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# Three Essays On Odd-Lot Transactions

Hardy Johnson
*University of Mississippi*

# THREE ESSAYS ON ODD-LOT TRANSACTIONS

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BENJAMIN HARDY JOHNSON IV

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**ABSTRACT**

This dissertation consists of three essays on odd-lot transactions. The first essay investigates the role odd lot trades play in equity markets, as well as how this role has changed over three distinct time periods- 2010, 2007, and 2005. In each of these time periods, we document the determinants of the proportions of odd lot transactions, the price contribution of odd lot trades, and the characteristics of odd lot trading on an intraday and intraweek basis. We find that odd lot transactions make up 8% of volume and 20-22% of trades. We find that odd lot proportions as well as the determinants of odd lot proportions vary greatly over time and by listing venue. We find that odd lot transactions contribute to price formation and this contribution varies over time and by listing venue, but has not increased over time. Intraday patterns of odd lot proportions exist and have not been static over time. Intraweek patterns of odd lot proportions exist and have remained fairly constant over our time periods.

The purpose of the second essay is threefold. First, we reexamine the relation between order imbalance and lagged, contemporaneous, and future returns documented by Chordia, Roll, and Subrahmanyam (2002, 2004) with data containing Nasdaq trades from 2011 that includes odd lot transactions. Second, we determine the relation between odd lot order imbalances and lagged, contemporaneous, and future returns. Finally, we document the relation between intraday order imbalances and intraday odd lot order imbalances and intraday returns.

The third essay examines the information contained in two subsets of odd lot transactions: those that were originally submitted as odd lot orders, which we define as pure odd lot transactions, and those that were submitted as a 100+ share order but subsequently executed as two trades with one of the trades being an odd lot trade, which we define as circumstantial odd lot transactions. We determine the price contribution and weighted price contribution of both subsets of odd lot transactions to determine how much information each group contributes to the informedness of odd lot transactions. We examine the volume, number of trades, and information content of odd lot transactions, both pure and circumstantial, around stock splits.

**DEDICATION**

To Elizabeth and Julia Karen

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## 1.1 Introduction

This study investigates the role odd lot trades play in equity markets, as well as how this role has changed from 2005 to 2010. This study builds on the findings of O'Hara, Yao, and Ye (2011), who examine the determinants and information content of odd lot trades. We extend this analysis by examining odd lot transactions during three distinct time periods: 2005, 2007, and 2010. In each of these time periods, we document the price contribution of odd lot trades, the determinants of the proportion of odd lots transactions, and the characteristics of odd lot trading on an intraday basis and by day-of-the-week. O'Hara, Yao, and Ye look at some of these issues in 2008 and 2009 for a sample of 120 NASDAQ stocks. We use a larger set of equity securities and three time periods to determine if the role of odd lots has changed over time.

In our study, we define odd lots as trades of less than 100 shares (including those that are a partial execution of 100+ share orders). We do not currently differentiate between odd lot trades that are submitted as odd lot orders and odd lot trades that are submitted as part of a 100+ share order, but executed in more than one trade with one of the trades being for less than 100 shares (for example, a 250 share order that is executed as two orders: one for 200 shares and one for 50 shares). There is limited research on odd lot transactions as trades of less than 100 shares are not reported in the NYSE Trades and Quotes (TAQ) database. Trades of more than 100 shares, but not in 100 share increments (for 125 shares, for example), are included in TAQ.

Although odd lot transactions can be submitted by either institutional or individual traders, a number of previous studies assume odd lot trades are individuals' transactions. Ritter (1988) and Dyl and Maberly (1992) use odd lots trades as a proxy for individuals' trades in

studies that investigate the Turn-of-the-Year Effect. Similarly, Lakonishok and Maberly (1990) use odd lot trades as a proxy for individuals' trades in their study on the Weekend Effect.

In contrast, recent studies suggest that odd lot transactions are not only individuals' trades. O'Hara, Yao, and Ye (2011) find that roughly one quarter of all trades initiated by high frequency traders (HFTs), who are not individual traders, are for less than 100 shares. Their study uses a database of 120 stocks that contain odd lot transactions. They investigate how odd lot transactions, which are missing from the TAQ database, affect market microstructure studies.

Odd lot transactions are approximately 20% of the average stock's transactions, accounting for approximately 7% of volume, and these trades are informative (O'Hara, Yao, and Ye, 2011). We believe it is non-trivial that seven percent of volume and twenty percent of trades are omitted from previous studies that use the TAQ database. To substantiate our belief, we use a robust sample of all stock trades executed on NASDAQ and confirm the O'Hara, Yao, and Ye results for a broader sample of stocks over multiple time periods.

**1.2 Hypothesis Development**

Many stock characteristics have changed over the past couple of decades. We examine three of these characteristics that are shown to be determinants of odd lot proportions (O'Hara, Yao, and Ye, 2011): stock price, volatility, and spreads.

Volatility changes through time. Campbell, Lettau, Malkiel, and Xu (2001) find that individual stock volatility increases over the period 1962 to 1997, especially in relation to overall market volatility. Schwert (2011) finds that overall market volatility fluctuates

dramatically over time, with the standard deviation of returns ranging from low single digits to roughly 60% since the inception of the U.S. stock markets. During our time period (2005, 2007, and 2010), standard deviation of returns fluctuates from roughly 8% to 22%.

Spreads have decreased over the last two decades (Barclay, Christie, Harris, Kandel, and Schultz, 1999; Goldstein and Kavajecz, 2000; Chordia, Roll, and Subrahmanyam, 2001; Bessembinder, 2003; Battalio, Hatch, and Jennings, 2004; DeFontnouvelle, Fish, and Harris, 2003; Boehmer and Boehmer, 2003; and Zhao and Chung, 2007). Spreads are a determinant of odd lot proportions (O'Hara, Yao, and Ye, 2011). Since spreads are declining over time, we determine if the relation between spreads and odd lot proportions changes over time.

Market participants have also changed over time. A dramatic increase in the use of computerized, algorithmic, and high frequency trading (HFT) is purported by Brogaard (2010) who reports that HFTs are involved in 74% of all trades and O'Hara, Yao, and Ye (2011) report HFTs are involved in 20-25% of odd lot transactions.

Changing determinants of odd lot proportions (volatility and spreads), changing market participants (the rise of HFTs), and the increase in the proportion of odd lot trading over time, lead us to hypothesize that the relation between odd lot proportions and their determinants have changed as well.

**Hypothesis 1**

*$H_o$: The sensitivity of odd lot proportions to volatility and spreads changes over time.*

Studies show that the informational role of transactions is shifting to smaller trade sizes. Barclay and Warner (1993) find that medium sized trades (trades sizes between 500 and 9,999

shares) account for 83% of the cumulative price change of equities, while accounting for only 38% of the trades for the time period 1981-1984. They also find small trades (100 to 499 shares) contribute only 2% to price formation while accounting for 60% of all trades. However, Chakravarty (2001) finds that medium sized trades account for 78% of price contribution but only 57% of all trades in his sample from 1990-1991. Small trades from this time period contribute negatively to price formation, while accounting for 36% of all trades. Choe and Hansch (2005), using a sample from 1993 to 2003, find that price formation dramatically shifts in 1997 when small stock trades account for roughly 75% of price contribution.

To determine the price contribution of all trades, not just 100+ share trades, odd lot transactions must be included in the analysis. The first study to look at the price contribution of odd lot transactions is O'Hara, Yao, and Ye (2011), who find that 27-35% of weighted price contribution occurs in odd lot transactions. They also find that the proportion of odd lot transactions increase over their sample from 14% at the beginning of 2008 to 22% in 2009. In their study, O'Hara, Yao, and Ye find that roughly 65% of weighted price contribution comes from trades of 100 to 500 shares and only 4% from trades of 500 to 9,999 shares.

The informational role of small and medium sized trades differs between earlier studies. We interpret the results from these previous studies as implying that the information contained in trades is moving into smaller and smaller trade sizes over time. Therefore, we expect to see that the price contribution of odd lot transactions is increasing over time.

**Hypothesis 2**

*$H_0$: The price contribution of odd lot transactions is increasing over time.*

Many stock characteristics exhibit intraday patterns. Wood, McInish, and Ord (1985) and Chan, Christie, and Schultz (1995) find that volatility has a U-shaped intraday pattern. Pagano, Peng, and Schwartz (2008) find that the institution of the opening and closing crosses on NASDAQ dampens the volatility at the open and close. However, their findings conclude that the U-shaped pattern remains. Jain and Joh (1988) and Foster and Viswanathan (1993) document a U-shaped pattern for volume. Garvey and Wu (2009) document a U-shaped intraday pattern of spreads. Since volatility and spreads are determinants of odd lot proportions (O'Hara, Yao, and Ye, 2011), we predict that odd lot proportions will also have a similar U-shaped intraday pattern.

The intraday pattern of informed trades can also be used to predict the intraday pattern of odd lot transactions. One of Garvey and Wu's (2009) conclusions is that informed traders are trading more at the beginning and end of the day and less in the middle of the day. Similarly, Foster and Viswanathan (1993) find that adverse selection costs are also U-shaped intraday, suggesting informed traders are participating at the beginning and end of the day. We know that odd lot traders contribute to price formation to an extent that is greater than their proportion of volume (O'Hara, Yao, and Ye, 2011). Based on the assumption that odd lot traders are informed, as they tend to be price-setters as opposed to price-takers, we predict that odd lot traders are also participating more at the beginning and end of the day, thereby dictating a U-shaped pattern to odd lot transactions.

**Hypothesis 3**

*$H_0$: The intraday pattern of odd lot proportions follows a U-shaped pattern.*

Many stock characteristics display a day-of-the-week pattern. Kiymaz and Berument (2003) document day-of-the-week patterns in several market metrics across several exchanges. For the United States, they report that volume is highest on Tuesdays, with Mondays and Fridays having the lowest volume.

A volatility day-of-the-week effect is documented on most exchanges (Balanam, Bayear, and Kahn, 2001, and Alagidede, 2008). However, the days of the week that exhibit higher volatility vary across countries. Kiumaz and Berument (2001) document a volatility day-of-the-week effect in the U.S. with Wednesdays and Fridays having the highest volatility. O'Hara, Yao, and Ye (2011) show that odd lot proportions are driven by volatility. Hence, we predict that odd lot proportions will follow a day-of-the-week pattern, with proportions being the highest on Wednesdays and Fridays.

**Hypothesis 4**

*$H_0$: A day-of-the-week pattern exists in odd lot proportions, with highest proportions being on Wednesdays and Fridays.*

### 1.3 Data and Methods

Our sample consists of all trades in the NASDAQ Historical TotalView ITCH (ITCH) database from July 1 to December 31 for the years 2010, 2007, and 2005. The ITCH database includes all trades that execute on NASDAQ. We filter our sample to include only stocks that trade at least five times a day and at least 1,000 shares every day for the respective six month period (i.e. a stock will be included in the 2010 sample if it trades at least 5 times a day and at least 1000 shares every day during from July through December 2010, but might not be

included in the 2005 and 2007 sample, should it not meet the volume criteria for those six month periods). Each stock is also classified as being listed on either the NYSE or NASDAQ exchange. For our analysis, we only use trades that execute during market hours. Trades executing for under 100 shares are denoted as odd lot trades.

We compare our 2010 ITCH sample, which includes odd lot transactions, to trades in the NYSE Trade and Quote (TAQ) database from July to December, 2010. We apply the same filters to the TAQ data that we apply to the ITCH sample. We use data from the Center for Research in Security Prices (CRSP) to calculate daily stock returns, closing prices, daily high and low prices, closing bid and asks, and market capitalizations for July through December, 2010, 2007, and 2005.

We follow O'Hara, Yao, and Ye (2011) methods for the first several parts of our analysis. We first compare our ITCH sample to the corresponding TAQ sample to confirm their findings that odd lot transactions exclusively are omitted from the TAQ database.

We also follow O'Hara, Yao and Ye (2011) methods in regressing odd lot proportions on price, spread, and volatility, using fixed effects and random effects regressions. We use the Barclay and Warner (1993) method of calculating price contribution and weighted price contribution for seven transaction size classes: less than 100 shares, 100-500 shares, 501-900 shares, 901-1900 shares, 1901-4900 shares, 4901-9999 shares, and over 10,000 shares. We then compare the price contribution of each trade size class to its proportion of volume, both univariately and multivariately, to determine the informativeness of odd lot transactions.

Finally, we plot the intraday and intraweek trading activity of odd lot volume and proportions to determine if odd lot transactions display an intraday and/or day-of-the-week

pattern. We perform our analysis on each of our three time periods to determine if and how the characteristics of odd lot transactions have changed over time.

**1.4 Results**

*Average Stock Day Odd Lot Transactions*

The number of stocks that trade at least five times and at least 1,000 shares per day on the NASDAQ exchange, on every day of our sample period of July through December for 2010, 2007, and 2005 are listed in Table 1. Table 1 also lists the number of days and the number of stock days that are in each sample. We show these statistics for all stocks and by listing venue. The year 2007 has the most stocks executing at least five trades and at least 1,000 shares per day for all stocks and for each exchange. Our data appears consistent with the Battalio, Egginton, Van Ness, and Van Ness (2011) finding that NASDAQ has seen a decrease in order flow market share in recent years.

Table 2 shows our preliminary evidence that the characteristics of odd lot transactions vary over time and by exchange. Table 2 lists average total volume, odd lot volume, number of trades, number of odd lot trades, and odd lot proportions for our sample by exchange with 2010 averages in Panel A, 2007 averages in Panel B, and 2005 averages in Panel C. Odd lot proportions are defined as the percentage of all volume and trades that occur as odd lot transactions. Table 2 reports the largest average volume and largest odd lot volume occurs in 2007, which is consistent with NASDAQ losing market share in recent years (Battalio, Egginton, Van Ness, and Van Ness, 2011). Panel A reports that, in 2010, odd lot transactions account for roughly 8% of volume and roughly 20-22% of all trades. These percentages are consistent with

the O'Hara, Yao, and Ye (2011) findings of similar proportions in their sample of trades from 2008 to 2009.

Although absolute volume varies by exchange listing, odd lot proportions of volume are relatively the same for NASDAQ and NYSE-listed stocks in 2010, as well as in 2005, as reported by Panel C. However, there is a larger proportion of odd lot trades in NYSE stocks as opposed to NASDAQ stocks in 2005 (25.8% compared to 16.0%). Panel B shows that odd lot proportions are larger on NASDAQ (6.9% by volume and 19.4% by trades) than they are on NYSE (4.5% and 14.0%). Odd lot volume makes up roughly 6% of all volume in 2005 and 2007 and jumps to roughly 8% by 2010.

Table 3 lists the results of standard t-tests of total volume and trades, odd lot volume and trades, and odd lot proportions of volume and trades between the years 2010 and 2007, 2007 and 2005, and 2010 and 2005, with all stocks reported in Panel A, NASDAQ-listed stocks in Panel B, and NYSE-listed stocks in Panel C. Most of the volume and trade metrics vary significantly between each of our time periods. Regardless of listing venue, 2007 has the largest total volume and number of trades, confirming the Battalio, Egginton, Van Ness, and Van Ness (2011) finding that NASDAQ has lost market share of order flow since 2007. Odd lot proportions are also varying over time. We confirm that the odd lot proportion of volume increases over time by reporting a positive difference between 2010 and 2005 in both listing venues. Odd lot proportion of trades also increases between 2005 and 2010 for all stocks and NASDAQ-listed stocks, but decreases for NYSE stocks. Odd lot proportions increasing from 2005 to 2010 is also consistent with O'Hara, Yao, and Ye (2011), who find that odd lot proportions are increasing over the two years of their sample.

*Odd Lot Transactions and TAQ*

O'Hara, Yao, and Ye (2011) determine that odd lot transactions are omitted from the TAQ database for their sample years of 2008 and 2009. We compare the trades in the ITCH database in 2010 to the corresponding trades in the TAQ database to determine if the O'Hara, Yao, and Ye findings hold for 2010 as well, and the results are listed in Table 4.

After omitting odd lot transactions from the stock days in our ITCH data, we compare the transactions reported by ITCH to the corresponding stock days in TAQ. We find that 342,524 out of 423,689 stock days match exactly, meaning that the volume and number of trades reported by TAQ exactly matches the volume and number of shares reported by ITCH, excluding odd lot transactions. The average difference between TAQ and ITCH is 153.10 shares and 0.44 trades, representing non-matching proportions 0.40% and 0.30%, respectively. Although economically insignificant, these differences are statistically significant, so we further investigate the data to determine the source of the discrepancies.

We find time stamping issues in the datasets. We consider trades that occur during market hours for our analysis and some trades are marked seconds or nanoseconds before the open in one dataset while they are marked seconds or nanoseconds into the trading day in the other dataset. A similar issue occurs at the close. As we find that one half of one percent does not completely match in the two datasets, again excluding odd lot transactions, and we have identified the source leading to the small discrepancy, we are confident in confirming the O'Hara, Yao, and Ye (2011) finding that odd lot trades and odd lot trades exclusively are omitted from the TAQ dataset.

*Determinants of Odd Lot Proportions*

Since spreads and volatility change over time, we postulate that their relation to odd lot proportions changes over time, as well. Decreasing spreads are documented by many studies (Barclay, Christie, Harris, Kandel, and Schultz, 1999; Goldstein and Kavajecz, 2000; Chordia, Roll, and Subrahmanyam, 2001; Bessembinder, 2003; Battalio, Hatch, and Jennings, 2004; DeFontnouvelle, Fish, and Harris, 2003; Boehmer and Boehmer, 2003; and Zhao and Chung, 2007). Volatility changes are also documented (Campbell, Lettau, Malkiel, and Xu, 2001; and Schwert, 2011). In our study, we use the closing bid-ask spread, obtained from CRSP as a percentage of closing stock price as our measure of spread. We use range, which is the dollar difference between the daily high and daily low price, as a proxy for volatility. We also include price in our analysis as it is shown to be a determinant of odd lot proportions (O'Hara, Yao, and Ye, 2011). We use fixed and random effects regressions to control for any stock specific characteristics that may influence odd lot proportions. We also run our analysis with OLS and random effects regressions following the methods of O'Hara, Yao, and Ye (2011), but do not report the results as these regressions only measure cross sectional variations in the variables and do not control for stock specific characteristics.

We regress the proportion of odd lot volume and proportion of odd lot trades on stock price, spread, and range, using both fixed effects and random effects. The results of the fixed effects regressions are listed in Table 5. We only report the fixed effects because Haussman Tests between the coefficients of the fixed and random effects regressions reject that the two estimators are the same and the random effects coefficients are not consistent. The analysis is

divided into exchange listings and year with Panel A listing 2010 results, Panel B listing 2007 results, and Panel C listing 2005 results.

Consistent with O'Hara, Yao, and Ye (2011), stock price is a positive predictor of both odd lot proportions of volume and odd lot proportions of trades. Positive regression coefficients for price are consistent across listings exchanges, time periods, and estimation technique.

O'Hara, Yao, and Ye (2011) find spread to be a positive predictor of odd lot proportions, using a sample from 2008 to 2009. We confirm these results with our 2010 sample. The coefficients of our regressions for spreads are consistently positive. The spread coefficients are also positive for all stocks and NASDAQ-listed stocks in our 2007 and 2005 samples. However, the spread coefficients for NYSE-listed stocks in 2007 and 2005 are negative, suggesting that in 2007 and 2005, odd lot proportions of volume and trades decreased as spreads increased. The negative spread coefficients for NYSE-listed stocks in 2007 and 2005 is preliminary evidence supporting Hypothesis 1 that asserts the sensitivity of odd lot proportions to the determinants of odd lot proportions varies over time. For NYSE stocks, the sensitivity to spreads switches signs over our sample time period.

O'Hara, Yao, and Ye (2011) find volatility, as proxied by range, to be a negative predictor of odd lot proportions. We confirm these results with consistently negative coefficients for range across all time periods and listing venues.

Hypothesis 1 asserts that the sensitivity of odd lot proportions to volatility and spreads changes over time. We find strong evidence to support this hypothesis. Table 6 reports the results of z-tests of the coefficients listed in Table 5 between 2010 and 2007, 2007 and 2005,

and 2010 and 2005. Panel A of Table 6 lists the results of the z-tests for all stocks, Panel B lists the results for NASDAQ-listed stocks, and Panel C lists the results for NYSE-listed stocks. We also empirically test whether the sensitivity of odd lot proportions to changes in price, which is shown to be a predictor of odd lot proportions, varies over time.

Although we confirm that price is a consistently positive predictor of odd lot proportions in Table 5, Table 6 shows that the sensitivity of odd lot proportions of volume and trades to price varies across each of our time periods for all stocks, regardless of listing venue. The sensitivity of odd lot proportions to spreads varies across our time periods for all listing venues as well, especially for NYSE-listed stocks, which confirms our finding in Table 5 of spread coefficients changing signs for NYSE stocks between 2005 and 2010. The sensitivity of odd lot proportions to volatility, as proxied by range, varies across our time periods for all stocks and by listing venue. The significant differences in the coefficients of the determinants of odd lot proportions between our time periods lends strong support to the changing sensitivity of odd lot proportions to their determinants over time, thereby supporting Hypothesis 1.

*Price Contribution of Odd Lot Transactions*

To test Hypothesis 2 that the price contribution of odd lot transactions is changing over time, we use the Barclay and Warner (1993) calculation of price contribution and weighted price contribution. These calculations measure the proportion of the daily price change of a stock that can be attributed to trades occurring in particular size classes. Consistent with previous literature (Barclay and Warner, 1993; Chakravarty, 2001; and O'Hara, Yao, and Ye, 2011), we define our trade size classes to be: less than 100 shares, 100-500 shares, 501-900

shares, 901-1900 shares, 1901-4900 shares, 4901-9999 shares, and greater than 10,000 shares. The Barclay and Warner (1993) calculation of price contribution (PC) and weighted price contribution (WPC) is as follows.

The return on each trade *i* is calculated as the execution price of the trade less the execution price of the previous trade for that stock. Each trade is categorized into size class *j* according to the definitions above. The price contribution, *PC*, of size class *j* for stock *s* on day *t* is then calculated as the ratio of the sum the returns on trades *i* in class *j* for stock *s* on day *t* to the sum of the returns for all trades *i* for stock *s* on day *t*.

$$PC_j^{s,t} = \frac{\sum_{i=1}^{n} r_{i,j}^{s,t}}{\sum_{i=1}^{n} r_i^{s,t}}$$

The weight, *W*, for stock *s* on day *t* is calculated as the ratio of sum of the returns of all trades *i* in stock *s* on day *t* to the sum of all trades *i* in all stocks on day *t*.

$$W_s^t = \frac{\sum_{i=1}^{n} r_i^{s,t}}{\sum_{s=1}^{n}\sum_{i=1}^{n} r_i^{s,t}}$$

The weighted price contribution, *WPC*, for size class *j* on day *t* is calculated as the sum of the products of the weight for stock *s* on day *t* and the *PC* of size class *j* for stock *s* on day *t* for all stocks.

$$WPC_j^t = \sum_{s=1}^{n} (W_s^t * PC_j^{s,t})$$

The weighted price contribution *WPC* for size class *j* is calculated as the mean of all weighted price contributions for size class *j* on all days *t*.

$$WPC_j = \frac{\sum_{t=1}^{n} WPC_j^t}{t}$$

Table 7 reports the weighted price contributions for all seven size classes by listing venue and year. Our positive price contribution for the odd lot transaction size class of < 100 shares confirm the O'Hara, Yao, and Ye (2011) finding that odd lot transactions contribute positively to price formation. Odd lot transactions contribute more to price formation than all other classes with the exception of 100-500 shares. Size class 100-500 shares show the largest weighted price contribution, which is consistent with Barclay and Warner (1993), Chakravarty (2001) and Alexander and Peterson (2007), who conclude informed traders break their large trades into 100 to 500 share transactions.

Hypothesis 2 asserts that the weighted price contribution of odd lot transactions increases over time. We test this hypothesis by testing the differences between the WPCs from 2010 and 2007, 2007 and 2005, and 2010 and 2005, for the seven trade size classes using standard t-tests. We report the results of the tests in Table 8, with the results for all stocks listed in Panel A, NASDAQ-listed stocks in Panel B, and NYSE-listed stocks in Panel C. The WPC for odd lot transactions in all stocks increases from 2007 to 2010, 2005 to 2007, and from 2005 to 2010. For NASDAQ-listed stocks, WPC increases from 2005 to 2007 and from 2005 to 2010, and does not decrease from 2007 to 2010. For NYSE-listed stocks, WPC decreases from 2005 to 2007, but increases from 2007 to 2010 and from 2005 to 2010. WPCs for odd lot transactions generally increasing over our sample lend strong support to WPCs for odd lot transactions increasing over time, supporting Hypothesis 2.

We further investigate the price contribution of the seven trade size classes by comparing price contribution to proportion of volume. The difference between PC and proportion of volume of a particular class indicates the amount by which a particular size class

contributes to price formation above what is expected given its proportion of volume. Table 9 reports the results of the comparison with the 2010 comparison in Panel A, 2007 comparison in Panel B, and 2005 comparison in Panel C. If the informativeness of odd lot transactions is increasing over time, we expect the difference between PC and proportion of volume to be increasing over time. However, the difference between PC and proportion of volume is not increasing over time. For all stocks and for NASDAQ-listed stocks, the difference increases from 2005 to 2007, but decreases from 2007 to 2010. For NYSE-listed stocks, the difference decreases from 2005 to 2007 and decreases again from 2007 to 2010. Since the difference between PC and proportion of volume is not increasing over time, we suggest that the information contained in odd lot transactions is not increasing over time, which does not support Hypothesis 2 and is in contrast to the findings in Table 8. We further investigate the contradictory findings in a multivariate framework.

It is interesting to note that the difference between odd lot transaction price contribution and odd lot proportion of volume is greater than the difference between the PC of trades of 100-500 shares and its respective proportion of volume. Using this measure of informedness, the results suggest that odd lot transactions contain more information than trades in the 100-500 share size class.

We now test, in a multivariate framework, if odd lot transactions are contributing more to price formation than their proportion of volume dictates. Following the method of O'Hara, Yao, and Ye (2011), we use a weighted least squares regression of the price contribution of trade size classes on a dummy that equals one if the size class is less than 100 shares and zero otherwise; a dummy variable that equals one if the size class is greater than or equal to 100

shares and zero otherwise; and the size class proportion of volume and trades. The observations are weighted for the WLS regression by the weight calculated in the WPC models: the ratio of the return on stock *s* on day *t* to the return of the market on day *t*. We avoid perfect colinearity issues by suppressing the intercept in the WLS regression. If odd lot transactions contribute to price formation above their proportion of volume, we expect a significantly positive coefficient for the < 100 shares dummy variable.

Table 10 reports the results of the weighted least squares regressions and we include the proportion of volume in the regressions reported in columns one, three, and five, and the proportion of trades in the regressions reported in columns two, four, and six. Results are reported by listing venue and by year. The coefficients for the odd lot transactions dummy variable are consistently positive, except for NYSE-listed stocks when including proportion of trades in 2010 and 2005. The positive coefficient for the odd lot transaction dummy variable suggests that odd lot transactions contribute to price formation above what is dictated by odd lot proportion of volume and trades. This finding is consistent with O'Hara, Yao, and Ye (2011).

However, we find evidence that does not support Hypothesis 2 in the results listed in Table 10. We hypothesized that the information contained in odd lot transactions increases over time. If information is increasing over time, the coefficients of the < 100 shares dummy variables will increase in magnitude from 2005 to 2010, which is not the case. For all stocks and for NASDAQ stocks, the odd lot transaction dummy coefficient increases from 2005 to 2007 but decreases from 2007 to 2010, which is true regardless of the inclusion of odd lot proportions of volume or trades in the regression. NYSE-listed stocks do not show a pattern of increasing <100 shares coefficients either, with the coefficients decreasing in one period or the other.

It is interesting to note that transactions of 100 shares or more have a negative coefficient while the coefficient for transactions of less than 100 shares are largely positive in all of the regressions that include proportion of volume and a large portion of the regressions that include proportion of trades, suggesting that trades of 100 shares or more contribute less to price formation than their proportion of volume predicates. Using this definition of informedness, odd lot transactions contain more information than transactions of more than 100 shares.

We attempt to definitively determine if the information contained in odd lot transactions is increasing or decreasing over time with the regression results reported in Table 11. To obtain the results, we run weighted least squares regression on three subsets of our data, with each subset containing two years of observations: 2010 and 2007, 2007 and 2005, and 2010 and 2005. Price contribution of trades size classes is the dependent variable, and the independent variables are year dummies, a dummy variable equal to one if the trade size class is odd lot trades, interaction terms between the odd lot transactions dummy variable and the year dummies, the trade size class proportion of volume in columns one, three, and five, and the trade size class proportion of trades in columns two, four, and six. The observations are weighted for the WLS regression by the weight from the WPC calculation as described earlier. Panel A lists the regression results for all stocks, Panel B lists the results for NASDAQ-listed stocks, and Panel C lists the results for NYSE-listed stocks. We expect to see positive coefficients for the interaction terms in each of the regressions if the information contained in odd lot transactions is increasing over time.

The interaction terms denoting odd lot transactions in the later year of the subset are not consistently positive. The price contribution of odd lot transactions is decreasing between 2007 and 2010 for all stocks and NASDAQ-listed stocks, but increasing between 2005 and 2007 and between 2005 and 2010 for all stocks and NASDAQ-listed stocks. The results for NYSE-listed stocks are also mixed with positive coefficients for some of the regressions and negative for others, depending on the model specification and time period. With half of the coefficients for the interactions terms being negative, we conclude that the price contribution of odd lot transactions does not increase over time, which does not support Hypothesis 2.

We believe odd lot transaction informedness not to be increasing over time to be an important conclusion. Odd lot transactions contain information at least as far back as 2005. Most microstructure studies omit odd lot transactions. Omitting odd lot transactions omits the information contained therein, and therefore, may bias the results of previous studies.

*Intraday Patterns of Odd Lot Transactions*

Figure 1 plots the average total volume and number of trades on the NASDAQ exchange by minute of the trading day for our three time periods. Panel A includes all transactions. Panel B includes odd lot transactions only. Panel C plots the proportion of odd lot volume and trades relative to all volume and trades. Table 12 reports the results of regressing total volume, total number of trades, odd lot volume, odd lot trades, and the proportion of odd lot volume and trades on 26 30-minute intervals with interval 13 omitted. Panel A reports 2010 regression results, Panel B reports 2007 results, and Panel C reports 2005 results.

