



# Measures of implicit trading costs and buy–sell asymmetry

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## Abstract

This paper shows that the widely documented buy–sell asymmetry in implicit institutional trading cost is mainly driven by mechanical characteristics of a specific class of measures: pre-trade measures. If a post-trade measure is used, the asymmetry is reversed in both rising and falling markets. Both pre-trade and post-trade measures are highly influenced by market movement, while during-trade measures are relatively neutral to market movement. I further 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. This paper demonstrates that simple mechanical characteristics of trading cost measures can have important implications for how empirical results are interpreted.

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Previous studies find that institutional buys incur higher implicit trading costs than do sells (Kraus and Stoll, 1972; Holthausen et al., 1987, 1990; Chan and Lakonishok, 1993, 1995; and Keim and Madhavan, 1996).<sup>1</sup> In a review paper, Macey and O’Hara (1997, p. 204) state that

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<sup>1</sup>Implicit trading costs, as opposed to explicit trading costs (commissions, etc.), are trading costs not explicitly paid by investors (imbedded in transaction prices).

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.

Intuitively, if implicit trading costs truly measure execution quality, then one would not expect there to be a buy–sell asymmetry unless one believes there are systematic differences in terms of order difficulty between buys and sells. Chan and Lakonishok (1993) propose an information-based explanation for this buy–sell asymmetry phenomenon. Saar (2001) develops an information-based theoretical model to explain this asymmetry. Chiyachantana et al. (2004) 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. They argue that existing information-based explanations fail to explain the reversal of buy–sell asymmetry during bearish markets. They explain their findings by noting that “this finding suggests that the liquidity available to buy (sell) orders is higher in bearish (bullish) markets.” In this study, I provide a simple yet 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 broadly classified into 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, typically the prior day’s close (Perold, 1988). During-trade measures use some kind of average price over the trading horizon, typically the volume-weighted average price (VWAP) (Berkowitz et al., 1988).<sup>2</sup> Post-trade measures use prices after the trade, typically the day’s close at the end of the trading horizon.

I argue that buy–sell asymmetry is mainly driven by the mechanical characteristics of the measures of implicit trading costs. If a pre-trade measure is used, when the market is rising, the execution price will tend to be higher than the pre-trade benchmark price for both buys and sells. This will produce a positive cost for buys, but a negative cost for sells. Therefore, 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 relatively neutral to market movement. Fig. 1 summarizes my main predictions regarding buy–sell asymmetry.

Most previous studies fall into Cell 1 in Fig. 1 (pre-trade measures and rising markets in sample). Most of Chiyachantana et al. (2004) findings can be explained by Cells 1 and 2 in Fig. 1. Using institutional trading data, I confirm my predictions in Fig. 1 for all three classes of trading cost measures in all six cells.

I 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.

<sup>2</sup>VWAP appears in several recent studies (e.g., Lert, 2001; Konishi, 2002; Madhavan, 2002; Werner, 2003; Ting, 2006; and Goldstein et al., 2009). Domowitz et al., 2001 use a different during-trade benchmark, the mean of the day’s high, low, open, and close (HLOC) prices. HLOC can be viewed as an easy approximation of VWAP.

		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)

Fig. 1. Summary of main predictions on buy–sell asymmetry. This figure summarizes the 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.

Side		Measures of Implicit Trading Costs			
		Pre-Trade Measures	VWAP Cost	Post-Trade Measures	
Market Condition	↑	All	0	0	0
		Buys	+ C <sub>1</sub>	0	- C <sub>2</sub>
		Sells	- C <sub>1</sub>	0	+ C <sub>2</sub>
	↓	All	0	0	0
		Buys	- C <sub>1</sub> '	0	+ C <sub>2</sub> '
		Sells	+ C <sub>1</sub> '	0	- C <sub>2</sub> '

Fig. 2. Trading is a double-sided and zero-sum game—what if we have a complete trading database? This figure summarizes my 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<sub>1</sub>, C<sub>2</sub>, C<sub>1</sub>', and C<sub>2</sub>' are all positive. C<sub>1</sub> (–C<sub>1</sub>') 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<sub>2</sub> (–C<sub>2</sub>') 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.

