a mutual fund's performance using a market index as the benchmark, because any mutual fund is part of the market index. In addition, we can

$$\text{Prior Close Cost} \equiv \text{Side} * \frac{P_E - \text{Prior Close}}{P_E} \qquad (2)$$

$$\text{VWAP Cost} \equiv \text{Side} * \frac{P_E - \text{VWAP}}{P_E} \qquad (3)$$

$$\text{Close Cost} \equiv \text{Side} * \frac{P_E - \text{Close}}{P_E} \qquad (4)$$

For the purposes of this study, we do not consider the opportunity cost of unfilled orders. This is one of the reasons why we call our pre-trade measure Prior Close Cost instead of the more frequently used name, Implementation Shortfall (Perold (1988), and Perold and Sirri (1998)). Another reason is that Implementation Shortfall also includes explicit trading costs. Opportunity cost can be viewed as a different dimension of the trading cost measurement problem. We focus on the benchmark price dimension. One can define opportunity cost relative to different benchmark prices. Many previous studies also ignore opportunity cost because they find that fill rates are close to 100 percent. Keim and Madhavan (1995, 1997) find that institutional orders were completely filled more than 95 percent of the time in their sample provided by the Plexus group. Chakravarty, Panchapagesan, and Wood (2002) find similar high fill rates in more recent Plexus data.

C. Buy-Sell Asymmetry

If a pre-trade measure is used, when the market is rising, the execution price will be higher than the pre-trade benchmark price in general. This will produce a positive cost for buys and a negative cost for sells. When the market is falling, the execution price will be lower than the pre-trade benchmark price in general. This will produce a negative cost for buys and a positive cost for sells. Therefore, if a pre-trade

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prove that: $\text{VWAP Cost}_{-I} = \text{VWAP Cost} * \frac{1}{1-f_I}$, where VWAP Cost$_{-I}$ is the VWAP Cost excluding the institutional investor's own trades from the benchmark VWAP, and f_I is the institutional investor's "market share": the institutional investor's own volume divided by the total market volume. The proof is very simple and available upon request. This result is useful because it is extremely difficult, if not impossible, to identify a particular institutional investor's trades in intraday market data (the NYSE TAQ). Using this formula, one can compute VWAP Cost$_{-I}$ without having to explicitly identify these trades in intraday market data.

measure is used, buys (sells) have higher implicit trading costs during rising (falling) markets. The opposite is true if a post-trade measure is used. Sells (Buys) have higher trading costs during rising (falling) markets. Both pre-trade and post-trade measures are highly influenced by market movement.

It appears that the "culprit" of buy-sell asymmetry is the fact that in equation (1) Side takes the value of one for buys and -1 for sells. We are not saying that the definition is inappropriate. To the contrary, the definition makes perfect sense. However, we do need to pay close attention to mechanical characteristics of measures of implicit trading costs implied by such a definition.

No matter what the market trend is, on average (in aggregate), the during-trade benchmark price (VWAP) should not be systematically different from the execution price for either buys or sells. Therefore, we do not expect buy-sell asymmetry for during-trade measures. During-trade measures are neutral to market movement. Our main predictions regarding buy-sell asymmetry for different measures of implicit trading costs during both rising and falling markets are summarized in Figure 1.

D. Trading is a Double-Sided and Zero-Sum Game

Trading is a double-sided game. For any transaction to take place, there has to be a willing buyer and a willing seller. Therefore, any transaction has to be both a buy and a sell at the same time. If we have a complete trading database that includes all transactions from all market participants (buy-side institutional investors, sell-side brokers, individual investors, market makers, and specialists, etc.), then every transaction will be recorded twice, once as a buy for one market participant and once as a sell for another market participant. The Plexus data and our data provided by the Abel/Noser Corporation are trading databases of a subset of buy-side institutional investors. It is possible that in the Plexus data or the Abel/Noser data, there are buys and sells recorded by different institutions that are actually the same transactions. It can happen for agency trades, where the sell-side broker simply acts as a middleman between two buy-side institutional investors.

Trading is a zero-sum game. The zero-sumness has two dimensions. The first dimension is a direct implication of the double-sidedness of trading. Harris (2003) lists this dimension of zero-sumness as one of the "key recurrent themes" of his book. Harris (2003) states "the accounting gains made by one side must equal the accounting losses suffered by the other side". As long as we have both sides of each transaction in our database, then regardless of the particular measure (benchmark price), the aggregate implicit trading cost will be zero. This is why "market impact" and "price impact" may not be appropriate names for implicit trading costs. For any given transaction, a positive (negative) price impact for the buyer is a negative (positive) price impact for the seller, and they sum to zero. These names, "market impact" and "price impact", imply a single-sided view of trading.

The second dimension of the zero-sum game nature of trading is a feature of using the average as the benchmark. The first dimension of zero-sumness is due to double counting. However, if we look at buys and sells separately (now each transaction is only counted once), both pre-trade and post-trade measures will be non-zero as long as the market is not completely flat. The second dimension of the zero-sumness is that if we have a complete trading database, then VWAP Cost will be zero for both buys and sells. In investment performance measurement, the value-weighted sum of all alphas should also be zero. This zero-sumness does not mean that VWAP Cost is not useful. VWAP Cost is as useful as the alpha. It means that VWAP Cost and the alpha are measures of relative performance. By comparing a trader against the VWAP, we are evaluating him relative to the "average trader". Alphas are also investment performance measures relative to the "average investor".

Figure 2 summarizes our predictions for different measures of implicit trading costs during both rising and falling markets separately for all, buys, and sells. The hypothetical scenario here is that we have a complete trading database. Figure 2 will hold exactly when daily benchmark prices are used, because benchmark prices will be the same for transactions on the same stock from different market participants as long as they happen on the same day. However, when multiday or intraday benchmark prices are used, Figure 2 will only hold approximately, because benchmark prices for transactions on the same stock from different market participants may not line up perfectly. In Figure 2 we list VWAP Cost instead of during-trade measures because the quantities will only be exactly zero for VWAP Cost. C_1, C_2, C_1', and C_2' are all positive. C_1 (- C_1') is the trading value-weighted market-wide return measured from the pre-trade benchmark price to the VWAP, with the VWAP in the denominator, during rising (falling) markets. C_2 (- C_2') is the trading value-weighted market-wide return measured from the VWAP to the post-trade benchmark price, with the VWAP in the denominator, during rising (falling) markets. We note that in Figure 2 there is still buy-sell asymmetry for both pre-trade and post-trade measures, and that it is consistent with our predictions in Figure 1. Figure 2 serves as a useful benchmark for our empirical study, where we have only a trading database of a subset of buy-side institutional investors. If our empirical results deviate from Figure 2, then it must be due to the incompleteness of our trading database.

E. Different Implicit Trading Cost Measures Serve Different Purposes

"Paper" returns of investment strategies are usually measured from Prior Close to the end of the investment horizon (Perold (1988)). Therefore, Prior Close Cost (a pre-trade measure) is suitable for measuring the impact of trading costs on the profitability of investment strategies. However, Prior Close Cost may not be a good measure of execution quality, because the market movement from Prior Close to the trading horizon is not completely under the control of the trader or broker in question.

A trader's (broker's) execution quality can be measured by comparing his execution price against the average (VWAP). It is very much the same philosophy behind comparing a mutual fund's performance against a market index return. A very nice analogy can be drawn between the VWAP in the context of trading and the index in the context of investing. VWAP Cost (multiplied by -1) is like the alpha in investment performance measurement. Since we do not have a counterpart of the CAPM in trading, we simply benchmark a trader against the average. Trading to achieve the VWAP is like managing an index fund to achieve the market index return. If we call indexing "passive investing", then VWAP trading can be called "passive trading". Just like indexing has become increasingly popular over the last several decades (largely inspired by extensive academic research), VWAP trading has become more and more popular among practitioners in the last several years.[7] However, simply achieving the VWAP does not mean that the trader (broker) has abnormal skill, just like an index fund manager does not have abnormal skill. A trader (broker) has abnormal skill only if he can consistently beat the VWAP, in other words, a consistently negative and significant VWAP Cost.

F. Decompositions of Implicit Trading Cost Measures

Different implicit trading cost measures can be related through decompositions. Decompositions also provide insights about the characteristics of different measures. We will use the following decompositions in our empirical analysis:

$$\underbrace{\left(\text{Side} * \frac{P_E - \text{Prior Close}}{P_E}\right)}_{\substack{|||\\ \text{Prior Close Cost}}} = \underbrace{\left(\text{Side} * \frac{P_E - \text{VWAP}}{P_E}\right)}_{\substack{|||\\ \text{VWAP Cost}}} + \underbrace{\left(\text{Side} * \frac{\text{VWAP} - \text{Prior Close}}{P_E}\right)}_{\substack{|||\\ \text{Market Movement Cost}\\ \text{Prior Close to VWAP}}} \qquad (5)$$

$$\underbrace{\left(\text{Side} * \frac{P_E - \text{Close}}{P_E}\right)}_{\substack{|||\\ \text{Close Cost}}} = \underbrace{\left(\text{Side} * \frac{P_E - \text{VWAP}}{P_E}\right)}_{\substack{|||\\ \text{VWAP Cost}}} - \underbrace{\left(\text{Side} * \frac{\text{Close} - \text{VWAP}}{P_E}\right)}_{\substack{|||\\ \text{Market Movement Cost}\\ \text{VWAP to Close}}} \qquad (6)$$

Equations (5) and (6) also contain definitions of two new Market Movement Cost items, Market Movement Cost Prior Close to VWAP and Market Movement Cost VWAP to Close. We note that these Market Movement Cost items are essentially "market quantities". They are driven by Prior Close, VWAP, and Close, which are all market prices. The institutional investor's execution price P_E in the denominator is only a scaling factor. We refer to these Market Movement Cost items as "costs" because they are "side-dependent".

[7] Conversations with Japanese and Hong Kong traders who trade U.S. equity show that they are especially happy about this development. Now, they can put trading on "autopilot", and go to sleep gracefully knowing that they will be able to achieve the average when they wake up.

