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Price clustering and the stability of stock prices

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ABSTRACT

Understanding factors that influence volatility is vital to analysts, investment professionals, and firm managers. In this study, we take a non-traditional approach to identify the determinants of volatility by examining how frictions in the formation of prices affect the stability of stock prices. In particular, we test the hypothesis that clustering on round pricing increments will result in more volatile financial markets. A possible explanation for clustering-induced volatility may be that stocks with a greater degree of clustering will have less informative prices and thus exhibit greater volatility. Our multivariate tests seem to confirm our hypothesis as we observe a strong, positive relation between price clustering and stock price volatility. A variety of additional tests suggest that causation flows from clustering to volatility instead of the other way around.

1. Introduction

Much of economic theory revolves around the formation of equilibrium prices. However, in practice, frictions might adversely affect the ability of prices to find their equilibrium. For instance, empirical research shows that prices tend to cluster on round increments in both equity and commodity markets (Wyckoff, 1963; Niederhoffer and Osborne, 1966; Ball, Torous, and Tschoegl, 1985; Harris, 1991; Alexander and Peterson, 2007; Ikenberry and Weston, 2008). Explanations for this type of anomalous price behavior generally fall into two camps. The first explanation suggests that investors' prefer round numbers in attempt to mitigate cognitive processing costs (Wyckoff, 1963; Niederhoffer and Osborne, 1966; Ikenberry and Weston, 2008). The second explanation, which is not mutually exclusive from the first explanation, is predicated on the idea that investors prefer to deal in round prices in attempt to minimize negotiation costs (Ball et al., 1985; Harris, 1991).[1]

While prior research has documented the presence of clustering in financial markets, few, if any studies, have examined the effect of clustering on the quality of financial markets. The main objective of this paper is to take a step in this direction. In particular, we test the hypothesis that the degree of clustering on round pricing increments leads to less stable stock prices. The theory underlying this hypothesis is based on the notion that the price system transmits information to market participants (Hayek, 1945; Friedman, 1977). When clustering on round increments exists, the lack of granularity in stock prices may reduce the informativeness of prices. Therefore, stocks with more clustering may exhibit higher levels of volatility. The implications of our tests are broad, as they suggest that investors' preferences for round prices – whether because of cognitive biases or an aversion to negotiation costs – can adversely affect the informativeness of prices and subsequently increase the volatility of stock prices.

Besides extending the literature that discusses both clustering and volatility, our tests have important practical implications. Analysts and other investment professionals use models that rely on volatility forecasts (Hamid and Iqbal, 2004). Furthermore, managers attempting to maximize the value of shareholders must also be concerned with the level of volatility in the firms' stock price, given that volatility can affect the firms' cost of capital projections. While prior research has found that financial markets exhibit excess volatility (Shiller, 1981), we argue that frictions in how prices are formed can, in part, explain this excess volatility.

In our empirical analysis, we calculate the level of clustering as the percent of daily prices that close on round increments (Harris, 1991). Because our sample time period runs from 1995 to 2012, we control for the structural change in tick sizes (decimalization) that occurred during the beginning of 2001. Consistent with the presence of clustering, we do not find closing prices to be uniformly distributed across all pricing increments. Instead, we find an abnormally high level of clustering in both the pre-decimalization period and the post-decimalization period, respectively.

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[1] An additional explanation also exists for the presence of clustering, which Alexander and Peterson (2007) define as the *collusion explanation*.Christie and Schultz (1994) and Christie, Harris, and Schultz (1994) show that quotes by NASDAQ dealers tend to cluster on even-eighths of dollars and argue that collusion among dealers is the only viable explanation for this type of phenomenon. Similar conclusions are drawn in Dutta and Madhavan (1997) and Simaan, Weaver, and Whitcomb (2003).

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Additional results in this study show a strong contemporaneous correlation between the degree of price clustering and volatility. These results hold in both univariate and multivariate tests. Our results are also robust to measures of return volatility as well as price volatility.[2] These latter tests are important. Our measure of return volatility captures the width of distribution of daily returns whereas our measure of price volatility captures the size of daily price movements.

We recognize that observing correlation between clustering and volatility in stock prices is not tantamount to identifying a causal link. In fact, it is possible that greater levels of volatility might magnify the biases associated with preferences for round prices and lead to higher levels of clustering. We therefore conduct a number of tests that begin to allow us to infer the direction of the relation between clustering and volatility. Additional multivariate tests find that last month's clustering levels are directly related to the current month's volatility. These results hold when we include last month's volatility as an additional control variable.

In unreported tests, we estimate the relation between last month's return volatility and the current month's clustering levels, we do not find a direct association. While we do find a positive relation between last month's price volatility and the current month's clustering level, the relation is markedly weaker when we control for last month's clustering as an additional independent variable. In other unreported tests, we replicate these types of Granger-like tests but apply the intuition to intraday data.[3] In particular, we find that the level of price clustering during the previous 15-minute interval is directly associated with both return and price volatility during the current 15-minute interval – even after controlling for volatility during the previous 15 min. We do not, however, find that price volatility during the previous 15 minute interval predicts the level of contemporaneous clustering, particularly when we control for previous clustering levels. Admittedly, we do find that prior return volatility is directly associated contemporaneous clustering, although the relationship weakens by nearly 30% when we control for prior clustering levels. Again, these Granger-like causality tests suggest that causation flows from clustering to volatility instead of the other way around.