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. Fig. 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.

Fig. 2 can be viewed as a “limiting” case of Fig. 1, when we have a complete trading database including all market participants. We expect Fig. 1 to hold even if our database only includes a subset of market participants. On the other hand, if we can meaningfully

distinguish between liquidity demanders and liquidity suppliers (e.g., designated market makers), and to the extent that a given sample contains more liquidity demanders than liquidity suppliers, then we might expect positive instead of zero overall trading costs for the sample. It is not the purpose of Fig. 2 to simply emphasize that different trading cost measures will sum to zero and therefore are not useful. Note that investment alphas of all market participants should also sum to zero, although alpha is a very meaningful investment performance measure. The purpose of Fig. 2 is to highlight that certain mechanical properties of measures of implicit trading costs can have important implications for how we interpret empirical results. For example, for pre-trade and post-trade measures in trending markets, buys and sells will have non-zero costs of opposite signs, and this seems to be the driving force behind buy–sell asymmetry, even when our trading database only includes a subset of market participants. In contrast to pre-trade and post-trade measures, VWAP cost has zero sums for buys and sells separately, and this seems to be why we often find aggregate VWAP cost to be of very small magnitude in empirical studies.

I 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. I 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 I regress prior close cost onto its two components separately, I get an *R*-square of 88.6% for market movement cost prior close to VWAP, and an *R*-square of only 7.9% for VWAP cost. This means that we can approximate prior close cost with very high accuracy without knowing the institutional investor's execution price (it does not matter what price the trader or broker gets). This result highlights the fact that prior close cost is overwhelmingly dominated by market movement.

I also conduct multivariate regression analysis to try to explain cross-sectional variations in implicit trading costs by various factors. As previous studies have found, the *R*-squares are usually very small for this type of regressions (e.g., 1.2%). My earlier finding that prior close cost is dominated by market movement provides an explanation for why the *R*-Squares are so small. Since the dependent variable mainly captures market movement and all factors are forward-looking, this type of regressions is synonymous with short-term price prediction. In fact, it would have been surprising if I had found large *R*-squares, as it would have been a clear violation of market efficiency.

The rest of the paper is organized as follows. Section 1 discusses related issues and methodology. Section 2 describes the data. Section 3 discusses empirical results and Section 4 concludes.

## 1. Discussion and methodology

### 1.1. Typical institutional trading process

Fig. 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 institution. The PM also specifies a trading horizon, which is often a trading day. The trading horizon

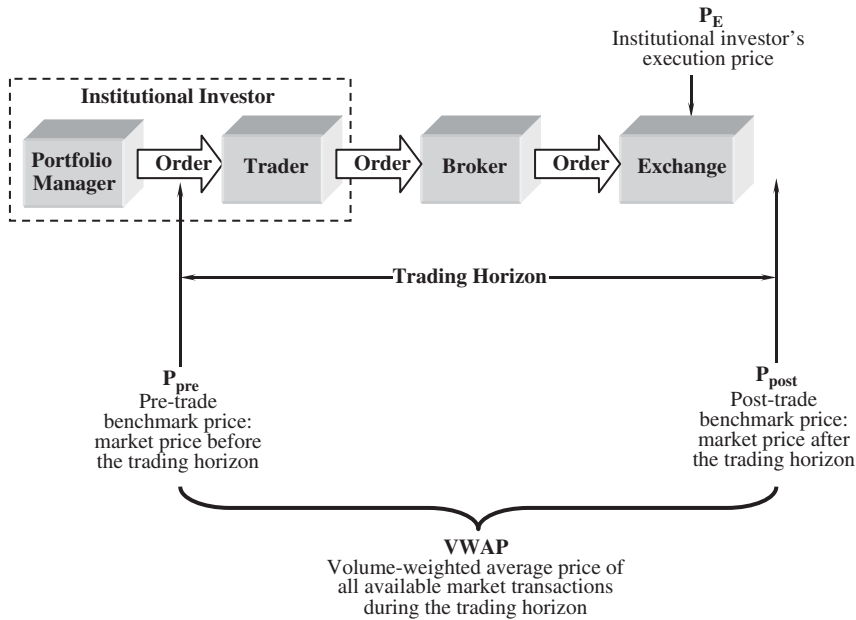


Fig. 3. Typical institutional trading process. This figure depicts a typical institutional trading process (see [Pozen, 2002](#) for more background institutional information and case studies of real institutional trading processes). The portfolio manager (PM) and the trader are inside the same buy-side institutional investor.  $P_{pre}$ , VWAP, and  $P_{post}$  are market prices, whereas  $P_E$  is the institutional investor’s own execution price.