Figure 1, Panel A shows the expected U-shaped pattern for volume and number of trades in all years of our sample. Table 12 supports the U-shape with larger coefficients reported at the beginning and ending of the day, with the middle of the day showing insignificant coefficients. The U-shaped pattern supports Jain and Joh (1988) and Foster and Viswanathan (1993), who also find a U-shaped pattern to volume. Panel B shows that odd lot volume and odd lot number of trades follow a U-shaped pattern similar to total volume and total number of trades. The U-shaped pattern is also supported with the regression results in Table 12.

Hypothesis 3 asserts a U-shaped pattern of odd lot proportions of volume and number of trades. The figures in Panel C suggest that there is not a U-shaped pattern of odd lot proportions. There is a spike in volume and number of trades at the end of the day in all three time periods, which is similar to the end of the day spikes seen in Panels A and B. However, 2010 odd lot proportion of volume starts out lower at the beginning of the trading day and seems to follow a slight reverse U-shape during the middle of the day, until the spike in the last 30 minutes. The 2010 odd lot proportion of trades appears fairly constant in the middle of the day until the spike in the last 30 minutes. There is little evidence in Figure 1 to support Hypothesis 3 that odd lot proportions follow a U-shaped intraday pattern in 2010, except for the sharp upturn in proportions at the very end of the trading day.

The fifth and sixth columns of Table 12 also fail to support Hypothesis 3. In 2010, the coefficients for the periods in the beginning and end of the day tend to be negative, except for the spike at the end of the day that starts in period 26. In 2007, Table 12 shows only slight evidence of a U-shape at the beginning of the day with positive coefficients in periods 1 and 2

and at the end of the day for the regression using odd lot proportion of volume. However, since periods 3 and 4 have negative coefficients in the regression using odd lot proportion of volume, we conclude that there is not a U-shaped pattern to odd lot proportions in 2007. Panel C of Table 12 also has negative coefficients for periods during the early part of the trading day, lending evidence that a U-shaped pattern to odd lot proportions does not exist in 2005, either.

*Intraweek Patterns of Odd Lot Proportions*

Figure 2 graphs volume and number of trades over the days-of-the-week for all three of our sample time periods. Panel A graphs total volume and number of trades, Panel B graphs odd lot volume and number of trades, and Panel C graphs odd lot proportions of volume and trades. As in Table 1, volume and number of trades is highest in 2007, which is consistent with a decrease in market share for NASDAQ (Battalio, Egginton, Van Ness, and Van Ness, 2011). Odd lot volume and number of shares are also highest in 2007.

The patterns seem to be somewhat consistent with Kiymaz and Berument (2003), who show Monday and Friday have the lowest volume and Tuesday has the highest volume. In Figure 2, Panel A, Monday and Friday have the lowest volume but Thursday has the highest volume in 2005 and 2007. Tuesday shows a slightly higher volume in 2010, which is consistent with Kiymaz and Berument (2003). The odd lot transaction patterns in Panel B are similar to the total volume and number of trades pattern in Panel A, with Monday and Friday having the lowest numbers.

We further investigate the day-of-the-week patterns using regression results reported in Table 13. We regress the total volume, total number of trades, odd lot volume, number of odd

lot trades, odd lot proportion of volume, and odd lot proportion on day of the week dummies excluding Wednesday, using stock day observations. Panel A reports the regression results for 2010, Panel B reports the results for 2007, and Panel C reports the results for 2005. In 2010, the coefficients for Monday and Friday are the most negative in the regressions using total volume, suggesting these days have the lowest volume, and Tuesday has the largest coefficient, suggesting Tuesday has the highest volume. The regression results are consistent with Kiymaz and Berument (2003). The results in Panel B and Panel C show that Monday and Friday have the lowest volume in 2007 and 2005, as well. Table 13 shows that odd lot volume follows a similar pattern to total volume in all three time frames, with lowest odd lot volume tending to be on Mondays and Fridays.

Hypothesis 4 asserts that a day-of-the-week pattern exists for odd lot proportions of volume and trades, with the highest proportions registering on Wednesday and Friday. Panel C of Figure 1 contradicts this hypothesis. There is a slight U-shaped pattern to odd lot proportions of volume and trades in 2010, 2007, and 2005, which is different than our prediction of Wednesdays and Fridays having the largest proportions. The exception to the slight U-shaped pattern is odd lot proportion of trades in 2005, which has a slight reverse U-shape.

Table 13 also contradicts Hypothesis 4. In 2010, Monday shows the highest proportion of odd lot volume and trades. In 2007, all days-of-the-week have a larger odd lot proportion of volume and trades relative to Wednesday. In 2005, Fridays have the lowest odd lot proportion of volume and trades.

We also investigate if the intraweek patterns of odd lot proportions change over time. Figure 2, Panel C shows evidence that 2010, 2007, and 2005 all display a slight U-shaped pattern, as do the odd lot proportions of trades in 2010 and 2007. 2005 proportions of odd lot trades display a slight reverse U-shaped pattern, which suggests that the intraweek pattern for odd lot proportions of trades from 2005 to 2007 is the only instance where there is a change to patterns over time.

The regression results in Table 13, however, suggest that odd lot patterns change over time. In 2005, the Friday dummy coefficient is lower in the odd lot proportion of volume regression and the rest of the week is not significantly different from Wednesday. In 2007, all days have a higher odd lot proportion of volume relative to Wednesday, and in 2010 only Monday has a higher odd lot proportion of volume. Similar discrepancies between the years can be identified in the regressions using odd lot proportion of trades. In 2007, all days have a higher proportion of odd lot trades, whereas all days but Tuesday have lower odd lot proportions of trades in 2005, and there seems to be a slight U-shaped pattern in 2010, with Mondays and Fridays having the largest proportion of odd lot trades.

**1.5 Conclusions**

We examine several characteristics of odd lot transactions and how they change over time. Using a sample containing all trades that execute on NASDAQ from July to December, 2010, 2007, and 2005, we find that odd lot transactions make up roughly 8% of all volume and 20-22% of all trades. Odd lot proportions increase from 2007 and 2005 to 2010. We also find that odd lot transactions and odd lot transactions exclusively are omitted from the TAQ

database. These findings are consistent with O'Hara, Yao, and Ye (2011). We also find that odd lot proportions vary by listing venue.

We find that the determinants of odd lot proportions drastically change subsequent to 2005 and across listing venues. Price, which is a positive predictor of odd lot proportions in the vast majority of regressions, is a negative predictor for NYSE stocks in 2007 and 2005. Spread, which is a positive predictor of odd lot proportions in 2010, is a negative predictor in 2007 and 2005. Volatility, which is a negative predictor or odd lot proportions in 2010, is a positive predictor in 2007 and 2005.

The weighted price contribution of odd lot transactions is positive for all three of our time periods, with no discernible patterns of odd lot WPC increasing or decreasing over time. The price contribution of odd lot transactions is above their proportion of volume, leading us to conclude that odd lot transactions contain information and have since at least 2005. Therefore, odd lot trades must be included in studies on capital markets and asset pricing in instances where the results could be biased by their exclusion.

Intraday patterns in odd lot proportion exist and have not been static over time. There is a slight reverse U-shape during the trading day with a large spike in odd lot proportions in the last thirty minutes of trading. Intraweek patterns in odd lot proportions also exist, but remain fairly constant over time. There is a very slight U-shaped pattern with the highest proportions being on Mondays and Fridays.

**Table 1. Number of Days, Stocks, and Stock Days by Exchange and by Year**

| | *All* | | | *NASDAQ* | | | *NYSE* | | |
|---|---|---|---|---|---|---|---|---|---|
| ***Variable*** | ***2010*** | ***2007*** | ***2005*** | ***2010*** | ***2007*** | ***2005*** | ***2010*** | ***2007*** | ***2005*** |
| ***No. Days*** | 128 | 127 | 127 | 128 | 127 | 127 | 128 | 127 | 127 |
| ***No. Stocks*** | 3,319 | 3,826 | 1,999 | 1,421 | 1,901 | 1,401 | 1,898 | 1,925 | 598 |
| ***No. Stock Days*** | 424,832 | 485,902 | 253,873 | 181,888 | 241,427 | 177,927 | 242,944 | 244,475 | 75,946 |

Table 1 lists the number of days, the number stocks that trade at least 5 times and at least 1,000 shares on NASDAQ every day of the six months July through December, and the number of stock days of at least 5 trades and 1,000 shares on NASDAQ during the six months July to December for 2010, 2007, and 2005, for all socks, stocks listed on the NASDAQ, and stocks listed on the NYSE.

**Table 2. Summary Statistics: Average Stock Days**

**Panel A: 2010 means**

| *Variable* | *All Stocks* | *NASDAQ* | *NYSE* |
|---|---|---|---|
| ***Volume*** | | | |
| ***Total*** | 361,296.20 | 320,440.57 | 413,163.72 |
| | (1,676,922.19) | (1,248,206.94) | (1,979,468.50) |
| ***Odd*** | 13,920.40 | 13,690.37 | 14,877.96 |
| | (29,838.22) | (33,756.34) | (27,313.63) |
| ***No. Trades*** | | | |
| ***Total*** | 1970.44 | 1,819.67 | 2,198.52 |
| | (4,996.49) | (4,379.43) | (5,529.95) |
| ***Odd*** | 326.88 | 333.67 | 339.97 |
| | (697.31) | (817.65) | (610.82) |
| ***% Odd*** | | | |
| ***Volume*** | 0.0810 | 0.0815 | 0.0788 |
| | (0.0614) | (0.0598) | (0.0592) |
| ***No. Trades*** | 0.2177 | 0.2289 | 0.2044 |
| | (0.1244) | (0.1282) | (0.1140) |
| | N=424,832 | N=181,888 | N=242,944 |

**Panel B: 2007 Means**

| *Variable* | *All Stocks* | *NASDAQ* | *NYSE* |
|---|---|---|---|
| ***Volume*** | | | |
| ***Total*** | 464,733.30 | 462,597.74 | 466,918.29 |
| | (2,441,960.67) | (2,397,673.58) | (2,486,459.62) |
| ***Odd*** | 13,968.77 | 15,925.58 | 11,959.04 |
| | (34,377.56) | (40,065.03) | (27,184.68) |
| ***No. Trades*** | | | |
| ***Total*** | 2,299.69 | 2,227.56 | 2,373.48 |
| | (6,391.75) | (5,961.15) | (6,803.38) |
| ***Odd*** | 328.75 | 360.61 | 296.03 |
| | (793.61) | (895.68) | (671.27) |
| ***% Odd*** | | | |
| ***Volume*** | 0.0572 | 0.0693 | 0.0447 |
| | (0.0518) | (0.0576) | (0.0414) |
| ***No. Trades*** | 0.1675 | 0.1941 | 0.1402 |
| | (0.1183) | (0.1231) | (0.1064) |

| | N=485,902 | N=241,427 | N=244,475 |
|---|---|---|---|

**Panel C: 2005 Means**

| *Variable* | *All Stocks* | *NASDAQ* | *NYSE* |
|---|---|---|---|
| ***Volume*** | | | |
| ***Total*** | 244,878.90 | 277,665.15 | 168,004.21 |
| | (1,350,783.05) | (1,501,459.18) | (899,178.15) |
| ***Odd*** | 5,233.51 | 5,768.96 | 3,941.10 |
| | (12,191.12) | (13,659.37) | (7,392.63) |
| ***No. Trades*** | | | |
| ***Total*** | 941.09 | 1,041.63 | 705.36 |
| | (2,836.69) | (2,987.16) | (2431.66) |
| ***Odd*** | 143.44 | 137.15 | 158.61 |
| | (337.47) | (362.07) | (268.38) |
| ***% Odd*** | | | |
| ***Volume*** | 0.0552 | 0.0553 | 0.0548 |
| | (0.0592) | (0.0510) | (0.0755) |
| ***No. Trades*** | 0.1889 | 0.1602 | 0.2582 |
| | (0.1641) | (0.1077) | (0.2392) |
| | N=253,873 | N=177,927 | N=75,946 |

Table 2 lists the mean total volume, odd lot volume, total number of trades, number of odd lot trades, odd lot volume as a proportion of total volume, and the number of odd lot trades as a proportion of the total number of trades calculated from all trades executed on NASDAQ for all stocks, NASDAQ-listed stocks, and NYSE-listed stocks for July through December, 2010, 2007, and 2005. Panel A lists averages for 2010. Panel B lists averages for 2007. Panel C lists averages for 2005. N denotes the number of stock days used to calculate the averages for each category. Standard deviations are reported in parentheses.

**Table 3. Differences in Means**

**Panel A: All Stocks**

| *Variable* | *2010-2007* | *2007-2005* | *2010-2005* |
|---|---|---|---|
| ***Volume*** | | | |
| ***Total*** | -103,437.10*** | 219,854.40*** | 116,417.30*** |
| | (<.0001) | (<.0001) | (<.0001) |
| ***Odd*** | -48.37 | 8,735.26*** | 8,686.89*** |
| | (0.472) | (<.0001) | (<.0001) |
| ***No. Trades*** | | | |
| ***Total*** | -329.25*** | 1,358.60*** | 1,029.35*** |
| | (<.0001) | (<.0001) | (<.0001) |
| ***Odd*** | -1.87 | 185.31*** | 183.44*** |
| | (0.244) | (<.0001) | (<.0001) |
| ***% Odd*** | | | |
| ***Volume*** | 0.0238*** | 0.0020*** | 0.0258*** |
| | (<.0001) | (<.0001) | (<.0001) |
| ***No. Trades*** | 0.0502*** | -0.0214*** | 0.0288*** |
| | (<.0001) | (<.0001) | (<.0001) |

**Panel B: NASDAQ Listed Stocks**

| *Variable* | *2010-2007* | *2007-2005* | *2010-2005* |
|---|---|---|---|
| ***Volume*** | | | |
| ***Total*** | -142,157.17*** | 184,932.59*** | 42,775.42*** |
| | (<.0001) | (<.0001) | (<.0001) |
| ***Odd*** | -2,235.21*** | 10,156.62*** | 7,921.41*** |
| | (<.0001) | (<.0001) | (<.0001) |
| ***No. Trades*** | | | |
| ***Total*** | -407.89*** | 1,185.93*** | 778.04*** |
| | (<.0001) | (<.0001) | (<.0001) |
| ***Odd*** | -26.94*** | 223.46*** | 196.52*** |
| | (<.0001) | (<.0001) | (<.0001) |
| ***% Odd*** | | | |
| ***Volume*** | 0.0122*** | 0.0140*** | 0.0262*** |
| | (<.0001) | (<.0001) | (<.0001) |
| ***No. Trades*** | 0.0348*** | 0.0339*** | 0.0687*** |
| | (<.0001) | (<.0001) | (<.0001) |

**Panel C: NYSE Listed Stocks**

| *Variable* | *2010-2007* | *2007-2005* | *2010-2005* |
|---|---|---|---|
| ***Volume*** | | | |
| ***Total*** | -53,754.57*** | 298,914.08*** | 245,159.51*** |
| | (<.0001) | (<.0001) | (<.0001) |
| ***Odd*** | 2,918.92*** | 8,017.94*** | 10,936.86*** |
| | (<.0001) | (<.0001) | (<.0001) |
| ***No. Trades*** | | | |
| ***Total*** | -174.96*** | 1,668.12*** | 1,493.16*** |
| | (<.0001) | (<.0001) | (<.0001) |
| ***Odd*** | 43.94*** | 137.42*** | 181.36*** |
| | (<.0001) | (<.0001) | (<.0001) |
| ***% Odd*** | | | |
| ***Volume*** | 0.0341*** | -0.0101*** | 0.0240*** |
| | (<.0001) | (<.0001) | (<.0001) |
| ***No. Trades*** | 0.0642*** | -0.1180*** | -0.0538*** |
| | (<.0001) | (<.0001) | (<.0001) |

Table 3 lists the differences in mean total volume, odd lot volume, total trades, odd lot trades, odd lot proportion of volume, and odd lot proportion of trades between 2010 and 2007, 2007 and 2005, and 2010 and 2005 from all trades executing on NASDAQ for July through December, 2010, 2007, and 2005. Panel A lists the differences in means for all stocks, Panel B lists the differences in means for NASDAQ-listed stocks, and Panel C lists the differences in means for NYSE-listed stocks. P-values from standard t-tests testing the differences in the means are reported in parentheses. ***, ** & * denote significance at the 1%, 5% & 10% levels, respectively.

**Table 4. Odd Lot Transactions in TAQ**

| *No. Days match* | *Stock Days* | *Avg. Not Matched* | *Mean (p-value)* |
|---|---|---|---|
| ***= 100%*** | 342,524 | ***Volume*** | 153.10*** |
| | | | (<.0001) |
| ***< 100%*** | 81,165 | | |
| | | ***Trades*** | 0.44*** |
| | | | (<.0001) |
| | | ***% Volume*** | 0.004*** |
| | | | (<.0001) |
| | | ***% Trades*** | 0.003*** |
| | | | (<.0001) |
| | | | N=424,832 |

Table 4 lists the number of stock days in the NYSE Trade and Quote database that have the exact same number of trades and shares trades as the corresponding stock day in the NASDAQ Historical TotalView ITCH database, less odd lot transactions, and the number of stock days that do not exactly match. It lists the average difference in volume, number of trades, and proportions of volume and number of trades between the two databases. N denotes the number of stock days used to calculate the averages for each category. P-values are in reported in parentheses. ***, ** & * denote significance at the 1%, 5% & 10% levels, respectively.

**Table 5. Determinants of Odd Lot Proportions of Volume and Number of Trades**

**Panel A: 2010**

| | *All Stocks* | | *NASDAQ* | | *NYSE* | |
|---|---|---|---|---|---|---|
| ***Variable*** | ***% Odd Volume*** | ***% Odd Trades*** | ***% Odd Volume*** | ***% Odd Trades*** | ***% Odd Volume*** | ***% Odd Trades*** |
| ***Intercept*** | 0.0726*** | 0.2113*** | 0.0767*** | 0.2256*** | 0.0669*** | 0.1949*** |
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) |
| ***Price ($)*** | 0.0006*** | 0.0007*** | 0.0005*** | 0.0007*** | 0.0006*** | 0.0007*** |
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) |
| ***Spread (%)*** | 0.1003*** | 0.4108*** | 0.0738** | 0.3923*** | 0.0399 | 0.4133** |
| | (<.0001) | (<.0001) | (0.021) | (<.0001) | (0.700) | (0.046) |
| ***Range ($)*** | -0.0105*** | -0.0187*** | -0.0109*** | -0.0201*** | -0.0098*** | -0.0172*** |
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) |
| ***$R^2$*** | 0.0176 | 0.0116 | 0.0169 | 0.0104 | 0.0208 | 0.0140 |

**Panel B: 2007**

| | *All Stocks* | | *NASDAQ* | | *NYSE* | |
|---|---|---|---|---|---|---|
| ***Variable*** | ***% Odd Volume*** | ***% Odd Trades*** | ***% Odd Volume*** | ***% Odd Trades*** | ***% Odd Volume*** | ***% Odd Trades*** |
| ***Intercept*** | 0.0463*** | 0.1433*** | 0.0592*** | 0.1745*** | 0.0332*** | 0.1112*** |
| | (<.0001) | (0.001) | (<.0001) | (0.001) | (<.0001) | (<.0001) |
| ***Price ($)*** | 0.0005*** | 0.0011*** | 0.0007*** | 0.0014*** | 0.0004*** | 0.0009*** |
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) |
| ***Spread (%)*** | 0.0469*** | 0.0617* | 0.1317*** | 0.1971*** | -0.0600*** | -0.1116** |
| | (0.015) | (0.033) | (0.022) | (0.047) | (0.019) | (0.013) |
| ***Range ($)*** | -0.0040*** | -0.0083*** | -0.0072*** | -0.0132*** | -0.0023*** | -0.0056*** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) |
| $R^2$ | 0.0117 | 0.0106 | 0.0176 | 0.0135 | 0.0095 | 0.0099 |

**Panel C: 2005**

| | *All Stocks* | | *NASDAQ* | | *NYSE* | |
|---|---|---|---|---|---|---|
| ***Variable*** | ***% Odd Volume*** | ***% Odd Trades*** | ***% Odd Volume*** | ***% Odd Trades*** | ***% Odd Volume*** | ***% Odd Trades*** |
| ***Intercept*** | 0.0383*** | 0.1574*** | 0.0371*** | 0.1242*** | 0.0420*** | 0.2404*** |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.002) | (<.0001) |
| ***Price ($)*** | 0.0008*** | 0.0016*** | 0.0011*** | 0.0022*** | 0.0004*** | 0.0009*** |
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) |
| ***Spread (%)*** | 0.1783*** | 0.3041*** | 0.2862*** | 0.5048*** | -0.3219*** | -0.6303** |
| | (0.041) | (0.091) | (0.041) | (0.082) | (0.118) | (0.037) |
| ***Range ($)*** | -0.0079*** | -0.0195*** | -0.0092*** | -0.0189*** | -0.0061*** | -0.0201*** |
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) |
| $R^2$ | 0.0130 | 0.0138 | 0.0192 | 0.0198 | 0.0068 | 0.0102 |

Table 5 lists the results of fixed effect regressions with odd lot transactions as a proportion of volume and odd lot transactions as a proportion of all trades as the dependent variables on all NASDAQ trades that occurred from July through December, 2010, 2007, and 2005, for all stocks, NASDAQ-listed stocks, and NYSE-listed stocks. The independent variables are price, measured in dollars; closing bid ask spread, measured as a percentage of the midpoint; and range, measured as the dollar value difference between the daily high and daily low. Panel A lists the results from 2010, Panel B lists the results from 2007, and Panel C lists the results from 2005. P-values are in reported parentheses. ***, ** & * denote significance at the 1%, 5% & 10% levels, respectively.

**Table 6. Differences in Estimation Coefficients of Determinants of Odd Lot Proportions**

**Panel A: All Stocks**

| | *% Odd Volume* | | | *% Odd Trades* | | |
|---|---|---|---|---|---|---|
| ***Variable*** | ***2010-2007*** | ***2007-2005*** | ***2010-2005*** | ***2010-2007*** | ***2007-2005*** | ***2010-2005*** |
| ***Price ($)*** | 0.0001*** | -0.0003*** | -0.0002*** | -0.0004*** | -0.0006*** | -0.0010*** |
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) |
| ***Spread (%)*** | 0.0534* | -0.1314*** | -0.0780 | 0.3492*** | -0.2424** | 0.1067 |
| | (0.081) | (0.002) | (0.109) | (<.0001) | (0.012) | (0.318) |
| ***Range ($)*** | -0.0064*** | 0.0038*** | -0.0026*** | -0.0103*** | 0.0111*** | 0.0008* |
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (0.072) |

**Panel B: NASDAQ Listed Stocks**

| | *% Odd Volume* | | | *% Odd Trades* | | |
|---|---|---|---|---|---|---|
| ***Variable*** | ***2010-2007*** | ***2007-2005*** | ***2010-2005*** | ***2010-2007*** | ***2007-2005*** | ***2010-2005*** |
| ***Price ($)*** | -0.0002*** | -0.0004*** | -0.0005*** | -0.0007*** | -0.0008*** | -0.0015*** |
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) |
| ***Spread (%)*** | -0.0579 | -0.1545*** | -0.2124*** | 0.1951** | -0.3076*** | -0.1125 |
| | (0.135) | (0.001) | (<.0001) | (0.024) | (0.001) | (0.303) |
| ***Range ($)*** | -0.0037*** | 0.0020*** | -0.0017*** | -0.0068*** | 0.0057*** | -0.0011* |
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (0.074) |

**Panel C: NYSE Listed Stocks**

| | *% Odd Volume* | | | *% Odd Trades* | | |
|---|---|---|---|---|---|---|
| ***Variable*** | ***2010-2007*** | ***2007-2005*** | ***2010-2005*** | ***2010-2007*** | ***2007-2005*** | ***2010-2005*** |
| ***Price ($)*** | 0.0002*** | -0.0001** | 0.0001*** | -0.0002*** | 0.0000 | -0.0002** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | (<.0001) | (0.038) | (<.0001) | (<.0001) | (0.750) | (0.031) |
| ***Spread (%)*** | 0.0999 | 0.2619** | 0.3618** | 0.5249** | 0.5187* | 1.0436*** |
| | (0.343) | (0.028) | (0.021) | (0.013) | (0.089) | (0.004) |
| ***Range ($)*** | -0.0075*** | 0.0038*** | -0.0037*** | -0.0116*** | 0.0154*** | 0.0038*** |
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) |

Table 6 lists the differences in the coefficients from fixed effects regressions of proportion of odd lot volume and proportion of odd lot trades on price, measured in dollars; closing bid ask spread, measured as a percentage of the midpoint; and range, measured as the dollar value difference between the daily high and daily low between 2010 and 2007, 2007 and 2005, and 2010 and 2005 for all NASDAQ trades that occurred from July through December, 2010, 2007, and 2005. Panel A lists the differences in coefficients for all stocks, Panel B lists the differences in coefficients for NASDAQ-listed stocks, and Panel C lists the differences in coefficients for NYSE-listed stocks. P-values from z-tests testing the differences in coefficients are reported in parentheses. ***, ** & * denote significance at the 1%, 5% & 10% levels, respectively.

**Table 7. Weighted Price Contribution**

| | All | | | NASDAQ | | | NYSE | | |
|---|---|---|---|---|---|---|---|---|---|
| ***Size Class*** | ***2010*** | ***2007*** | ***2005*** | ***2010*** | ***2007*** | ***2005*** | ***2010*** | ***2007*** | ***2005*** |
| ***< 100 Shares*** | 0.1856 | 0.1336 | 0.1048 | 0.3188 | 0.3696 | 0.2010 | 0.2257 | 0.1795 | 0.2056 |
| ***100 - 500*** | 0.4909 | 0.2650 | 0.3887 | 0.6379 | 0.5857 | 0.7604 | 0.7429 | 0.7802 | 0.7499 |
| ***501 – 900*** | 0.0111 | -0.0186 | 0.0104 | 0.0189 | 0.0181 | 0.0202 | 0.0139 | 0.0170 | 0.0210 |
| ***901 – 1,900*** | 0.0096 | 0.0069 | 0.0080 | 0.0164 | 0.0181 | 0.0142 | 0.0123 | 0.0159 | 0.0177 |
| ***1,901 – 4,900*** | 0.0036 | 0.0025 | 0.0019 | 0.0064 | 0.0067 | 0.0036 | 0.0044 | 0.0058 | 0.0042 |
| ***4,901 – 9,999*** | 0.0005 | 0.0006 | 0.0004 | 0.0008 | 0.0015 | 0.0005 | 0.0008 | 0.0014 | 0.0013 |
| ***> 10,000*** | 0.0004 | 0.0001 | 0.0001 | 0.0008 | 0.0004 | 0.0002 | 0.0003 | 0.0002 | 0.0003 |

Table 7 lists the weighted price contribution for seven trade size classes: less than 100 shares, 100 to 500 shares, 501 to 900 shares, 901 to 1900 shares, 1901 to 4900 shares, 4901 to 9999 shares, and over 10,000 shares for trades occurring on NASDAQ from July through December 2010, 2007, and 2005 for all stocks, NASDAQ-listed stocks, and NYSE-listed stocks.

**Table 8. Differences in Weighted Price Contributions**

**Panel A: All Stocks**

| *Size Class* | *2010-2007* | *2007-2005* | *2010-2005* |
|---|---|---|---|
| ***< 100 Shares*** | 0.0520* | 0.0288*** | 0.0808*** |
| | (0.078) | (<.0001) | (<.0001) |
| ***100-500*** | 0.2259*** | -0.1237*** | 0.1022*** |
| | (<.0001) | (<.0001) | (<.0001) |
| ***501-900*** | 0.0297 | -0.0290 | 0.0007 |
| | (0.255) | (0.267) | (0.458) |
| ***901-1,900*** | 0.0027*** | -0.0011* | 0.0016*** |
| | (<.0001) | (0.052) | (0.001) |
| ***1,901-4,900*** | 0.0011*** | 0.0006*** | 0.0017*** |
| | (<.0001) | (0.005) | (<.0001) |
| ***4,901-9,999*** | -0.0001 | 0.0002** | 0.0001 |
| | (0.819) | (0.039) | (0.209) |
| ***> 10,000*** | 0.0003*** | 0.0000 | 0.0003** |
| | (<.0001) | (0.129) | (0.021) |

**Panel B: NASDAQ Listed Stocks**

| *Size Class* | *2010-2007* | *2007-2005* | *2010-2005* |
|---|---|---|---|
| ***< 100 Shares*** | -0.0508 | 0.1686*** | 0.1178*** |
| | (0.135) | (<.0001) | (<.0001) |
| ***100-500*** | 0.0522 | -0.1747*** | -0.1225*** |
| | (0.115) | (<.0001) | (<.0001) |
| ***501-900*** | 0.0008 | -0.0021 | -0.0013 |
| | (0.510) | (0.308) | (0.510) |
| ***901-1,900*** | -0.0017* | 0.0039*** | 0.0022** |
| | (0.098) | (<.0001) | (0.011) |
| ***1,901-4,900*** | -0.0003 | 0.0031*** | 0.0028*** |
| | (0.503) | (<.0001) | (<.0001) |
| ***4,901-9,999*** | -0.0007*** | 0.0010*** | 0.0003 |
| | (0.009) | (<.0001) | (0.290) |

| | | | |
|---|---|---|---|
| ***> 10,000*** | 0.0004 | 0.0002*** | 0.0006** |
| | (0.237) | (<.0001) | (0.079) |

**Panel C: NYSE Listed Stocks**

| *Size Class* | *2010-2007* | *2007-2005* | *2010-2005* |
|---|---|---|---|
| ***< 100 Shares*** | 0.0462*** | -0.0261* | 0.0201* |
| | (0.002) | (0.097) | (0.088) |
| ***100-500*** | -0.0373** | 0.0303* | -0.0070 |
| | (0.011) | (0.054) | (0.549) |
| ***501-900*** | -0.0031*** | -0.0040 | -0.0071** |
| | (0.001) | (0.222) | (0.030) |
| ***901-1,900*** | -0.0036*** | -0.0018 | -0.0054*** |
| | (<.0001) | (0.254) | (0.001) |
| ***1,901-4,900*** | -0.0014*** | 0.0016*** | 0.0002 |
| | (0.001) | (0.003) | (0.740) |
| ***4,901-9,999*** | -0.0006*** | 0.0001 | -0.0005*** |
| | (<.0001) | (0.634) | (0.005) |
| ***> 10,000*** | 0.0001 | -0.0001 | 0.0000 |
| | (0.231) | (0.438) | (0.969) |

Table 8 lists the differences in the weighted price contribution for seven trade size classes: less than 100 shares, 100 to 500 shares, 501 to 900 shares, 901 to 1900 shares, 1901 to 4900 shares, 4901 to 9999 shares, and over 10,000 shares between 2010 and 2007, 2007 and 2005, and 2010 and 2005 for trades occurring on NASDAQ from July through December 2010, 2007, and 2005. Panel A lists the differences in weighted price contribution for all stocks, Panel B lists the differences in weighted price contribution for NASDAQ-listed stocks, and Panel C lists the differences in weighted price contribution for NYSE-listed stocks. P-values from standard t-tests testing the differences in the means are reported in parentheses. ***, ** & * denote significance at the 1%, 5% & 10% levels, respectively.