Equation (5) shows that VWAP Cost can be viewed as Prior Close Cost controlling for stock-specific during-trade market movement (Market Movement Cost Prior Close to VWAP). CJJW and Keim (2003) control for market-wide during-trade market movement by subtracting market index return measured over the trading horizon from pre-trade measures. For comparison purposes, we also analyze a similar measure:

$$\begin{matrix}\text{Prior Close Cost Net of} \\ \text{Market Index Movement}\end{matrix} \equiv \text{Side} * \left(\frac{P_E - \text{Prior Close}}{P_E} - \text{Market Index Movement} \right) \quad (7)$$

Market Index Movement is the value-weighted market index return over the trading horizon. The following simple decomposition holds:

$$\text{Prior Close Cost} = \begin{matrix}\text{Prior Close Cost Net of} \\ \text{Market Index Movement}\end{matrix} + \text{Market Index Movement Cost} \quad (8)$$

where $\text{Market Index Movement Cost} \equiv \text{Side} * \text{Market Index Movement}$

II. Data

We obtain proprietary transaction-level institutional trading data from the Abel/Noser Corporation, a NYSE member firm and a leading execution quality measurement service provider to institutional investors. In a study of brokerage commissions and institutional trading patterns, Goldstein, Irvine, Kandel, and Wiener (2003) also use data supplied by Abel/Noser. The Abel/Noser data are similar to the Plexus data used by many previous studies (Wagner and Edwards (1993), Keim and Madhavan (1995, 1997), Jones and Lipson (1999, 2001), Conrad, Johnson, and Wahal (2001, 2003), Chakravarty, Panchapagesan, and Wood (2002), CJJW, and Keim (2003)).[8] Our sample period is the fourth quarter of 2001. Figure 4 plots the Daily CRSP value-weighted indexes during our sample period. The general market trend is mildly bullish, with significant numbers of both up and down trading days.

[8] Some institutions in our Abel/Noser sample were former Plexus clients. Some other institutions use both Abel/Noser's and Plexus's services at the same time.

[Insert Figure 4 about here]

For each transaction the data include the date of the transaction, the stock traded (identified by both symbols and CUSIPs), the number of shares traded, the dollar principal traded, commissions paid by the institution, whether it is a buy or sell by the institution, and whether it is listed (NYSE/Amex) or OTC (NASDAQ).[9] The data were provided to us under the condition that the names of all buy-side institutions, funds, traders, and sell-side brokers would be removed from the data. However, we were given identification codes that enable us to separately identify all entities involved.

We follow Keim and Madhavan (1997) and eliminate transactions under 100 shares, and stocks trading under $1.00. Following Conrad, Johnson, and Wahal (2001), we eliminate any transaction if the closing price on the day prior to the transaction date, as recorded by the Abel/Noser, is not within one percent of the price recorded by CRSP. Also following Conrad, Johnson, and Wahal (2001), we exclude transactions if any of the three implicit trading cost measures (Prior Close Cost, VWAP Cost, and Close Cost) are larger (smaller) than 50 percent (-50 percent). Our final sample comprises transactions originated from 322 institutions (42 investment managers and 280 plan sponsors), with 20.1 billion shares traded and $544.5 billion traded.[10] There are 4,686 stocks traded in our sample.

We aggregate individual transactions to form units of observations. Individual transactions are usually called "tickets". The way institutions cut tickets can be arbitrary, and may differ across different institutions. Therefore, we choose to aggregate the data using reliable dimensions, which ensures uniform treatment of the data across the whole sample. We aggregate the data at the fund level.[11] The two units

[9] We match the Abel/Noser data with CRSP, and use daily market prices and volumes from CRSP. We find that the daily prices and volumes provided by Abel/Noser are highly reliable. The only market information we use that is not from CRSP is the VWAP. Many previous studies use market prices provided by the Plexus Group.

[10] An example of investment managers is Fidelity. An example of plan sponsors is the California Public Employees' Retirement System (CalPERS). We are not indicating either Fidelity or CalPERS is in our sample since the data is completely anonymous. In our sample, investment managers are larger than plan sponsors in general. Since results reported in this study are not qualitatively different across these two subsamples, we do not report results separately for these two groups.

[11] We choose to aggregate the data at the fund level because it is closest to the "order" concept, which is the unit of observation in most previous studies that use the Plexus data. Results in this study are not sensitive to how we aggregate the data.

of observations we use are Fund Daily Transaction Groups (hereafter, Fund DTGs) and Fund Package Transaction Groups (hereafter, Fund PTGs). All transactions with the same fund, stock, side (buy or sell), and date form a unique Fund DTG. All transactions with the same fund, stock, side, and consecutive trading dates form a unique Fund PTG. Most of our results do not differ qualitatively between Fund DTGs and Fund PTGs.

Fund PTGs are a higher level of aggregation of Fund DTGs, and hence there are fewer Fund PTGs than Fund DTGs (there are 1,128,873 Fund DTGs and 763,586 Fund PTGs in our sample). Figure 5 plots the distribution of length of Fund PTGs. Seventy-seven percent of Fund PTGs span only one trading day (these Fund PTGs are the same as the corresponding Fund DTGs), but they tend to be smaller in size (41 percent of dollar principal traded and 40 percent of shares traded). Two percent of Fund PTGs (12 percent of dollar principal traded and 13 percent of shares traded) last longer than a week (5 trading days).

[Insert Figure 5 about here]

III. Empirical Results

A. Sample Characteristics

Table I presents summary statistics of our sample. Buys and sells are reasonably balanced. 51.1 percent of dollar principal traded are buys. There are more listed than OTC transactions. 73.2 percent of dollar principal traded and 65.4 percent of shares traded are listed. Trading is concentrated in large cap stocks. 71.5 percent of dollar principal and 59.4 percent of shares are traded in large cap stocks (the top 10 percent stocks in terms of market cap).

The average size of Fund DTGs is $0.48 million and 17,800 shares. The average size of Fund PTGs is $0.71 million and 26,315 shares. These trade sizes are somewhat smaller but in line with studies that use the Plexus data. One reason could be that we have a larger number of institutions (322), and we probably have more small institutions. However, our results are not qualitatively different between the 42 investment managers (larger institutions) and the 280 plan sponsors (smaller institutions). The average trading price is $27.10 per share.

[Insert Table I about here]

Table II presents percentiles of different measures of implicit trading costs and their components. For both Fund DTGs (Table II, Panel A) and Fund PTGs (Table II, Panel B) and for all measures, the medians are close to zero relative to the absolute magnitudes of the measures. All the measures can be large positive and large negative, and they are reasonably symmetric around their medians. These results support our notion that trading is a zero-sum game, and that implicit trading costs can be both positive and negative. The reason that the measures are not centered at exactly zero is because our trading database includes only a subset of buy-side institutions.

The absolute magnitudes of implicit trading costs can be substantial. For example, the 75^{th} percentile of Prior Close Cost for Fund PTGs is 168.73 basis points, or 1.69 percent. The magnitudes of trading cost measures are larger for Fund PTGs than for Fund DTGs, which is expected because Fund PTGs span multiple trading days.

Equation (5) shows that VWAP Cost and Market Movement Cost Prior Close to VWAP are the two components of Prior Close Cost. So it is not surprising that Prior Close Cost is much larger than VWAP Cost (a factor of about three to four). It is interesting, however, that Market Movement Cost Prior Close to VWAP is almost on the same level of magnitude as Prior Close Cost, even though the former is a component of the latter. This is consistent with one of our findings later that Market Movement Cost Prior Close to VWAP is the dominant component of Prior Close Cost.

[Insert Table II about here]

B. Trading Costs Decompositions and Buy-Sell Asymmetry

Tables III, IV, and V all have the same columns, and they all show results for all transactions and for buys and sells separately. These tables all show several implicit trading cost measures, Prior Close Cost, VWAP Cost, Close Cost, and Prior Close Cost Net of Market Index Movement. These tables also show decompositions of trading cost measures (equations (5), (6), and (8)). For example, Prior Close Cost is equal to Market Movement Cost Prior Close to VWAP plus VWAP Cost. However, these tables show Market Movement items (Market Movement Cost items not multiplied by Side) instead of Market Movement Cost items. This choice makes these tables easier to read because Market Movement items are basically returns. Because of this choice, the decompositions hold only for buys. For sells, the decompositions hold if Market Movement items are multiplied by -1. The decompositions do not hold for all transactions, because Market Movement items for all are value-weighted averages of Market Movement items for buys and sells. These tables also show Market Movement items for one-day before and one-day after the trading horizon (Market Movement Two-Day Prior Close to Prior Close and Market Movement Close to One-Day Post Close). These items capture pre-trade and post-trade market movement. Tables III, IV, and V all have two panels. Panel A's show results for Fund DTGs and Panel B's show results for Fund PTGs. Since the results for Fund DTGs and Fund PTGs are qualitatively similar, we focus our discussions on results for Fund DTGs (Panel A's).

The numbers of observations are very large for almost all of our empirical results, mostly hundreds of thousands or even over one million observations. As a result, statistical significance is frequently achieved. We focus on economic significance instead of statistical significance for this reason.

Table III shows results for the whole sample. There is almost no buy-sell asymmetry in commissions. As plotted in Figure 4, the market indexes are mildly bullish during our sample period. Consistent with our predictions in Figure 1, Close Cost is higher for sells than for buys. However, Prior Close Cost is also higher for sells than for buys. This is because the trading in our sample is not completely lined up with market indexes, either because of the weighting across different stocks or the timing across different trading days. VWAP Cost numbers are close to zero, as we would expect based on Figure 2. The reason that they are not exactly zero is because we do not a complete trading database.

On average, institutional investors in our sample seem to chase market trends. The pre-trade movement is positive for buys (45.22 basis points), but negative for sells (-16.56 basis points). This trend appears to continue during the trading horizon. However, there is relatively very little reversal of this trend on the day after the trading horizon. These findings are consistent with recent findings by Griffin, Harris, and Topaloglu (2003). Consistent with earlier discussions, the buy-sell asymmetry for Close Cost and for Prior Close Cost Net of Market Index Movement are in the same direction. Keim (2003) uses a measure that is similar to Prior Close Cost Net of Market Index Movement. In Table 2 of Keim (2003), for U.S. equity markets during 1996-1997 (rising markets in general), sells have higher costs than buys. These results are consistent with our claim that Prior Close Cost Net of Market Index Movement shares some common properties with Close Cost.

[Insert Table III about here]

Table IV segments Table III by market-wide during-trade market movement. We present the results on four segments of the data separately. R_{VW} is the return on the CRSP value-weighted index during the trading horizon. The cutoffs for the four segments are: -1 percent, zero, and 1 percent. We divide the total of 64 trading days in our sample into four segments in Table IV, Panel A.

The results in Table IV are consistent with Figure 1. When R_{VW} is higher than 1 percent (the top segment), Prior Close Cost is higher for buys than for sells and Close Cost is lower for buys than for sells. When R_{VW} is lower than or equal to -1 percent (the bottom segment), Prior Close Cost is lower for buys than for sells, and Close Cost is higher for buys than for sells. All VWAP Cost numbers are close to zero and there is no clear asymmetry between buys and sells. Moving from the top down to the bottom of this panel shows that Prior Close Cost monotonically decreases for buys and increases for sells, and that Close Cost increases for buys and decreases for sells. This is another way of looking at our buy-sell asymmetry results. We can also see "shadows" of Figure 2 in these results, even though not exactly the same as Figure 2 due to the incompleteness of our trading data.