can also be shorter than a trading day, or it can span multiple trading days. Since many institutions in my sample do not provide intraday time stamps, I mainly analyze daily frequency in my empirical analysis. As for the multi-day issue, I 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 vs. 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.

1.2. Measures of implicit trading costs

I focus on implicit trading costs in this study. Measures of implicit trading costs take the following common form:

$$\text{Implicit trading cost} \equiv \text{Side} * \frac{\text{Execution price } (P_E) - \text{Benchmark price}}{\text{Execution price } (P_E)},$$

where

$$\text{Side} = \begin{cases} 1 & \text{for buys} \\ -1 & \text{for sells} \end{cases} \quad \text{and}$$

$$\text{Benchmark price} \equiv \begin{cases} P_{\text{pre}} & \text{for pre-trade measures} \\ \text{VWAP} & \text{for during-trade measures} \\ P_{\text{post}} & \text{for post-trade measures} \end{cases} \quad (1)$$

As in Fig. 3,  $P_E$  denotes the institutional investor's execution price.<sup>3</sup> Different implicit trading cost measures use different benchmark prices.  $P_{\text{pre}}$  denotes the pre-trade benchmark price. Following most previous studies, I use prior close as  $P_{\text{pre}}$  in my empirical study. Prior close is the closing price on the day prior to the trading horizon. The during-trade benchmark price, VWAP, is the volume-weighted average price of all available market transactions during the trading horizon.<sup>4</sup> 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 multi-day.  $P_{\text{post}}$  denotes the post-trade benchmark price. I use close, the closing price of the trading horizon, as  $P_{\text{post}}$ . I analyze the following three implicit trading cost measures in detail empirically:

$$\text{Prior close cost} \equiv \text{Side} * \frac{P_E - \text{Prior close}}{P_E}, \quad (2)$$

$$\text{VWAP cost} \equiv \text{Side} * \frac{P_E - \text{VWAP}}{P_E}, \quad (3)$$

$$\text{Close cost} \equiv \text{Side} * \frac{P_E - \text{Close}}{P_E}. \quad (4)$$

The “culprit” of buy–sell asymmetry is the fact that in Eqs. (1)–(4), Side takes the value of 1 for buys and  $-1$  for sells. I am not saying that the definitions are inappropriate. To the contrary, the definitions make perfect sense. However, we do need to pay close attention to the mechanical characteristics of the measures of implicit trading costs implied by such definitions. For the purposes of this study, I do not consider

<sup>3</sup>Alternatively, one can use the benchmark price instead of the execution price in the denominator. Both make sense and it may not make a big difference empirically. I choose to use the execution price in the denominator because: (1) it makes it easier to compare the results obtained by using different benchmark prices, because they all have the same denominator; (2) it makes it more convenient to compute the corresponding dollar trading cost (simply multiply the trading cost measure by the dollar principal traded). For the same reason, it also makes it easier to compute aggregate trading costs; and (3) the decompositions I show later will hold exactly only if I use the execution price in the denominator. If I use the benchmark price in the denominator, the decompositions will hold approximately.

<sup>4</sup>One of the potential problems of VWAP cost is that the institutional investor's own trades are part of the benchmark. Note that 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, it can be shown that:  $\text{VWAP Cost}_{-I} = \text{VWAP Cost} / (1 - f_I)$ , where  $\text{VWAP Cost}_{-I}$  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. See Hu (2007) for the proof and more details.

the opportunity cost of unfilled orders. Opportunity cost can be viewed as a different dimension of the trading cost measurement problem. I 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 the fill rates are close to 100% (e.g., Keim and Madhavan, 1995, 1997 and Chakravarty et al., 2005).