**Table 9. Price Contribution vs. Proportion of Trades by Size Class**
**Panel A: 2010**

| | *All* | | | *NASDAQ* | | | *NYSE* | | |
|---|---|---|---|---|---|---|---|---|---|
| ***Size Class*** | ***PC*** | ***%Vol*** | ***diff*** | ***PC*** | ***%Vol*** | ***diff*** | ***PC*** | ***%Vol*** | ***diff*** |
| ***< 100 Shares*** | 0.2263 | 0.0797 | 0.1465*** (<.0001) | 0.2918 | 0.0817 | 0.2102*** (<.0001) | 0.1768 | 0.0786 | 0.0982*** (<.0001) |
| ***100 - 500*** | 0.6965 | 0.7666 | -0.0701*** (<.0001) | 0.6132 | 0.7539 | -0.1407*** (<.0001) | 0.7593 | 0.7762 | -0.0169* (.0600) |
| ***501 – 900*** | 0.0252 | 0.0646 | -0.0395*** (<.0001) | 0.0312 | 0.0660 | -0.0348*** (<.0001) | 0.0205 | 0.0636 | -0.0431*** (<.0001) |
| ***901 – 1900*** | 0.0353 | 0.0710 | -0.0357*** (<.0001) | 0.0457 | 0.0725 | -0.0268*** (<.0001) | 0.0271 | 0.0698 | -0.0427*** (<.0001) |
| ***1,901 – 4,900*** | 0.0299 | 0.0790 | -0.0491*** (<.0001) | 0.0343 | 0.0823 | -0.0480*** (<.0001) | 0.0263 | 0.0763 | -0.0500*** (<.0001) |
| ***4,901 – 9,999*** | 0.0072 | 0.0654 | -0.0582*** (<.0001) | 0.0020 | 0.0707 | -0.0686*** (<.0001) | 0.0116 | 0.0609 | -0.0494*** (<.0001) |
| ***> 10,000*** | 0.0199 | 0.0930 | -0.0731*** (<.0001) | 0.0271 | 0.1020 | -0.0748*** (<.0001) | 0.0139 | 0.0855 | -0.0717*** (<.0001) |
| | N=424,832 | | | N=181,888 | | | N=242,944 | | |

**Panel B: 2007**

| | *All* | | | *NASDAQ* | | | *NYSE* | | |
|---|---|---|---|---|---|---|---|---|---|
| ***Size Class*** | ***PC*** | ***%Vol*** | ***diff*** | ***PC*** | ***%Vol*** | ***diff*** | ***PC*** | ***%Vol*** | ***diff*** |
| ***< 100 Shares*** | 0.2686 | 0.0566 | 0.2120*** (<.0001) | 0.3236 | 0.0693 | 0.2543*** (<.0001) | 0.1582 | 0.0447 | 0.1136*** (<.0001) |
| ***100 - 500*** | 0.6524 | 0.7558 | -0.1034*** (<.0001) | 0.5801 | 0.7262 | -0.1460*** (<.0001) | 0.7699 | 0.7758 | -0.0060 (.5932) |
| ***501 – 900*** | 0.0193 | 0.0673 | -0.0479*** (<.0001) | 0.0345 | 0.0719 | -0.0374*** (<.0001) | 0.0278 | 0.0698 | -0.0420*** (<.0001) |
| ***901 – 1900*** | 0.0344 | 0.0657 | -0.0313*** (<.0001) | 0.0391 | 0.0776 | -0.0385*** (<.0001) | 0.0329 | 0.0779 | -0.0451*** (<.0001) |
| ***1,901 – 4,900*** | 0.0214 | 0.0635 | -0.0421*** (<.0001) | 0.0294 | 0.0869 | -0.0575*** (<.0001) | 0.0196 | 0.0807 | -0.0610*** (<.0001) |
| ***4,901 – 9,999*** | 0.0077 | 0.0461 | -0.0383*** (<.0001) | 0.0115 | 0.0685 | -0.0570*** (<.0001) | 0.0118 | 0.0632 | -0.0514*** (<.0001) |
| ***> 10,000*** | -0.0024 | 0.0593 | -0.0617*** (<.0001) | -0.0025 | 0.0854 | -0.0880*** (<.0001) | 0.0126 | 0.0682 | -0.0557*** (<.0001) |
| | | N=485,902 | | | N=241,427 | | | N=244,475 | |

**Panel C: 2005**

| | *All* | | | *NASDAQ* | | | *NYSE* | | |
|---|---|---|---|---|---|---|---|---|---|
| ***Size Class*** | ***PC*** | ***%Vol*** | ***diff*** | ***PC*** | ***%Vol*** | ***diff*** | ***PC*** | ***%Vol*** | ***diff*** |
| ***< 100 Shares*** | 0.1827 | 0.0551 | 0.1276*** (<.0001) | 0.1743 | 0.0553 | 0.1189*** (<.0001) | 0.2035 | 0.0548 | 0.1487*** (<.0001) |
| ***100 - 500*** | 0.7474 | 0.7718 | -0.0244*** (.0075) | 0.7477 | 0.7639 | -0.0162 (.1416) | 0.7901 | 0.7460 | -0.0441*** (.0065) |
| ***501 – 900*** | 0.0278 | 0.0857 | -0.0579*** (<.0001) | 0.0270 | 0.0806 | -0.0536*** (<.0001) | 0.0302 | 0.0987 | -0.0685*** (<.0001) |
| ***901 – 1900*** | 0.0354 | 0.0933 | -0.0579*** (<.0001) | 0.0373 | 0.0904 | -0.0532*** (<.0001) | 0.0298 | 0.1019 | -0.0721*** (<.0001) |
| ***1,901 – 4,900*** | 0.0168 | 0.0947 | -0.0778*** (<.0001) | 0.0167 | 0.0935 | -0.0768*** (<.0001) | 0.0174 | 0.1004 | -0.0829*** (<.0001) |
| ***4,901 – 9,999*** | 0.0173 | 0.0723 | -0.0550*** (<.0001) | 0.0141 | 0.0701 | -0.0561*** (<.0001) | 0.0355 | 0.0842 | -0.0487*** (.0061) |
| ***> 10,000*** | 0.0143 | 0.0909 | -0.0766*** (<.0001) | 0.0114 | 0.0789 | -0.0674*** (<.0001) | 0.0262 | 0.1415 | -0.1154*** (<.0001) |
| | N=253,873 | | | N=177,927 | | | N=75,946 | | |

Table 9 lists the price contribution (PC), proportion of volume (%Vol), and difference (diff) between PC and %Vol for trade size classes of less than 100 shares, 100 to 500 shares, 501 to 900 shares, 901 to 1900 shares, 1901 to 4900 shares, 4901 to 9999 shares, and over 10,000 shares for all trades occurring on NASDAQ from July through December, 2010, 2007 and 2005 for all stocks, NASDAQ-listed stocks, and NYSE-listed stocks, with 2010 results in Panel A, 2007 results in Panel B, and 2005 results in Panel C. P-values of the t-test that diff is significantly different from zero appear in parentheses. ***, ** & * denote significance at the 1%, 5% & 10% levels, respectively.

**Table 10. Weighted Least Squares Regression: PC on Trade Size Class and Proportion of Volume**

**Panel A: 2010**

| *Variable* | *All Stocks* | | *NASDAQ* | | *NYSE* | |
|---|---|---|---|---|---|---|
| ***Trade Size*** | | | | | | |
| ***< 100 shares*** | 0.1764*** | 0.0370*** | 0.2373*** | 0.0938*** | 0.1330*** | -0.0025 |
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (0.2181) |
| ***100+ shares*** | -0.0270*** | 0.0075*** | -0.0236*** | 0.0044** | -0.0287*** | 0.0113*** |
| | (<.0001) | (<.0001) | (<.0001) | (0.016) | (<.0001) | (<.0001) |
| ***% Volume*** | 0.9094*** | | 0.8401*** | | 0.9560*** | |
| | (<.0001) | | (<.0001) | | (<.0001) | |
| ***% Trades*** | | 0.9396*** | | 0.8918*** | | 0.9682*** |
| | | (<.0001) | | (<.0001) | | (<.0001) |
| $R^2$ | 0.1148 | 0.1194 | 0.0811 | 0.0864 | 0.1502 | 0.1532 |

**Panel B: 2007**

| *Variable* | *All Stocks* | | *NASDAQ* | | *NYSE* | |
|---|---|---|---|---|---|---|
| ***Trade Size*** | | | | | | |
| ***< 100 shares*** | 0.2788*** | 0.1649*** | 0.3023*** | 0.1798*** | 0.1231*** | 0.0176*** |
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) |
| ***100+ shares*** | -0.0564*** | -0.0230** | -0.0310*** | -0.0096*** | -0.0339*** | 0.0092*** |
| | (<.0001) | (0.014) | (<.0001) | (<.0001) | (<.0001) | (<.0001) |
| ***% Volume*** | 0.9401*** | | 0.8114*** | | 0.9943*** | |
| | (<.0001) | | (<.0001) | | (<.0001) | |
| ***% Trades*** | | 0.9244*** | | 0.8557*** | | 0.9510*** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | (<.0001) | | (<.0001) | | (<.0001) |
| ***$R^2$*** | 0.0016 | 0.0017 | 0.0521 | 0.0587 | 0.1053 | 0.1099 |

**Panel C: 2005**

| ***Variable*** | ***All Stocks*** | | ***NASDAQ*** | | ***NYSE*** | |
|---|---|---|---|---|---|---|
| ***Trade Size*** | | | | | | |
| ***< 100 shares*** | 0.1475*** | 0.0092*** | 0.1373*** | 0.0296*** | 0.1621*** | -0.0276*** |
| | (<.0001) | (0.001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) |
| ***100+ shares*** | -0.0423*** | 0.0145*** | -0.0424*** | 0.0049*** | -0.0426*** | 0.0346*** |
| | (<.0001) | (<.0001) | (<.0001) | (0.004) | (<.0001) | (<.0001) |
| ***% Volume*** | 0.9784*** | | 0.9959*** | | 0.9532*** | |
| | (<.0001) | | (<.0001) | | (<.0001) | |
| ***% Trades*** | | 0.9486*** | | 0.9551*** | | 0.9379*** |
| | | (<.0001) | | (<.0001) | | (<.0001) |
| ***$R^2$*** | 0.1053 | 0.1095 | 0.1252 | 0.1306 | 0.0804 | 0.0832 |

Table 10 lists the results of weighted least squares regressions with price contribution (PC) of trade size classes as the dependent variable and the ratio of daily stock returns to daily market returns as the weight. The independent variables are a dummy set to one if the size class is less than 100 shares and zero otherwise, a dummy variable set to one if the size class is greater than 100 shares and zero otherwise, the size class proportion of volume in columns one, three, and five, and the size class proportion of trades in columns two, four, and six for all stocks, NASDAQ-listed stocks, and NYSE-listed stocks for trades occurring July through December, 2010, 2007, and 2005. 2010 results are listed in Panel A, 2007 results are listed in Panel B, and 2005 results are listed in Panel C. P-values are reported in parentheses. ***, ** & * denote significance at the 1%, 5% & 10% levels, respectively.

**Table 11. Weighted Least Squares Regression: Price Contribution with Panel Data**
**Panel A: All Stocks**

| *Variable* | *2010 & 2007* | | *2007 & 2005* | | *2010 & 2005* | |
|---|---|---|---|---|---|---|
| ***Intercept*** | -0.0517*** | -0.0249*** | -0.0366*** | 0.0175** | -0.0291*** | 0.0158*** |
| | (<.0001) | (<.0001) | (<.0001) | (0.0143) | (<.0001) | (<.0001) |
| ***2010*** | 0.0215** | 0.0339*** | | | -0.0059*** | -0.0093*** |
| | (0.0028) | (<.0001) | | | (<.0001) | (<.0001) |
| ***2007*** | | | -0.0247*** | -0.0432*** | | |
| | | | (0.0060) | (<.0001) | | |
| ***<100 shares*** | 0.3318*** | 0.1880*** | 0.1852*** | -0.0060 | 0.1791*** | -0.0056** |
| | (<.0001) | (<.0001) | (<.0001) | (0.6357) | (<.0001) | (0.0180) |
| ***<100*2010*** | -0.1264*** | -0.1586*** | | | 0.0295*** | 0.0350*** |
| | (<.0001) | (<.0001) | | | (<.0001) | (<.0001) |
| ***<100*2007*** | | | 0.1535*** | 0.1941*** | | |
| | | | (<.0001) | (<.0001) | | |
| ***% Volume*** | 0.9206*** | | 0.9608*** | | 0.9374*** | |
| | (<.0001) | | (<.0001) | | (<.0001) | |
| ***% Trades*** | | 0.9336*** | | 0.9375*** | | 0.9436*** |
| | | (<.0001) | | (<.0001) | | (<.0001) |
| $R^2$ | 0.0025 | 0.0028 | 0.0022 | 0.0024 | 0.0673 | 0.0721 |

**Panel B: NASDAQ Listed Stocks**

| *Variable* | *2010 & 2007* | | *2007 & 2005* | | *2010 & 2005* | |
|---|---|---|---|---|---|---|
| ***Intercept*** | -0.0347*** | -0.0133*** | -0.0146*** | 0.0178*** | -0.0185*** | 0.0128*** |
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) |
| ***2010*** | 0.0149*** | 0.0220*** | | | -0.0260*** | -0.0159*** |
| | (<.0001) | (<.0001) | | | (<.0001) | (<.0001) |
| ***2007*** | | | -0.0393*** | -0.0381*** | | |
| | | | (<.0001) | (<.0001) | | |
| ***<100 shares*** | 0.3357*** | 0.1893*** | 0.1579 | 0.0207*** | 0.1610*** | 0.0223*** |
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) |
| ***<100*2010*** | -0.0773*** | -0.0994*** | | | 0.1134*** | 0.0663*** |
| | (<.0001) | (<.0001) | | | (<.0001) | (<.0001) |
| ***<100*2007*** | | | 0.1906*** | 0.1683*** | | |
| | | | (<.0001) | (<.0001) | | |
| ***% Volume*** | 0.8260*** | | 0.9025*** | | 0.9157*** | |
| | (<.0001) | | (<.0001) | | (<.0001) | |
| ***% Trades*** | | 0.8730*** | | 0.9057*** | | 0.9250*** |
| | | (<.0001) | | (<.0001) | | (<.0001) |
| $R^2$ | 0.0370 | 0.0432 | 0.0467 | 0.0534 | 0.0606 | 0.0665 |

**Panel C: NYSE Listed Stocks**

| *Variable* | *2010 & 2007* | | *2007 & 2005* | | *2010 & 2005* | |
|---|---|---|---|---|---|---|
| ***Intercept*** | -0.0288*** | 0.0073*** | -0.0507*** | 0.0324*** | -0.0431*** | 0.0301*** |
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) |
| ***2010*** | -0.0057*** | 0.0063*** | | | 0.0148*** | -0.0150*** |
| | (.001) | (.001) | | | (<.0001) | (<.0001) |
| ***2007*** | | | 0.0220*** | -0.0218*** | | |
| | | | (<.0001) | (<.0001) | | |
| ***<100 shares*** | 0.1530*** | 0.0089*** | 0.2117*** | -0.0619*** | 0.2052*** | -0.0616*** |
| | (<.0001) | (.001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) |
| ***<100*2010*** | 0.0126*** | -0.0228*** | | | -0.0437*** | 0.0477*** |
| | (.001) | (<.0001) | | | (<.0001) | (<.0001) |
| ***<100*2007*** | | | -0.0588*** | 0.0699*** | | |
| | | | (<.0001) | (<.0001) | | |
| ***% Volume*** | 0.9755*** | | 0.9752*** | | 0.9547*** | |
| | (<.0001) | | (<.0001) | | (<.0001) | |
| ***% Trades*** | | 0.9588*** | | 0.9451*** | | 0.9532*** |
| | | (<.0001) | | (<.0001) | | (<.0001) |
| $R^2$ | 0.0806 | 0.0847 | 0.0569 | 0.0606 | 0.0626 | 0.0656 |

Table 11 lists the results of weighted least squares regressions with price contribution (PC) of trade size classes as the dependent variable and the ratio of daily stock returns to daily market returns as the weight. The independent variables are a dummy variable set to one if the year of the observation is in 2010 and zero otherwise for columns one, two, five and six, a dummy variable set to one if the observation is in 2007 and zero otherwise for columns three and four, a dummy variable set to

one if the size class is less than 100 shares and zero otherwise, an interaction term set to one if the trades size class is equal to one and the year of the observation is 2010 and zero otherwise for columns one, two, four, and five, an interaction term set to one if the trades size class is equal to one and the year of the observation is 2007 and zero otherwise for columns three and four, the size class proportion of volume in columns one, three, and five, and the size class proportion of trades in columns two, four, and six for all trades executing on NASDAQ for July through December 2010, 2007, and 2005. Column one and two report results from 2010 and 2007. Columns three and four report results from 2007 and 2005. Columns five and six report results from 2010 and 2005. Panel A reports results for all stocks, Panel B reports results for NASDAQ-listed stocks, and Panel C reports results for NYSE-listed stocks. P-values are reported in parentheses. ***, ** & * denote significance at the 1%, 5% & 10% levels, respectively.

**Table 12. Regression: Volume and Trades on Intraday Intervals**
**Panel A: 2010**

| | All Transactions | | Odd Lot Transactions | | % Odd Lot Transactions | |
|---|---|---|---|---|---|---|
| **Variable** | **Volume** | **Trades** | **Volume** | **Trades** | **Volume** | **Trades** |
| ***Intercept*** | 1,876,763.81*** | 78,305.57*** | 10,918.60*** | 1,850.21*** | 0.0426*** | 0.1683*** |
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) |
| ***Period 1*** | 3,523,935.47*** | 84,913.49*** | 15,607.35*** | 1,939.10*** | -0.0128*** | -0.0273*** |
| | (<.0001) | (<.0001) | (<.0001) | (0.001) | (<.0001) | (<.0001) |
| ***Period 2*** | 2,784,498.79*** | 72,580.02*** | 14,040.47*** | 1,621.73*** | -0.0095*** | -0.0285*** |
| | (<.0001) | (0.001) | (<.0001) | (0.004) | (<.0001) | (<.0001) |
| ***Period 3*** | 3,035,492.25*** | 92,893.60*** | 15,827.77*** | 2,095.09*** | -0.0070*** | -0.0212*** |
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) |
| ***Period 4*** | 1,938,158.91*** | 59,907.59*** | 10,308.01*** | 1,357.09** | -0.0057*** | -0.0176*** |
| | (<.0001) | (0.006) | (<.0001) | (0.016) | (<.0001) | (<.0001) |
| ***Period 5*** | 1,714,415.82*** | 55,181.62** | 9,294.88*** | 1,267.35** | -0.0047*** | -0.0145*** |
| | (<.0001) | (0.012) | (<.0001) | (0.025) | (<.0001) | (<.0001) |
| ***Period 6*** | 1,240,464.99*** | 41,993.27* | 6,784.59*** | 955.14* | -0.0035*** | -0.0107*** |
| | (0.004) | (0.056) | (<.0001) | (0.090) | (<.0001) | (0.009) |
| ***Period 7*** | 1,182,362.28*** | 40,284.35* | 6,514.68*** | 936.47* | -0.0031*** | -0.0089** |
| | (0.006) | (0.066) | (<.0001) | (0.096) | (<.0001) | (0.030) |
| ***Period 8*** | 817,076.90* | 28,874.73 | 4,522.35*** | 649.77 | -0.0019** | -0.0063 |
| | (0.059) | (0.188) | (0.007) | (0.248) | (0.011) | (0.123) |
| ***Period 9*** | 718,348.96* | 25,164.70 | 3,892.52** | 592.56 | -0.0020*** | -0.0046 |
| | (0.096) | (0.251) | (0.020) | (0.292) | (0.008) | (0.266) |
| ***Period 10*** | 394,975.27 | 14,920.86 | 2,149.55 | 361.94 | -0.0008 | -0.0006 |
| | (0.360) | (0.496) | (0.198) | (0.520) | (0.266) | (0.882) |
| ***Period 11*** | 264,011.31 | 8,372.01 | 1,364.95 | 208.04 | -0.0013* | -0.0018 |
| | (0.541) | (0.702) | (0.413) | (0.711) | (0.096) | (0.658) |
| ***Period 12*** | 24,902.59 | 246.13 | 110.13 | 24.26 | -0.0004 | -0.0011 |
| | (0.954) | (0.991) | (0.947) | (0.966) | (0.557) | (0.791) |
| ***Period 14*** | -30,692.85 | -822.47 | -240.94 | -19.27 | -0.0000 | 0.0006 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | (0.943) | (0.970) | (0.885) | (0.973) | (0.969) | (0.876) |
| ***Period 15*** | 32,772.30 | -715.48 | 67.03 | -31.49 | -0.0015** | -0.0048 |
| | (0.939) | (0.974) | (0.968) | (0.955) | (0.048) | (0.240) |
| ***Period 16*** | -21,726.45 | -1,709.68 | -140.95 | -43.35 | -0.0007 | -0.0022 |
| | (0.960) | (0.938) | (0.933) | (0.939) | (0.331) | (0.596) |
| ***Period 17*** | 13,714.15 | -180.01 | 59.76 | -10.03 | -0.0009 | -0.0016 |
| | (0.975) | (0.993) | (0.971) | (0.986) | (0.252) | (0.690) |
| ***Period 18*** | 76,396.08 | 544.96 | 283.58 | 6.99 | -0.0013* | -0.0023 |
| | (0.859) | (0.980) | (0.865) | (0.990) | (0.096) | (0.573) |
| ***Period 19*** | 467,139.78 | 15,364.07 | 2,429.44 | 367.05 | -0.0012 | -0.0009 |
| | (0.279) | (0.483) | (0.146) | (0.514) | (0.121) | (0.832) |
| ***Period 20*** | 607,987.71 | 18,324.88 | 3,175.77* | 413.42 | -0.0019** | -0.0048 |
| | (0.159) | (0.403) | (0.057) | (0.462) | (0.013) | (0.237) |
| ***Period 21*** | 639,605.61 | 20,641.39 | 3,395.09** | 477.32 | -0.0019** | -0.0046 |
| | (0.139) | (0.346) | (0.042) | (0.396) | (0.014) | (0.261) |
| ***Period 22*** | 569,376.84 | 21,710.76 | 3,250.06* | 487.94 | -0.0006 | -0.0030 |
| | (0.187) | (0.322) | (0.052) | (0.386) | (0.400) | (0.457) |
| ***Period 23*** | 1,069,286.61** | 36,478.78* | 5,813.38*** | 832.29 | -0.0027*** | -0.0080* |
| | (0.014) | (0.096) | (0.001) | (0.139) | (0.001) | (0.050) |
| ***Period 24*** | 1,362,354.94*** | 51,378.90** | 7,492.85*** | 1,183.50** | -0.0015** | -0.0031 |
| | (0.002) | (0.019) | (<.0001) | (0.036) | (0.045) | (0.441) |
| ***Period 25*** | 2,364,532.41*** | 90,060.41*** | 13,101.82*** | 2,046.76*** | -0.0017** | -0.0042 |
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (0.028) | (0.301) |
| ***Period 26*** | 6,644,732.94*** | 321,344.36*** | 33,124.81*** | 7,719.46*** | 0.0037*** | 0.0337*** |
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) |
| $R^2$ | 0.6330 | 0.5541 | 0.7407 | 0.5173 | 0.7213 | 0.5252 |

**Panel B: 2007**

| | **All Transactions** | | **Odd Lot Transactions** | | **% Odd Lot Transactions** | |
|---|---|---|---|---|---|---|
| **Variable** | **Volume** | **Trades** | **Volume** | **Trades** | **Volume** | **Trades** |
| ***Intercept*** | 3,157,881.89*** | 91,933.40*** | 15,947.08*** | 2,140.98*** | 0.0288*** | 0.1298*** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) |
| ***Period 1*** | 2,686,267.19*** | 108,376.72*** | 11,944.73*** | 2,858.97*** | 0.0041*** | 0.0412*** |
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) |
| ***Period 2*** | 2,960,358.01*** | 82,761.75*** | 14,168.95*** | 2,066.36*** | -0.0006 | 0.0067* |
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (0.378) | (0.055) |
| ***Period 3*** | 2,751,991.01*** | 73,381.25*** | 13,254.01*** | 1,801.09*** | -0.0012* | 0.0026 |
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (0.068) | (0.449) |
| ***Period 4*** | 1,871,428.30*** | 46,559.90*** | 9,076.88*** | 1,107.74*** | -0.0015** | -0.0023 |
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (0.020) | (0.497) |
| ***Period 5*** | 1,742,884.11*** | 48,879.69*** | 8,552.49*** | 1,168.49*** | -0.0007 | 0.0014 |
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (0.306) | (0.693) |
| ***Period 6*** | 1,321,760.32*** | 37,517.03*** | 6,260.66*** | 921.13*** | -0.0005 | 0.0029 |
| | (<.0001) | (0.002) | (<.0001) | (0.002) | (0.401) | (0.396) |
| ***Period 7*** | 1,186,550.83*** | 35,032.80*** | 5,743.93*** | 842.23*** | -0.0002 | 0.0027 |
| | (<.0001) | (0.003) | (<.0001) | (0.004) | (0.754) | (0.442) |
| ***Period 8*** | 723,908.27*** | 20,336.72* | 3,532.09*** | 480.89* | -0.0004 | -0.0000 |
| | (0.007) | (0.087) | (<.0001) | (0.096) | (0.496) | (0.993) |
| ***Period 9*** | 579,400.16** | 19,029.09 | 2,856.64*** | 471.60 | 0.0002 | 0.0035 |
| | (0.030) | (0.110) | (0.003) | (0.103) | (0.806) | (0.309) |
| ***Period 10*** | 305,992.00 | 8,998.25 | 1,455.87 | 228.50 | -0.0001 | 0.0025 |
| | (0.252) | (0.449) | (0.133) | (0.429) | (0.828) | (0.467) |
| ***Period 11*** | 269,968.89 | 8,360.53 | 1,403.24 | 200.09 | -0.0001 | 0.0000 |
| | (0.312) | (0.482) | (0.148) | (0.488) | (0.840) | (0.991) |
| ***Period 12*** | 34,361.06 | 1,955.55 | 142.51 | 42.41 | -0.0001 | 0.0001 |
| | (0.897) | (0.869) | (0.883) | (0.883) | (0.849) | (0.981) |
| ***Period 14*** | 3,265.46 | 1,468.11 | -14.14 | 50.62 | 0.0002 | 0.0019 |
| | (0.990) | (0.902) | (0.988) | (0.861) | (0.805) | (0.587) |
| ***Period 15*** | 27,996.71 | 1,227.04 | 76.40 | 32.32 | -0.0005 | 0.0004 |
| | (0.916) | (0.918) | (0.937) | (0.911) | (0.454) | (0.902) |
| ***Period 16*** | 60,452.21 | 2,660.62 | 205.03 | 74.97 | -0.0000 | 0.0048 |
| | (0.821) | (0.823) | (0.832) | (0.795) | (0.995) | (0.166) |

| | | | | | | |
|---|---|---|---|---|---|---|
| ***Period 17*** | 62,267.71 | 2,157.96 | 291.77 | 61.34 | -0.0000 | 0.0035 |
| | (0.815) | (0.856) | (0.763) | (0.832) | (0.970) | (0.307) |
| ***Period 18*** | 239,685.46 | 6,678.93 | 1,067.10 | 146.45 | -0.0001 | 0.0028 |
| | (0.369) | (0.574) | (0.271) | (0.612) | (0.888) | (0.410) |
| ***Period 19*** | 672,567.25** | 20,542.22* | 3,437.22*** | 484.24* | 0.0007 | 0.0053 |
| | (0.012) | (0.084) | (<.0001) | (0.094) | (0.280) | (0.128) |
| ***Period 20*** | 1,012,875.19*** | 33,680.50*** | 5,081.17*** | 814.03*** | 0.0015** | 0.0070** |
| | (<.0001) | (0.005) | (<.0001) | (0.005) | (0.026) | (0.045) |
| ***Period 21*** | 1,053,527.25*** | 32,456.55*** | 5,331.27*** | 758.02*** | 0.0006 | 0.0053 |
| | (<.0001) | (0.007) | (<.0001) | (0.009) | (0.394) | (0.125) |
| ***Period 22*** | 1,049,292.37*** | 35,381.39*** | 5,364.02*** | 843.64*** | 0.0017** | 0.0101*** |
| | (<.0001) | (0.003) | (<.0001) | (0.004) | (0.012) | (0.004) |
| ***Period 23*** | 1,846,157.28*** | 56,441.13*** | 9,150.67*** | 1,351.91*** | 0.0014** | 0.0093*** |
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (0.039) | (0.007) |
| ***Period 24*** | 2,162,893.82*** | 67,822.49*** | 10,663.73*** | 1,601.86*** | 0.0020*** | 0.0106*** |
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (0.002) | (0.002) |
| ***Period 25*** | 3,436,746.36*** | 104,167.98*** | 16,793.34*** | 2,407.71*** | 0.0011 | 0.0085** |
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (0.106) | (0.014) |
| ***Period 26*** | 7,272,618.19*** | 247,996.12*** | 31,069.19*** | 5,782.62*** | 0.0037*** | 0.0327*** |
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) |
| $R^2$ | 0.8340 | 0.7372 | 0.8823 | 0.7276 | 0.3656 | 0.5249 |