These patterns are less clear in the middle two segments of Table IV, Panel A, where R_{VW} is between -1 percent and 1 percent. Again, this is because the trading in our sample is not completely lined up with the CRSP value-weighted index.

[Insert Table IV about here]

Table V segments Table III by stock-specific during-trade market movement. We divide the whole sample into four segments, depending on R_i, the stock-specific return during the trading horizon. The cutoffs for the four segments are: -2 percent, zero, and 2 percent. We choose higher cutoffs than those in Table IV because stock-specific returns are more volatile than market index returns.

The results in Table V confirm all our predictions in Figure 1. In the top two segments (rising), Prior Close Cost is higher for buys than for sells, and Close Cost is lower for buys than for sells. In the bottom two segments (falling), Prior Close Cost is lower for buys than for sells, and Close Cost is higher for buys than for sells. All VWAP Cost numbers are close to zero and there is no clear asymmetry between buys and sells. Also, we can see even clearer "shadows" of Figure 2.

These cost numbers may sometimes seem large compared to those in previous studies, especially the large negative costs. It is because of our segmentation of clear market trends. Previous studies often aggregate rising and falling markets. Chakravarty, Panchapagesan, and Wood (2002) also find large positive and large negative trading costs using the Plexus data. In their Table 3, Panel C, for "Price Impact Measure I" (a version of Prior Close Cost) and after decimalization (falling markets), the trading cost is -221.1 basis points for buys and 263.3 basis points for sells.

[Insert Table V about here]

C. Decomposition Regressions of Implicit Trading Costs

Table VI presents decomposition regressions of implicit trading cost measures. Since the results for Fund DTGs (Panel A) and Fund PTGs (Panel B) are similar, we focus our discussions on the results for Fund DTGs.

The purpose of this table is to show the relative importance of components of both Prior Close Cost and Close Cost. We use regressions in an unconventional manner. The focus is neither the regression coefficients nor their statistical significance, which is why we do not indicate statistical significance. The most informative quantities in this table are the R-squares (in bold). According to equation (5), Prior Close Cost is equal to Market Movement Cost Prior Close to VWAP plus VWAP Cost. We regress Prior

Close Cost separately onto each of its two components. If the two components are statistically independent, then slopes of both regressions will be one, and the R-squares of the two regressions will sum to exactly one. The relative magnitudes of the two R-squares indicate the relative importance of the two components. This is analogous to a variance decomposition. In Table VI, the R-squares of each pair of regressions sum to very close to one, and all slope coefficients are reasonably close to one, which indicates that the two components have very low correlation.

We mainly discuss the decomposition regressions for Prior Close Cost, since one of the goals of this study is to understand the relation between Prior Close Cost and VWAP Cost. Close Cost is not widely used, and it is included for comparison purposes. In Table VI, Panel A, regressing Prior Close Cost on VWAP Cost yields an R-square of 7.9 percent, which indicates that these two measures are very different, and that it is important to distinguish between Prior Close Cost and VWAP Cost. Hypothetically, if we had found that Prior Close Cost is dominated by VWAP Cost, then it would not have been important to distinguish between the two.

Regressing Prior Close Cost on Market Movement Cost Prior Close to VWAP yields a slope coefficient of 0.98 and an R-square of 88.6 percent. This R-square is extremely high, especially given that we have a very large number of observations (1,128,873). This shows that Prior Close Cost is overwhelmingly dominated by Market Movement Cost Prior Close to VWAP. In other words, these two measures are very close. This result means that we can approximate Prior Close Cost with very high accuracy without even knowing the institutional investor's execution price (it does not matter what price the trader or broker gets). We only need to have the following transaction-specific information: the date, stock, and side of the transaction. We can then obtain the relevant VWAP and Prior Close from publicly available databases such as CRSP and the NYSE TAQ, and accurately estimate Prior Close Cost by computing Market Movement Cost Prior Close to VWAP.[12] Therefore, Prior Close Cost is a poor measure of execution quality, since it mainly captures market movement.

[12] Market Movement Cost Prior Close to VWAP is formally defined with the execution price in the denominator (equation (5)). However, the execution price only serves as a scaling factor. Replacing the execution price with the

Another way to interpret this result is that the VWAP is a very good approximation of execution prices, i.e., the deviations of execution prices from the VWAP are small compared to the market movement from Prior Close to VWAP. This result suggests that the trader (broker) can make a difference, but the difference that the trader can make is small compared to the market trend. However, the portfolio manager may be able to make a bigger difference by choosing to trade in more favorable market environments.

This result is also related to Bessembinder (2003)'s result that average effective spreads increase monotonically with the time between the transaction and the benchmark midquote. As the time between the transaction and the benchmark price becomes longer, the market movement component becomes larger and more important.[13] Prior Close Cost can be viewed as an effective spread with extremely long time between the transaction and the benchmark price. For conventional intraday effective spreads with short times between the transaction and the benchmark price, the market movement component may not dominate. Intraday effective spreads are not studied here because they are more suitable for retail orders.[14] Also, many institutions in our sample do not provide reliable intraday time stamps.

Regressing Close Cost onto its two components separately yields an R-square of 67.2 percent for Market Movement Cost VWAP to Close and an R-square of 33.4 percent for VWAP Cost. These results suggest that the market movement component is less important for Close Cost than for Prior Close Cost, even though the market movement component is still the dominant component for Close Cost.

To better understand how market movement drives implicit trading cost measures and how our decomposition regressions work, we run decomposition regressions on two subsamples, high stock-specific during-trade market movement and low stock-specific during-trade market movement. The high

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VWAP will not make a big difference, because our results show that the VWAP is a very good approximation of the execution price.

[13] In results not reported here, the market movement component is less dominant for Open Cost than for Prior Close Cost.

[14] Effective spreads are very widely used to study trading costs of intraday transactions. See, for example, Blume and Goldstein (1992), Hasbrouck (2003), and Werner (2003).

movement subsample includes all Fund DTGs whose stock-specific returns during the trading horizon (R_i) are higher than 2 percent or lower than or equal to -2 percent (482,029 observations). This subsample is a combination of the data used in the top and bottom segments of Table V, Panel A. The low movement subsample includes all remaining Fund DTGs (646,844 observations), which is a combination of the data used in the middle two segments of Table V, Panel A.

The results show that the dominance of the market movement component is even higher for the high movement subsample, and lower for the low movement subsample. The R-square of regressing Prior Close Cost on Market Movement Cost Prior Close to VWAP is 89.9 percent for the high movement subsample, and 72.4 percent for the low movement subsample. The R-square of regressing Prior Close Cost on VWAP Cost is 6.9 percent for the high movement subsample, and 20.4 percent for the low movement subsample.

[Insert Table VI about here]

D. Regression Analysis of Implicit Trading Costs

In Table VII we analyze implicit trading cost measures by running multivariate regressions. Panel A examines Fund DTGs, and the dependent variable is Prior Close Cost, VWAP Cost, or Close Cost. Panel B examines Fund PTGs. We again focus most of our discussions on Fund DTGs, since results are similar for Fund PTGs.

Most factors used are identified by previous studies (Keim and Madhavan (1995, 1997), and Conrad, Johnson, and Wahal (2001, 2003)), Buy Indicator, Log(Market Cap), Log(Relative Volume), Inverse Prior Close, Listed Indicator, Return Volatility, and an additional factor for Fund PTGs, Package Length. For Prior Close Cost, we generally find results similar to those in previous studies. Sided Stock Return Two-Day Prior Close to Prior Close is a proxy for stock-specific pre-trade market movement. It has a positive impact on Prior Close Cost. However, the magnitude is small. If Sided Stock Return Two-Day Prior Close to Prior Close increases by one basis point, then on average Prior Close Cost increases by 0.079 basis point.

As previous studies have found, the R-square is small when we use these factors above, only 1.2 percent in our case. The small R-Square is not surprising, given our finding in Table VI that Prior Close Cost is overwhelmingly dominated by market movement. Since all above factors are forward-looking, this regression is synonymous with short-term price prediction. In fact, it would have been surprising if we had found high R-squares for this regression.

We study a new factor, Sided Market Index Return. It is the sided (multiplied by -1 for sells) return on the CRSP value-weighted index during the trading horizon, which is a proxy for market-wide during-trade market movement. We run all our regressions both with and without this factor.

We find that this factor has a large impact on Prior Close Cost. If Sided Market Index Return increases by one basis point, then on average Prior Close Cost increases by 0.795 basis point. Also, the R-square jumps from 1.2 percent to 7.3 percent because of this one additional factor.

We find a similar result for Close Cost. The R-square jumps from 0.9 percent to 6.6 percent, and the coefficient on Sided Market Index Return is economically significant, at -0.452. However, for VWAP Cost, after we add Sided Market Index Return, the R-square barely moves at all, and the coefficient on Sided Market Index Return is economically insignificant, at -0.007. These results support our claim that both pre-trade and post-trade measures are highly influenced by market movement, but during-trade measures are neutral to market movement.

Also, the R-squares for VWAP Cost are even smaller, about 0.3 percent. This shows that VWAP Cost is almost "factor neutral". This result makes sense, because we believe VWAP Cost is a measure of the trader's (broker's) skill and effort, which is largely unobservable to us. This result also provides some justification for the industry practice of directly comparing VWAP Cost numbers across traders (brokers) without adjusting for any factors.

In Table VII, Panel B, in the regression for Prior Close Cost of Fund PTGs without Sided Market Index Return as a factor, the coefficient on Buy Indicator is 5.365, which means buys have higher Prior Close Cost than sells. But after adding Sided Market Index Return, the coefficient on Buy Indicator becomes -44.720. This result again supports our claim that Prior Close Cost Net of Market Index

Movement shares some common properties with Close Cost. The results for Fund DTGs in Table VII, Panel A, are qualitatively similar, even though the coefficient on Buy Indicator is statistically insignificant in the regression without Sided Market Index Return (the coefficient is 0.680 and its standard error is 0.652). One reason for the statistical insignificance is that the markets during our sample period are only mildly bullish.

[Insert Table VII about here]

IV. Conclusion

This study makes a number of contributions to the current literature. First, we provide a previously unexplored explanation for the widely documented buy-sell asymmetry phenomenon. It is mainly driven by mechanical characteristics of measures of implicit trading costs. This study shows that seemingly simple mechanical characteristics of measures of implicit trading costs can have fundamental implications for how we interpret empirical results.