### 1.3. Decompositions of implicit trading cost measures

Decompositions provide insights about the characteristics of and relation among different measures. I will use the following decompositions in my empirical analysis:

$$\underbrace{\left(\text{Side} * \frac{P_E - \text{Prior close}}{P_E}\right)}_{\text{Prior close cost}} = \underbrace{\left(\text{Side} * \frac{P_E - \text{VWAP}}{P_E}\right)}_{\text{VWAP cost}} + \underbrace{\left(\text{Side} * \frac{\text{VWAP} - \text{Prior close}}{P_E}\right)}_{\text{Market movement cost prior close to VWAP}} \quad (5)$$

$$\underbrace{\left(\text{Side} * \frac{P_E - \text{Close}}{P_E}\right)}_{\text{Close cost}} = \underbrace{\left(\text{Side} * \frac{P_E - \text{VWAP}}{P_E}\right)}_{\text{VWAP cost}} - \underbrace{\left(\text{Side} * \frac{\text{Close} - \text{VWAP}}{P_E}\right)}_{\text{Market movement cost VWAP to close}} \quad (6)$$

Eqs. (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. I 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. I refer to these market movement cost items as “costs” because they are side-dependent.

Eq. (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). Keim (2003) controls for market-wide during-trade market movement by subtracting market index return measured over the trading horizon from pre-trade measures. For comparison purposes, I also analyze a similar measure:

$$\text{Prior close cost net of market index movement} \equiv \text{Side} * \left( \frac{P_E - \text{Prior close}}{P_E} - \text{Market index movement} \right). \quad (7)$$

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

$$\text{Prior close cost} = \frac{\text{Prior close cost net of}}{\text{market index movement}} + \text{Market index movement cost},$$

where

$$\text{Market index movement cost} \equiv \text{Side} * \text{Market index movement}. \quad (8)$$

Lehmann (2003) outlines a general decomposition framework related to the above and shows that a trader's daily trading profits have three components: close-to-close returns on yesterday's closing position, market timing profits relative to the closing price benchmark (which is usually thought of as market impact or price impact), and execution costs relative to the trade-by-trade benchmark.

## 2. Data

I obtain 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. The Abel/Noser data are similar to the Plexus data used by many previous studies (e.g., Keim and Madhavan, 1995, 1997; Jones and Lipson, 1999, 2001; and Conrad et al., 2001, 2003). Several recent studies, such as Chemmanur et al. (2009), Goldstein et al. (2009), and Bethel et al. (2009), make use of the Abel/Noser data. My sample period is the fourth quarter of 2001, during which the general market trend is bullish, with significant numbers of both up and down trading days.

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, and whether it is a buy or sell by the institution. The data were provided to me under the condition that the names of all institutions, funds, traders, and brokers were removed from the data. However, I was given identification codes that enable me to separately identify all entities involved.

I follow Keim and Madhavan (1997) and eliminate transactions under 100 shares, and stocks trading under \$1.00. Following Conrad et al. (2001), I eliminate any transaction if the closing price on the day prior to the transaction date, as recorded by the Abel/Noser, is not within 1% of the price recorded by CRSP. Also following Conrad et al. (2001), I exclude transactions if any of the three implicit trading cost measures (prior close cost, VWAP cost, and close cost) are larger (smaller) than 50% (–50%). My final sample comprises transactions originated from 322 institutions with 20.1 billion shares traded and \$544.5 billion traded. There are 4,686 different stocks traded in my sample.

I 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, I choose to aggregate the data using reliable dimensions, which ensures uniform treatment of the data across the entire sample. I aggregate the data at the fund level.<sup>5</sup> The unit of observation I use is either a Fund Daily Transaction Group (Fund DTG) or a Fund Package Transaction Group (Fund PTG). All

<sup>5</sup>I 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. Results in this study are not sensitive to how I aggregate the data.



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. Since my results do not differ qualitatively between Fund DTGs and Fund PTGs, I only report results based on Fund DTGs for brevity.