**Panel C: 2005**

| | **All Transactions** | | **Odd Lot Transactions** | | **% Odd Lot Transactions** | |
|---|---|---|---|---|---|---|
| **Variable** | **Volume** | **Trades** | **Volume** | **Trades** | **Volume** | **Trades** |
| ***Intercept*** | 844,603.80*** | 17,514.59*** | 3,319.80*** | 487.12*** | 0.0208*** | 0.1392*** |
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) |
| ***Period 1*** | 1,044,443.57*** | 17,089.14*** | 3,219.18*** | 382.85*** | -0.0026*** | -0.0096*** |
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) |
| ***Period 2*** | 984,697.79*** | 16,983.08*** | 3,499.46*** | 490.54*** | -0.0018*** | 0.0005 |
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (0.832) |

| | | | | | | |
|---|---|---|---|---|---|---|
| ***Period 3*** | 893,143.94*** | 16,962.88*** | 3,293.17*** | 510.31*** | -0.0009* | 0.0063*** |
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (0.070) | (0.005) |
| ***Period 4*** | 680,820.12*** | 13,239.70*** | 2,533.99*** | 398.85*** | -0.0006 | 0.0063*** |
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (0.226) | (0.005) |
| ***Period 5*** | 621,408.31*** | 11,618.83*** | 2,346.69*** | 360.22*** | -0.0009* | 0.0038* |
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (0.062) | (0.087) |
| ***Period 6*** | 446,017.70*** | 9,367.32*** | 1,724.62*** | 296.41*** | -0.0000 | 0.0081*** |
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (0.918) | (<.0001) |
| ***Period 7*** | 359,883.40*** | 7,171.61*** | 1,418.94*** | 210.40*** | -0.0003 | 0.0018 |
| | (<.0001) | (0.001) | (<.0001) | (<.0001) | (0.598) | (0.421) |
| ***Period 8*** | 243,639.35*** | 4,902.09** | 958.19*** | 150.57*** | -0.0002 | 0.0017 |
| | (0.001) | (0.022) | (<.0001) | (0.002) | (0.679) | (0.458) |
| ***Period 9*** | 196,731.21*** | 3,369.97 | 729.87*** | 87.76* | -0.0008* | -0.0038* |
| | (0.005) | (0.115) | (0.001) | (0.075) | (0.095) | (0.089) |
| ***Period 10*** | 139,102.20** | 2,710.12 | 504.11** | 75.87 | -0.0004 | -0.0002 |
| | (0.046) | (0.204) | (0.019) | (0.124) | (0.451) | (0.946) |
| ***Period 11*** | 109,854.46 | 2,611.42 | 452.88** | 83.23* | 0.0001 | 0.0026 |
| | (0.115) | (0.221) | (0.036) | (0.092) | (0.916) | (0.255) |
| ***Period 12*** | 40,033.22 | 1,254.56 | 166.54 | 34.69 | 0.0003 | 0.0035 |
| | (0.565) | (0.557) | (0.438) | (0.481) | (0.589) | (0.118) |
| ***Period 14*** | -19,823.30 | 230.04 | -87.75 | -4.23 | 0.0006 | 0.0012 |
| | (0.776) | (0.914) | (0.683) | (0.931) | (0.209) | (0.589) |
| ***Period 15*** | 5,171.56 | -328.91 | -15.57 | -7.27 | -0.0006 | -0.0024 |
| | (0.941) | (0.877) | (0.942) | (0.883) | (0.220) | (0.282) |
| ***Period 16*** | 10,920.70 | -71.84 | -21.53 | -2.85 | -0.0005 | -0.0010 |
| | (0.875) | (0.973) | (0.920) | (0.954) | (0.343) | (0.642) |
| ***Period 17*** | 57,496.93 | 1,651.46 | 225.84 | 48.12 | 0.0003 | 0.0016 |
| | (0.409) | (0.439) | (0.293) | (0.329) | (0.498) | (0.464) |
| ***Period 18*** | 69,230.74 | 2,065.00 | 240.96 | 61.58 | 0.0003 | 0.0028 |
| | (0.320) | (0.333) | (0.262) | (0.212) | (0.585) | (0.218) |
| ***Period 19*** | 187,277.56*** | 4,256.94** | 725.25*** | 121.89** | 0.0001 | 0.0013 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | (0.007) | (0.047) | (0.001) | (0.014) | (0.814) | (0.556) |
| ***Period 20*** | 260,242.98*** | 5,797.38*** | 979.95*** | 166.37*** | 0.0008 | 0.0020 |
| | (<.0001) | (0.007) | (<.0001) | (0.001) | (0.108) | (0.376) |
| ***Period 21*** | 278,793.12*** | 6,639.73*** | 1,156.91*** | 172.02*** | 0.0013*** | 0.0003 |
| | (<.0001) | (0.002) | (<.0001) | (0.001) | (0.009) | (0.885) |
| ***Period 22*** | 294,705.71*** | 7,622.46*** | 1,224.17*** | 190.31*** | 0.0012** | 0.0020 |
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (0.018) | (0.364) |
| ***Period 23*** | 453,299.62*** | 10,858.83*** | 1,838.57*** | 275.85*** | 0.0010** | 0.0010 |
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (0.038) | (0.642) |
| ***Period 24*** | 573,156.03*** | 14,454.12*** | 2,327.78*** | 361.31*** | 0.0016*** | 0.0033 |
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (0.001) | (0.139) |
| ***Period 25*** | 900,694.34*** | 21,570.21*** | 3,487.91*** | 534.97*** | 0.0019*** | 0.0053** |
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (0.018) |
| ***Period 26*** | 1,779,920.56*** | 47,448.91*** | 5,989.55*** | 1,118.95*** | 0.0048*** | 0.0277*** |
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) |
| $R^2$ | 0.8432 | 0.7615 | 0.8708 | 0.7819 | 0.5315 | 0.5223 |

Table 12 reports the results of regressions with the average total volume, total number of trades, odd lot volume, number of odd lot trades, odd lot proportion of volume, and odd lot proportion of trades for the minute of the trading day as the dependent variables. The independent variables are dummy variables set to one if the minute of the trading day is during the 15 minute interval, and zero otherwise. Panel A reports results for 2010, Panel B reports results for 2007, and Panel C reports results for 2005. P-values are reported in parentheses. ***, ** & * denote significance at the 1%, 5% & 10% levels, respectively.

**Table 13. Regression: Volume and Trades on Day-of-the-Week**

**Panel A: 2010**

| | *All Transactions* | | *Odd Lot Transactions* | | *% Odd Lot Transactions* | |
|---|---|---|---|---|---|---|
| ***Variable*** | ***Volume*** | ***Trades*** | ***Volume*** | ***Trades*** | ***Volume*** | ***Trades*** |
| ***Intercept*** | 370,691.84*** | 2,023.28*** | 14,250.62*** | 333.06*** | 0.0811*** | 0.2174*** |
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) |
| ***Monday*** | -55,736.25*** | -281.84*** | -1,396.67*** | -32.30*** | 0.0021*** | 0.0042*** |
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) |
| ***Tuesday*** | 14,911.46* | 70.58*** | 524.78*** | 13.58*** | -0.0002 | -0.0005 |
| | (0.061) | (0.003) | (<.0001) | (<.0001) | (0.401) | (0.411) |
| ***Thursday*** | 12,256.25 | 53.98** | 96.10 | 5.77* | -0.0019*** | -0.0041*** |
| | (0.123) | (0.023) | (0.497) | (0.081) | (<.0001) | (<.0001) |
| ***Friday*** | -21,973.56*** | -124.59*** | -957.96*** | -19.74*** | -0.0004 | 0.0020*** |
| | (0.006) | (<.0001) | (<.0001) | (<.0001) | (0.133) | (0.001) |
| $R^2$ | 0.0002 | 0.0007 | 0.0006 | 0.0006 | 0.0004 | 0.0005 |

**Panel B: 2007**

| | *All Transactions* | | *Odd Lot Transactions* | | *% Odd Lot Transactions* | |
|---|---|---|---|---|---|---|
| ***Variable*** | ***Volume*** | ***Trades*** | ***Volume*** | ***Trades*** | ***Volume*** | ***Trades*** |
| ***Intercept*** | 489,103.06*** | 2,408.45*** | 14,132.24*** | 333.87*** | 0.0539*** | 0.1593*** |
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) |
| ***Monday*** | -80,424.45*** | -357.62*** | -1,481.68*** | -38.20*** | 0.0049*** | 0.0114*** |
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) |
| ***Tuesday*** | -21,689.80* | -100.34*** | 76.10 | -0.41 | 0.0042*** | 0.0114*** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | (0.054) | (0.001) | (0.632) | (0.911) | (<.0001) | (<.0001) |
| ***Thursday*** | 12,972.87 | 54.98* | 588.94*** | 12.96*** | 0.0017*** | 0.0047*** |
| | (0.249) | (0.062) | (<.0001) | (<.0001) | (<.0001) | (<.0001) |
| ***Friday*** | -30,230.78*** | -130.04*** | 42.86 | 1.11 | 0.0056*** | 0.0133*** |
| | (0.007) | (<.0001) | (0.786) | (0.760) | (<.0001) | (<.0001) |
| $R^2$ | 0.0002 | 0.0005 | 0.0004 | 0.0005 | 0.0017 | 0.0018 |

**Panel C: 2005**

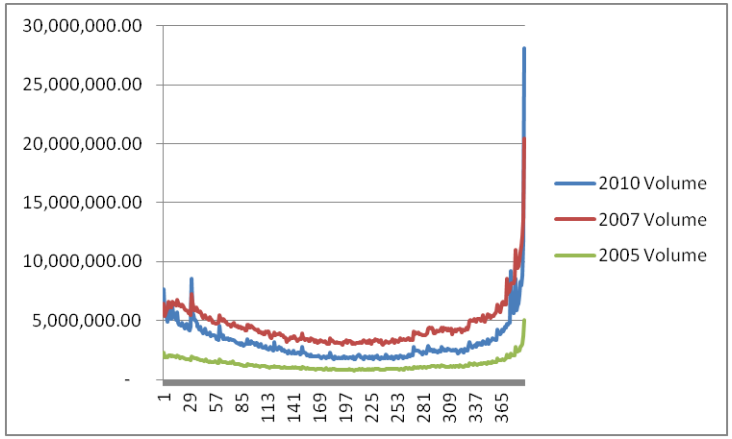
| | ***All Transactions*** | | ***Odd Lot Transactions*** | | ***% Odd Lot Transactions*** | |
|---|---|---|---|---|---|---|
| ***Variable*** | ***Volume*** | ***Trades*** | ***Volume*** | ***Trades*** | ***Volume*** | ***Trades*** |
| ***Intercept*** | 263,054.99*** | 1,002.40*** | 5,523.64*** | 156.72*** | 0.0553*** | 0.1923*** |
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) |
| ***Monday*** | -31,173.88*** | -94.34*** | -387.04*** | -20.21*** | -0.0000 | -0.0041*** |
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (0.995) | (<.0001) |
| ***Tuesday*** | -16,536.72** | -53.20*** | -216.06*** | -10.60*** | 0.0005 | -0.0002 |
| | (0.048) | (0.002) | (0.005) | (<.0001) | (0.194) | (0.879) |
| ***Thursday*** | 3,695.09 | 17.30 | 127.09* | -0.76 | 0.0001 | -0.0029*** |
| | (0.662) | (0.330) | (0.099) | (0.721) | (0.830) | (0.005) |
| ***Friday*** | -46,439.37*** | -172.82*** | -948.18*** | -34.47*** | -0.0012*** | -0.0095*** |
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) |
| $R^2$ | 0.0002 | 0.0006 | 0.0010 | 0.0015 | 0.0001 | 0.0005 |

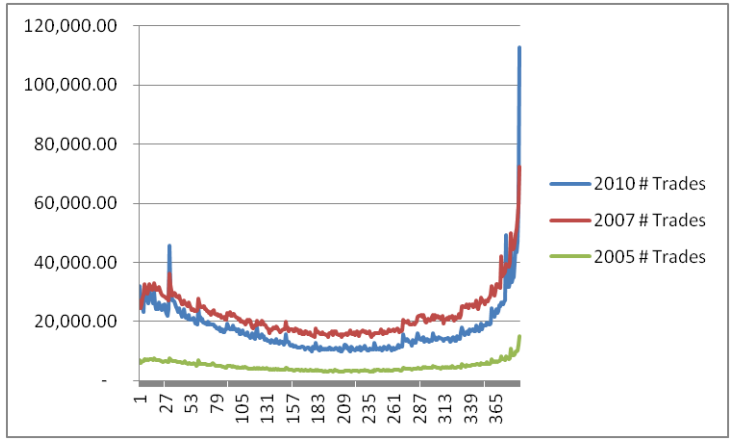
Table 13 reports the results of regressions with total volume, total number of trades, odd lot volume, number of odd lot trades, odd lot proportion of volume, and odd lot proportion of trades for stock days as the dependent variables. The independent

variables are dummies set to one if the stock day falls on the day of the week, and zero otherwise. Panel A reports the results for 2010, Panel B reports the results for 2007, and Panel C reports the results for 2005. P-values are reported in parentheses. ***, ** & * denote significance at the 1%, 5% & 10% levels, respectively.

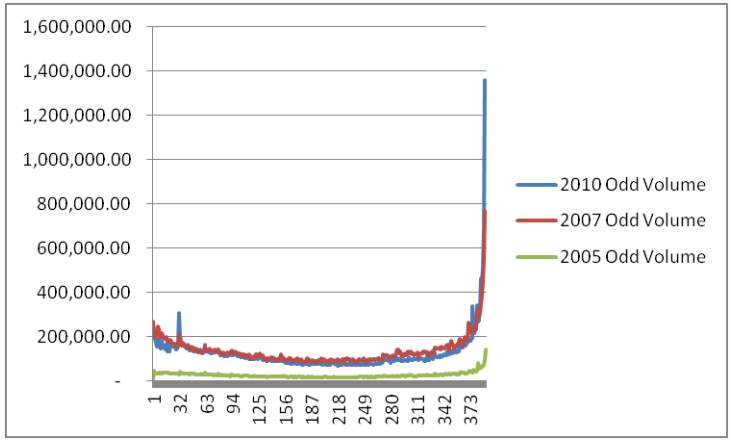
**Figure 1. Intraday Volume and Number of Trades: 2010, 2007, & 2005**

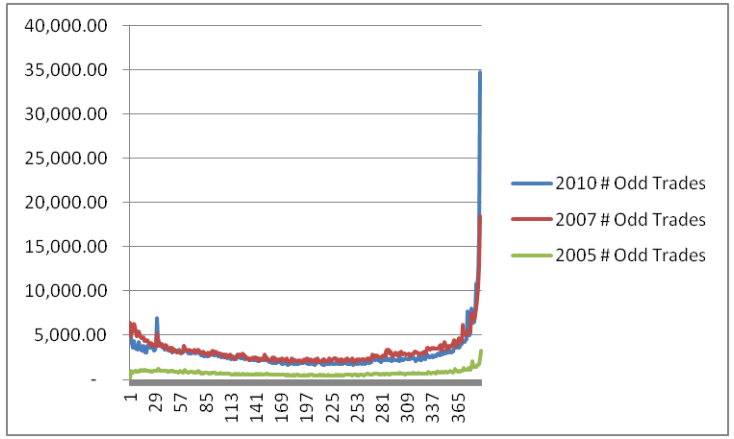
**Panel A: Total Volume and Number of Trades**




**Panel B: Odd Lot Volume and Number of Trades**



**Panel C: Odd Lot Proportions of Volume and Number of Trades**

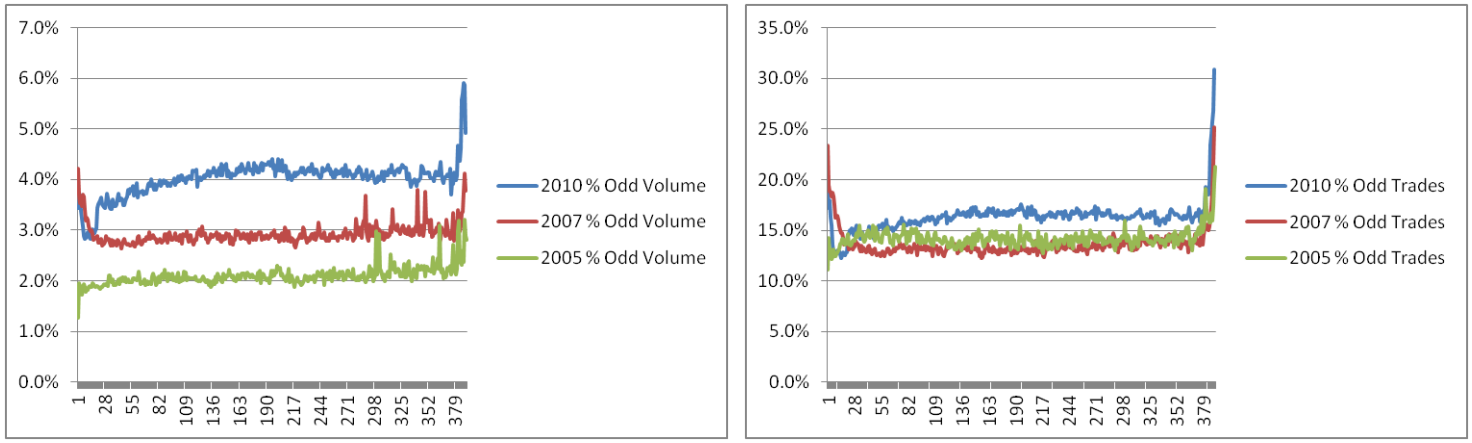
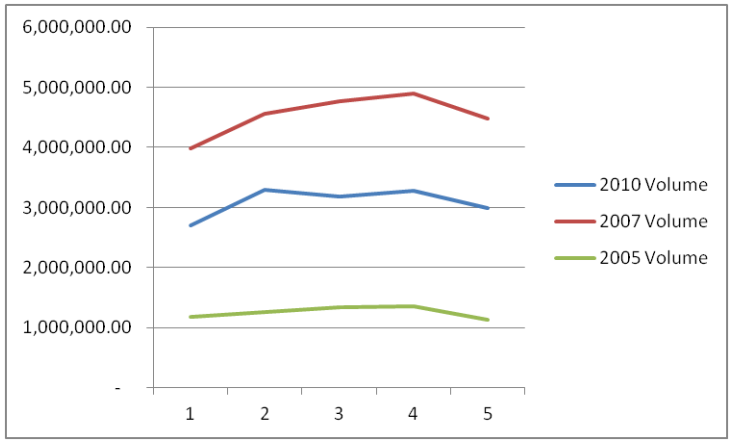
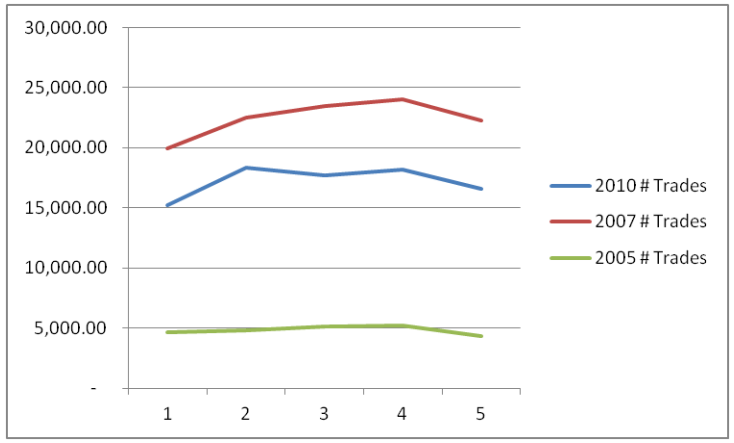



Figure 1 graphs volume and number of trades over the minute of the trading day for trades executed on NASDAQ from July through December, 2010, 2007, and 2005. Panel A graphs total volume and number of trades. Panel B graphs odd lot volume and number of trades. Panel C graphs odd lot proportions of volume and trades.

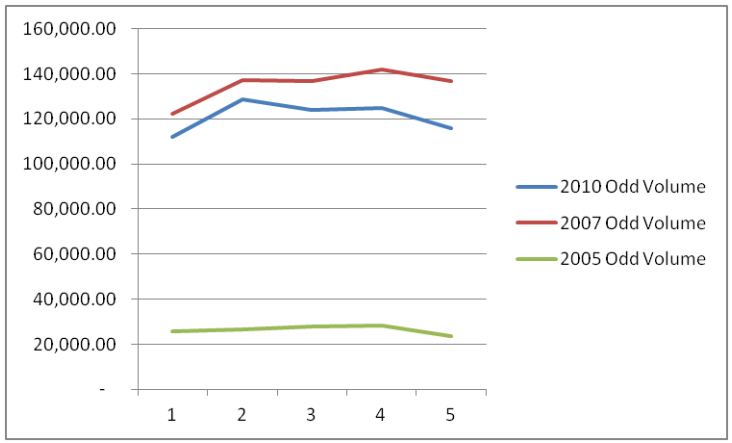
**Figure 2. Intraweek Volume and Number of Trades: 2010, 2007, & 2005**

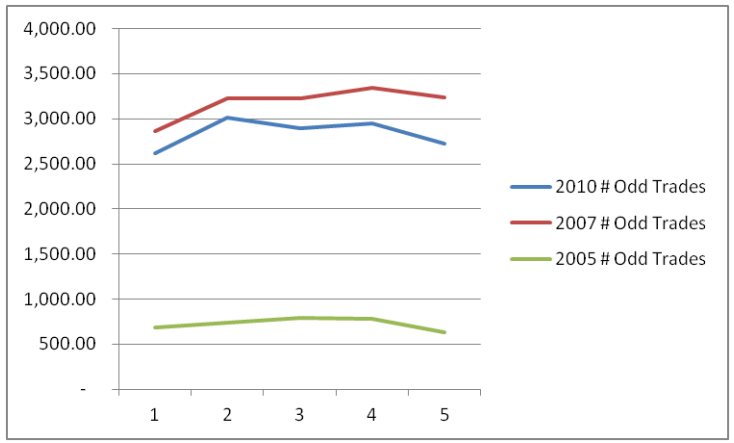
**Panel A: Total Volume and Number of Trades**




**Panel B: Odd Lot Volume and Number of Trades**



**Panel C: Odd Lot Proportions of Volume and Number of Trades**

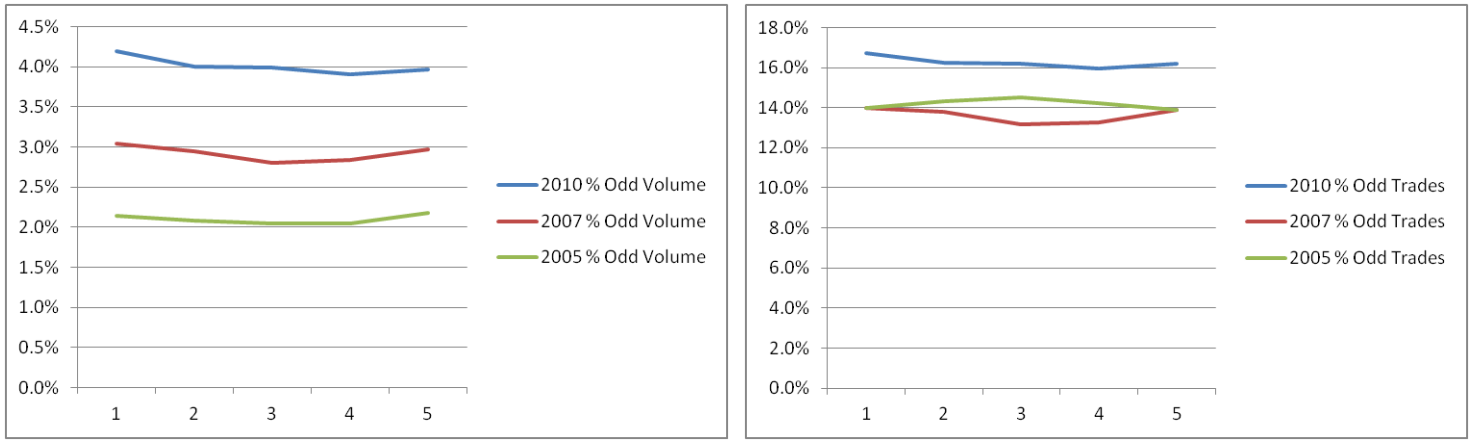



Figure 2 graphs volume and number of trades over the day-of-the-week for all trades executed on NASDAQ from July through December, 2010, 2007, and 2005. Panel A graphs total volume and number of trades. Panel B graphs odd lot volume and number of trades. Panel C graphs odd lot proportions of volume and number of trades.

**ORDER IMBALANCE AND ODD LOT TRANSACTIONS**

## 2.1 Introduction

The purpose of this study is to document the relation between order imbalances and returns while considering odd lot transactions. Chordia, Roll, and Subrahmanyam (2002) and Chordia and Subrahmanyam (2004) show a negative relation between order imbalances and lagged returns, a positive relation between order imbalances and contemporaneous returns, and a slightly positive relation between order imbalances and future returns. The data used in their study, the NYSE Trade and Quote (TAQ) and the Institute for the Study of Security Prices (ISSM) datasets, does not contain odd lot transactions (trades for less than 100 shares). O'Hara, Yao, and Ye (2011) show that odd lot transactions are a non-trivial portion of total transactions. Hence, we investigate the relation between odd lot order imbalances and returns using a dataset that includes odd lot transactions.

Chordia, Roll, and Subrahmanyam (2002) investigate the relation between daily S&P 500 order imbalances and daily S&P 500 returns. The study, which extrapolates net buys and net sells from total volume, uses the intuition that days with heavy buying or selling supply different signals to the market than supplied by days where the two are relatively equal. Total volume, which does not differentiate between buy volume and sell volume, does not capture all of the information contained in a day's trades. Chordia, Roll, and Subrahmanyam's results show a positive contemporaneous relation between returns and order imbalance, suggesting order imbalances cause price pressures. They also find a negative relation between lagged returns and order imbalance, which is consistent with the inventory paradigm models described by Stoll (1978), Ho and Stoll (1983), and Spiegel and Subrahmanyam (1995). However, Chordia, Roll, and Subrahmanyam find that, for the overall market, there is no predictive power of

lagged order imbalances on current market returns. Therefore, there is no opportunity for a profitable trading strategy using order imbalance.

Chordia and Subrahmanyam (2004) continue this line of research by investigating individual stock returns and their relation to individual stock order imbalance. They find that there is some predictive power of lagged individual stock order imbalance on current individual stock returns and a profitable trading strategy is feasible. However, they find any profits from such a strategy would likely be mitigated by transaction costs, thus rendering the strategy unprofitable.

Both the Chordia, Roll, and Subrahmanyam (2002) and Chordia and Subrahmanyam (2004) studies use the ISSM and TAQ databases for the period 1988 through 1998. They use the Lee and Ready (1991) algorithm to categorize each transaction as a buy or a sell. While Lee and Radhakrishna (2000) and Odders-White (2000) find the Lee-Ready algorithm to be 85-93% accurate and justify its use, Ellis, Michaely, and O'Hara (2000) find the algorithm to be only 75% accurate on NASDAQ stocks. Our study employs the NASDAQ Total View ITCH database, which contains all trades that execute on NASDAQ, including odd lot transactions, and identifies buyer and seller initiated transactions, negating the need for an algorithm to sign trades. O'Hara, Yao, and Ye (2011) argue that, due to the omission of odd lot transactions in the TAQ database, studies relying on TAQ may be biased since odd lot transactions comprise roughly 20% of transactions and 7% of volume. They also find that odd lot transactions contain a higher cumulative price impact (25-35%) than their proportion of trades and volume would dictate. Since odd lot traders contribute to price formation, we seek to see if the conclusions of Chordia,

Roll and Subrahmanyam (2002) and Chordia and Subrahmanyam (2004) hold when considering the order imbalances of all NASDAQ transactions, including odd lot transactions.

We also investigate the relation between returns and odd lot order imbalances, and compare this relation to that of returns and order imbalance of all transactions on NASDAQ. Chordia, Roll, and Subrahmanyam (2002) find a positive relation between order imbalance and current market returns and conclude that order imbalances exert price pressure on the market. Since odd lot transactions are such a small proportion of total volume (7% of volume according to O'Hara, Yao, and Ye, 2011), the price pressure of an odd lot trade is expected to be smaller than the price pressure of a 100+ share (trades for 100 shares or more). Returns reflect the information in 100+ share trades because they exert more price pressure than odd lot trades. If the information in odd lot trades is different from that in 100+ share trades, the relation between odd lot order imbalance and returns will likely be different. This study will determine if and how the relation between order imbalance and returns and that between odd lot order imbalance and returns are different.

Significant changes in market microstructure have occurred since or during the time period (1988-1998) used by Chordia, Roll, and Subrahmanyam (2002) and Chordia and Subrahmanyam (2004) to document the relation between order imbalances and returns. For example, decimalization (Bessembinder, 2003; Chung, Van Ness, and Van Ness, 2004; Gibson, Singh, and Yerramilli, 2003; Chakravarty, Panchapagesan, and Wood, 2005; and Bacidore, Battalio, Jennings, and Farkas, 2001), NASDAQ market reforms (Barclay, Christie, Harris, Kandel and Schultz, 1999), increased competition (Goldstein, Shkilko, Van Ness, and Van Ness, 2008; Battalio, Hatch, and Jennings, 2004; Bessembinder, 2003), the rise of algorithmic trading

(Brogaard, 2010), faster trading (Boehmer, 2005; Boehmer, Jennings, and Wei, 2007), and technological advances such as the NYSE Hybrid (Hendershott and Moulton, 2010) all affect equity markets in varying ways.

We have a dataset that includes odd lot trades and identifies trades as either buys or sells, and we use this database to re-examine the relation between order imbalances and returns. In addition to examining order imbalances and the impact of the inclusion of odd lot transactions, we examine the relation of order imbalances and intraday patterns. McInish, Wood, and Ord (1985) show that there is a U-shaped pattern of intraday returns. Should the contemporaneous positive relation between order imbalances and returns (Chordia, Roll, and Subrahmanyam, 2002) hold, we expect to see a U-shaped pattern of intraday order imbalances.