Second, we emphasize that trading is a double-sided and zero-sum game. The double-sided and zero-sum game nature of trading has important implications for how we apply trading cost measures and analyze the trading process.

Third, we clarify the confusion in both current academic literature and industry practice on different measures of implicit trading costs (pre-trade versus during-trade measures), and on different related research questions (trading costs of investment strategies versus execution quality). We argue that pre-trade measures are suitable for measuring trading costs of investment strategies, and during-trade measures are suitable for measuring execution quality.

Fourth, we relate different trading cost measures through decompositions. We decompose a pre-trade measure into a market movement component and a during-trade measure, and find that empirically, the market movement component is the dominant component of the pre-trade measure. Our results cast doubt on previous findings on execution quality that use pre-trade measures, because pre-trade measures mainly capture market movement.

REFERENCES

Berkowitz, Stephen A., Dennis E. Logue, and Eugene A. Noser, 1988, The total costs of transacting on the NYSE, *Journal of Finance* 43, 97-112.

Blume, Marshall, and Michael A. Goldstein, 1992, Displayed and effective spreads by market, 1992, Working paper, University of Pennsylvania.

Bessembinder, Hendrik, 2003, Issues in assessing trade execution costs, *Journal of Financial Markets* 6, 233-257.

Chakravarty, Sugato, Venkatesh Panchapagesan, and Robert A.Wood, 2002, Has decimalization hurt institutional investors? An investigation into trading costs and order routing practices of buy-side institutions, Working paper, University of Memphis.

Chan, Louis K.C., and Josef Lakonishok, 1993, Institutional trades and intraday stock price behavior, *Journal of Financial Economics* 33, 173-199.

Chan, Louis K.C., and Josef Lakonishok, 1995, The behavior of stock prices around institutional trades, *Journal of Finance* 50, 1147-1174.

Chiyachantana, Chiraphol N., Pankaj K. Jain, Christine Jiang, and Robert A. Wood, 2003, International evidence on institutional trading behavior and price impact, *Journal of Finance*, forthcoming.

Conrad, Jennifer S., Kevin M. Johnson, and Sunil Wahal, 2001, Institutional trading and soft dollars, *Journal of Finance* 56, 397-416.

Conrad, Jennifer S., Kevin M. Johnson, and Sunil Wahal, 2003, Institutional trading and alternative trading systems, *Journal of Financial Economics* 70, 99-134.

Domowitz, Ian, Jack Glen, and Ananth Madhavan, 2001, Liquidity, volatility and equity trading costs across countries and over time, *International Finance* 4, 221-255.

Griffin, John M., Jeffrey H. Harris, and Selim Topaloglu, 2003, The dynamics of institutional and individual trading, *Journal of Finance*, forthcoming.

Goldstein, Michael, Paul Irvine, Eugene Kandel, and Zvi Wiener, 2003, Brokerage commissions and institutional trading patterns, Working paper, Babson College.

Harris, Lawrence, 1998, Optimal dynamic order submission strategies in some stylized trading problems, *Financial Markets, Institutions & Instruments* 7, 1-76.

Harris, Lawrence, 2003, Trading and exchanges: Market microstructure for practitioners, Oxford University Press, Inc., New York, NY.

Hasbrouck, Joel, 2003, Trading costs and returns for US equities: The evidence from daily data, Working paper, New York University.

Holthausen, Robert W., Richard W. Leftwich, and David Mayers, 1987, The effect of large block transactions on security prices: A cross-sectional analysis, *Journal of Financial Economics* 19, 237-267.

Holthausen, Robert W., Richard W. Leftwich, and David Mayers, 1990, Large-block transactions, the speed of response, and temporary and permanent stock-price effects, *Journal of Financial Economics* 26, 71-96.

Jones, Charles M., and Marc L. Lipson, 1999, Execution costs of institutional equity orders, *Journal of Financial Intermediation* 8, 123-140.

Jones, Charles M., and Marc L. Lipson, 2001, Sixteenths: Direct evidence on institutional execution costs, *Journal of Financial Economics* 59, 253-278.

Keim, Donald B., 2003, The cost of trend chasing and the illusion of momentum profits, Working paper, University of Pennsylvania.

Keim, Donald B., and Ananth Madhavan, 1995, Anatomy of the trading process: Empirical evidence on the behavior of institutional traders, *Journal of Financial Economics* 37, 371-398.

Keim, Donald B., and Ananth Madhavan, 1996, The upstairs market for large-block transactions: Analysis and measurement of price effects, *Review of Financial Studies* 9, 1-36.

Keim, Donald B., and Ananth Madhavan, 1997, Transaction costs and investment style: An inter-exchange analysis of institutional equity trades, *Journal of Financial Economics* 46, 265-292.

Konishi, Hizuru, 2002, Optimal slice of a VWAP trade, *Journal of Financial Markets* 5, 197-221.

Korajczyk, Robert A., and Ronnie Sadka, 2003, Are momentum profits robust to trading costs? *Journal of Finance*, forthcoming.

Kraus Alan, and Hans R. Stoll, 1972, Price impacts of block trading on the New York Stock Exchange, *Journal of Finance* 27, 569-588.

Lesmond, David A., Michael J. Schill, and Chunsheng Zhou, 2003, The illusory nature of momentum profits, *Journal of Financial Economics*, forthcoming.

Macey, Jonathan R., and Maureen O'Hara, 1997, The law and economics of best execution, *Journal of Financial Intermediation* 6, 188-223.

Madhavan, Ananth, 2002, VWAP strategies, *Investment Guides, Transaction Performance: The changing face of trading* Spring 2002 32-38, edited by Brian R. Bruce, Institutional Investor Journals, Inc., New York, NY.

Perold, Andre F., 1988, The implementation shortfall: Paper versus reality, *Journal of Portfolio Management* 14, 4-9.

Perold, Andre F., and Erik R. Sirri, 1998, The cost of international equity trading, Working paper, Harvard University.

Pozen, Robert C., 2002, The mutual fund business, 2nd edition, Chapter 6, Brokerage transactions for mutual funds, Houghton Mifflin Company, Boston, MA.

Saar, Gideon, 2001, Price impact asymmetry of block trades: An institutional trading explanation, *Review of Financial Studies* 14, 1153-1181.

Schwartz, Robert A., and Benn Steil, 2002, Controlling institutional trading costs, *Journal of Portfolio Management* 28, 39-49.

Wagner, Wayne H., and Mark Edwards, 1993, Best execution, *Financial Analyst Journal* 49, 65-71.

Werner, Ingrid M., 2003, Execution quality for institutional orders routed to Nasdaq dealers before and after decimals, Working paper, Ohio State University.

Table I
Summary Statistics

This table presents summary statistics of our sample. Our sample includes equity trading data from 322 institutions for the fourth quarter of 2001. Listed refers to stocks listed on the NYSE/Amex, and OTC refers to NASDAQ. Market cap information is from CRSP monthly files as of September 2001 (search forward if missing). The total number of stocks traded in our sample is 4,686. We first sort all stocks by market cap in descending order, and then classify the top 10 percent of stocks as large cap, the next 20 percent of stocks as mid cap, the next 30 percent of stocks as small cap, and the bottom 40 percent of stocks as micro cap. Median market cap within each category are reported below. DTGs refer to Daily Transaction Groups, and PTGs refer to Package Transaction Groups.

	N (# of Fund DTGs)	N (# of Fund PTGs)	$ Principal Traded (M)	Shares Traded (M)	Median Market Cap ($M)
Total	1,128,873	763,586	544,492	20,094	
Buys	56.5%	57.3%	51.1%	50.9%	
Sells	43.5%	42.7%	48.9%	49.1%	
Listed	65.5%	66.9%	73.2%	65.4%	
OTC	34.5%	33.1%	26.8%	34.6%	
Large Cap	46.3%	49.8%	71.5%	59.4%	8,831
Mid Cap	30.6%	29.6%	20.8%	25.3%	1,490
Small Cap	17.9%	16.2%	6.8%	12.2%	379
Micro Cap	5.2%	4.3%	0.9%	3.1%	78

Table II
Measures of Implicit Trading Costs

This table presents percentiles of different measures of implicit trading costs and their components. Trading costs are expressed in basis points (bps), and they are dollar value-weighted averages. DTGs refer to Daily Transaction Groups, and PTGs refer to Package Transaction Groups.

Table II. Measures of Implicit Trading Costs
Panel A. Fund DTGs (N = 1,128,873)

	Prior Close Cost (bps)	VWAP Cost (bps)	Close Cost (bps)	Prior Close Cost Net of Market Index Movement (bps)	Market Movement Cost Prior Close to VWAP (bps)	Market Movement Cost VWAP to Close (bps)	Market Index Movement Cost Prior Close to Close (bps)
10th	-286.05	-95.58	-193.54	-279.13	-280.89	-144.20	-151.32
25th	-114.50	-32.92	-73.59	-120.37	-115.47	-56.03	-71.11
Median	6.33	1.01	-0.17	9.82	7.67	6.94	0.13
75th	139.96	39.90	57.29	142.55	136.84	77.07	71.11
90th	325.00	104.09	165.60	311.06	310.51	177.37	151.32

Table II. Measures of Implicit Trading Costs
Panel B. Fund PTGs (N = 763,586)

	Prior Close Cost (bps)	VWAP Cost (bps)	Close Cost (bps)	Prior Close Cost Net of Market Index Movement (bps)	Market Movement Cost Prior Close to VWAP (bps)	Market Movement Cost VWAP to Close (bps)	Market Index Movement Cost Prior Close to Close (bps)
10th	-321.02	-104.24	-231.33	-312.30	-314.80	-177.75	-171.17
25th	-121.93	-36.89	-82.93	-127.46	-124.56	-69.17	-73.88
Median	16.49	3.97	-0.00	18.23	12.11	6.14	0.14
75th	168.73	48.68	75.49	169.92	159.62	88.66	78.18
90th	392.12	118.14	209.64	374.40	375.85	211.33	173.55

Table III
Trading Costs and Decompositions

This table presents different trading costs and their decompositions. For example, Prior Close Cost is equal to Market Movement Cost Prior Close to VWAP plus VWAP Cost. However, the table shows Market Movement items (Market Movement Cost items not multiplied by Side) instead of Market Movement Cost items. This choice makes the table easier to read because Market Movement items are basically returns. Because of this choice, the decompositions hold only for buys. For sells, the decompositions hold if Market Movement items are multiplied by -1. The decompositions do not hold for all transactions, because Market Movement items for all are value-weighted averages of Market Movement items for buys and sells. Trading costs are expressed in basis points (bps), and they are dollar value-weighted averages. DTGs refer to Daily Transaction Groups, and PTGs refer to Package Transaction Groups. Standard errors are in parentheses.