Thus far, our attempts to identify causality only allow us to weakly infer support for our hypothesis that clustering leads to greater volatility. To better determine the direction of this relation, we examine both clustering and volatility surrounding exogenous events that affect the quality of markets. In an ideal world, we would like to examine the level of volatility surrounding an exogenous shock to clustering. However, identifying such shocks is difficult. Therefore, we take a non-traditional approach and attempt to rule out the possibility of reverse causation by examining the level of clustering surrounding exogenous shocks to volatility. Admittedly, these tests do not directly examine the casual inferences that we make in our analysis. However, these tests do speak about the presence of reverse causality. First, we examine both clustering and volatility surrounding the implementation of the Securities and Exchange Commission's Regulation SHO in May 2005. Regulation SHO (Reg SHO hereafter) eliminated the uptick rule for a group of 1000 randomly selected pilot stocks.[4] Prior research (see Alexander and Peterson, 2008; Diether, Lee, and Werner, 2009) shows a significant decrease in volatility surrounding the implementation of Reg SHO. Therefore, using Reg SHO as a natural, randomized experiment, seems to be an appropriate identification strategy.

Both univariate and multivariate tests show that while volatility markedly decreases for pilot stocks surrounding Reg SHO, clustering levels do not. Furthermore, we test whether the results hold when we compare Reg SHO-changes in volatility and clustering levels for pilot stocks to similar changes in non-pilot stocks. Again, results from this difference-in-difference type approach show that while volatility decreases for pilot vis-à-vis non-pilot stocks during Reg SHO, clustering levels are unaffected. We are able to deduce from these tests that exogenous changes in volatility do not cause changes in price clustering. Combined with the findings from our Granger-like causality tests, the results from the Reg SHO tests seems to support our hypothesis that causality flows from clustering to volatility instead of the other way around.

In our final set of tests, we examine both clustering and volatility surrounding the September 11th, 2001 terrorist attacks. Again, this exogenous and unanticipated event, which we argue is an appropriate identification strategy, resulted in the closure of U.S. financial markets from the morning of September 11th until September 17th, and created an unusual level of volatility in stock prices. As expected, results from both our univariate and multivariate tests show that stocks became much more volatile during the month after the attacks than compared to the month before the attacks. In fact, in economic terms, we find that return volatility increased nearly 40% during this period while price volatility increased approximately 23%. Despite these large changes to volatility, we again do not find that price clustering changed in a meaningful way. We recognize that this event study is not a perfect, natural experiment in our attempt to test our hypothesis as we are only able to infer that exogenous changes to volatility do not affect the level of price clustering. However, given the findings from the entire set of tests, we argue that the results from our empirical analysis seem to support the idea that increases in clustering tends to increase the volatility of stock prices.

This study provides an important contribution to the literature and our understanding of the formation of equilibrium stock prices. We contribute to the growing body of evidence that the volatility observed in financial markets can, in part, be attributed to cognitive biases (LeRoy and Porter, 1981; Shiller, 1981; Barberis and Thaler, 2003; Huang, Lin, and Yang, 2015). In the presence of cognitive biases and/or high negotiation costs, our findings suggest that investor preferences for round pricing increments can create instability in stock prices. The externalities of such preferences include less informative prices, potentially higher risk, and the possibility of less efficient financial markets.

2. Data description

To empirically test our research question, we collect data from the Center for Research in Security Prices (CRSP) for the period 1995 to 2012. From these data we observe firm-specific information on daily prices, volume, shares outstanding, exchange listing, and closing bid/ask prices. We retain all stocks defined as CRSP common shares (i.e. share codes 10 & 11). We follow Harris (1991) and exclude firm-observations with a daily stock price of less than $2. In addition, we require stocks to trade in at least 200 days during any particular year. These restrictions reduce the possibility of the bid/ask bounce and/or infrequently traded stocks biasing our results. The final sample consists of 10,195 unique firm observations and 801,030 firm-month observations.

We recognize that this time period includes two distinct tick-size regimes. In January of 2001, the NYSE reduced its minimum tick-size from sixteenths ($0.0625) to decimals (i.e. $0.01).[5] Shortly thereafter, NASDAQ followed suit and decreased its minimum tick size to decimals. The period preceding the tick-size reduction is generally referred to as the pre-decimalization period, to distinguish it from the post-

[2] While these results are obtained using monthly data, we also find a robust association between price clustering and volatility using quarterly data as well as annual data. Furthermore, we conduct a series of tests using non-calendar monthly data, which is obtained from randomly selecting four-week periods as the starting point of our analysis. In each of these tests, we find a strong positive relationship between price clustering and volatility.

[3] We extract trades from the NYSE Euronext Daily Trades and Quotes (DTAQ) database for the first three months of 2015. The results using intraday stock prices are seemingly identical to those of the daily analysis.

[4] The uptick rule restricts investors from shorting stocks on down- or even-ticks and had been enforced since the 1934 Securities Exchange Act.

[5] On June 24th, 1997 the NYSE reduced the minimum price increment from eighths to sixteenths.