**2.2 Hypothesis Development**

Previous literature uses odd lot transactions as a proxy for individual traders (Ritter, 1998, and Dyl and Maberly, 1992) who are presumed to be uninformed traders (Odean, 1998; Baker and Wurgler, 2006; and Barber and Odean, 2000). However, O'Hara, Yao, and Ye (2011) find that odd lot transactions contain information and contribute significantly more to price contribution than their proportional share of volume or number of trades. The disproportionate price contribution of odd lot traders leads us to believe that odd lot traders are not uninformed as previously thought. Since odd lot trades contain information, we will re-examine the relation between order imbalances and returns documented by Chorida, Roll, and Subrahmanyam (2002, 2004) with a dataset that includes odd lot transactions. We expect that

by using a dataset that contains all transactions, including odd lot transactions, we can better explain market and individual equity returns since we will be incorporating the information contained in all transactions into the study, not just information contained in 100+ share transactions. We expect to see greater explanatory power reflected in larger coefficients of determination in regressions of returns on order imbalance when using a dataset containing odd lot transactions relative to the coefficients of determination in the regressions that use a dataset without odd lot transactions.

**Hypothesis 1**

*$H_0$: With the inclusion of odd lot transactions, order imbalance will be better able to explain market and individual equity returns than when odd lot transactions are not included in the analysis.*

Chordia, Roll, and Subrahmanyam (2002) conclude that investors are contrarian insofar as they are net buyers after stock market declines and net sellers after stock market gains. We do not believe that odd lot traders will display different trading behavior from all other traders in response to positive or negative returns. In other words, if all traders are net buyers, we assume that odd lot traders will also be net buyers and if all traders are net sellers, we assume that odd lot traders will also be net sellers. We, therefore, predict that odd lot traders will display a contrarian behavior with regards to stock price increases and decreases. We predict the direction of the relation between odd lot order imbalance and lagged returns will have the same direction as the relation between the overall NASDAQ exchange order imbalance and returns.

**Hypothesis 2**

*$H_0$: Odd lot order imbalance and lagged returns will have the same negative relation displayed by overall market order imbalance and lagged returns.*

We expect the relation between odd lot order imbalance and contemporaneous returns to be similar to the relation between overall market order imbalance and contemporaneous returns. Chordia, Roll, and Subrahmanyam (2002) find a positive relation between overall market order imbalance and contemporaneous returns and conclude that order imbalances exert price pressure on current stock prices. Given the size of odd lot trades coupled with the fact that odd lot trades account for only 7% of volume, we do not expect odd lot order imbalance to sufficiently add to or detract from the price pressure exerted by the overall order imbalance. We, therefore, expect the relation between odd lot order imbalances and contemporaneous returns to be the same as the relation between the total market order imbalance and contemporaneous returns.

**Hypothesis 3**

*$H_0$: Odd lot order imbalance and contemporaneous returns will have the same positive relation displayed by overall market order imbalance and contemporaneous returns.*

Chordia, Roll, and Subrahmanyam (2004) conclude that a trading strategy based on the overall market and individual stock order imbalances can yield positive returns. However, they further conclude that any positive return will be mitigated by transaction costs, because the

return is so small. We expect a similar profitable trading strategy based on odd lot order imbalances.

**Hypothesis 4**

*$H_0$: The relation between individual stock odd lot order imbalance and future individual stock returns will be positive.*

Although the intraday relation between order imbalances and intraday returns, as well as the intraday pattern of order imbalances, is unknown, there is literature that implies what the intraday order imbalance pattern will look like and what the relation between intraday order imbalances and intraday returns will be. Chordia, Roll, and Subrahmanyam (2002) and Chordia and Subrahmanyam (2004) find that order imbalances are positively related to contemporaneous returns and McInish, Wood, and Ord (1985) documented a U-shaped intraday pattern to returns. The intersection of these two studies leads to our prediction that order imbalances will also follow a U-shaped pattern since there is a positive relation between order imbalance and returns.

**Hypothesis 5**

*$H_0$: Intraday order imbalances and intraday odd lot order imbalances are predictors of intraday returns and follow a U-shaped pattern.*

**2.3 Data**

Our sample consists of all trades in the NASDAQ Historical TotalView ITCH (ITCH) database from July 1, 2010 to June 30, 2011. The ITCH database includes all trades that execute on NASDAQ. We filter our sample to include only stocks that trade at least five times a day and at least 1,000 shares every day for all 253 trading days of our sample. For our analysis, we only use trades that execute during regular market hours, and only stocks listed on the NASDAQ exchange. Trades executing for less than 100 shares are denoted as odd-lot trades. Odd-lot trades that are submitted as a single odd-lot order and execute in full or are further divided into multiple odd lot-trades are denoted as pure odd-lot trades. Odd-lot trades that are submitted as part of a 100+ share order that is subsequently divided into smaller executions, one of which is an odd-lot trade, are termed circumstantial odd-lot trades. We use data from the Center for Research in Security Prices (CRSP) for daily stock and market returns.

Order imbalance (OIB) is calculated as the number of shares purchased minus the number of shares sold for a stock-day, divided by the total volume for that stock-day. Odd-lot OIB is the number of shares purchased in odd-lot transactions minus the number of shares sold in odd-lot transactions for a stock-day, divided by the total odd-lot volume for that stock-day. Pure odd-lot OIB is the number of shares purchased in pure odd-lot transactions minus the number of shares sold in pure odd-lot transactions for a stock-day, divided by the total pure odd-lot volume for that stock-day. Circumstantial odd-lot OIB is the number of odd-lot shares purchased in circumstantial odd-lot transactions minus the number of shares sold in circumstantial odd-lot transactions for a stock-day, divided by the total circumstantial odd-lot volume for that stock-day.

Trade imbalance (TIB) is calculated as the number of buy trades minus the number of sell trades for a stock-day, divided by the total number of trades for that stock-day. Odd-lot TIB is the number of odd-lot buy trades minus the number of odd-lot sell trades for a stock-day, divided by the total number of odd-lot trades for that stock-day. Pure odd-lot TIB is the number of pure odd-lot buy trades minus the number of pure odd-lot sell trades for a stock-day, divided by the total number of pure odd-lot trades for that stock-day. Circumstantial odd-lot TIB is the number of circumstantial odd-lot buy trades minus the number of circumstantial odd-lot sell trades for a stock-day, divided by the total number of circumstantial odd-lot trades for that stock-day.

**2.4 Results**

Table 1 lists summary statistics for our sample. The average daily raw return and daily excess return over the CRSP equally weighted index are reported. Also reported are the average total volume and number of trades, odd-lot volume and number of trades, pure odd-lot volume and number of trades, and circumstantial odd-lot volume and number of trades from July 1, 2010 through June 31, 2011, for all NASDAQ listed stock-days for a total of 351,379 stock-days included in the sample. Finally, Table 1 lists the average daily order imbalance and trade imbalance, odd-lot order imbalance and trade imbalance, pure odd-lot order imbalance and trade imbalance, and circumstantial odd-lot order imbalance and trade imbalance.

In our sample, the mean OIB and TIB is negative, suggesting there are more sells than buys by volume and number of trades, which is in contrast with Chordia, Roll, and Subrahmanyam (2002) and Chordia and Subrahmanyam (2004), who find mean order

imbalances to be positive in a sample of NYSE listed stock-days from 1988 to 1998. We find odd-lot OIB and TIB and pure odd-lot OIB and TIB to be positive, and circumstantial OIB to be positive and circumstantial TIB to be negative, for the average stock-day day. Mean odd-lot order imbalances that have different signs than overall market order imbalance lends cursory evidence to reject hypotheses 2-4, which stipulate that odd-lot order imbalances behave similarly to overall market order imbalances, with regards to their relation to returns. However, we investigate these relations in a multivariate framework to discover their true nature.

Table 2 lists autocorrelations between OIB and TIB for all transactions in Panel A, odd-lot transactions in Panel B, pure odd-lot transactions in Panel C, and circumstantial odd-lot transactions in Panel D. There is significant autocorrelation between all OIB and TIB variables over lagged 1 through 4 trading days. Although significant in all panels, the autocorrelation in our sample is weaker than the findings of Chordia, Roll, and Subrahmanyam (2002) who find autocorrelations as high as 54% in their sample. Our findings shown in Panel A where we use all trades in calculating OIB and TIB are reasonably comparable to Chorida, Roll, and Subrahmanyam. We find autocorrelations to be as high as 20% for OIB and 23% for TIB. Regardless, we include lagged order and trade imbalances in our regressions to control for the effect of past OIB and TIB on current OIB and TIB.

Hypothesis 1 postulates that by including odd-lot transactions in the calculations of order imbalance, order imbalance will be better able to explain returns than if odd-lot transactions are not included. We test Hypothesis 1 by comparing regressions using two subsamples of our data: one that excludes odd-lot transactions in the calculation of OIB and TIB (which is approximately analogous to the sample used by Chordia, Roll, and Subrahmanyam

(2002) and Choridia and Subrahmanyam (2004)), and one that includes odd-lot transactions. Using both samples, we run fixed effects regressions of order imbalance on lagged returns, and fixed effects regressions of contemporaneous and future returns on order imbalance. The results are reported in Table 3 and Table 4. Table 3 shows the regression estimations using raw returns and Table 4 shows estimations using excess returns over the CRSP equally weighted index.

Results of regressing contemporaneous order imbalances on lagged returns are reported in Columns 1 and 2 of Table 3 and 4; contemporaneous returns on order imbalances in Columns 3 and 4; and future returns on contemporaneous order imbalances in Columns 5 and 6.

Panel A of Tables 3 and 4 list regression coefficients using OIB and TIB that are calculated excluding odd-lot transactions while Panel B uses OIB and TIB calculated including odd-lot transactions. By comparing the r-squareds of the regressions, we can assess which models better predict returns. In both tables, the r-squares of the regressions that include odd-lot transactions are uniformly higher than the r-squares of the respective regressions that do not include odd-lot transactions. The higher r-square of regressions including odd-lot data supports Hypothesis 1 by showing that models that include odd-lot transactions are better able to explain the relation between returns and order imbalance.

For the remainder of the study, we report only fixed effects regression results and excess returns using the CRSP equally weighted index. Not reported are results using OLS regressions and results using the CRSP value weighted index, as results are similar to those reported.

Chordia, Roll, and Subrahmanyam (2002) find that there is a positive relation between contemporaneous returns and order imbalances, surmising that there are positive (negative) price pressures put on equity prices during the course of the trading day when there are more buys (sells) than sells (buys). The results in Tables 3 and 4 support this finding by showing a positive regression coefficient for OIB and TIB in columns 3 and 4. In our sample, as order imbalance increases, so do contemporaneous raw and excess returns, as expected.

However, our results are inconsistent with the findings of Chordia, Roll, and Subrahmanyam (2002), who find a negative relation between lagged returns and contemporaneous order imbalances, and also with Chordia and Subrahmanyam (2004), who find a slightly positive relation between future returns and contemporaneous order imbalances. Columns 1 and 2 of Tables 3 and 4 show the estimates from the regression of OIB and TIB on lagged returns, controlling for past order imbalances. In both panels of tables 3 and 4, the regression coefficient for lagged returns is positive, suggesting that the market is not acting contrarianly, as Chordia, Roll, and Subrahmanyam (2002) concluded. Rather, in our sample, traders are purchasing (selling) equities on days following positive (negative) returns.

Columns 5 and 6 of Tables 3 and 4 report the estimates from fixed effects regressions of future daily stock returns on contemporaneous order imbalance. The regression coefficient for OIB and TIB is uniformly negative, which is the opposite of the findings of Chordia and Subrahmanyam (2004) who find a slightly positive coefficient. However, since both this study and Chordia and Subrahmanyam (2004) find a significant relation between order imbalance and future returns, both conclude that a profitable trading strategy could be implemented in a frictionless environment. In our sample, a trader could short stocks that have high levels of

order imbalance on the previous day and expect a positive raw and abnormal return. However, as Chordia and Subrahmanyam (2004) also conclude, the profits from any such trading strategy are far too small to overcome trading costs that would be associated with its implementation.

We test Hypothesis 2, which asserts odd-lot order imbalances have a negative relation with lagged returns, by regressing daily odd-lot order imbalances, pure order imbalances, and circumstantial odd-lot order imbalances on lagged daily returns and report the results in Table 5. Panel A lists the results of fixed effects regressions with odd-lot OIB and TIB as the dependent variables and lagged raw returns as the independent variable of interest, with lagged OIB and lagged TIB as control variables. Panel B uses excess returns as the independent variable of interest. In both panels, Columns 1-3 show estimates using odd-lot, pure odd-lot, and circumstantial odd-lot OIBs as the dependent variables, and Columns 4-6 use odd-lot, pure odd-lot, and circumstantial odd-lot TIBs as the dependent variables.

The results in Panel A contradict Hypothesis 2, which asserts that odd-lot order imbalances will have a negative relation with lagged returns. In each regression, lagged returns have a positive relation with odd-lot order imbalances. We conclude that odd-lot traders are not contrarian and are net purchasers of equities on days following positive returns, and net sellers of equities on days following negative returns. As with overall market order imbalance results reported in Tables 3 and 4, these results are inconsistent with the results of Chordia, Roll, and Subrahmanyam (2002) who conclude market participants trade contrarianly with regards to lagged daily stock returns.

We explore the relation between excess returns and odd-lot order imbalances, and show that some odd-lot traders behave contrarianly with regards to excess returns (see Panel

B). In aggregate, lagged excess returns have either a non-significant relation with odd-lot order imbalances when measured by OIB, or a slightly negative relation with odd-lot order imbalances when measured by TIB. The findings in Panel B suggest pure odd-lot traders do not behave contrarianly and excess returns have a positive relation to pure odd-lot order imbalances.

However, circumstantial odd-lot traders are net sellers of stocks on days after negative returns and net buyers of stocks on days following positive returns, as shown by negative regression coefficients for lagged excess returns in Columns 3 and 6. This result is counterintuitive, as we expect the coefficients of circumstantial odd-lot trades to be similar to 100+ share trades since circumstantial odd-lot trades are submitted as 100+ orders and with the same information as 100+ share orders. However, Columns 3 and 4 in Table 4, Panel A show that 100+ share order imbalance has a negative relation with lagged excess returns, yet Table 5 shows circumstantial odd-lot order imbalance has a positive relation with excess returns.

Hypothesis 3 asserts that odd-lot order imbalances will have the same positive relation to contemporaneous returns as total market order imbalances have. This relation is documented by Chordia, Roll, and Subrahmanyam (2002) and Chordia and Subrahmanyam (2004) using a sample of NYSE stocks trades from 1988 to 1998. Table 6 lends evidence that confirms Hypothesis 3. Panel A of Table 6 reports the results of fixed effects regressions with contemporaneous daily raw returns as the dependent variable and odd-lot order imbalances as the independent variable, controlling for lagged order imbalances. Columns 1 and 4 report use odd-lot OIB and TIB, Columns 2 and 5 report use pure odd-lot OIB and TIB, and Column 4 and 6

use circumstantial odd-lot OIB and TIB. In all regressions, the odd-lot order imbalance variable of interest is positive. This result suggests that odd-lot traders behave similarly to all traders in aggregate, and are net buyers (sellers) on days with positive (negative) returns. We conclude that the price pressures observed by Chordia, Roll and Subrahmanyam (2004) still exist and that order imbalances are driving contemporaneous returns.

Panel B of Table 6 also lists the coefficients of fixed effects regressions with odd-lot order imbalances as the independent variables, but with excess returns as the dependent variable. The results are similar to the results in Panel A with all odd-lot OIB and TIB regression coefficients being positive.

Hypothesis 4 postulates that odd-lot order imbalances have a positive relation to future returns. We find strong evidence to reject this hypothesis in Table 7, which reports estimates from regressing future daily returns on contemporaneous odd-lot order imbalances. In both Panel A and Panel B, coefficients for odd-lot, pure odd-lot, and circumstantial odd-lot order imbalances are consistently negative (Panel A uses raw returns as the dependent variable and Panel B uses excess returns). Again, we agree with Chorida, Roll, and Subrahmanyam (2004) that a profitable trading strategy can be implemented in a frictionless environment (albeit their strategy involves buying stocks with a high prior day's OIB, while our strategy involves shorting), any profits generated would likely be negated by transactions costs. For example, if odd-lot order imbalance doubled relative to odd-lot volume (i.e. a 1.00 or 100% increase in order imbalance), one could expect to generate a 0.19% raw return (or 0.16% excess return) on average by shorting, which is certainly smaller than the trading costs of implementing the strategy.

We investigate the intraday patterns of odd-lot order imbalance to test Hypothesis 5, which asserts odd-lot order imbalances have a U-shaped pattern over minutes 2 through 381 of the trading day. We omit minutes 1 and minutes 382-391 to mitigate the influence of the opening and closing cross. Results from analyses that include the full trading day (not reported) are similar. Figure 1 is a graph of average total odd-lot volume and number of trades (Panel A) odd-lot, pure odd-lot, and circumstantial odd-lot trading by volume (in Panel B) and by number of trades (in Panel C). Panel A, which we include for comparison to odd-lot results, shows the expected U-shaped pattern for total market volume and number of trades. Both Panels B and C show a clear U-shaped pattern for all odd-lot trades, which supports Hypothesis 5. We confirm the U-shaped pattern by regressing odd-lot, pure odd-lot, and circumstantial odd-lot buy and sell volume and number of trades on 15 minute period of the trading day and report the results in the Appendix.

Figure 2 graphs average odd-lot OIB and TIB over minutes 2-391 of the trading day, with Panel A graphing odd-lot OIB and TIB, Panel B graphing pure odd-lot OIB and TIB, and Panel C graphing circumstantial odd-lot OIB and TIB. We omit minute 1 to mitigate the influence of the opening cross. Results from analyses which include the full trading day (not reported) are similar. Figure 2 lends evidence to reject Hypothesis 5 by showing no clear pattern, thus no U-shaped pattern, to intraday odd-lot order imbalances. We confirm this lack of pattern by regressing odd-lot, pure odd-lot, and circumstantial odd-lot OIB and TIB on 15 minute intervals of the trading day in the Appendix.

## 2.5 Conclusion

This study investigates total market, odd-lot, pure odd-lot, and circumstantial odd-lot order imbalances, and arrives at several important conclusions. First, we show that odd-lot transactions add to capital market studies, as including odd-lot transactions increases the accuracy and efficiency of models, relative to those that exclude odd-lot transactions. To date the vast majority of capital market studies exclude odd-lot trades. Second, we show that odd-lot traders behave similarly to 100+ share traders with regards to buying and selling of stock-days in relation to prior, current, and future daily returns, although the nature of the relation between order imbalances and lagged and future returns needs to be further investigated to fully explain the nature of the relationship. Finally, we show that odd-lot buying and selling follows a similar intraday pattern to total market volume, but there is no discernible pattern of order imbalance on an intraday level.

**Table 1. Summary Statistics**

| *Variable* | | | | |
|---|---|---|---|---|
| ***Raw Return*** | | 0.0013 | | |
| | | (0.0283) | | |
| ***Excess Return*** | | 0.0002 | | |
| | | (0.0257) | | |
| | | ***TOTAL*** | ***BUY*** | ***SELL*** |
| ***Volume*** | ***All*** | 283,127 | 141,227 | 141,900 |
| | | (1,044,082) | (521,081) | (529,598) |
| | ***Odd*** | 13,500 | 6,750 | 6,750 |
| | | (32,843) | (16,500) | (16,620) |
| | ***Pure*** | 5,269 | 2,637 | 2,632 |
| | | (14,231) | (7,170) | (7,231) |
| | ***Circum*** | 8,231 | 4,114 | 4,118 |
| | | (19,166) | (9,698) | (9,745) |
| ***Trades*** | ***All*** | 1,688 | 842 | 846 |
| | | (3,893) | (1,951) | (1,956) |
| | ***Odd*** | 329 | 164 | 165 |
| | | (820) | (412) | (417) |
| | ***Pure*** | 151 | 75 | 76 |
| | | (435) | (220) | (222) |
| | ***Circum*** | 178 | 89 | 89 |
| | | (404) | (205) | (207) |
| | | ***OIB*** | ***TIB*** | |
| ***Order Imbalance*** | ***All*** | -0.0092 | -0.0064 | |
| | | (0.2536) | (0.2222) | |
| | ***Odd*** | 0.0020 | 0.0080 | |
| | | (0.3326) | (0.3373) | |
| | ***Pure*** | 0.0086 | 0.0151 | |
| | | (0.3195) | (0.3142) | |
| | ***Circum*** | -0.0018 | 0.0022 | |
| | | (0.4599) | (0.4672) | |

***N* = 351,379**

Table 1 lists the daily mean raw and excess return, total market, odd-lot, pure odd-lot, and circumstantial odd-lot total volume and number of trades, buy volume and number of trades, sell volume and number of trades, and order imbalance calculated as a percentage of volume (OIB) and as a percentage of trades (TIB) from all trades executed on NASDAQ for all NASDAQ listed stocks occurring from July 2010 through June 2011. Standard deviations are reported in parentheses.

**Table 2. Order Imbalance Autocorrelations**

**Panel A: All Trades**

| *Variables* | $OIB_t$ | $OIB_{t-1}$ | $OIB_{t-2}$ | $OIB_{t-3}$ | $OIB_{t-4}$ |
|---|---|---|---|---|---|
| $OIB_t$ | 1.0000 | | | | |
| $OIB_{t-1}$ | 0.1997*** (0.000) | 1.0000 | | | |
| $OIB_{t-2}$ | 0.1094*** (0.000) | 0.1994*** (0.000) | 1.0000 | | |
| $OIB_{t-3}$ | 0.0777*** (0.000) | 0.1095*** (0.000) | 0.1995*** (0.000) | 1.0000 | |
| $OIB_{t-4}$ | 0.0669*** (0.000) | 0.0776*** (0.000) | 0.1094*** (0.000) | 0.1992*** (0.000) | 1.0000 |
| | $TIB_t$ | $TIB_{t-1}$ | $TIB_{t-2}$ | $TIB_{t-3}$ | $TIB_{t-4}$ |
| $TIB_t$ | 1.0000 | | | | |
| $TIB_{t-1}$ | 0.2270*** (0.000) | 1.0000 | | | |
| $TIB_{t-2}$ | 0.1301*** (0.000) | 0.2267*** (0.000) | 1.0000 | | |
| $TIB_{t-3}$ | 0.0840*** (0.000) | 0.1304*** (0.000) | 0.2268*** (0.000) | 1.0000 | |
| $TIB_{t-4}$ | 0.0691*** (0.000) | 0.0840*** (0.000) | 0.1303*** (0.000) | 0.2266*** (0.000) | 1.0000 |

**Panel B: Odd-lot Trades**

| *Variables* | $OIB_t$ | $OIB_{t-1}$ | $OIB_{t-2}$ | $OIB_{t-3}$ | $OIB_{t-4}$ |
|---|---|---|---|---|---|
| $OIB_t$ | 1.0000 | | | | |
| $OIB_{t-1}$ | 0.1421*** (0.000) | 1.0000 | | | |
| $OIB_{t-2}$ | 0.0906*** | 0.1421*** | 1.0000 | | |

| | | | | | |
|---|---|---|---|---|---|
| | (0.000) | (0.000) | | | |
| $OIB_{t-3}$ | 0.0613*** | 0.0910*** | 0.1421*** | 1.0000 | |
| | (0.000) | (0.000) | (0.000) | | |
| $OIB_{t-4}$ | 0.0491*** | 0.0612*** | 0.0911*** | 0.1419*** | 1.0000 |
| | (0.000) | (0.000) | (0.000) | (0.000) | |

| | $TIB_t$ | $TIB_{t-1}$ | $TIB_{t-2}$ | $TIB_{t-3}$ | $TIB_{t-4}$ |
|---|---|---|---|---|---|
| $TIB_t$ | 1.0000 | | | | |
| $TIB_{t-1}$ | 0.1789*** | 1.0000 | | | |
| | (0.000) | | | | |
| $TIB_{t-2}$ | 0.1164*** | 0.1790*** | 1.0000 | | |
| | (0.000) | (0.000) | | | |
| $TIB_{t-3}$ | 0.0796*** | 0.1170*** | 0.1790*** | 1.0000 | |
| | (0.000) | (0.000) | (0.000) | | |
| $TIB_{t-4}$ | 0.0658*** | 0.0796*** | 0.1170*** | 0.1788*** | 1.0000 |
| | (0.000) | (0.000) | (0.000) | (0.000) | |

**Panel C: Pure Odd-lot Trades**

| *Variables* | $OIB_t$ | $OIB_{t-1}$ | $OIB_{t-2}$ | $OIB_{t-3}$ | $OIB_{t-4}$ |
|---|---|---|---|---|---|
| $OIB_t$ | 1.0000 | | | | |
| $OIB_{t-1}$ | 0.0808*** | 1.0000 | | | |
| | (0.000) | | | | |
| $OIB_{t-2}$ | 0.0507*** | 0.0810*** | 1.0000 | | |
| | (0.000) | (0.000) | | | |
| $OIB_{t-3}$ | 0.0362*** | 0.0508*** | 0.0808*** | 1.0000 | |
| | (0.000) | (0.000) | (0.000) | | |
| $OIB_{t-4}$ | 0.0300*** | 0.0363*** | 0.0509*** | 0.0807*** | 1.0000 |
| | (0.000) | (0.000) | (0.000) | (0.000) | |

| | $TIB_t$ | $TIB_{t-1}$ | $TIB_{t-2}$ | $TIB_{t-3}$ | $TIB_{t-4}$ |
|---|---|---|---|---|---|
| $TIB_t$ | 1.0000 | | | | |

| | | | | | |
|---|---|---|---|---|---|
| $TIB_{t-1}$ | 0.1351*** (0.000) | 1.0000 | | | |
| $TIB_{t-2}$ | 0.0928*** (0.000) | 0.1353*** (0.000) | 1.0000 | | |
| $TIB_{t-3}$ | 0.0673*** (0.000) | 0.0929*** (0.000) | 0.1350*** (0.000) | 1.0000 | |
| $TIB_{t-4}$ | 0.0554*** (0.000) | 0.0674*** (0.000) | 0.0930*** (0.000) | 0.1348*** (0.000) | 1.0000 |

**Panel D: Circumstantial Odd-lot Trades**

| *Variables* | $OIB_t$ | $OIB_{t-1}$ | $OIB_{t-2}$ | $OIB_{t-3}$ | $OIB_{t-4}$ |
|---|---|---|---|---|---|
| $OIB_t$ | 1.0000 | | | | |
| $OIB_{t-1}$ | 0.1273*** (0.000) | 1.0000 | | | |
| $OIB_{t-2}$ | 0.0836*** (0.000) | 0.1271*** (0.000) | 1.0000 | | |
| $OIB_{t-3}$ | 0.0547*** (0.000) | 0.0841*** (0.000) | 0.1272*** (0.000) | 1.0000 | |
| $OIB_{t-4}$ | 0.0456*** (0.000) | 0.0546*** (0.000) | 0.0840*** (0.000) | 0.1270*** (0.000) | 1.0000 |
| | $TIB_t$ | $TIB_{t-1}$ | $TIB_{t-2}$ | $TIB_{t-3}$ | $TIB_{t-4}$ |
| $TIB_t$ | 1.0000 | | | | |
| $TIB_{t-1}$ | 0.1480*** (0.000) | 1.0000 | | | |
| $TIB_{t-2}$ | 0.0968*** (0.000) | 0.1479*** (0.000) | 1.0000 | | |
| $TIB_{t-3}$ | 0.0632*** (0.000) | 0.0976*** (0.000) | 0.1481*** (0.000) | 1.0000 | |

| | | | | | |
|---|---|---|---|---|---|
| $TIB_{t-4}$ | 0.0538*** | 0.0631*** | 0.0974*** | 0.1478*** | 1.0000 |
| | (0.000) | (0.000) | (0.000) | (0.000) | |

Table 2 lists autocorrelations for stock-day order imbalance calculated as percentage of volume (OIB) and as a percentage of trades (TIB) lagged 1 to 4 trading days, for all, odd-lot, pure odd-lot, and circumstantial odd-lot transactions executed on NASDAQ for all NASDAQ listed stocks occurring from July 2010 through June 2011. Panel A lists autocorrelations for all trades, Panel B lists autocorrelations for odd-lot trades, Panel C lists autocorrelations for pure odd-lot trades, and Panel D lists autocorrelations for circumstantial odd-lot trades. P-values are in reported in parentheses. ***, ** & * denote significance at the 1%, 5% & 10% levels, respectively.