Table III. Trading Costs and Decompositions
Panel A. Fund DTGs

Side	N	$ Principal Traded (M)	Shares Traded (M)	Commissions (bps)	Prior Close Cost (bps)	VWAP Cost (bps)	Close Cost (bps)	Prior Close Cost Net of Market Index Movement (bps)	Market Movement Two-Day Prior Close to Prior Close (bps)	Market Movement Prior Close to VWAP (bps)	Market Movement VWAP to Close (bps)	Market Movement Close to One-Day Post Close (bps)	Market Index Movement (bps)
All	1,128,873	544,492	20,094	11.79	23.36	4.16	-3.45	25.23	14.99	-7.57	17.02	24.22	22.43
				(0.05)	(2.39)	(0.53)	(0.90)	(2.27)	(2.10)	(2.20)	(0.76)	(1.60)	(0.51)
Buys	638,247	278,056	10,221	11.78	14.09	2.70	-21.42	-6.04	45.22	11.39	24.11	20.01	20.12
				(0.08)	(3.88)	(0.88)	(1.14)	(3.59)	(2.93)	(3.54)	(1.01)	(2.22)	(0.75)
Sells	490,626	266,436	9,873	11.80	33.04	5.69	15.31	57.87	-16.56	-27.35	9.62	28.61	24.83
				(0.07)	(2.70)	(0.55)	(1.37)	(2.63)	(2.99)	(2.61)	(1.15)	(2.29)	(0.67)

Table III. Trading Costs and Decompositions
Panel B. Fund PTGs

Side	N	$ Principal Traded (M)	Shares Traded (M)	Commissions (bps)	Prior Close Cost (bps)	VWAP Cost (bps)	Close Cost (bps)	Prior Close Cost Net of Market Index Movement (bps)	Market Movement Two-Day Prior Close to Prior Close (bps)	Market Movement Prior Close to VWAP (bps)	Market Movement VWAP to Close (bps)	Market Movement Close to One-Day Post Close (bps)	Market Index Movement (bps)
All	763,586	544,492	20,094	11.79	72.59	3.31	-6.15	71.95	25.07	2.30	32.25	28.87	59.29
				(0.07)	(4.39)	(0.93)	(2.73)	(4.41)	(2.41)	(4.37)	(2.28)	(2.04)	(1.45)
Buys	437,625	278,056	10,221	11.78	70.15	0.07	-40.77	11.47	39.29	70.08	40.84	23.46	58.68
				(0.11)	(6.87)	(1.38)	(3.89)	(6.72)	(3.20)	(6.72)	(3.27)	(2.83)	(1.79)
Sells	325,961	266,436	9,873	11.80	75.14	6.70	29.98	135.07	10.23	-68.44	23.28	34.51	59.94
				(0.10)	(5.37)	(1.23)	(3.85)	(5.38)	(3.60)	(5.58)	(3.20)	(2.94)	(2.28)

Table IV

Trading Costs and Decompositions, Segmentation by Market-Wide During-Trade Market Movement

This table segments the data by market-wide during-trade market movement and presents different trading costs and their decompositions. For example, Prior Close Cost is equal to Market Movement Cost Prior Close to VWAP plus VWAP Cost. However, the table shows Market Movement items (Market Movement Cost items not multiplied by Side) instead of Market Movement Cost items. This choice makes the table easier to read because Market Movement items are basically returns. Because of this choice, the decompositions hold only for buys. For sells, the decompositions hold if Market Movement items are multiplied by -1. The decompositions do not hold for all transactions, because Market Movement items for all are value-weighted averages of Market Movement items for buys and sells. R_{vw} is the return on the CRSP value-weighted index during the trading horizon. Trading costs are expressed in basis points (bps), and they are dollar value-weighted averages. DTGs refer to Daily Transaction Groups, and PTGs refer to Package Transaction Groups. Standard errors are in parentheses.

Table IV. Trading Costs and Decompositions, Segmentation by Market-Wide During-Trade Market Movement
Panel A. Fund DTGs

	Side	N	$ Principal Traded (M)	Shares Traded (M)	Commissions (bps)	Prior Close Cost (bps)	VWAP Cost (bps)	Close Cost (bps)	Prior Close Cost Net of Market Index Movement (bps)	Market Movement Two-Day Prior Close to Prior Close (bps)	Market Movement Prior Close to VWAP (bps)	Market Movement VWAP to Close (bps)	Market Movement Close to One-Day Post Close (bps)	Market Index Movement (bps)
R_{VW} > 1% 16 days	All	286,708	141,480	5,302	11.80	19.56	6.12	-2.28	19.47	31.52	117.62	86.70	80.74	166.71
					(0.09)	(3.32)	(0.94)	(1.71)	(3.28)	(3.56)	(3.15)	(1.23)	(2.96)	(0.38)
	Buys	161,845	69,983	2,593	11.59	136.15	3.67	-92.45	-32.46	65.43	132.47	96.13	69.64	168.61
					(0.12)	(4.26)	(1.35)	(1.98)	(4.22)	(4.07)	(4.04)	(1.72)	(3.68)	(0.52)
	Sells	124,863	71,497	2,709	12.00	-94.57	8.51	85.98	70.29	-1.67	103.08	77.47	91.61	164.86
					(0.13)	(4.89)	(1.31)	(2.31)	(4.85)	(5.78)	(4.82)	(1.77)	(4.61)	(0.55)
0 < R_{VW} <= 1% 20 days	All	345,146	161,333	5,921	11.63	34.64	5.02	-4.91	33.77	-17.22	-4.82	22.13	-7.76	37.94
					(0.09)	(3.20)	(0.92)	(2.01)	(3.22)	(4.86)	(3.11)	(1.52)	(2.95)	(0.23)
	Buys	191,589	81,612	2,996	11.74	29.04	4.53	-27.16	-9.32	2.65	24.50	31.70	-3.28	38.36
					(0.13)	(4.31)	(1.55)	(2.56)	(4.30)	(7.55)	(4.27)	(1.75)	(3.87)	(0.32)
	Sells	153,557	79,721	2,925	11.53	40.37	5.53	17.87	77.89	-37.56	-34.84	12.35	-12.34	37.52
					(0.13)	(4.74)	(0.97)	(3.08)	(4.69)	(6.10)	(4.47)	(2.51)	(4.45)	(0.33)
-1% < R_{VW} <= 0 22 days	All	387,861	187,709	6,875	11.75	20.36	2.00	-3.73	22.56	50.26	-53.21	-8.79	22.17	-41.77
					(0.10)	(4.47)	(1.04)	(1.22)	(4.16)	(3.18)	(3.63)	(1.14)	(2.85)	(0.34)
	Buys	220,920	97,528	3,579	11.71	-33.32	0.22	3.15	8.98	84.88	-33.54	-2.94	17.36	-42.30
					(0.15)	(7.04)	(1.85)	(1.56)	(6.66)	(4.04)	(5.67)	(1.57)	(4.33)	(0.57)
	Sells	166,941	90,181	3,296	11.80	78.43	3.94	-11.17	37.24	12.81	-74.49	-15.11	27.38	-41.19
					(0.12)	(4.67)	(0.79)	(1.92)	(4.66)	(4.88)	(4.56)	(1.68)	(3.58)	(0.33)
R_{VW} <= -1% 6 days	All	109,158	53,970	1,997	12.33	10.03	3.95	-1.14	24.14	-54.71	-185.19	-91.16	-21.23	-178.93
					(0.16)	(13.03)	(1.06)	(2.71)	(12.21)	(4.49)	(11.99)	(2.18)	(4.63)	(0.33)
	Buys	63,893	28,933	1,053	12.55	-163.52	3.54	83.81	16.52	-17.28	-167.06	-80.28	-25.40	-180.04
					(0.23)	(21.29)	(1.37)	(3.58)	(21.34)	(5.84)	(21.18)	(3.21)	(6.47)	(0.45)
	Sells	45,265	25,037	944	12.06	210.60	4.44	-99.30	32.95	-97.97	-206.16	-103.74	-16.41	-177.65
					(0.21)	(8.96)	(1.63)	(3.32)	(9.01)	(6.85)	(8.61)	(2.85)	(6.59)	(0.49)

Table IV. Trading Costs and Decompositions, Segmentation by Market-Wide During-Trade Market Movement
Panel B. Fund PTGs

	Side	N	$ Principal Traded (M)	Shares Traded (M)	Commissions (bps)	Prior Close Cost (bps)	VWAP Cost (bps)	Close Cost (bps)	Prior Close Cost Net of Market Index Movement (bps)	Market Movement Two-Day Prior Close to Prior Close (bps)	Market Movement Prior Close to VWAP (bps)	Market Movement VWAP to Close (bps)	Market Movement Close to One-Day Post Close (bps)	Market Index Movement (bps)
$R_{VW} > 1\%$	All	224,239	211,877	8,023	12.24	72.48	1.52	-8.89	69.77	20.08	132.02	123.81	26.61	230.02
					(0.14)	(7.22)	(1.68)	(5.21)	(7.73)	(4.10)	(7.53)	(4.06)	(3.58)	(1.98)
	Buys	127,593	109,888	4,062	11.86	187.39	-8.29	-137.70	-36.98	38.81	195.68	129.41	17.69	224.37
					(0.18)	(10.32)	(2.19)	(6.39)	(10.42)	(5.33)	(10.40)	(5.22)	(4.39)	(1.97)
	Sells	96,646	101,989	3,961	12.65	-51.33	12.10	129.89	184.78	-0.09	63.43	117.79	36.23	236.11
					(0.21)	(10.24)	(2.55)	(7.75)	(10.49)	(6.29)	(10.96)	(6.29)	(5.75)	(3.51)
$0 < R_{VW} <= 1\%$	All	220,276	122,960	4,464	11.21	72.05	7.43	1.30	71.26	5.59	-0.68	24.29	16.33	41.74
					(0.13)	(5.34)	(1.73)	(5.23)	(5.35)	(5.33)	(5.36)	(4.23)	(3.54)	(0.36)
	Buys	123,662	62,842	2,308	11.60	70.00	7.45	-22.32	28.39	11.06	62.55	29.77	19.22	41.61
					(0.20)	(8.05)	(3.07)	(9.16)	(8.11)	(7.45)	(7.91)	(7.22)	(5.11)	(0.54)
	Sells	96,614	60,118	2,157	10.81	74.19	7.42	25.99	116.07	-0.12	-66.77	18.57	13.30	41.88
					(0.15)	(6.96)	(1.51)	(5.14)	(6.96)	(7.62)	(6.76)	(4.31)	(4.87)	(0.47)
$-1\% < R_{VW} <= 0$	All	230,047	125,390	4,495	11.30	59.17	3.81	-5.13	59.42	58.03	-69.02	-21.67	33.61	-43.48
					(0.14)	(7.67)	(1.82)	(3.92)	(7.21)	(4.30)	(6.34)	(3.38)	(4.04)	(0.49)
	Buys	133,634	62,708	2,304	11.49	-12.11	1.54	14.27	31.61	69.34	-13.66	-12.73	29.01	-43.72
					(0.23)	(12.73)	(3.05)	(4.96)	(12.25)	(5.47)	(10.98)	(4.51)	(6.47)	(0.84)
	Sells	96,413	62,682	2,191	11.11	130.48	6.08	-24.54	87.24	46.71	-124.40	-30.62	38.21	-43.24
					(0.15)	(7.03)	(1.96)	(5.95)	(7.09)	(6.62)	(6.66)	(5.03)	(4.80)	(0.52)
$R_{VW} <= -1\%$	All	89,024	84,265	3,112	12.21	93.65	1.05	-11.63	97.13	17.00	-213.39	-106.15	45.78	-191.44
					(0.17)	(16.83)	(2.06)	(6.86)	(16.13)	(5.60)	(15.92)	(5.87)	(5.50)	(1.24)
	Buys	52,736	42,619	1,548	12.25	-110.85	8.57	100.97	81.84	37.95	-119.41	-92.40	36.44	-192.69
					(0.24)	(26.78)	(2.77)	(9.87)	(27.06)	(7.49)	(26.73)	(9.01)	(8.14)	(1.62)
	Sells	36,288	41,646	1,564	12.17	302.92	-6.64	-126.86	112.77	-4.44	-309.56	-120.22	55.35	-190.15
					(0.25)	(17.31)	(3.03)	(8.93)	(17.12)	(8.32)	(17.71)	(7.55)	(7.31)	(1.87)