### 3. Empirical results

#### 3.1. Trading cost decomposition and buy–sell asymmetry

In Table 1, Panel A presents percentiles of different measures of implicit trading costs and their components. 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 the 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 the trading database includes only a subset of buy-side institutions. The absolute magnitudes of implicit trading costs can be substantial. For example, the 75th percentile of prior close cost is 139.96 basis points (bps). Eq. (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 3–4). However, it is interesting that market movement cost prior close to VWAP is almost at 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 my findings later that market movement cost prior close to VWAP is the dominant component of prior close cost.

Table 1 Panel B, Tables 2 and 3 all have the same columns, and they all show results for all transactions and for buys and sells separately. These tables 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 (Eqs. (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. The numbers of observations are very large for almost all of the empirical results. As a result, statistical significance is frequently achieved. I therefore focus on economic significance.

In Table 1, Panel B shows the results for the entire sample. There is almost no buy–sell asymmetry in commissions. As mentioned earlier, the market indexes are bullish during my sample period. Consistent with my predictions in Fig. 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 my sample is not completely lined up with market indexes, either because of the

Table 1

Trading costs and decompositions.

This table presents different measures of trading costs and their decompositions. Panel A presents percentiles of different measures of implicit trading costs and their components. Panel B 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. The unit of observation is a Fund Daily Transaction Group (Fund DTG).

Percentile	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)	
<i>Panel A. Percentiles of measures of implicit trading costs</i>														
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	
Side	<i>N</i>	\$ 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)	
<i>Panel B. Decompositions of trading cost measures</i>														
All	1,128,873	544,492	20,094	11.79 (0.05)	23.36 (2.39)	4.16 (0.53)	-3.45 (0.90)	25.23 (2.27)	14.99 (2.10)	-7.57 (2.20)	17.02 (0.76)	24.22 (1.60)	22.43 (0.51)	
Buys	638,247	278,056	10,221	11.78 (0.08)	14.09 (3.88)	2.70 (0.88)	-21.42 (1.14)	-6.04 (3.59)	45.22 (2.93)	11.39 (3.54)	24.11 (1.01)	20.01 (2.22)	20.12 (0.75)	
Sells	490,626	266,436	9,873	11.80 (0.07)	33.04 (2.70)	5.69 (0.55)	15.31 (1.37)	57.87 (2.63)	-16.56 (2.99)	-27.35 (2.61)	9.62 (1.15)	28.61 (2.29)	24.83 (0.67)	

weighting across different stocks or the timing across different trading days. VWAP cost numbers are close to zero, as one would expect based on Fig. 2.

On average, institutional investors in my sample seem to chase market trends. The pre-trade movement is positive for buys (45.22 bps), but negative for sells (−16.56 bps). 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 findings by Griffin et al. (2003). The buy–sell asymmetry for close cost and that for prior close cost net of market index movement are in the same direction. These results show that prior close cost net of market index movement shares some common properties with close cost.

Table 2 segments Table 1 Panel B by market-wide during-trade market movement. I 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%, zero, and 1%. The results in Table 2 are consistent with the predictions in Fig. 1. When  $R_{VW}$  is higher than 1% (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% (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 the buy–sell asymmetry results. We can also see “shadows” of Fig. 2 in these results. These patterns are less clear in the middle two segments of Table 2, where  $R_{VW}$  is between −1% and 1%. This is because the trading in the sample is not completely lined up with the CRSP value-weighted index.

Table 3 segments Table 1 Panel B by stock-specific during-trade market movement. I 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%, zero, and 2%. I choose higher cutoffs than those in Table 2 because stock-specific returns are more volatile than market index returns. The results in Table 3 confirm all my predictions in Fig. 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 Fig. 2.

### 3.2. Decomposition regressions of implicit trading costs

Table 4 presents decomposition regressions of implicit trading cost measures. The purpose of this table is to show the relative importance of components of both prior close cost and close cost. I use regressions in a somewhat unconventional manner. The focus is neither the regression coefficients nor their statistical significance. The most informative quantities in this table are the  $R$ -squares (in bold). According to Eq. (5), prior close cost is equal to market movement cost prior close to VWAP plus VWAP cost. I 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

Table 2

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. The unit of observation is a Fund Daily Transaction Group (Fund DTG). (Standard errors are in parentheses).