**Table 3. Order Imbalance and Raw Returns**
**Panel A: Exclusive of Odd-lot Trades**

| *Variable* | $OIB_t$ | $TIB_t$ | $Return_{i,t}$ | | $Return_{i,t+1}$ | |
|---|---|---|---|---|---|---|
| *Intercept* | -0.0076*** | -0.0078*** | 0.0015*** | 0.0015*** | 0.0013*** | 0.0013*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| $Return_{i,t-1}$ | 0.1663*** | 0.1454*** | | | | |
| | (0.000) | (0.000) | | | | |
| $OIB_t$ | | | 0.0394*** | | -0.0006*** | |
| | | | (0.000) | | (0.001) | |
| $OIB_{t-1}$ | 0.1582*** | | -0.0070*** | | -0.0010*** | |
| | (0.000) | | (0.000) | | (0.000) | |
| $OIB_{t-2}$ | 0.0503*** | | -0.0029*** | | -0.0005** | |
| | (0.000) | | (0.000) | | (0.011) | |
| $OIB_{t-3}$ | 0.0285*** | | -0.0016*** | | -0.0013*** | |
| | (0.000) | | (0.000) | | (0.000) | |
| $OIB_{t-4}$ | 0.0270*** | | -0.0023*** | | 0.0003* | |
| | (0.000) | | (0.000) | | (0.090) | |
| $TIB_t$ | | | | 0.0362*** | | -0.0015*** |
| | | | | (0.000) | | (0.000) |
| $TIB_{t-1}$ | | 0.1837*** | | -0.0082*** | | -0.0006*** |
| | | (0.000) | | (0.000) | | (0.005) |
| $TIB_{t-2}$ | | 0.0581*** | | -0.0026*** | | -0.0000 |
| | | (0.000) | | (0.000) | | (0.886) |
| $TIB_{t-3}$ | | 0.0320*** | | -0.0012*** | | -0.0015*** |
| | | (0.000) | | (0.000) | | (0.000) |
| $TIB_{t-4}$ | | 0.0293*** | | -0.0024*** | | 0.0007*** |
| | | (0.000) | | (0.000) | | (0.003) |
| $R^2$ | 0.0364 | 0.0489 | 0.1254 | 0.0779 | 0.0004 | 0.0004 |

**Panel B: Inclusive of Odd-lot Trades**

| *Variable* | $OIB_t$ | $TIB_t$ | $Return_{i,t}$ | | $Return_{i,t+1}$ | |
|---|---|---|---|---|---|---|
| ***Intercept*** | -0.0070*** | -0.0047*** | 0.0015*** | 0.0014*** | 0.0013*** | 0.0013*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| $Return_{i,t-1}$ | 0.1554*** | 0.1422*** | | | | |
| | (0.000) | (0.000) | | | | |
| $OIB_t$ | | | 0.0424*** | | -0.0009*** | |
| | | | (0.000) | | (0.000) | |
| $OIB_{t-1}$ | 0.1616*** | | -0.0079*** | | -0.0011*** | |
| | (0.000) | | (0.000) | | (0.000) | |
| $OIB_{t-2}$ | 0.0525*** | | -0.0032*** | | -0.0007*** | |
| | (0.000) | | (0.000) | | (0.000) | |
| $OIB_{t-3}$ | 0.0281*** | | -0.0019*** | | -0.0015*** | |
| | (0.000) | | (0.000) | | (0.000) | |
| $OIB_{t-4}$ | 0.0271*** | | -0.0026*** | | 0.0004* | |
| | (0.000) | | (0.000) | | (0.070) | |
| $TIB_t$ | | | | 0.0432*** | | -0.0022*** |
| | | | | (0.000) | | (0.000) |
| $TIB_{t-1}$ | | 0.1894*** | | -0.0106*** | | -0.0013*** |
| | | (0.000) | | (0.000) | | (0.000) |
| $TIB_{t-2}$ | | 0.0668*** | | -0.0039*** | | -0.0013*** |
| | | (0.000) | | (0.000) | | (0.000) |
| $TIB_{t-3}$ | | 0.0273*** | | -0.0026*** | | -0.0022*** |
| | | (0.000) | | (0.000) | | (0.000) |
| $TIB_{t-4}$ | | 0.0279*** | | -0.0034*** | | 0.0004* |
| | | (0.000) | | (0.000) | | (0.095) |
| $R^2$ | 0.0381 | 0.0531 | 0.1366 | 0.1086 | 0.0005 | 0.0011 |

Table 3 lists the results of fixed effects regressions with contemporaneous stock-day odd-lot order imbalance calculated as a percentage of volume (OIB) and as a percentage of trades (TIB), contemporaneous daily stock returns, and future daily stock returns as the dependent variables from trades executed on NASDAQ for all NASDAQ listed stocks occurring from July 2010

through June 2011. The independent variables are lagged daily stock returns, contemporaneous OIB and TIB, and OIB and TIB lagged 1 to 4 days. Panel A lists results from regressions with OIB and TIB calculated excluding odd-lot transactions, and Panel B lists results from regressions with OIB and TIB calculated including odd-lot transactions. P-values are in reported in parentheses. ***, ** & * denote significance at the 1%, 5% & 10% levels, respectively.

**Table 4. Order Imbalance and Excess Returns**
**Panel A: Exclusive of Odd-lot Trades**

| *Variable* | $OIB_t$ | $TIB_t$ | $Return_{i,t}$ | | $Return_{i,t+1}$ | |
|---|---|---|---|---|---|---|
| *Intercept* | -0.0075*** | -0.0077*** | 0.0004*** | 0.0004*** | 0.0002*** | 0.0002*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| $Return_{i,t-1}$ | 0.2091*** | 0.2078*** | | | | |
| | (0.000) | (0.000) | | | | |
| $OIB_t$ | | | 0.0319*** | | -0.0003* | |
| | | | (0.000) | | (0.064) | |
| $OIB_{t-1}$ | 0.1581*** | | -0.0055*** | | -0.0009*** | |
| | (0.000) | | (0.000) | | (0.000) | |
| $OIB_{t-2}$ | 0.0503*** | | -0.0024*** | | -0.0004** | |
| | (0.000) | | (0.000) | | (0.027) | |
| $OIB_{t-3}$ | 0.0285*** | | -0.0013*** | | -0.0011*** | |
| | (0.000) | | (0.000) | | (0.000) | |
| $OIB_{t-4}$ | 0.0270*** | | -0.0019*** | | 0.0003* | |
| | (0.000) | | (0.000) | | (0.092) | |
| $TIB_t$ | | | | 0.0296*** | | -0.0011*** |
| | | | | (0.000) | | (0.000) |
| $TIB_{t-1}$ | | 0.1828*** | | -0.0066*** | | -0.0007*** |
| | | (0.000) | | (0.000) | | (0.000) |
| $TIB_{t-2}$ | | 0.0583*** | | -0.0024*** | | -0.0001 |
| | | (0.000) | | (0.000) | | (0.703) |
| $TIB_{t-3}$ | | 0.0321*** | | -0.0010*** | | -0.0012*** |
| | | (0.000) | | (0.000) | | (0.000) |
| $TIB_{t-4}$ | | 0.0293*** | | -0.0020*** | | 0.0005*** |
| | | (0.000) | | (0.000) | | (0.008) |
| $R^2$ | 0.0365 | 0.0492 | 0.1001 | 0.0632 | 0.0003 | 0.0003 |

**Panel B: Inclusive of Odd-lot Trades**

| *Variable* | $OIB_t$ | $TIB_t$ | $Return_{i,t}$ | | $Return_{i,t+1}$ | |
|---|---|---|---|---|---|---|
| ***Intercept*** | -0.0069*** | -0.0045*** | 0.0004*** | 0.0003*** | 0.0002*** | 0.0002*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| $Return_{i,t-1}$ | 0.1868*** | 0.1593*** | | | | |
| | (0.000) | (0.000) | | | | |
| $OIB_t$ | | | 0.0338*** | | -0.0005*** | |
| | | | (0.000) | | (0.003) | |
| $OIB_{t-1}$ | 0.1619*** | | -0.0061*** | | -0.0009*** | |
| | (0.000) | | (0.000) | | (0.000) | |
| $OIB_{t-2}$ | 0.0524*** | | -0.0026*** | | -0.0005*** | |
| | (0.000) | | (0.000) | | (0.006) | |
| $OIB_{t-3}$ | 0.0281*** | | -0.0014*** | | -0.0012*** | |
| | (0.000) | | (0.000) | | (0.000) | |
| $OIB_{t-4}$ | 0.0270*** | | -0.0020*** | | 0.0003* | |
| | (0.000) | | (0.000) | | (0.051) | |
| $TIB_t$ | | | | 0.0324*** | | -0.0019*** |
| | | | | (0.000) | | (0.000) |
| $TIB_{t-1}$ | | 0.1904*** | | -0.0081*** | | -0.0009*** |
| | | (0.000) | | (0.000) | | (0.000) |
| $TIB_{t-2}$ | | 0.0666*** | | -0.0029*** | | -0.0005** |
| | | (0.000) | | (0.000) | | (0.011) |
| $TIB_{t-3}$ | | 0.0272*** | | -0.0014*** | | -0.0014*** |
| | | (0.000) | | (0.000) | | (0.000) |
| $TIB_{t-4}$ | | 0.0277*** | | -0.0021*** | | 0.0007*** |
| | | (0.000) | | (0.000) | | (0.001) |
| $R^2$ | 0.0381 | 0.0532 | 0.1055 | 0.0739 | 0.0003 | 0.0006 |

Table 4 lists the results of fixed effects regressions with contemporaneous stock-day odd-lot order imbalance calculated as a percentage of volume (OIB) and as a percentage of trades (TIB), contemporaneous daily stock excess returns over the CRSP equally weighted index, and future daily stock excess returns as the dependent variables from trades executed on NASDAQ for all NASDAQ listed stocks occurring from July 2010 through June 2011. The independent variables

are lagged daily stock excess returns, contemporaneous OIB and TIB, and OIB and TIB lagged 1 to 4 days. Panel A lists results from regressions with OIB and TIB calculated excluding odd-lot transactions, and Panel B lists results from regressions with OIB and TIB calculated including odd-lot transactions. P-values are in reported in parentheses. ***, ** & * denote significance at the 1%, 5% & 10% levels, respectively.

**Table 5. Odd-lot Order Imbalance on Lagged Returns**
**Panel A: Raw Returns**

| *Variable* | *Odd $OIB_t$* | *Pure $OIB_t$* | *Circ $OIB_t$* | *Odd $TIB_t$* | *Pure $TIB_t$* | *Circ $TIB_t$* |
|---|---|---|---|---|---|---|
| ***Intercept*** | 0.0082*** | 0.0116*** | 0.0063*** | 0.0147*** | 0.0192*** | 0.0109*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| ***Return $_{i, t-1}$*** | 0.1792*** | 0.1736*** | 0.2023*** | 0.1781*** | 0.1945*** | 0.1767*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| ***$OIB_t$*** | 0.6580*** | 0.3408*** | 0.8918*** | | | |
| | (0.000) | (0.000) | (0.000) | | | |
| ***$OIB_{t-1}$*** | 0.0187*** | 0.0116*** | 0.0185*** | | | |
| | (0.000) | (0.000) | (0.000) | | | |
| ***$OIB_{t-2}$*** | 0.0190*** | 0.0093*** | 0.0260*** | | | |
| | (0.000) | (0.000) | (0.000) | | | |
| ***$OIB_{t-3}$*** | 0.0077*** | 0.0015 | 0.0098*** | | | |
| | (0.000) | (0.483) | (0.001) | | | |
| ***$OIB_{t-4}$*** | 0.0029 | -0.0009 | 0.0052* | | | |
| | (0.135) | (0.677) | (0.062) | | | |
| ***$TIB_t$*** | | | | 1.0579*** | 0.6561*** | 1.3715*** |
| | | | | (0.000) | (0.000) | (0.000) |
| ***$TIB_{t-1}$*** | | | | -0.0042** | 0.0040* | -0.0135*** |
| | | | | (0.039) | (0.086) | (0.000) |
| ***$TIB_{t-2}$*** | | | | 0.0222*** | 0.0213*** | 0.0244*** |
| | | | | (0.000) | (0.000) | (0.000) |
| ***$TIB_{t-3}$*** | | | | 0.0107*** | 0.0112*** | 0.0055* |
| | | | | (0.000) | (0.000) | (0.058) |
| ***$TIB_{t-4}$*** | | | | 0.0006 | 0.0001 | 0.0035 |
| | | | | (0.751) | (0.980) | (0.214) |
| ***$R^2$*** | 0.2541 | 0.0738 | 0.2389 | 0.4865 | 0.2170 | 0.4192 |

**Panel B: Excess Returns**

| *Variable* | *Odd $OIB_t$* | *Pure $OIB_t$* | *Circ $OIB_t$* | *Odd $TIB_t$* | *Pure $TIB_t$* | *Circ $TIB_t$* |
|---|---|---|---|---|---|---|
| ***Intercept*** | 0.0085*** | 0.0118*** | 0.0067*** | 0.0150*** | 0.0194*** | 0.0111*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| ***Return $_{i, t-1}$*** | 0.0174 | 0.1710*** | -0.0595** | -0.0279* | 0.0974*** | -0.0981*** |
| | (0.382) | (0.000) | (0.033) | (0.090) | (0.000) | (0.000) |
| ***$OIB_t$*** | 0.6583*** | 0.3408*** | 0.8923*** | | | |
| | (0.000) | (0.000) | (0.000) | | | |
| ***$OIB_{t-1}$*** | 0.0256*** | 0.0132*** | 0.0290*** | | | |
| | (0.000) | (0.000) | (0.000) | | | |
| ***$OIB_{t-2}$*** | 0.0177*** | 0.0090*** | 0.0239*** | | | |
| | (0.000) | (0.000) | (0.000) | | | |
| ***$OIB_{t-3}$*** | 0.0072*** | 0.0014 | 0.0089*** | | | |
| | (0.000) | (0.518) | (0.002) | | | |
| ***$OIB_{t-4}$*** | 0.0025 | -0.0010 | 0.0046 | | | |
| | (0.198) | (0.637) | (0.100) | | | |
| ***$TIB_t$*** | | | | 1.0584*** | 0.6563*** | 1.3721*** |
| | | | | (0.000) | (0.000) | (0.000) |
| ***$TIB_{t-1}$*** | | | | 0.0043** | 0.0092*** | -0.0028 |
| | | | | (0.033) | (0.000) | (0.352) |
| ***$TIB_{t-2}$*** | | | | 0.0201*** | 0.0201*** | 0.0216*** |
| | | | | (0.000) | (0.000) | (0.000) |
| ***$TIB_{t-3}$*** | | | | 0.0099*** | 0.0106*** | 0.0044 |
| | | | | (0.000) | (0.000) | (0.127) |
| ***$TIB_{t-4}$*** | | | | -0.0001 | -0.0004 | 0.0027 |
| | | | | (0.975) | (0.848) | (0.338) |
| ***$R^2$*** | 0.2539 | 0.0738 | 0.2388 | 0.4863 | 0.2168 | 0.4191 |

Table 5 lists the results of fixed effects regressions with contemporaneous stock-day odd-lot, pure odd-lot, and circumstantial odd-lot order imbalance calculated as a percentage of volume (OIB) and as percentage of trades (TIB) as the dependent variables from trades executed on NASDAQ for all NASDAQ listed stocks occurring from July 2010 through June 2011. The independent variables are lagged daily stock returns, contemporaneous OIB and TIB, and OIB

and TIB lagged 1 to 4 days. Panel A lists the results from regressions using daily raw stock returns, and Panel B lists the results from regressions using daily stock excess returns over the CRSP equally weighted index. P-values are in reported in parentheses. ***, ** & * denote significance at the 1%, 5% & 10% levels, respectively.

**Table 6. Contemporaneous Returns on Order Imbalance**

**Panel A: Raw Returns**

| *Variable* | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| ***Intercept*** | 0.0014*** | 0.0015*** | 0.0015*** | 0.0013*** | 0.0013*** | 0.0014*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| ***Odd OIB$_t$*** | 0.0099*** | | | | | |
| | (0.000) | | | | | |
| ***Pure OIB$_t$*** | | 0.0052*** | | | | |
| | | (0.000) | | | | |
| ***Circ OIB$_t$*** | | | 0.0065*** | | | |
| | | | (0.000) | | | |
| ***Odd TIB$_t$*** | | | | 0.0107*** | | |
| | | | | (0.000) | | |
| ***Pure TIB$_t$*** | | | | | 0.0053*** | |
| | | | | | (0.000) | |
| ***Circ TIB$_t$*** | | | | | | 0.0065*** |
| | | | | | | (0.000) |
| ***OIB$_t$*** | 0.0361*** | 0.0410*** | 0.0375*** | | | |
| | (0.000) | (0.000) | (0.000) | | | |
| ***OIB$_{t-1}$*** | -0.0082*** | -0.0080*** | -0.0082*** | | | |
| | (0.000) | (0.000) | (0.000) | | | |
| ***OIB$_{t-2}$*** | -0.0034*** | -0.0033*** | -0.0034*** | | | |
| | (0.000) | (0.000) | (0.000) | | | |
| ***OIB$_{t-3}$*** | -0.0020*** | -0.0020*** | -0.0021*** | | | |
| | (0.000) | (0.000) | (0.000) | | | |
| ***OIB$_{t-4}$*** | -0.0026*** | -0.0026*** | -0.0026*** | | | |
| | (0.000) | (0.000) | (0.000) | | | |
| ***TIB$_t$*** | | | | 0.0321*** | 0.0401*** | 0.0349*** |
| | | | | (0.000) | (0.000) | (0.000) |
| ***TIB$_{t-1}$*** | | | | -0.0106*** | -0.0107*** | -0.0106*** |
| | | | | (0.000) | (0.000) | (0.000) |
| ***TIB$_{t-2}$*** | | | | -0.0041*** | -0.0040*** | -0.0041*** |
| | | | | (0.000) | (0.000) | (0.000) |
| ***TIB$_{t-3}$*** | | | | -0.0027*** | -0.0027*** | -0.0027*** |
| | | | | (0.000) | (0.000) | (0.000) |
| ***TIB$_{t-4}$*** | | | | -0.0034*** | -0.0034*** | -0.0034*** |
| | | | | (0.000) | (0.000) | (0.000) |
| ***$R^2$*** | 0.1470 | 0.1403 | 0.1467 | 0.1172 | 0.1119 | 0.1164 |

**Panel B: Excess Returns**

| *Variable* | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| ***Intercept*** | 0.0004*** | 0.0003*** | 0.0004*** | 0.0003*** | 0.0002*** | 0.0003*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| ***Odd OIB$_t$*** | 0.0038*** | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | (0.000) | | | | | |
| ***Pure OIB$_t$*** | | 0.0039*** | | | | |
| | | (0.000) | | | | |
| ***Circ OIB$_t$*** | | | 0.0017*** | | | |
| | | | (0.000) | | | |
| ***Odd TIB$_t$*** | | | | 0.0030*** | | |
| | | | | (0.000) | | |
| ***Pure TIB$_t$*** | | | | | 0.0031*** | |
| | | | | | (0.000) | |
| ***Circ TIB$_t$*** | | | | | | 0.0011*** |
| | | | | | | (0.000) |
| ***OIB$_t$*** | 0.0314*** | 0.0327*** | 0.0329*** | | | |
| | (0.000) | (0.000) | (0.000) | | | |
| ***OIB$_{t-1}$*** | -0.0062*** | -0.0062*** | -0.0062*** | | | |
| | (0.000) | (0.000) | (0.000) | | | |
| ***OIB$_{t-2}$*** | -0.0027*** | -0.0027*** | -0.0027*** | | | |
| | (0.000) | (0.000) | (0.000) | | | |
| ***OIB$_{t-3}$*** | -0.0015*** | -0.0014*** | -0.0015*** | | | |
| | (0.000) | (0.000) | (0.000) | | | |
| ***OIB$_{t-4}$*** | -0.0020*** | -0.0020*** | -0.0020*** | | | |
| | (0.000) | (0.000) | (0.000) | | | |
| ***TIB$_t$*** | | | | 0.0292*** | 0.0305*** | 0.0312*** |
| | | | | (0.000) | (0.000) | (0.000) |
| ***TIB$_{t-1}$*** | | | | -0.0081*** | -0.0082*** | -0.0081*** |
| | | | | (0.000) | (0.000) | (0.000) |
| ***TIB$_{t-2}$*** | | | | -0.0030*** | -0.0030*** | -0.0030*** |
| | | | | (0.000) | (0.000) | (0.000) |
| ***TIB$_{t-3}$*** | | | | -0.0014*** | -0.0014*** | -0.0014*** |
| | | | | (0.000) | (0.000) | (0.000) |
| ***TIB$_{t-4}$*** | | | | -0.0021*** | -0.0021*** | -0.0021*** |
| | | | | (0.000) | (0.000) | (0.000) |
| ***$R^2$*** | 0.1076 | 0.1081 | 0.1073 | 0.0749 | 0.0752 | 0.0746 |

Table 6 lists the results of fixed effects regressions with contemporaneous daily stock returns as the dependent variable and contemporaneous stock-day odd-lot, pure odd-lot, and circumstantial odd-lot order imbalance calculated as a percentage of volume (OIB) and as percentage of trades (TIB), contemporaneous OIB and TIB, and OIB and TIB lagged 1 to 4 days as the independent variables from trades executed on NASDAQ for all NASDAQ listed stocks occurring from July 2010 through June 2011. Panel A lists the results from regressions using daily raw stock returns, and Panel B lists the results from regressions using daily stock excess returns over the CRSP equally weighted index. P-values are in reported in parentheses. ***, ** & * denote significance at the 1%, 5% & 10% levels, respectively.

**Table 7. Future Returns on Order Imbalance**

**Panel A: Raw Returns**

| *Variable* | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| ***Intercept*** | 0.0013*** | 0.0013*** | 0.0013*** | 0.0013*** | 0.0013*** | 0.0013*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| ***Odd OIB$_t$*** | -0.0019*** | | | | | |
| | (0.000) | | | | | |
| ***Pure OIB$_t$*** | | -0.0007*** | | | | |
| | | (0.000) | | | | |
| ***Circ OIB$_t$*** | | | -0.0014*** | | | |
| | | | (0.000) | | | |
| ***Odd TIB$_t$*** | | | | -0.0016*** | | |
| | | | | (0.000) | | |
| ***Pure TIB$_t$*** | | | | | -0.0008*** | |
| | | | | | (0.000) | |
| ***Circ TIB$_t$*** | | | | | | -0.0010*** |
| | | | | | | (0.000) |
| ***OIB$_t$*** | 0.0004* | -0.0006*** | 0.0004 | | | |
| | (0.070) | (0.006) | (0.115) | | | |
| ***OIB$_{t-1}$*** | -0.0011*** | -0.0011*** | -0.0011*** | | | |
| | (0.000) | (0.000) | (0.000) | | | |
| ***OIB$_{t-2}$*** | -0.0007*** | -0.0007*** | -0.0007*** | | | |
| | (0.000) | (0.000) | (0.000) | | | |
| ***OIB$_{t-3}$*** | -0.0015*** | -0.0015*** | -0.0015*** | | | |
| | (0.000) | (0.000) | (0.000) | | | |
| ***OIB$_{t-4}$*** | 0.0004* | 0.0003* | 0.0004** | | | |
| | (0.059) | (0.086) | (0.024) | | | |
| ***TIB$_t$*** | | | | -0.0005* | -0.0017*** | -0.0009*** |
| | | | | (0.093) | (0.000) | (0.003) |
| ***TIB$_{t-1}$*** | | | | -0.0013*** | -0.0013*** | -0.0013*** |
| | | | | (0.000) | (0.000) | (0.000) |
| ***TIB$_{t-2}$*** | | | | -0.0013*** | -0.0013*** | -0.0013*** |
| | | | | (0.000) | (0.000) | (0.000) |
| ***TIB$_{t-3}$*** | | | | -0.0022*** | -0.0021*** | -0.0022*** |
| | | | | (0.000) | (0.000) | (0.000) |
| ***TIB$_{t-4}$*** | | | | 0.0004 | 0.0003 | 0.0004* |
| | | | | (0.100) | (0.153) | (0.069) |
| ***$R^2$*** | 0.0008 | 0.0005 | 0.0009 | 0.0013 | 0.0011 | 0.0013 |

**Panel B: Excess Returns**

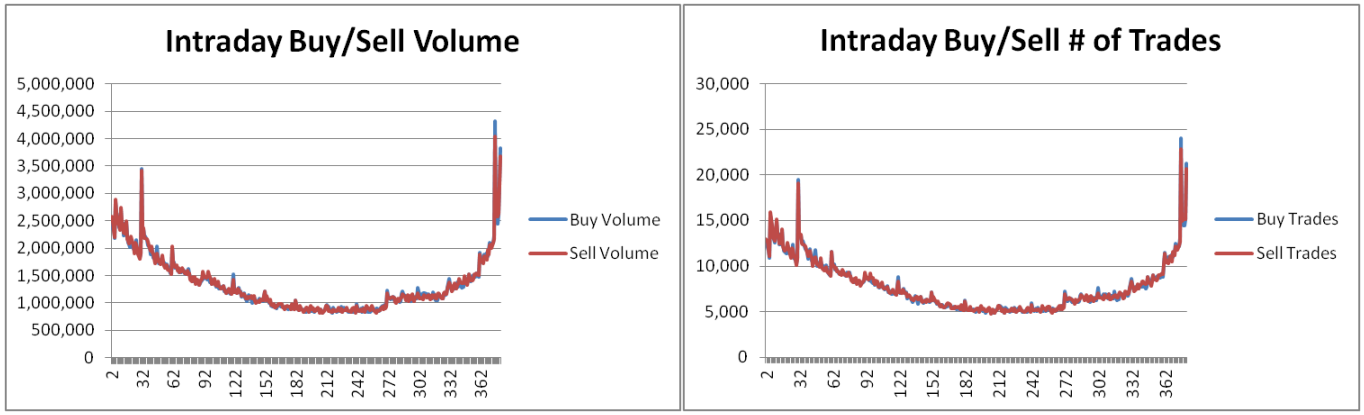
| *Variable* | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| ***Intercept*** | 0.0002*** | 0.0002*** | 0.0002*** | 0.0002*** | 0.0002*** | 0.0002*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| ***Odd OIB$_t$*** | -0.0016*** | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | (0.000) | | | | | |
| ***Pure OIB$_t$*** | | -0.0006*** | | | | |
| | | (0.000) | | | | |
| ***Circ OIB$_t$*** | | | -0.0012*** | | | |
| | | | (0.000) | | | |
| ***Odd TIB$_t$*** | | | | -0.0013*** | | |
| | | | | (0.000) | | |
| ***Pure TIB$_t$*** | | | | | -0.0005*** | |
| | | | | | (0.001) | |
| ***Circ TIB$_t$*** | | | | | | -0.0009*** |
| | | | | | | (0.000) |
| ***OIB$_t$*** | 0.0005*** | -0.0003 | 0.0005** | | | |
| | (0.007) | (0.135) | (0.011) | | | |
| ***OIB$_{t-1}$*** | -0.0009*** | -0.0010*** | -0.0009*** | | | |
| | (0.000) | (0.000) | (0.000) | | | |
| ***OIB$_{t-2}$*** | -0.0005*** | -0.0005** | -0.0005** | | | |
| | (0.009) | (0.010) | (0.012) | | | |
| ***OIB$_{t-3}$*** | -0.0012*** | -0.0012*** | -0.0012*** | | | |
| | (0.000) | (0.000) | (0.000) | | | |
| ***OIB$_{t-4}$*** | 0.0004** | 0.0003* | 0.0004** | | | |
| | (0.045) | (0.063) | (0.018) | | | |
| ***TIB$_t$*** | | | | -0.0005* | -0.0015*** | -0.0007*** |
| | | | | (0.079) | (0.000) | (0.010) |
| ***TIB$_{t-1}$*** | | | | -0.0009*** | -0.0009*** | -0.0009*** |
| | | | | (0.000) | (0.000) | (0.000) |
| ***TIB$_{t-2}$*** | | | | -0.0005** | -0.0005** | -0.0005** |
| | | | | (0.015) | (0.019) | (0.018) |
| ***TIB$_{t-3}$*** | | | | -0.0014*** | -0.0014*** | -0.0014*** |
| | | | | (0.000) | (0.000) | (0.000) |
| ***TIB$_{t-4}$*** | | | | 0.0006*** | 0.0006*** | 0.0007*** |
| | | | | (0.001) | (0.003) | (0.001) |
| ***$R^2$*** | 0.0007 | 0.0004 | 0.0007 | 0.0008 | 0.0006 | 0.0008 |

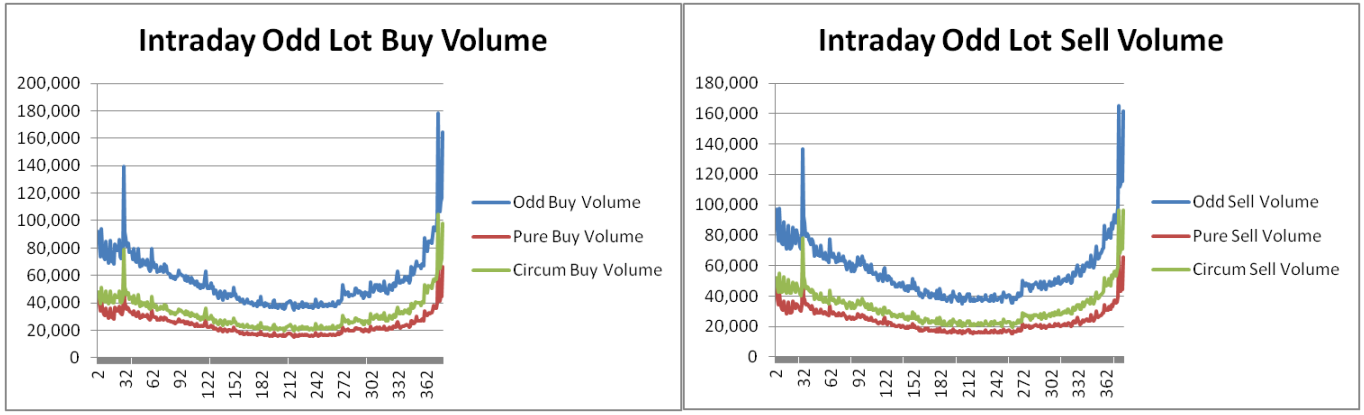
Table 7 lists the results of fixed effects regressions with future daily stock returns as the dependent variable and contemporaneous stock-day odd-lot, pure odd-lot, and circumstantial odd-lot order imbalance calculated as a percentage of volume (OIB) and as percentage of trades (TIB), contemporaneous OIB and TIB, and OIB and TIB lagged 1 to 4 days as the independent variables from trades executed on NASDAQ for all NASDAQ listed stocks occurring from July 2010 through June 2011. Panel A lists the results from regressions using daily raw stock returns, and Panel B lists the results from regressions using daily stock excess returns over the CRSP equally weighted index. P-values are in reported in parentheses. ***, ** & * denote significance at the 1%, 5% & 10% levels, respectively.