Table V

Trading Costs and Decompositions, Segmentation by Stock-Specific During-Trade Market Movement

This table segments the data by stock-specific during-trade market movement and presents different trading costs and their decompositions. For example, Prior Close Cost is equal to Market Movement Cost Prior Close to VWAP plus VWAP Cost. However, the table shows Market Movement items (Market Movement Cost items not multiplied by Side) instead of Market Movement Cost items. This choice makes the table easier to read because Market Movement items are basically returns. Because of this choice, the decompositions hold only for buys. For sells, the decompositions hold if Market Movement items are multiplied by -1. The decompositions do not hold for all transactions, because Market Movement items for all are value-weighted averages of Market Movement items for buys and sells. R_i is the stock-specific return during the trading horizon. Trading costs are expressed in basis points (bps), and they are dollar value-weighted averages. DTGs refer to Daily Transaction Groups, and PTGs refer to Package Transaction Groups. Standard errors are in parentheses.

Table V. Trading Costs and Decompositions, Segmentation by Stock-Specific During-Trade Market Movement

Panel A. Fund DTGs

	Side	N	$ Principal Traded (M)	Shares Traded (M)	Commissions (bps)	Prior Close Cost (bps)	VWAP Cost (bps)	Close Cost (bps)	Prior Close Cost Net of Market Index Movement (bps)	Market Movement Two-Day Prior Close to Prior Close (bps)	Market Movement Prior Close to VWAP (bps)	Market Movement VWAP to Close (bps)	Market Movement Close to One-Day Post Close (bps)	Market Index Movement (bps)
$R_i > 2\%$	All	272,156	131,408	5,706	11.95	51.98	10.97	-8.50	47.07	66.11	343.25	142.29	61.09	85.29
					(0.11)	(4.66)	(1.38)	(2.82)	(4.30)	(4.01)	(3.28)	(1.75)	(3.45)	(0.87)
	Buys	164,196	73,897	3,167	12.03	348.60	6.95	-136.88	268.41	97.94	341.65	143.83	49.41	80.19
					(0.14)	(4.23)	(1.97)	(2.86)	(4.36)	(5.00)	(3.92)	(1.85)	(4.26)	(1.14)
	Sells	107,960	57,511	2,539	11.86	-329.16	16.14	156.45	-237.32	25.21	345.30	140.31	76.10	91.84
					(0.17)	(6.07)	(1.86)	(4.23)	(6.20)	(6.50)	(5.55)	(3.22)	(5.65)	(1.33)
$0 < R_i <= 2\%$	All	328,434	150,618	4,779	11.21	6.55	2.33	1.26	11.95	23.31	59.14	30.86	23.26	34.56
					(0.07)	(0.95)	(0.35)	(0.86)	(1.21)	(2.22)	(0.70)	(0.68)	(1.88)	(0.80)
	Buys	189,811	79,096	2,504	11.21	62.27	1.95	-28.46	34.50	43.02	60.32	30.41	18.75	27.76
					(0.10)	(0.98)	(0.44)	(0.94)	(1.63)	(2.75)	(0.87)	(0.82)	(2.43)	(1.17)
	Sells	138,623	71,522	2,275	11.21	-55.08	2.75	34.12	-13.00	1.52	57.83	31.37	28.25	42.08
					(0.11)	(1.35)	(0.54)	(1.37)	(1.75)	(3.52)	(1.12)	(1.12)	(2.89)	(1.05)
$-2\% < R_i <= 0$	All	318,410	151,421	4,818	11.28	2.58	-0.14	-1.35	7.45	26.84	-70.50	-16.51	2.48	-0.06
					(0.08)	(1.16)	(0.44)	(0.86)	(1.50)	(3.81)	(1.00)	(0.81)	(2.11)	(0.82)
	Buys	174,882	74,247	2,361	11.17	-69.64	-0.54	15.07	-64.62	45.35	-69.11	-15.61	0.97	-5.02
					(0.12)	(1.59)	(0.68)	(1.10)	(2.06)	(6.90)	(1.43)	(0.98)	(2.76)	(1.19)
	Sells	143,528	77,174	2,458	11.39	72.07	0.24	-17.14	76.78	9.03	-71.84	-17.38	3.94	4.71
					(0.11)	(1.38)	(0.56)	(1.26)	(1.86)	(3.50)	(1.39)	(1.27)	(3.18)	(1.12)
$R_i <= -2\%$	All	209,873	111,045	4,791	13.06	40.63	4.46	-6.71	41.67	-72.95	-427.38	-104.27	11.54	-37.75
					(0.16)	(10.21)	(1.84)	(2.33)	(9.64)	(6.80)	(6.61)	(1.79)	(5.37)	(1.18)
	Buys	109,358	50,816	2,189	13.18	-425.03	2.41	104.14	-382.65	-28.23	-427.43	-101.73	7.05	-42.38
					(0.29)	(13.26)	(3.67)	(4.22)	(12.71)	(9.18)	(12.39)	(2.62)	(8.65)	(1.85)
	Sells	100,515	60,228	2,602	12.96	433.52	6.18	-100.23	399.67	-110.67	-427.33	-106.41	15.32	-33.85
					(0.17)	(6.55)	(1.34)	(2.98)	(6.82)	(9.64)	(6.28)	(2.46)	(6.65)	(1.48)

Table V. Trading Costs and Decompositions, Segmentation by Stock-Specific During-Trade Market Movement
Panel B. Fund PTGs

	Side	N	$ Principal Traded (M)	Shares Traded (M)	Commissions (bps)	Prior Close Cost (bps)	VWAP Cost (bps)	Close Cost (bps)	Prior Close Cost Net of Market Index Movement (bps)	Market Movement Two-Day Prior Close to Prior Close (bps)	Market Movement Prior Close to VWAP (bps)	Market Movement VWAP to Close (bps)	Market Movement Close to One-Day Post Close (bps)	Market Index Movement (bps)
$R_i > 2\%$	All	208,331	177,067	7,385	12.30	113.20	2.35	-24.83	103.88	40.71	417.93	228.61	18.62	144.57
					(0.14)	(6.85)	(1.83)	(5.79)	(6.20)	(4.22)	(4.95)	(3.82)	(3.65)	(2.77)
	Buys	126,310	105,553	4,337	12.24	427.65	-15.87	-230.41	298.58	53.08	443.52	214.55	13.16	129.07
					(0.17)	(5.86)	(2.38)	(5.87)	(6.48)	(5.45)	(5.63)	(4.52)	(4.38)	(2.85)
	Sells	82,021	71,514	3,048	12.40	-350.93	29.24	278.61	-183.49	22.46	380.17	249.37	26.68	167.44
					(0.26)	(9.29)	(2.72)	(7.89)	(10.60)	(6.66)	(8.98)	(6.64)	(6.31)	(5.27)
$0 < R_i <= 2\%$	All	202,792	113,986	3,510	10.69	26.38	6.01	17.83	30.30	31.20	53.72	39.86	22.68	56.59
					(0.12)	(2.45)	(0.86)	(2.34)	(3.43)	(3.35)	(1.95)	(1.81)	(2.69)	(2.15)
	Buys	118,447	59,880	1,837	10.83	75.42	4.90	-21.79	25.29	39.16	70.52	26.69	17.83	50.13
					(0.20)	(3.23)	(1.20)	(2.98)	(4.53)	(4.41)	(2.51)	(2.26)	(3.57)	(2.82)
	Sells	84,345	54,106	1,673	10.54	-27.89	7.25	61.68	35.84	22.39	35.14	54.43	28.06	63.73
					(0.14)	(3.53)	(1.22)	(3.47)	(5.20)	(5.08)	(2.82)	(2.74)	(4.06)	(3.29)
$-2\% < R_i <= 0$	All	197,265	113,945	3,526	10.69	22.50	3.22	13.94	30.10	30.00	-72.48	-19.09	15.40	16.14
					(0.11)	(2.27)	(0.98)	(2.02)	(3.27)	(4.19)	(1.79)	(1.60)	(2.72)	(2.05)
	Buys	111,308	54,168	1,683	10.76	-51.60	4.36	35.71	-60.58	37.38	-55.96	-31.36	12.55	8.98
					(0.17)	(3.36)	(1.81)	(3.21)	(4.82)	(7.05)	(2.49)	(2.16)	(3.88)	(3.17)
	Sells	85,957	59,777	1,844	10.62	89.64	2.19	-5.79	112.27	23.32	-87.45	-7.98	18.00	22.63
					(0.14)	(2.59)	(0.87)	(2.47)	(3.66)	(4.79)	(2.40)	(2.26)	(3.82)	(2.67)
$R_i <= -2\%$	All	155,198	139,494	5,672	12.92	99.73	2.40	-18.45	99.66	-3.82	-506.22	-181.29	57.92	-11.49
					(0.17)	(14.60)	(2.55)	(7.28)	(14.90)	(6.34)	(11.27)	(4.94)	(5.71)	(3.13)
	Buys	81,560	58,455	2,363	12.85	-467.95	19.92	211.35	-454.34	16.30	-487.87	-191.43	57.95	-13.61
					(0.31)	(22.46)	(4.51)	(11.01)	(22.65)	(8.47)	(21.58)	(9.01)	(9.77)	(4.74)
	Sells	73,638	81,039	3,308	12.97	509.21	-10.24	-184.21	499.26	-18.33	-519.45	-173.97	57.91	-9.95
					(0.20)	(11.00)	(2.99)	(7.32)	(11.89)	(9.03)	(11.65)	(5.48)	(6.85)	(4.16)