	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	5302	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	2593	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	2709	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)
$0 < R_{VW} \leq 1\%$ 20 days	All	345,146	161,333	5921	11.63	34.64	5.02	-4.91	33.77	-17.22	-4.82	22.13	-7.76	37.94

Table 2 (continued)

	Side	<i>N</i>	\$ 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)
					(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	2996	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	2925	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)
$-1\% < R_{VW} \leq 0$ 22 days	All	387,861	187,709	6875	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	3579	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	3296	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)
$R_{VW} \leq -1\%$ 6 days	All	109,158	53,970	1997	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	1053	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 3

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. The unit of observation is a Fund Daily Transaction Group (Fund DTG). (Standard errors are in parentheses).

	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 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	5706	11.95 (0.11)	51.98 (4.66)	10.97 (1.38)	-8.50 (2.82)	47.07 (4.30)	66.11 (4.01)	343.25 (3.28)	142.29 (1.75)	61.09 (3.45)	85.29 (0.87)
	Buys	164,196	73,897	3167	12.03 (0.14)	348.60 (4.23)	6.95 (1.97)	-136.88 (2.86)	268.41 (4.36)	97.94 (5.00)	341.65 (3.92)	143.83 (1.85)	49.41 (4.26)	80.19 (1.14)
	Sells	107,960	57,511	2539	11.86 (0.17)	-329.16 (6.07)	16.14 (1.86)	156.45 (4.23)	-237.32 (6.20)	25.21 (6.50)	345.30 (5.55)	140.31 (3.22)	76.10 (5.65)	91.84 (1.33)
$0 < R_i \leq 2\%$	All	328,434	150,618	4779	11.21 (0.07)	6.55 (0.95)	2.33 (0.35)	1.26 (0.86)	11.95 (1.21)	23.31 (2.22)	59.14 (0.70)	30.86 (0.68)	23.26 (1.88)	34.56 (0.80)
	Buys	189,811	79,096	2504	11.21 (0.10)	62.27 (0.98)	1.95 (0.44)	-28.46 (0.94)	34.50 (1.63)	43.02 (2.75)	60.32 (0.87)	30.41 (0.82)	18.75 (2.43)	27.76 (1.17)
	Sells	138,623	71,522	2275	11.21 (0.11)	-55.08 (1.35)	2.75 (0.54)	34.12 (1.37)	-13.00 (1.75)	1.52 (3.52)	57.83 (1.12)	31.37 (1.12)	28.25 (2.89)	42.08 (1.05)
$-2\% < R_i \leq 0$	All	318,410	151,421	4818	11.28 (0.08)	2.58 (1.16)	-0.14 (0.44)	-1.35 (0.86)	7.45 (1.50)	26.84 (3.81)	-70.50 (1.00)	-16.51 (0.81)	2.48 (2.11)	-0.06 (0.82)
	Buys	174,882	74,247	2361	11.17 (0.12)	-69.64 (1.59)	-0.54 (0.68)	15.07 (1.10)	-64.62 (2.06)	45.35 (6.90)	-69.11 (1.43)	-15.61 (0.98)	0.97 (2.76)	-5.02 (1.19)
	Sells	143,528	77,174	2458	11.39 (0.11)	72.07 (1.38)	0.24 (0.56)	-17.14 (1.26)	76.78 (1.86)	9.03 (3.50)	-71.84 (1.39)	-17.38 (1.27)	3.94 (3.18)	4.71 (1.12)
$R_i \leq -2\%$	All	209,873	111,045	4791	13.06 (0.16)	40.63 (10.21)	4.46 (1.84)	-6.71 (2.33)	41.67 (9.64)	-72.95 (6.80)	-427.38 (6.61)	-104.27 (1.79)	11.54 (5.37)	-37.75 (1.18)
	Buys	109,358	50,816	2189	13.18 (0.29)	-425.03 (13.26)	2.41 (3.67)	104.14 (4.22)	-382.65 (12.71)	-28.23 (9.18)	-427.43 (12.39)	-101.73 (2.62)	7.05 (8.65)	-42.38 (1.85)
	Sells	100,515	60,228	2602	12.96 (0.17)	433.52 (6.55)	6.18 (1.34)	-100.23 (2.98)	399.67 (6.82)	-110.67 (9.64)	-427.33 (6.28)	-106.41 (2.46)	15.32 (6.65)	-33.85 (1.48)

Table 4

Decomposition regressions of implicit trading costs.