**Figure 1. Intraday Buys and Sells**

**Panel A: Total Market Buys / Sells by Volume and Number of Trades**




**Panel B: Odd-lot Buy/Sell Volume**



**Panel C: Odd-lot Buy/Sell Number of Trades**

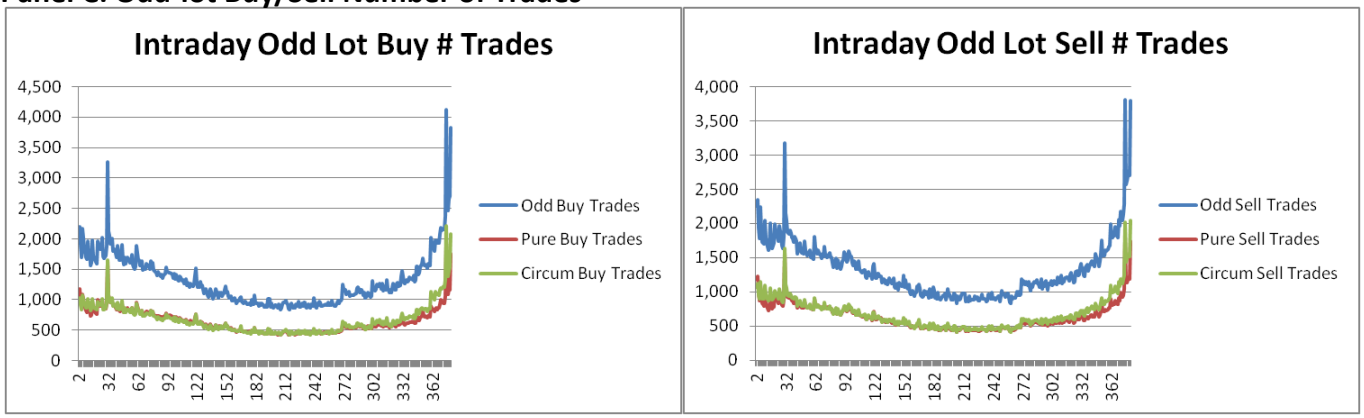
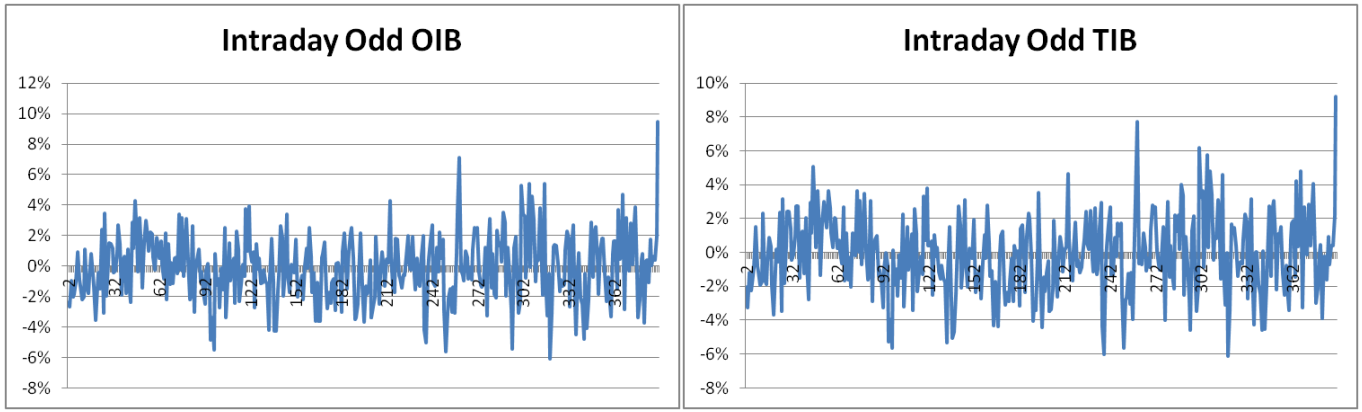


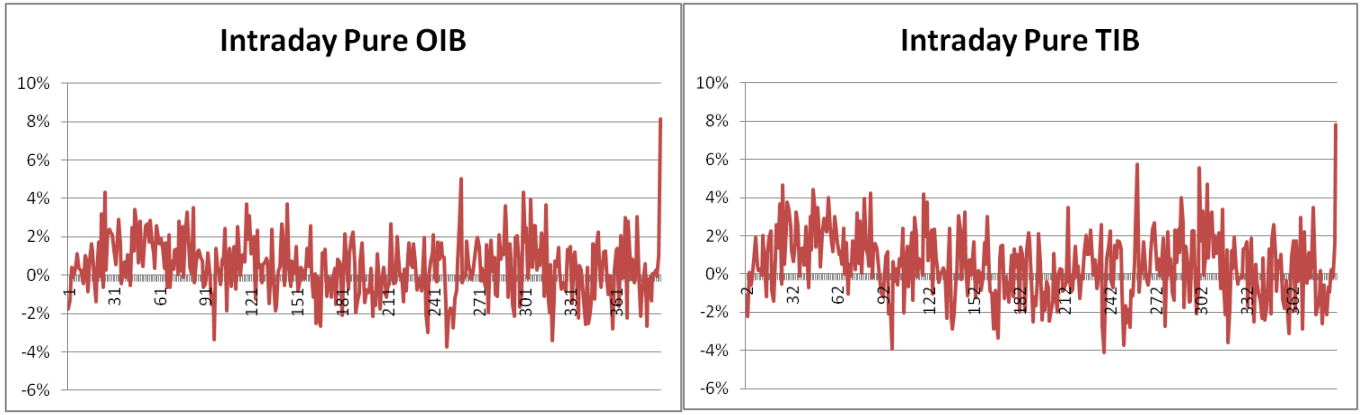

Figure 1 graphs buy and sell volume and number of trades over the minute of the trading day for trades executed on NASDAQ for all NASDAQ listed stocks occurring from July 2010 through June 2011. Panel A graphs total buy and sell volume and number of trades, Panel B graphs odd-lot, pure odd-lot, and circumstantial odd-lot volume, and Panel C graphs odd-lot, pure odd-lot, and circumstantial odd-lot number of trades.

**Figure 2. Intraday Odd-lot Order Imbalances**

**Panel A: Odd-lot OIB and TIB**




**Panel B. Pure Odd-lot OIB and TIB**



**Panel C. Circumstantial Odd-lot OIB and TIB**

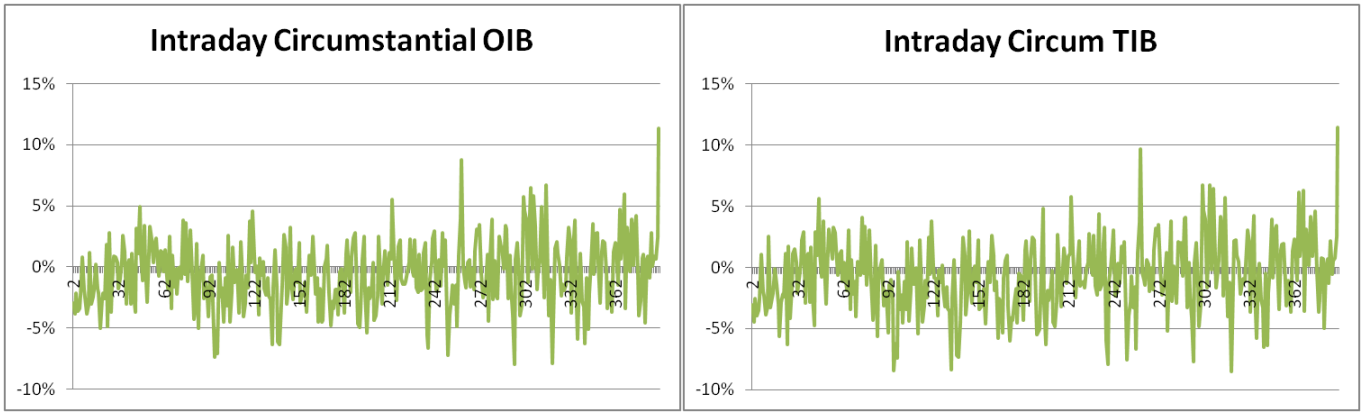



Figure 2 graphs odd-lot order imbalance calculated as a percentage of volume (OIB) and percentage of trades (TIB) over the minute of the trading day for trades executed on NASDAQ for all NASDAQ listed stocks occurring from July 2010 through June 2011. Panel A graphs odd-lot OIB and TIB, Panel B graphs pure odd-lot OIB and TIB, and Panel C graphs circumstantial odd-lot OIB and TIB.

**Appendix**
**Table A1.**

| | *Odd* | | | | *Pure* | | | | *Circumstantial* | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Volume* | | *#Trades* | | *Volume* | | *#Trades* | | *Volume* | | *#Trades* | |
| | ***Buy*** | ***Sell*** | ***Buy*** | ***Sell*** | ***Buy*** | ***Sell*** | ***Buy*** | ***Sell*** | ***Buy*** | ***Sell*** | ***Buy*** | ***Sell*** |
| ***Int*** | 36,502*** | 37,224*** | 870*** | 890*** | 15,927*** | 16,035*** | 434*** | 439*** | 20,575*** | 21,190*** | 436*** | 451*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| ***per1*** | 45,435*** | 47,725*** | 1,036*** | 1,083*** | 20,910*** | 21,167*** | 520*** | 526*** | 24,525*** | 26,558*** | 516*** | 557*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.001) | (0.000) |
| ***per2*** | 40,273*** | 40,010*** | 926*** | 908*** | 17,408*** | 16,485*** | 456*** | 420*** | 22,864*** | 23,525*** | 471*** | 488*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.002) | (0.001) |
| ***per3*** | 45,947*** | 44,681*** | 1,072*** | 1,025*** | 19,949*** | 19,064*** | 527*** | 493*** | 25,997*** | 25,617*** | 545*** | 533*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| ***per4*** | 32,468*** | 29,660*** | 768*** | 684*** | 14,230*** | 12,971*** | 385*** | 340*** | 18,238*** | 16,689*** | 383** | 344** |
| | (0.001) | (0.001) | (0.001) | (0.003) | (0.000) | (0.000) | (0.000) | (0.000) | (0.005) | (0.006) | (0.012) | (0.017) |
| ***per5*** | 30,190*** | 28,887*** | 721*** | 688*** | 13,365*** | 12,611*** | 372*** | 348*** | 16,824*** | 16,275*** | 349** | 339** |
| | (0.002) | (0.002) | (0.003) | (0.003) | (0.000) | (0.000) | (0.000) | (0.000) | (0.009) | (0.008) | (0.023) | (0.019) |
| ***per6*** | 24,084** | 23,150** | 577** | 550** | 10,834*** | 10,088*** | 302*** | 277*** | 13,250** | 13,062** | 275* | 273* |
| | (0.012) | (0.011) | (0.016) | (0.016) | (0.001) | (0.001) | (0.001) | (0.001) | (0.040) | (0.032) | (0.072) | (0.059) |
| ***per7*** | 22,436** | 23,578*** | 536** | 567** | 10,069*** | 9,971*** | 280*** | 280*** | 12,366* | 13,607** | 256* | 287** |
| | (0.019) | (0.010) | (0.025) | (0.013) | (0.001) | (0.001) | (0.001) | (0.001) | (0.056) | (0.026) | (0.095) | (0.047) |
| ***per8*** | 17,362* | 16,781* | 412* | 398* | 7,778** | 7,248** | 215** | 199** | 9,584 | 9,533 | 197 | 199 |
| | (0.069) | (0.065) | (0.084) | (0.080) | (0.013) | (0.018) | (0.014) | (0.018) | (0.138) | (0.117) | (0.196) | (0.167) |
| ***per9*** | 13,567 | 13,028 | 325 | 317 | 6,100* | 5,647* | 172** | 159* | 7,468 | 7,381 | 153 | 158 |
| | (0.155) | (0.152) | (0.173) | (0.162) | (0.051) | (0.064) | (0.048) | (0.058) | (0.247) | (0.225) | (0.316) | (0.273) |
| ***per10*** | 9,300 | 8,982 | 229 | 227 | 4,168 | 3,819 | 122 | 114 | 5,132 | 5,164 | 107 | 113 |
| | (0.329) | (0.323) | (0.336) | (0.318) | (0.182) | (0.210) | (0.161) | (0.176) | (0.426) | (0.396) | (0.481) | (0.433) |
| ***per11*** | 6,589 | 6,332 | 163 | 159 | 2,878 | 2,692 | 85 | 80 | 3,711 | 3,639 | 78 | 79 |
| | (0.489) | (0.486) | (0.493) | (0.484) | (0.356) | (0.377) | (0.328) | (0.340) | (0.565) | (0.549) | (0.608) | (0.584) |
| ***per12*** | 3,211 | 3,502 | 87 | 96 | 1,393 | 1,388 | 45 | 44 | 1,818 | 2,114 | 42 | 52 |
| | (0.736) | (0.700) | (0.714) | (0.672) | (0.655) | (0.649) | (0.601) | (0.601) | (0.778) | (0.728) | (0.783) | (0.717) |
| ***per13*** | 2,513 | 1,918 | 62 | 48 | 974 | 748 | 29 | 24 | 1,539 | 1,170 | 33 | 25 |
| | (0.792) | (0.833) | (0.794) | (0.832) | (0.755) | (0.806) | (0.734) | (0.778) | (0.811) | (0.847) | (0.830) | (0.865) |
| ***per15*** | 1,895 | 1,079 | 41 | 20 | 586 | 429 | 15 | 10 | 1,309 | 650 | 26 | 10 |
| | (0.842) | (0.906) | (0.863) | (0.931) | (0.851) | (0.888) | (0.859) | (0.909) | (0.839) | (0.915) | (0.865) | (0.944) |
| ***per16*** | 1,305 | 933 | 36 | 18 | 468 | 348 | 16 | 8 | 847 | 595 | 21 | 10 |
| | (0.891) | (0.918) | (0.878) | (0.936) | (0.881) | (0.909) | (0.856) | (0.922) | (0.895) | (0.922) | (0.892) | (0.944) |
| ***per17*** | 2,170 | 2,019 | 52 | 46 | 777 | 775 | 25 | 22 | 1,420 | 1,287 | 28 | 24 |
| | (0.820) | (0.824) | (0.826) | (0.839) | (0.803) | (0.799) | (0.777) | (0.794) | (0.826) | (0.832) | (0.855) | (0.867) |
| ***per18*** | 3,162 | 2,017 | 75 | 44 | 1,240 | 883 | 34 | 22 | 1,937 | 1,156 | 41 | 22 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (0.740) | (0.824) | (0.755) | (0.845) | (0.691) | (0.772) | (0.695) | (0.792) | (0.764) | (0.849) | (0.790) | (0.877) |
| ***per19*** | 10,708 | 9,930 | 250 | 228 | 4,394 | 4,110 | 114 | 104 | 6,347 | 5,852 | 136 | 124 |
| | (0.261) | (0.275) | (0.295) | (0.316) | (0.159) | (0.178) | (0.188) | (0.216) | (0.325) | (0.336) | (0.375) | (0.390) |
| ***per20*** | 10,412 | 9,830 | 239 | 220 | 4,484 | 4,120 | 113 | 101 | 5,975 | 5,744 | 125 | 119 |
| | (0.275) | (0.280) | (0.317) | (0.332) | (0.151) | (0.177) | (0.192) | (0.230) | (0.354) | (0.345) | (0.411) | (0.407) |
| ***per21*** | 14,500 | 11,810 | 338 | 265 | 5,474* | 4,705 | 146* | 118 | 9,061 | 7,135 | 192 | 147 |
| | (0.128) | (0.194) | (0.156) | (0.243) | (0.080) | (0.123) | (0.093) | (0.161) | (0.160) | (0.241) | (0.208) | (0.307) |
| ***per22*** | 15,313 | 15,127* | 351 | 341 | 5,978* | 5,905* | 156* | 150* | 9,363 | 9,253 | 195 | 191 |
| | (0.108) | (0.097) | (0.142) | (0.133) | (0.056) | (0.053) | (0.073) | (0.074) | (0.147) | (0.129) | (0.203) | (0.185) |
| ***per23*** | 20,532** | 21,004** | 465* | 473** | 7,494** | 7,614** | 191** | 192** | 13,108** | 13,427** | 274* | 281* |
| | (0.032) | (0.021) | (0.052) | (0.037) | (0.017) | (0.013) | (0.028) | (0.023) | (0.043) | (0.028) | (0.073) | (0.051) |
| ***per24*** | 29,774*** | 29,028*** | 683*** | 667*** | 11,015*** | 10,909*** | 285*** | 284*** | 18,828*** | 18,209*** | 398*** | 384*** |
| | (0.002) | (0.002) | (0.004) | (0.003) | (0.000) | (0.000) | (0.001) | (0.001) | (0.004) | (0.003) | (0.009) | (0.008) |
| ***per25*** | 51,254*** | 48,408*** | 1,158*** | 1,088*** | 18,395*** | 17,884*** | 463*** | 451*** | 32,924*** | 30,600*** | 695*** | 637*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| ***per26*** | 165,651*** | 162,901*** | 3,906*** | 3,854*** | 59,335*** | 59,119*** | 1,559*** | 1,559*** | 106,463*** | 103,949*** | 2,347*** | 2,295*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| $R^2$ | 0.6110 | 0.6268 | 0.5797 | 0.5986 | 0.6645 | 0.6724 | 0.6348 | 0.6493 | 0.5816 | 0.6001 | 0.5441 | 0.5633 |

Table A1 lists the results of OLS regressions with odd lot, pure odd lot, and circumstantial odd lot buy and sell volume and number of trades as the dependent variable and 15 minute period of the trading day as the dependent variables for trades executed on NASDAQ for all NASDAQ listed stocks occurring from July 2010 through June 2011. P-values are in reported in parentheses. ***, ** & * denote significance at the 1%, 5% & 10% levels, respectively.

**Table A2.**

| | *Odd* | | *Pure* | | *Circumstantial* | |
|---|---|---|---|---|---|---|
| | ***OIB*** | ***TIB*** | ***OIB*** | ***TIB*** | ***OIB*** | ***TIB*** |
| ***Int*** | -0.0056 | -0.0074 | -0.0008 | -0.0032 | -0.0086 | -0.0110 |
| | (0.283) | (0.172) | (0.829) | (0.430) | (0.192) | (0.120) |
| ***per1*** | -0.0106 | -0.0077 | -0.0018 | 0.0005 | -0.0183* | -0.0162 |
| | (0.157) | (0.325) | (0.726) | (0.926) | (0.054) | (0.111) |
| ***per2*** | 0.0025 | 0.0067 | 0.0129** | 0.0202*** | -0.0059 | -0.0065 |
| | (0.743) | (0.388) | (0.013) | (0.001) | (0.533) | (0.523) |
| ***per3*** | 0.0085 | 0.0137* | 0.0111** | 0.0179*** | 0.0059 | 0.0092 |
| | (0.255) | (0.079) | (0.032) | (0.002) | (0.534) | (0.364) |
| ***per4*** | 0.0207*** | 0.0270*** | 0.0201*** | 0.0281*** | 0.0204** | 0.0253** |
| | (0.006) | (0.001) | (0.000) | (0.000) | (0.031) | (0.013) |
| ***per5*** | 0.0097 | 0.0113 | 0.0117** | 0.0144** | 0.0075 | 0.0076 |
| | (0.193) | (0.147) | (0.024) | (0.014) | (0.428) | (0.456) |
| ***per6*** | 0.0073 | 0.0100 | 0.0129** | 0.0169*** | 0.0023 | 0.0023 |
| | (0.327) | (0.199) | (0.013) | (0.004) | (0.809) | (0.817) |
| ***per7*** | -0.0096 | -0.0099 | 0.0008 | 0.0003 | -0.0183* | -0.0209** |
| | (0.197) | (0.203) | (0.870) | (0.962) | (0.053) | (0.040) |
| ***per8*** | 0.0045 | 0.0053 | 0.0099* | 0.0121** | -0.0004 | -0.0022 |
| | (0.548) | (0.497) | (0.055) | (0.039) | (0.966) | (0.830) |
| ***per9*** | 0.0027 | 0.0012 | 0.0081 | 0.0090 | -0.0022 | -0.0073 |
| | (0.722) | (0.879) | (0.117) | (0.123) | (0.814) | (0.469) |
| ***per10*** | 0.0012 | -0.0004 | 0.0068 | 0.0060 | -0.0038 | -0.0075 |
| | (0.877) | (0.958) | (0.188) | (0.303) | (0.685) | (0.458) |
| ***per11*** | 0.0004 | 0.0002 | 0.0029 | 0.0031 | -0.0021 | -0.0035 |
| | (0.953) | (0.984) | (0.579) | (0.590) | (0.827) | (0.734) |
| ***per12*** | -0.0067 | -0.0070 | -0.0019 | -0.0003 | -0.0110 | -0.0144 |
| | (0.367) | (0.367) | (0.711) | (0.963) | (0.245) | (0.157) |
| ***per13*** | 0.0041 | 0.0041 | 0.0044 | 0.0040 | 0.0033 | 0.0036 |
| | (0.581) | (0.601) | (0.398) | (0.499) | (0.725) | (0.722) |

| | | | | | | |
|---|---|---|---|---|---|---|
| ***per15*** | 0.0066 | 0.0081 | 0.0023 | 0.0040 | 0.0093 | 0.0115 |
| | (0.373) | (0.301) | (0.658) | (0.494) | (0.326) | (0.259) |
| ***per16*** | 0.0010 | 0.0062 | 0.0011 | 0.0059 | 0.0002 | 0.0059 |
| | (0.896) | (0.426) | (0.827) | (0.316) | (0.981) | (0.558) |
| ***per17*** | -0.0018 | -0.0000 | -0.0023 | 0.0006 | -0.0023 | -0.0013 |
| | (0.811) | (0.996) | (0.650) | (0.916) | (0.807) | (0.899) |
| ***per18*** | 0.0112 | 0.0129* | 0.0083 | 0.0107* | 0.0126 | 0.0145 |
| | (0.134) | (0.099) | (0.109) | (0.068) | (0.183) | (0.154) |
| ***per19*** | 0.0060 | 0.0082 | 0.0050 | 0.0080 | 0.0061 | 0.0079 |
| | (0.422) | (0.294) | (0.331) | (0.172) | (0.516) | (0.435) |
| ***per20*** | 0.0039 | 0.0066 | 0.0070 | 0.0100* | 0.0013 | 0.0027 |
| | (0.601) | (0.401) | (0.178) | (0.087) | (0.894) | (0.787) |
| ***per21*** | 0.0252*** | 0.0299*** | 0.0163*** | 0.0235*** | 0.0312*** | 0.0354*** |
| | (0.001) | (0.000) | (0.002) | (0.000) | (0.001) | (0.001) |
| ***per22*** | 0.0001 | 0.0028 | -0.0002 | 0.0037 | -0.0001 | 0.0016 |
| | (0.986) | (0.723) | (0.966) | (0.532) | (0.992) | (0.874) |
| ***per23*** | -0.0047 | -0.0028 | -0.0041 | -0.0016 | -0.0048 | -0.0040 |
| | (0.532) | (0.715) | (0.430) | (0.786) | (0.613) | (0.697) |
| ***per24*** | 0.0063 | 0.0066 | 0.0011 | 0.0010 | 0.0093 | 0.0113 |
| | (0.398) | (0.400) | (0.826) | (0.868) | (0.325) | (0.267) |
| ***per25*** | 0.0179** | 0.0199** | 0.0068 | 0.0070 | 0.0249*** | 0.0304*** |
| | (0.017) | (0.011) | (0.189) | (0.231) | (0.009) | (0.003) |
| ***per26*** | 0.0055 | 0.0051 | -0.0013 | -0.0019 | 0.0096 | 0.0107 |
| | (0.465) | (0.514) | (0.797) | (0.749) | (0.312) | (0.293) |
| $R^2$ | 0.1425 | 0.1638 | 0.1659 | 0.2064 | 0.1618 | 0.1852 |

Table A2 lists the results of OLS regressions with odd lot, pure odd lot, and circumstantial odd lot order imbalance calculated as a percentage of volume (OIB) and percentage of trades (TIB) as the dependent variable and 15 minute period of the trading day as the dependent variables for trades executed on NASDAQ for all NASDAQ listed stocks occurring from July 2010 through June 2011. P-values are in reported in parentheses. ***, ** & * denote significance at the 1%, 5% & 10% levels, respectively.

**PURE VERSUS CIRCUMSTANTIAL ODD LOT TRANSACTIONS AND STOCK SPLITS**

### 3.1 Introduction

Stock transactions that execute for less than 100 shares are commonly referred to as odd lot trades. An odd lot trade occurs when the original order is for less than 100 shares, which we refer to as a pure odd lot transaction, or an odd lot trade can occur when an order for more than 100 shares is broken into multiple transactions and at least one of the transactions executes for less than 100 shares, which we refer to as a circumstantial odd lot transactions. We study the information contained in pure and circumstantial odd lot transactions. Prior research shows that 100+ share trades contain information (Barclay and Warner, 1993; Chakravarty, 2001; and O'Hara, Yao, and Ye, 2011). O'Hara, Yao, and Ye show that odd lot transactions contain information, but do not differentiate between pure and circumstantial odd lot transactions. We will answer whether pure and circumstantial odd lot trades are similar or different in information content.

We also examine pure and circumstantial odd lot transactions around stock splits. One explanation of stock splits, the trading range hypothesis, has emerged subsequent to the paper by Fama, Fisher, Jensen, and Roll (1969), who examines information incorporation into stock prices. This hypothesis states that firms target a particular stock price range for a variety of reasons. One reason is to encourage trading by smaller investors who prior to the split could not afford to trade in 100+ shares. This hypothesis is supported by evidence that small trades increase after a stock split (Lipson, 1999; Schultz, 2000; and Desai, Nimalendran, and Venkataraman, 1998). Kryzanowski and Zhang (1996) test the trading range hypothesis with data from the Toronto Stock Exchange, which includes odd lot transactions. Their results show odd lot trades decrease and small 100+ share trades increase subsequent to the split. Our

study adds to this area of research by documenting the informativeness of odd lot trades as well as the change in the number of odd lot transactions, both pure and circumstantial, before, and after the split.

Odd lot transactions contain information. O'Hara, Yao, and Ye (2011) find that odd lot trades have a weighted price contribution of 27-35%, which is larger than would be explained by the proportion of odd lot volume (7%) or by the proportion of odd lot trades (20%). However, they did not discern between odd lot trades submitted as odd lot orders and those submitted as part of an order for more than 100 shares but executed as multiple trades with one being for fewer than 100 shares. We add to this research by separating the circumstantial odd lot trades from the pure odd lot trades and examining the informativeness of each type of odd lot trade. We determine if each group contributes to the informativeness and if so, how much information each group of odd lot trades is contributing to informativeness of odd lot trades as a whole.

We will also study both pure and circumstantial odd lot transactions around stock splits. Shultz (2000) and Kadapakkam, Krishnamurthy, and Tse (2005) find strong evidence supporting the theory that firms split their stock to attract smaller investors, with both studies finding an increase in small trades following a stock split. Kryzanowski and Zhang (1996), using data from the Toronto Stock Exchange that contains odd lot transactions, show that odd lot transactions decrease while small 100+ share transactions increase after a stock split. These results support the trading range hypothesis, which asserts that small trades increase after a stock split. While the Kryzanowski and Zhang study includes odd lot transactions, they do not differentiate between pure and circumstantial odd lot trades, nor do they investigate the informativeness of

odd lot transactions around stock splits. After a stock split, some trades that would have been odd-lot transactions before the split will be 100+ share transactions due to the decrease in stock price and 100+ share trades becoming more affordable to traders. Therefore, we expect the some of the information contained in pre-split odd lot transactions to be transferred to 100+ share transactions post-split, thereby decreasing the price contribution of odd lot transactions and increasing the price contribution of 100+ share transactions.

### 3.2 Hypothesis Development

Odd lot transactions, when considered in whole, contain information (O'Hara, Yao, and Ye, 2011). Medium sized transactions contain information (Barclay and Warner, 1993; Chakravarty, 2001; and O'Hara, Yao, and Ye), because they are part of a larger informed trade that is broken up to avoid signaling the trader's information to the market (stealth trading). Similarly, we assume that some of the information contained in odd lot trades comes from medium sized transaction (100-500 shares) that are broken up into smaller trades. As circumstantial odd lots result from multiple partial executions of a 100+ share order, we expect circumstantial odd lot trades to have more information than pure odd lot trades because they are part of a larger informed trade, until they are broken up into smaller odd lot transactions.

**Hypothesis 1**

*$H_0$: The price contribution of circumstantial odd lot transactions is greater than the price contribution of pure odd lot transactions.*

Stock splits lead to an increase in trading activity (Copeland, 1979; Lamoureaux and Poon, 1987; and Arnold and Lipson, 1997; and Lipson, 1999). As a result of the increase in activity, we predict that there will be a decrease in the number of circumstantial odd lot transactions post-split. A higher level of trading activity increases the likelihood that an order will execute in full and lessen the likelihood that an order will be broken up into multiple trades. Hence, we predict a decrease in circumstantial odd lot transactions after a stock split.

**Hypothesis 2**

*$H_0$: There is a decrease in the number of circumstantial odd lot transactions after a stock split.*

Consistent with the trading range hypothesis, Kryzanowski and Zhang (1996) show a decrease in the number of odd lot transactions after a stock split. Because the stock is more affordable to trade in 100+ share trades, we anticipate a decrease in pure odd lot transactions after a stock split.

**Hypothesis 3**

*$H_0$: There is a decrease in the number of pure odd lot transactions after a stock split.*

We expect, with the decrease in share prices, some pre-split odd lot traders execute 100+ share orders post split. Odd lot transactions, when considered as a whole, contain information (O'Hara, Yao, and Ye, 2011) and we expect that some of the information contained in odd lot transactions is transferred to small 100+ share transactions after a stock split. Kryzanowski and Zhang (1996) show that the number of odd lot transactions decreases and number of small 100+ share transactions increases following a stock split. We expect to see an increase in the

information content of small 100+ share transactions and a decrease in the information content of odd lot transactions after a stock split.

**Hypothesis 4**

*$H_0$: The information content of small 100+ share transactions increases after a stock split. There is also a decrease in the information content of odd lot transactions after the split.*

Hypothesis 1 asserts that circumstantial odd lots contain more information than pure odd lot transactions, and Hypotheses 2 through 4 assert that the number and information content of all odd lot transactions will decrease after a stock split. However, there is no evidence suggesting that the information contained in circumstantial odd lot transactions will decrease more or less than the information contained in pure odd lot transactions. This study will empirically determine which group of odd lot transactions loses more information to 100+ share transactions after a stock split.