Table VI
Decomposition Regressions of Implicit Trading Costs

This table presents decomposition regressions of different measures of implicit trading costs. We run decomposition regressions on all transactions in the whole sample. We also run decomposition regressions on two subsamples, high stock-specific during-trade market movement and low stock-specific during-trade market movement. The dependent variable is either Prior Close Cost or Close Cost. The independent variable is either VWAP Cost or different Market Movement Costs, which are sided (multiplied by -1 for sells) market movement. The dependent variable is regressed on its two components separately. For example, Prior Close Cost is equal to Market Movement Cost Prior Close to VWAP plus VWAP Cost. R_i is the stock-specific return during the trading horizon. Implicit trading costs in regressions are expressed in basis points (bps), and they are dollar value-weighted averages. DTGs refer to Daily Transaction Groups, and PTGs refer to Package Transaction Groups. Standard errors are in parentheses.

Table VI. Decomposition Regressions of Implicit Trading Costs
Panel A. Fund DTGs

	Dependent Variables	Intercept	Market Movement Cost Prior Close to VWAP (bps)	Market Movement Cost VWAP to Close (bps)	VWAP Cost (bps)	R^2
All N = 1,128,873	Prior Close Cost (bps)	2.96 (0.11)	0.98 (0.00)			88.6%
		12.95 (0.31)			0.83 (0.00)	7.9%
	Close Cost (bps)	2.76 (0.11)		-1.00 (0.00)		67.2%
		-13.01 (0.16)			1.01 (0.00)	33.4%
High Movement $R_i <= -2\%$ or $R_i > 2\%$ N = 482,029	Prior Close Cost (bps)	4.84 (0.23)	0.98 (0.00)			89.9%
		31.59 (0.70)			0.82 (0.00)	6.9%
	Close Cost (bps)	4.68 (0.23)		-1.02 (0.00)		68.1%
		-24.14 (0.33)			1.04 (0.00)	34.3%
Low Movement $-2\% < R_i <= 2\%$ N = 646,844	Prior Close Cost (bps)	1.48 (0.08)	0.95 (0.00)			72.4%
		-0.95 (0.14)			0.86 (0.00)	20.4%
	Close Cost (bps)	1.27 (0.08)		-0.94 (0.00)		62.6%
		-4.62 (0.11)			0.89 (0.00)	30.1%

Table VI. Decomposition Regressions of Implicit Trading Costs
Panel B. Fund PTGs

	Dependent Variables	Intercept	Market Movement Cost Prior Close to VWAP (bps)	Market Movement Cost VWAP to Close (bps)	VWAP Cost (bps)	R^2
All N = 763,586	Prior Close Cost (bps)	6.10	0.98			**90.4%**
		(0.15)	(0.00)			
		26.10			0.77	**5.7%**
		(0.46)			(0.00)	
	Close Cost (bps)	6.06		-1.04		**75.4%**
		(0.15)		(0.00)		
		-13.61			1.12	**31.0%**
		(0.24)			(0.00)	
High Movement $R_i <= -2\%$ or $R_i > 2\%$ N = 363,529	Prior Close Cost (bps)	7.00	0.98			**91.4%**
		(0.28)	(0.00)			
		51.79			0.74	**4.7%**
		(0.93)			(0.01)	
	Close Cost (bps)	7.17		-1.05		**76.6%**
		(0.28)		(0.00)		
		-26.57			1.16	**31.5%**
		(0.48)			(0.00)	
Low Movement $-2\% < R_i <= 2\%$ N = 400,057	Prior Close Cost (bps)	5.29	0.97			**74.0%**
		(0.11)	(0.00)			
		2.11			0.92	**21.9%**
		(0.19)			(0.00)	
	Close Cost (bps)	5.20		-0.97		**67.0%**
		(0.11)		(0.00)		
		-1.06			0.94	**29.1%**
		(0.16)			(0.00)	

Table VII
Regression Analysis of Implicit Trading Costs

This table presents a regression analysis of different measures of implicit trading costs. The dependent variable in regressions is Prior Close Cost, VWAP Cost, or Close Cost. The dependent variables are expressed in basis points (bps), and they are dollar value-weighted averages. Definitions of the independent variables are as follows: Buy Indicator takes the value of one for buys, and zero for sells; Package Length is the number of trading days in the Package Transaction Group (Package Length only appears in regressions for fund PTGs in Panel B); Log (Market Cap) is the natural logarithm of market value of equity; Log (Relative Volume) is the natural logarithm of the ratio of shares traded relative to average daily market trading volume over the prior five trading days; Inverse Prior Close is the inverse of close price on the day prior to the trading horizon; Listed Indicator takes the value of one for stocks listed on the NYSE/Amex, and zero for NASDAQ; Return Volatility is the standard deviation of daily returns over previous ten trading days expressed in basis points (bps); Sided Stock Return Two-Day Prior Close to Prior Close is the stock's sided (multiplied by -1 for sells) return from two-day prior close to prior close expressed in basis points (bps); Sided Market Index Return is the sided (multiplied by -1 for sells) return on the CRSP value-weighted index during the trading horizon expressed in basis points (bps). DTGs refer to Daily Transaction Groups, and PTGs refer to Package Transaction Groups. Standard errors are in parentheses. Statistical significance is indicated by ** for one percent level and * for five percent level.

Table VII. Regression Analysis of Implicit Trading Costs
Panel A. Fund DTGs

	Prior Close Cost (bps)		VWAP Cost (bps)		Close Cost (bps)	
Intercept	-23.230**	4.963	-17.812**	-18.042**	-44.808**	-60.842**
	(4.811)	(4.660)	(1.635)	(1.635)	(2.844)	(2.762)
Buy Indicator	0.680	-33.690**	-1.800**	-1.520**	-36.672**	-17.126**
	(0.652)	(0.644)	(0.222)	(0.226)	(0.386)	(0.382)
Log (Market Cap)	2.709**	2.317**	1.537**	1.541**	3.431**	3.654**
	(0.233)	(0.226)	(0.079)	(0.079)	(0.138)	(0.134)
Log (Relative Volume)	4.177**	4.331**	1.951**	1.949**	2.052**	1.965**
	(0.165)	(0.159)	(0.056)	(0.056)	(0.097)	(0.095)
Inverse Prior Close	28.623**	25.467**	48.083**	48.109**	-7.544*	-5.749
	(5.915)	(5.729)	(2.010)	(2.010)	(3.497)	(3.395)
Listed Indicator	-17.720**	-16.592**	-7.266**	-7.275**	-4.976**	-5.617**
	(0.780)	(0.756))	(0.265)	(0.265)	(0.461)	(0.448)
Return Volatility (bps)	0.038**	0.036**	0.006**	0.006**	-0.012**	-0.011**
	(0.002))	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
Sided Stock Return	0.079**	0.072**	-0.001*	-0.001*	0.002**	0.006**
Two-Day Prior Close to Prior Close (bps)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)
Sided Market Index Return (bps)		0.795**		-0.007**		-0.452**
		(0.003)		(0.001)		(0.002)
R^2	**1.2%**	**7.3%**	**0.3%**	**0.3%**	**0.9%**	**6.6%**
N	1,128,873		1,128,873		1,128,873	

Table VII. Regression Analysis of Implicit Trading Costs
Panel B. Fund PTGs

	Prior Close Cost (bps)		VWAP Cost (bps)		Close Cost (bps)	
Intercept	-50.196**	-1.532	6.215**	4.897*	6.717	-26.194**
	(6.990)	(6.781)	(2.192)	(2.192)	(4.385)	(4.231)
Buy Indicator	5.365**	-44.720**	-3.086**	-1.728**	-53.150**	-19.277**
	(0.944)	(0.943)	(0.296)	(0.305)	(0.592)	(0.588)
Package Length	18.417**	18.577**	-2.672**	-2.677**	-9.376**	-9.484**
	(0.349)	(0.338)	(0.109)	(0.109)	(0.219)	(0.211)
Log (Market Cap)	3.940**	2.832**	0.561**	0.591**	1.898**	2.647**
	(0.337)	(0.327)	(0.106)	(0.106)	(0.211)	(0.204)
Log (Relative Volume)	7.772**	7.286**	1.497**	1.510**	0.964**	1.293**
	(0.239)	(0.232)	(0.075)	(0.075)	(0.150)	(0.145)
Inverse Prior Close	47.894**	48.438**	54.058**	54.044**	-12.873*	-13.240*
	(9.177)	(8.897)	(2.877)	(2.877)	(5.756)	(5.552)
Listed Indicator	-27.851**	-25.306**	-5.826**	-5.895**	-4.666**	-6.388**
	(1.133)	(1.099)	(0.355)	(0.355)	(0.711)	(0.686)
Return Volatility (bps)	0.080**	0.073**	0.009**	0.009**	-0.007**	-0.003
	(0.003)	(0.003)	(0.001)	(0.001)	(0.002)	(0.002)
Sided Stock Return	0.072**	0.071**	0.001*	0.001*	0.012**	0.013**
Two-Day Prior Close to Prior Close (bps)	(0.001)	(0.001)	(0.000)	(0.000)	(0.001)	(0.001)
Sided Market Index Return (bps)		0.774**		-0.021**		-0.524**
		(0.004)		(0.001)		(0.002)
R^2	**1.7%**	**7.6%**	**0.3%**	**0.3%**	**1.3%**	**8.2%**
N	763,586		763,586		763,586	