This table presents decomposition regressions of different measures of implicit trading costs. I run decomposition regressions on all transactions in the whole sample. I also run decomposition regressions on two sub-samples, 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. The unit of observation is a Fund Daily Transaction Group (Fund DTG). Standard errors are in parentheses.

	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	0.98			<b>88.6</b>
		(0.11)	(0.00)			
	Close cost (bps)	12.95			0.83	<b>7.9</b>
		(0.31)			(0.00)	
		2.76		-1.00		<b>67.2</b>
		(0.11)		(0.00)		
High movement $R_i \leq -2\%$ or $R_i > 2\%$ $N = 482,029$	Prior close cost (bps)	-13.01			1.01	<b>33.4</b>
		(0.16)			(0.00)	
	Close cost (bps)	4.84	0.98			<b>89.9</b>
		(0.23)	(0.00)			
		31.59			0.82	<b>6.9</b>
		(0.70)			(0.00)	
Low movement $-2\% < R_i \leq 2\%$ $N = 646,844$	Prior close cost (bps)	4.68		-1.02		<b>68.1</b>
		(0.23)		(0.00)		
	Close cost (bps)	-24.14			1.04	<b>34.3</b>
		(0.33)			(0.00)	
	Prior close cost (bps)	1.48	0.95			<b>72.4</b>
		(0.08)	(0.00)			
	Close cost (bps)	-0.95			0.86	<b>20.4</b>
		(0.14)			(0.00)	
		1.27		-0.94		<b>62.6</b>
		(0.08)		(0.00)		
		-4.62			0.89	<b>30.1</b>
		(0.11)			(0.00)	

the relative importance of the two components. This is analogous to a variance decomposition. In Table 4, 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.

I focus my discussion on 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 4, regressing prior close cost on VWAP cost yields an  $R$ -square of 7.9%, which indicates that these two measures are very different. Thus, it is important to distinguish between prior close cost and VWAP cost. 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% (implying a correlation coefficient of 0.94). This  $R$ -square is extremely high, especially given that I have a large number of observations. This shows that prior close cost is overwhelmingly dominated by market movement cost prior close to VWAP.

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.<sup>6</sup> 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 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 PM may be able to make a bigger difference by choosing to trade in more favorable market environments.

This result is also related to Bessembinder's (2003) 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.<sup>7</sup> 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.<sup>8</sup> Also, many institutions in my sample do not provide reliable intraday time stamps.

To better understand how market movement drives implicit trading cost measures and how my decomposition regressions work, I run decomposition regressions on two sub-samples, high stock-specific during-trade market movement and low stock-specific during-trade market movement. The high movement sub-sample includes all Fund DTGs whose stock-specific returns during the trading horizon ( $R_i$ ) are higher than 2% or lower than or equal to -2%. This sub-sample is a combination of the data used in the top and bottom segments of Table 3. The low movement sub-sample includes all remaining Fund DTGs,

<sup>6</sup>Market movement cost prior close to VWAP is formally defined with the execution price in the denominator (Eq. (5)). However, the execution price only serves as a scaling factor. Replacing the execution price with the VWAP will not make a big difference, because my results show that the VWAP is a very good approximation of the execution price.

<sup>7</sup>In results not reported here, the market movement component is relatively less dominant for open cost than for prior close cost.

<sup>8</sup>Effective spreads are very widely used to study trading costs of intraday transactions (e.g., Blume and Goldstein, 1992; Venkataraman, 2001; Van Ness et al., 2005; Goldstein et al., 2008; and Hasbrouck, 2009).



Table 5

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 10 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). The unit of observation is a Fund Daily Transaction Group (Fund DTG). Standard errors are in parentheses. Statistical significance is indicated by \*\* for the 1% level and \* for the 5% level.