**Hypothesis 5**

*$H_0$: The information content of circumstantial odd lot transactions will decrease more than the information content of pure odd lot transactions after a stock split.*

**3.3 Data**

Our sample consists of all trades in the NASDAQ Historical TotalView ITCH (ITCH) database from July 1, 2010 to March 3, 2011. The ITCH database includes all trades that execute on NASDAQ. We filter our sample to include only stocks that trade at least five times a day and at least 1,000 shares every day for all 190 trading days of our sample. Each stock is also

classified as being listed on either the NYSE or NASDAQ exchange. For our analysis, we only use trades that execute during market hours. Odd-lot trades that are submitted as a single odd-lot order and execute in full are denoted as pure odd-lot trades. Odd-lot trades that are submitted as part of a 100+ share order that is subsequently divided into smaller executions, one of which is the odd-lot trade, are denoted as circumstantial odd-lot trades. We use data from the Center for Research in Security Prices (CRSP) for closing prices, daily high and low prices, and closing ids and asks. We identify 48 2-for-1 stock splits that occurred during our sample period on stocks meeting our minimum volume and number of trades criteria. We use these 48 stocks as our sample for the latter portion of the study regarding stock splits.

**3.4 Results**

Table 1 lists summary statistics for our sample. The average total volume, pure odd-lot volume, circumstantial odd-lot volume, total number of trades, total number of pure odd-lot trades, total number of circumstantial odd-lot trades, and the proportion of pure and circumstantial volume and trades, is reported for all stocks, NASDAQ-listed stocks, and NYSE-listed stocks. Table 1 shows preliminary evidence that there are more circumstantial odd-lot transactions than pure odd-lot transactions with circumstantial odd-lot transactions comprising roughly 4.4% of volume (11.1% of trades) while pure odd-lot transactions comprise roughly 3.9% of volume (10.7% of trades) for all stocks.

To test Hypothesis 1, which asserts circumstantial odd-lot transactions contain more information than pure odd-lot transactions, we use the Barclay and Warner (1993) calculation of price contribution and weighted price contribution. These calculations measure the

proportion of a stock's daily price change that can be attributed to trades that occur in particular trade classes. Consistent with previous literature (Barclay and Warner, 1993; Chakravarty, 2001; and O'Hara, Yao, and Ye, 2011), we define our trade classes to be: less than 100 shares, 100-500 shares, 501-900 shares, 901-1900 shares, 1901-4900 shares, 4901-9999 shares, and greater than 10,000 shares. The less than 100 shares class is further divided into pure odd-lot transactions and circumstantial odd-lot transactions, for a total of eight trade classes. We follow Barclay and Warner (1993) in the calculation of price contribution (PC) and weighted price contribution (WPC).

The return on each trade *i* is calculated as the execution price of the trade less the execution price of the previous trade for that stock. Each trade is categorized into trade class *j* according to the definitions above. The price contribution, *PC*, of trade class *j* for stock *s* on day *t* is the ratio of the sum of the returns on trades *i* in class *j* for stock *s* on day *t* to the sum of the returns for all trades *i* for stock *s* on day *t*.

$$PC_j^{s,t} = \frac{\sum_{i=1}^{n} r_{i,j}^{s,t}}{\sum_{i=1}^{n} r_i^{s,t}}$$

The weight, *W*, for stock *s* on day *t* is the ratio of sum of the returns of all trades *i* in stock *s* on day *t* to the sum of all trades *i* in all stocks on day *t*.

$$W_s^t = \frac{\sum_{i=1}^{n} r_i^{s,t}}{\sum_{s=1}^{n}\sum_{i=1}^{n} r_i^{s,t}}$$

We calculate the weighted price contribution, *WPC*, for trade class *j* on day *t* as the sum of the products of the weight for stock *s* on day *t* and the *PC* of trade class *j* for stock *s* on day *t* for all stocks.

$$WPC_j^t = \sum_{s=1}^{n} (W_s^t * PC_j^{s,t})$$

The weighted price contribution *WPC* for trade class *j* is the mean of all weighted price contributions for trade class *j* on all days *t*.

$$WPC_j = \frac{\sum_{t=1}^{n} WPC_j^t}{\square}$$

Table 2 reports the weighted price contributions for all trade classes and by exchange listing. Both pure and circumstantial odd-lot transactions have positive weighted price contributions across all listing venues. This finding confirms that both types of odd-lot transactions contribute to price formation and are price setting and not price taking trades. Pure odd-lot transactions seem to have a larger WPC (17.40% for all stocks), contributing more to price formation, than circumstantial odd-lot transactions (8.50% for all stocks), which lends preliminary evidence to reject Hypothesis 1, which asserts that circumstantial odd-lot trades contribute more to price formation than pure odd-lot trades.

Table 3 reports the results of the weighted least squares regressions with price contribution of trade classes as the dependent variable. The independent variables are as follows: a dummy variable set to one if the trade class is pure odd-lot transactions, and zero otherwise; a dummy variable set to one if the trade class is circumstantial odd-lot transactions, and zero otherwise; a dummy variable set to one if the trade class is greater than or equal to 100 shares, and zero otherwise; and the trade class proportion of volume (columns 1, 3 and 5) or number of trades (columns 2, 4, and 6). For the WLS regressions, the observations are weighted by the weight calculated in the WPC models: the ratio of the return on stock *s* on day *t* to the return of the market on day *t*. We avoid perfect colinearity issues by suppressing the

intercept in the WLS regression. If pure odd-lot transactions and/or circumstantial odd-lot transactions contribute to price formation above their proportion of volume, we expect a positive and significant coefficient for the respective <100 shares dummy variable, which is the case for pure odd-lot transactions. For all listing venues and regression equations, the coefficient for pure odd-lot trade classes are positive, meaning pure odd-lot transactions contribute to price formation above and beyond what would be dictated by their proportion of volume and number of trades. Circumstantial odd-lot transactions contribute to price formation above and beyond what would be dictated by their proportion of volume only. When proportion of trades is used in the regression equation, the coefficient of the circumstantial dummy variable is either significantly negative or not significantly different from zero.

The results in Table 4 formally test Hypothesis 1 in a multivariate environment. Table 4 lists the results of regressing the price contribution of trade classes on a dummy variable that equals one if the trade class is circumstantial odd-lot trades, a dummy variable equal to one if the trade class exceeds 100 shares, and the trade class proportion of volume or trades for each stock-day in our sample. The regression coefficient for the circumstantial odd-lot dummy variable is our main variable of interest. This coefficient measures the impact of circumstantial odd-lot trades relative to the pure odd-lot trade class, controlling for proportions of volume and trades. The results are reported for all stocks and by listing venue. The results show that the price contribution of circumstantial odd-lot trades is uniformly less than that of pure odd-lot trades with negative coefficients in each of the six regressions. These results lend strong

evidence to reject Hypothesis 1, which asserts circumstantial odd-lot trades contain more price setting ability than pure odd-lot trades.

Hypotheses 2 through 5 investigate odd-lot transactions and the information content of odd-lot transactions before and after a stock split. For each of our 48 stock splits, we collect the mean proportions of odd-lot transactions, pure odd-lot transactions, and circumstantial odd-lot transactions relative to total volume and number of trades for 30 days prior to the split and 30 days after the split. We compare the pre-split and post-split proportions to test Hypotheses 2 and 3, which assert a decrease in the number of pure and circumstantial odd-lot proportions after a stock split. The results of testing Hypotheses 2 and 3 are reported in Table 5.

Table 5 lists the mean stock-day proportions of odd-lot, pure odd-lot, and circumstantial odd-lot proportions of volume and number of trades, both before and after stock splits in our sample. Also listed are results from t-tests testing the differences between the means. Odd-lot proportion, pure odd-lot proportion, and circumstantial odd-lot proportion of volume and trades decrease significantly after a stock split. These results lend univariate evidence that supports Hypotheses 2 and 3, which assert there is a decrease in the number of pure and circumstantial odd-lot trades after a stock split.

Table 6 lists mean proportions of odd-lot, pure odd-lot, and circumstantial odd-lot proportions of volume and number of trades by day for the trading week leading up to a stock split, and the trading week after a stock split. As expected, all odd-lot proportions seem to decrease in the week following the stock split with a clear delineation on the day of the split, which would univariately support Hypotheses 2 and 3, as well.

We further investigate Hypotheses 2 and 3 in a multivariate environment by regressing stock-day odd-lot proportions on the determinants of odd-lot proportions: price, spread, and volatility (O'Hara, Yao, and Ye, 2011) to test if odd-lot proportions decrease more than that dictated by changes in their determinants. We include a dummy variable that equals one if the stock-day is in the post-split period and this dummy variable is our variable of interest. Table 7 lists the results of the regressions with odd-lot, pure odd-lot, and circumstantial odd-lot proportions of volume and number of trades as the dependent variables. The regression coefficients for the post-split dummy variables are uniformly negative, suggesting that all odd-lot proportions decrease after a stock split while controlling for previously determined factors affecting odd-lot proportions. These results further confirm Hypotheses 2 and 3 and we conclude that pure odd-lot transactions and circumstantial odd-lot transactions decrease after a stock split. These results confirm the findings of Kryzanowski and Zhang (1996).

Hypothesis 4 postulates that the information content of 100 share transactions increases after a stock split and the information content of odd-lot transactions decreases after a stock split. We test this hypothesis by comparing the pre-split mean stock-day price contribution and post-split price contribution for each trade class defined earlier as well as a ninth class, which denotes trades for exactly 100 shares. We perform a t-test on the differences in the means and report the results in Table 8. Table 8 shows that the price contribution of pure odd-lot transactions increases after a stock split, while the price contribution of circumstantial odd-lot transactions and 100 share transactions does not change. These results lend univariate evidence that reject Hypotheses 4.

We know that odd-lot proportions and 100 share transaction proportions change after a stock split. Therefore, we test Hypotheses 4 with a multivariate approach that regresses price contributions of trade classes for each stock-day on the trade class proportion of volume for the stock-day to test if the price contribution of the trade classes changes more than what would be dictated by the proportion of volume after a stock split. We report the results in Table 9.

In regression 1, we include dummy variables denoting odd-lot trade classes, a dummy variable denoting the 100 shares trade class, a dummy variable denoting if the stock-day is post-split, interaction terms between the post-split variable and the odd-lot dummy variables, and an interaction term between the post-split variable and the 100 share dummy variable. We are particularly interested in the interaction terms as the coefficients of these variables tell us if the price contribution of odd-lot and 100 share trades changes after a stock split, while controlling for proportions of volume. Column 1 of Table 9 shows that the price contribution of 100 share trades does not increase after a stock split, when controlling for proportion of volume. This result rejects Hypothesis 4, as it relates to 100 share trades by showing an insignificant interaction term denoting 100 share trades on days after a stock split. The results in Column 1 also reject Hypothesis 4, as it relates to odd-lot trades as well by showing an insignificant coefficient for the interaction term denoting odd-lot trades on days after a stock split.

Regression 2 includes dummy variables for pure and circumstantial odd-lot trade classes, and interaction terms between the post-split dummy variable and the pure and circumstantial trade classes. The interaction terms relate how the information content of pure and circumstantial odd-lot trades is affected by a stock split, while controlling for proportions of

volume. The negative coefficient for the interaction term denoting post-split pure odd-lot trades shows that the information content of pure odd-lot trades decreases significantly after a stock split. However, the information content of circumstantial odd-lot transactions does not decrease as shown by the insignificant interaction variable. This result leads us to reject Hypothesis 5, which asserts that the information content of circumstantial odd-lot transactions decreases more after a stock split than the information content of pure odd-lot transactions.

**3.5 Conclusion**

This study looks at two areas that are important to our understanding of capital markets. First, we determine the origination of the information content of odd-lot transactions. We show that both pure and circumstantial odd-lot trades contribute to price formation, but pure odd-lot trades contribute more than circumstantial odd-lot trades. This result is somewhat counterintuitive. Previous research assumes that 100+ share trades contain more price setting ability than odd-lot trades (O'Hara, Yao, and Ye, 2011). However, circumstantial odd-lot trades are submitted as 100+ share orders, thereby with the same information content as 100+ share orders. Yet, we show that pure odd-lot orders contribute more to prices than their circumstantial counterparts.

Second, we look at the information content of various trade classes around a stock split. Our initial expectation is some of the information contained in odd-lot trades would transfer to 100+ share trades as the odd-lot trades double in size after a stock split, which we show is the case, with price contributions of 100 share trades increasing after a stock split, and the price contribution of pure odd-lot trades decreasing after a stock split.

**Table 1. Summary Statistics: Average Stock-days**

| *Variable* | *All Stocks* | *NASDAQ* | *NYSE* |
|---|---|---|---|
| ***Volume*** | | | |
| ***Total*** | 335,473.96 | 280,845.99 | 377,204.06 |
| | (1,416,443.35) | (1,029,537.86) | (1,650,823.80) |
| ***Pure*** | 5,591.01 | 4,887.72 | 6,128.25 |
| | (12,445.91) | (13,714.20) | (11,352.97) |
| ***Circumstantial*** | 8,343.04 | 8,179.27 | 8,468.14 |
| | (18,029.39) | (19,456.85) | (16,856.68) |
| ***# Trades*** | | | |
| ***Total*** | 1,914.65 | 1,672.55 | 2,099.58 |
| | (4,663.71) | (3,956.76) | (5,130.95) |
| ***Pure*** | 143.65 | 132.56 | 152.11 |
| | (335.82) | (400.37) | (276.25) |
| ***Circumstantial*** | 184.91 | 186.41 | 183.75 |
| | (396.32) | (427.56) | (370.70) |
| ***% Pure*** | | | |
| ***Volume*** | 0.0390 | 0.0380 | 0.0397 |
| | (0.0372) | (0.0375) | (0.0369) |
| ***Trades*** | 0.1065 | 0.1060 | 0.1068 |
| | (0.0804) | (0.0817) | (0.0795) |
| ***% Circum*** | | | |
| ***Volume*** | 0.0442 | 0.0484 | 0.0410 |
| | (0.0350) | (0.0376) | (0.0324) |
| ***Trades*** | 0.1106 | 0.1275 | 0.0977 |
| | (0.0716) | (0.0814) | (0.0599) |
| | N=633,080 | N=274,170 | N=358,910 |

Table 1 lists the mean total volume, odd-lot (pure) volume, odd-lot (circumstantial) volume, total number of trades, number of odd-lot trades (pure), number of odd-lot trades (circumstantial), odd-lot (pure) volume as a proportion of total volume, odd-lot (circumstantial) volume as a proportion of total volume, the number of odd-lot (pure) trades as a proportion of the total number of trades, and the number of odd-lot (circumstantial) trades as a proportion of the total number of trades calculated from all trades executed on NASDAQ for all stocks,

NASDAQ-listed stocks, and NYSE-listed stocks for July 2010 through March 2011. N denotes the number of stock-days used to calculate the averages for each category. Standard deviations are reported in parentheses.

**Table 2. Weighted Price Contribution**

| *Trade Class* | *All* | *NASDAQ* | *NYSE* |
|---|---|---|---|
| ***<100 Shares, Pure*** | 0.1740 | 0.1841 | 0.1642 |
| ***<100 Shares, Circum*** | 0.0850 | 0.1253 | 0.0590 |
| ***100-500*** | 0.7119 | 0.6551 | 0.7523 |
| ***501-900*** | 0.0132 | 0.0152 | 0.0116 |
| ***901-1,901*** | 0.0108 | 0.0133 | 0.0090 |
| ***1,901-4,901*** | 0.0040 | 0.0054 | 0.0031 |
| ***4,901-9,999*** | 0.0008 | 0.0010 | 0.0006 |
| ***<10,000*** | 0.0004 | 0.0006 | 0.0002 |

Table 2 lists the weighted price contribution for seven trade classes: less than 100 shares (pure), less than 100 shares (circumstantial), 100 to 500 shares, 501 to 900 shares, 901 to 1900 shares, 1901 to 4900 shares, 4901 to 9999 shares, and over 10,000 shares for trades occurring on NASDAQ from July 2010 through March 2011, for all stocks, NASDAQ-listed stocks, and NYSE-listed stocks.

**Table 3. Weighted Least Squares Regression: PC on Trade Class and Proportion of Volume**

| *Variable* | *All Stocks* | | *NASDAQ* | | *NYSE* | |
|---|---|---|---|---|---|---|
| ***Trade Class*** | | | | | | |
| ***<100 Shares, Pure*** | 0.1300*** | 0.0497*** | 0.1435*** | 0.0652*** | 0.1169*** | 0.0364*** |
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) |
| ***<100 Shares, Circum*** | 0.0357*** | -0.0318*** | 0.0754*** | 0.0006 | 0.0105*** | -0.0511*** |
| | (<.0001) | (<.0001) | (<.0001) | (0.766) | (<.0001) | (<.0001) |
| ***100+ Shares*** | -0.0270*** | 0.0076*** | -0.0234*** | 0.0066*** | -0.0288*** | 0.0091*** |
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) |
| ***% Volume*** | 0.9167*** | | 0.8547*** | | 0.9576*** | |
| | (<.0001) | | (<.0001) | | (<.0001) | |
| ***% Trades*** | | 0.9590*** | | 0.9137*** | | 0.9875*** |
| | | (<.0001) | | (<.0001) | | (<.0001) |
| $R^2$ | 0.1091 | 0.1132 | 0.0841 | 0.0888 | 0.1307 | 0.1338 |

Table 3 lists the results of weighted least squares regressions with price contribution (PC) of trade classes as the dependent variable and the ratio of daily stock returns to daily market returns as the weight. The independent variables are a dummy set to one if the trade class is less than 100 shares (pure) and zero otherwise, a dummy variable set to one if the trade class is less than 100 shares (circumstantial) and zero otherwise, a dummy variable set to one if the trade class is greater than 100 shares and zero otherwise, the trade class proportion of volume in columns one, three, and five, and the trade class proportion of trades in columns two, four, and six for all stocks, NASDAQ-listed stocks, and NYSE-listed stocks for trades occurring July 2010 through March 2011. P-values are reported in parentheses. ***, ** & * denote significance at the 1%, 5% & 10% levels, respectively.

**Table 4. Price Contribution: Pure Odd-lot vs. Circumstantial Odd-Lot**

| *Variable* | *All Stocks* | | *NASDAQ* | | *NYSE* | |
|---|---|---|---|---|---|---|
| ***Intercept*** | 0.0942*** | 0.0301*** | 0.1169*** | 0.0569*** | 0.0764*** | 0.0095* |
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (0.0857) |
| ***<100 Shares, Circum*** | -0.0545*** | -0.0538*** | -0.0345*** | -0.0444*** | -0.0685*** | -0.0586*** |
| | (<.0001) | (<.0001) | (0.001) | (<.0001) | (<.0001) | (<.0001) |
| ***100+ Shares*** | -0.1277*** | -0.0190*** | -0.1470*** | -0.0440*** | -0.1106*** | 0.0011 |
| | (<.0001) | (0.001) | (<.0001) | (<.0001) | (<.0001) | (0.8686) |
| ***% Volume*** | 0.9557*** | | 0.8808*** | | 1.0060*** | |
| | (<.0001) | | (<.0001) | | (<.0001) | |
| ***% Trades*** | | 0.9455*** | | 0.8743*** | | 0.9950*** |
| | | (<.0001) | | (<.0001) | | (<.0001) |
| $R^2$ | 0.0055 | 0.0059 | 0.0035 | 0.0038 | 0.0080 | 0.0084 |

Table 4 lists the results of OLS regressions with price contribution (PC) of trade classes as the dependent variable and a dummy set to one if the trade class is less than 100 shares (circumstantial) and zero otherwise, a dummy variable set to one if the trade class is greater than 100 shares and zero otherwise, the trade class proportion of volume in columns one, three, and five, and the trade class proportion of trades in columns two, four, and six for all stocks, NASDAQ-listed stocks, and NYSE-listed stocks for trades occurring July 2010 through March 2011. P-values are reported in parentheses. ***, ** & * denote significance at the 1%, 5% & 10% levels, respectively.

**Table 5. Odd-lot Proportions, Pre and Post Stock Split**

| *Variable* | | *Pre-Split* | *Post-Split* | *Diff (Pre-Post)* |
|---|---|---|---|---|
| ***Volume*** | ***Odd*** | 0.1391 | 0.0994 | 0.0397*** |
| | | | | (0.000) |
| | ***Pure*** | 0.0622 | 0.0422 | 0.0200*** |
| | | | | (0.000) |
| | ***Circumstantial*** | 0.0769 | 0.0572 | 0.0197*** |
| | | | | (0.000) |
| ***Number of Trades*** | ***Odd*** | 0.3141 | 0.2431 | 0.0709*** |
| | | | | (0.000) |
| | ***Pure*** | 0.1619 | 0.1169 | 0.0450*** |
| | | | | (0.000) |
| | ***Circumstantial*** | 0.1522 | 0.1262 | 0.0260*** |
| | | | | (0.000) |

Table 5 lists the mean proportion of odd-lot, pure odd-lot, and circumstantial odd-lot volume and number of trades for all trades occurring on the NASDAQ exchange before and after a stock split and the differences between the means for stock splits occurring between January 1, 2009 and June 30, 2011. P-values are reported in parentheses. ***, ** & * denote significance at the 1%, 5% & 10% levels, respectively.

**Table 6. Odd-Lot Proportions Pre and Post Stock Split by Day**

| | Volume | | | Number of Trades | | |
|---|---|---|---|---|---|---|
| Day | Odd | Pure | Circum | Odd | Pure | Circum |
| -5 | 0.1437 | 0.0626 | 0.0810 | 0.3221 | 0.1665 | 0.1556 |
| -4 | 0.1620 | 0.0819 | 0.0801 | 0.3362 | 0.1824 | 0.1538 |
| -3 | 0.1425 | 0.0648 | 0.0777 | 0.3190 | 0.1712 | 0.1478 |
| -2 | 0.1539 | 0.0759 | 0.0780 | 0.3369 | 0.1834 | 0.1535 |
| -1 | 0.1529 | 0.0661 | 0.0868 | 0.3379 | 0.1692 | 0.1687 |
| 1 | 0.1035 | 0.0404 | 0.0632 | 0.2489 | 0.1138 | 0.1351 |
| 2 | 0.0902 | 0.0353 | 0.0549 | 0.2267 | 0.1078 | 0.1189 |
| 3 | 0.0958 | 0.0410 | 0.0548 | 0.2372 | 0.1117 | 0.1256 |
| 4 | 0.0957 | 0.0388 | 0.0569 | 0.2428 | 0.1169 | 0.1259 |
| 5 | 0.0931 | 0.0394 | 0.0538 | 0.2315 | 0.1105 | 0.1210 |

Table 6 lists the mean proportion of odd-lot, pure odd-lot, and circumstantial odd-lot volume and number of trades for all trades occurring on the NASDAQ exchange for the five trading days before and five trading days after a stock split for stock splits occurring between January 1, 2009 and June 30, 2011.

**Table 7. Regression Results: Odd-lot Proportions on Determinants**

| | *Proportion of Volume* | | | *Proportion of Trades* | | |
|---|---|---|---|---|---|---|
| ***Variable*** | ***Odd*** | ***Pure*** | ***Circum*** | ***Odd*** | ***Pure*** | ***Circum*** |
| ***Intercept*** | 0.1500*** | 0.0616*** | 0.0884*** | 0.3218*** | 0.1418*** | 0.1801*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| ***Post*** | -0.0420*** | -0.0192*** | -0.0228*** | -0.0701*** | -0.0342*** | -0.0360*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| ***Price($)*** | 0.0002*** | 0.0002*** | 0.0001* | 0.0005*** | 0.0006*** | -0.0001 |
| | (0.002) | (0.005) | (0.071) | (0.000) | (0.000) | (0.326) |
| ***Spread(%)*** | -1.5183*** | 0.5192 | -2.0375*** | -2.0982** | 0.6015 | -2.6997*** |
| | (0.007) | (0.232) | (0.000) | (0.019) | (0.381) | (0.000) |
| ***Range($)*** | -0.0131*** | -0.0059*** | -0.0073*** | -0.0228*** | -0.0127*** | -0.0102*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| $R^2$ | 0.1057 | 0.0400 | 0.1204 | 0.1210 | 0.0775 | 0.0901 |

Table 7 lists the results of OLS regressions with stock-day odd-lot, pure odd-lot, and circumstantial odd-lot proportions of volume and number of trades as the dependent variables using all trades that occur on the NASDAQ exchange for 30 trading days before and 30 trading days after a stock split for stocks that had a 2-for1 split between July 1, 2010 and June 31, 2012. The independent variables are a dummy variable set to one if the stock-day is after a stock split and zero otherwise, the stock closing price, the closing spread as a percentage of the midpoint, and the daily trading range. P-values are reported in parentheses. ***, ** & * denote
significance at the 1%, 5% & 10% levels, respectively.

**Table 8. Price Contribution by Trade Class, Pre and Post Stock Split**

| *Trade Class* | *Pre* | *Post* | *Diff (Pre-Post)* |
|---|---|---|---|
| ***Odd, Pure*** | 0.2856 | 0.1418 | 0.1438** |
| | | | (0.050) |
| ***Odd, Circumstantial*** | 0.0452 | 0.0657 | -0.0205 |
| | | | (0.743) |
| ***100 Shares*** | 0.5565 | 0.6370 | -0.0805 |
| | | | (0.320) |
| ***101 to 500 Shares*** | 0.0643 | 0.1358 | -0.0715 |
| | | | (0.182) |
| ***501 to 900 Shares*** | -0.0111 | 0.0159 | -0.027 |
| | | | (0.366) |
| ***901 to 1,900 Shares*** | 0.0111 | 0.0050 | 0.0061 |
| | | | (0.840) |
| ***1,901 to 4,900 Shares*** | -0.0413 | 0.0110 | -0.0522* |
| | | | (0.085) |
| ***4,901 to 9,999 Shares*** | 0.0087 | -0.0011 | 0.0098 |
| | | | (0.635) |
| ***Over 10,000 Shares*** | 0.0275 | -0.0092 | 0.0366** |
| | | | (0.025) |

Table 8 lists the mean pre-split price contribution, the mean post-split price contribution, and the difference between the pre-split and post-split price contribution for nine trade classes: less than 100 shares (pure), less than 100 shares (circumstantial), 100 shares, 101 to 500 shares, 501 to 900 shares, 901 to 1900 shares, 1901 to 4900 shares, 4901 to 9999 shares, and over 10,000 shares for trades occurring on NASDAQ in stocks with a 2-for-1 split occurring from July 2010 through March 2011. P-values are reported in parentheses. ***, ** & * denote significance at the 1%, 5% & 10% levels, respectively.

**Table 9. Regression Results: Price Contribution on Proportion of Volume**

| *Variable* | *(1)* | *(2)* |
|---|---|---|
| ***Intercept*** | -0.0376 | -0.0688*** |
| | (0.184) | (0.010) |
| ***Odd*** | 0.1615*** | |
| | (0.000) | |
| ***Pure*** | | 0.2947*** |
| | | (0.000) |
| ***Circumstantial*** | | 0.0367 |
| | | (0.439) |
| ***100 Shares*** | 0.2291*** | |
| | (0.002) | |
| ***Post*** | 0.0240 | 0.0468 |
| | (0.507) | (0.129) |
| ***Post*Odd*** | -0.0737 | |
| | (0.185) | |
| ***Post*Pure*** | | -0.1716*** |
| | | 0.010 |
| ***Post*Circumstantial*** | | -0.0067 |
| | | (0.920) |
| ***Post*100 Shares*** | 0.0875 | |
| | (0.209) | |
| ***Proportion of Volume*** | 0.5811*** | 0.9631*** |
| | (0.000) | (0.000) |
| $R^2$ | 0.0221 | 0.0221 |

Table 9 lists the results of OLS regressions with price contribution of stock-day trade classes as the dependent variable for 30 trading days before and 30 trading day after a stock split for stocks that had a 2-for1 split between July 1, 2010 and June 31, 2011. The independent variables are a dummy variable set to one if the trade class is an odd-lot trade class and zero otherwise, a dummy variable set to one if the trade class is 100 shares and zero otherwise, a dummy variable set to one if the stock-day is after a stock split and zero otherwise, an interaction term between post and odd, an interaction term between post and 100 shares, and the trade class proportion of volume in regression 1; a dummy variable set to one if the trade class is less than 100 shares (odd) and zero otherwise, a dummy variable set to one if the trade class is less than 100 shares (circumstantial) and zero otherwise, a dummy variable set to one if the stock-day is after a stock split and zero otherwise, an interaction term between post and pure, an interaction term between post and circumstantial, and the trade class proportion of volume. P-values are reported in parentheses. ***, ** & * denote significance at the 1%, 5% & 10% levels, respectively.

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**CIRRICULUM VITAE**

**B. HARDY JOHNSON IV**
University of Mississippi • School of Business Administration
226 Holman Hall • Post Office Box 1848 • University, MS 38677
205.401.7299 • hjohnson@bus.olemiss.edu

## EDUCATION

Ph.D. in Finance, University of Mississippi, Oxford, MS — May, 2013
MBA, University of Alabama – Birmingham, Birmingham, AL — June, 2002
B.S. in Business Administration, Auburn University, Auburn, AL — June, 2000

## RESEARCH PAPERS

The Behavior, Characteristics, and Informativeness of Odd Lot Transactions over Time, with Robert Van Ness and Bonnie Van Ness (job market paper)

Order Imbalance and Odd Lot Transactions, with Robert Van Ness and Bonnie Van Ness (dissertation essay)

Pure versus Circumstantial Odd Lot Transactions and Stock Splits, with Robert Van Ness and Bonnie Van Ness (dissertation essay)

Tailored versus Mass Produced: Portfolio Managers concurrently Managing Separately Managed Accounts and Mutual Funds, with Fan Chen and Li-Wen Chen (under review)

## CONFERENCE ACTIVITIES

Presenter: Tailored versus Mass Produced: Portfolio Managers concurrently Managing Separately Managed Accounts and Mutual Funds, Financial Management Association Annual Meeting, Denver, CO, October, 2011

Presenter: Tailored versus Mass Produced: Portfolio Managers concurrently Managing Separately Managed Accounts and Mutual Funds, Southern Finance Association Annual Meeting, Key West, FL, November, 2011

## TEACHING EXPERIENCE

Investments, Undergraduate Level, University of Mississippi — Summer 2010 – Fall 2012

## HONORS AND AWARDS

University of Mississippi Graduate Student Research Grant — Summer 2012

INDUSTRY EXPERIENCE

| | |
|---|---|
| Financial Advisor, Citigroup / Smith Barney, Birmingham, AL | July, 2003 – July, 2008 |
| Financial Advisor, Sterne, Agee, & Leach, Birmingham, AL | July, 2008 – August 2009 |