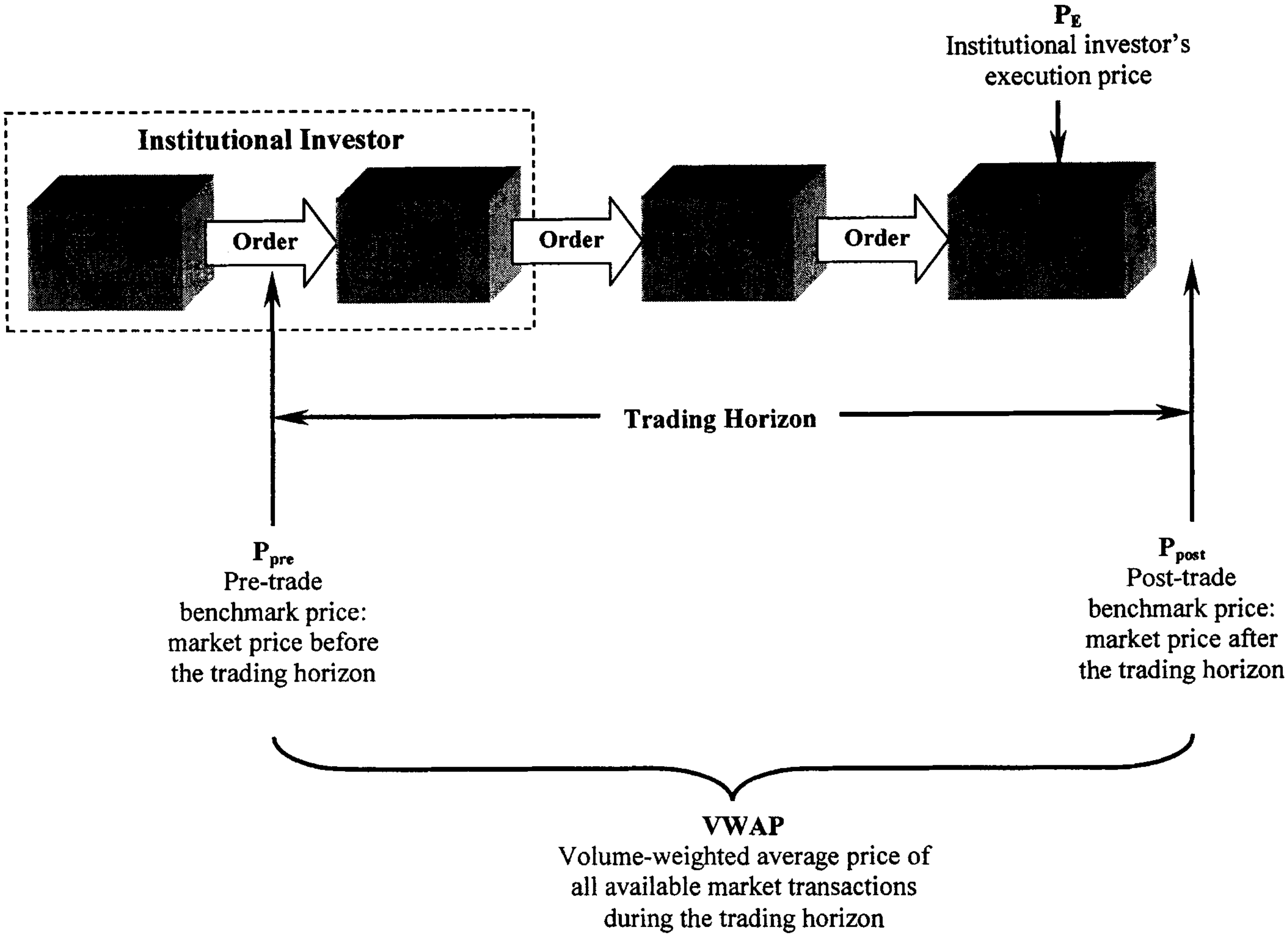

Figure 3. Typical Institutional Trading Process.* This figure depicts a typical institutional trading process (see Pozen (2002) for more background institutional information and case studies of real institutional trading processes). The Portfolio Manager (PM) and the trader are inside the same buy-side institutional investor. P_{pre}, VWAP, and P_{post} are market prices, whereas P_E is the institutional investor's own execution price.

* Figures 1 and 2 (summaries of predictions) appear in the introduction section.

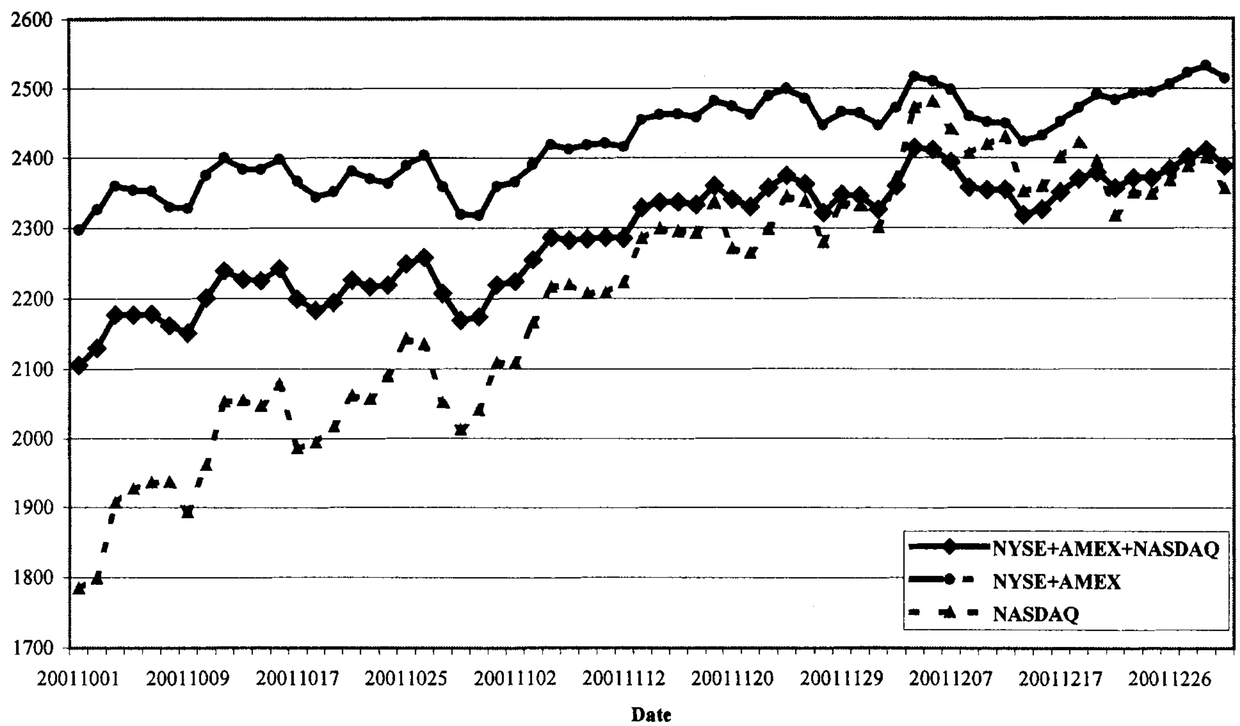

Figure 4. Daily CRSP Value-Weighted Indexes During Our Sample Period, 2001 Q4. This figure plots the Daily CRSP value-weighted indexes (NYSE+AMEX+NASDAQ, NYSE+AMEX, and NASDAQ) during our sample period, the fourth quarter of 2001.

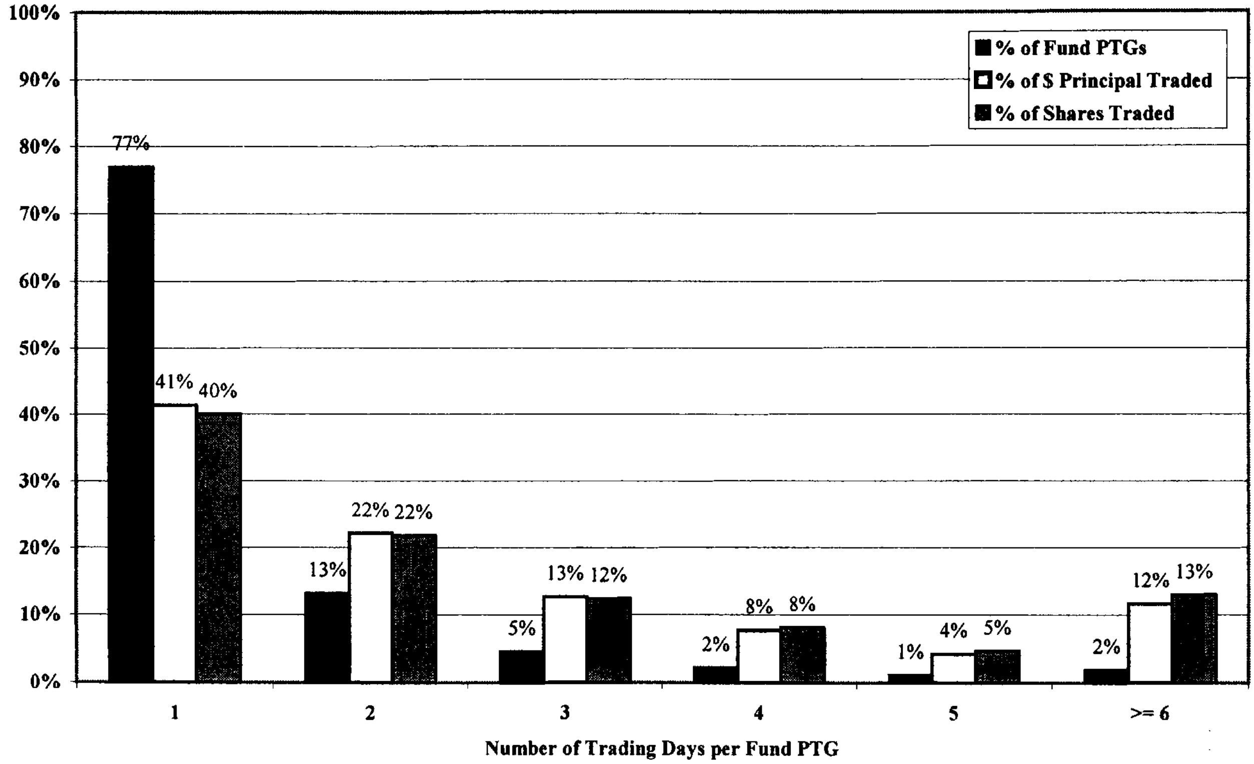

Figure 5. Length of Fund PTGs. This figure plots the distribution of length of Fund PTGs (Package Transaction Groups). The figure shows the percentage of the number of Fund PTGs that span the corresponding number of trading days, the percentage of $ principal traded in those Fund PTGs, and the percentage of shares traded in those Fund PTGs.