	Prior close cost (bps)		VWAP cost (bps)		Close cost (bps)	
Intercept	-23.230** (4.811)	4.963 (4.660)	-17.812** (1.635)	-18.042** (1.635)	-44.808** (2.844)	-60.842** (2.762)
Buy indicator	0.680 (0.652)	-33.690** (0.644)	-1.800** (0.222)	-1.520** (0.226)	-36.672** (0.386)	-17.126** (0.382)
Log (market cap)	2.709** (0.233)	2.317** (0.226)	1.537** (0.079)	1.541** (0.079)	3.431** (0.138)	3.654** (0.134)
Log (relative volume)	4.177** (0.165)	4.331** (0.159)	1.951** (0.056)	1.949** (0.056)	2.052** (0.097)	1.965** (0.095)
Inverse prior close	28.623** (5.915)	25.467** (5.729)	48.083** (2.010)	48.109** (2.010)	-7.544* (3.497)	-5.749 (3.395)
Listed indicator	-17.720** (0.780)	-16.592** (0.756)	-7.266** (0.265)	-7.275** (0.265)	-4.976** (0.461)	-5.617** (0.448)
Return volatility (bps)	0.038** (0.002)	0.036** (0.002)	0.006** (0.001)	0.006** (0.001)	-0.012** (0.001)	-0.011** (0.001)
Sided stock return two-day prior close to prior close (bps)	0.079** (0.001)	0.072** (0.001)	-0.001* (0.000)	-0.001* (0.000)	0.002** (0.000)	0.006** (0.000)
Sided market index return (bps)		0.795** (0.003)		-0.007** (0.001)		-0.452** (0.002)
$R^2$ (%)	<b>1.2</b>	<b>7.3</b>	<b>0.3</b>	<b>0.3</b>	<b>0.9</b>	<b>6.6</b>
$N$	1,128,873		1,128,873		1,128,873	

which is a combination of the data used in the middle two segments of Table 3. The results show that the market movement component is even more dominant for the high movement sub-sample, and less dominant for the low movement sub-sample.

### 3.3. Regression analysis of implicit trading costs

In Table 5, I analyze implicit trading cost measures by running multivariate regressions. The dependent variable is prior close cost, VWAP cost, or close cost. Most factors used are identified by previous studies (Keim and Madhavan, 1995, 1997; Conrad et al., 2001, 2003): buy indicator, log (market cap), log (relative volume), inverse prior close, listed

indicator, and return volatility. For prior close cost, I 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, on average prior close cost will increase by 0.079 bps.

As previous studies have found, the *R*-square tends to be small when one uses the factors above, only 1.2% in this case. The small *R*-Square is not surprising, given my finding in Table 4 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. It would have been a clear violation of market efficiency had I found high *R*-squares for this regression.

In addition, I 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. I run all my regressions both with and without this factor. I find that this factor has a large impact on prior close cost. If sided market index return increases by one basis point, prior close cost will increase by 0.795 bps, on average. Also, the *R*-square jumps from 1.2% to 7.3% because of this one additional factor.

I find a similar result for close cost. The *R*-square jumps from 0.9% to 6.6%, and the coefficient on sided market index return is economically significant, at  $-0.452$ . However, for VWAP cost, after I add sided market index return, the *R*-square barely changes at all, and the coefficient on sided market index return is economically insignificant, at  $-0.007$ . These results support my 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%. This shows that VWAP cost is almost “factor neutral.” This result suggests that VWAP cost may capture the trader’s skill and effort, which is largely unobservable to researchers. This result also provides some justification for the practice of directly comparing VWAP cost numbers across traders without adjusting for various factors.

#### 4. Conclusion

Previous studies document that institutional buys incur higher implicit trading costs than do sells. In this study, I provided 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 institutional trading data, I empirically confirm these predictions. I conclude that the buy–sell asymmetry phenomenon is mainly driven by the mechanical characteristics of the measures of implicit trading costs. I emphasize that trading is a double-sided and zero-sum game and discuss related implications.

I relate different trading cost measures through decompositions. I 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. This means that we can approximate the pre-trade measure, a widely-used measure of institutional execution quality, with very high accuracy without knowing the institutional investor's execution price. Overall, my study demonstrates that simple the mechanical characteristics of the measures of implicit trading costs can have important implications for how we interpret empirical results.

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