Addenda to

How Noise Trading Affects Markets: An Experimental Analysis

By

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Addendum 1
Noise Trading: The Motivation behind Our Experimental Design

Dow and Gorton [2006] suggest that the concept of “noise” traces back to the Rational Expectations literature, where adding a random component to aggregate asset supply made prices partially revealing. In such a non-revealing rational expectations equilibrium (REE), informed traders could profit from their trades, thereby providing at least a partial answer to the Grossman-Stiglitz conundrum of how information-gathering is compensated in an informationally efficient market. The notion of noise in that literature is rather elusive in that it is not clear what economic phenomenon (e.g. a certain type of agent or a certain type of shock that agents experience) is the source of this noise. What matters in these models is simply that a mean-zero normally distributed random variable, termed noise, influences aggregate supply.

The microstructure literature relies on a similar device to explain how prices do not become instantaneously revealing. In the microstructure literature, “noise” is now ascribed to a specific trading behavior by uninformed traders. The Kyle [1985] model is perhaps closer to the REE models, where the uninformed trades are viewed as a mean-zero normally distributed random variable. The sequential trade models depart from this normality framework, but employ the same concept of noise trade as exogenously given. Both microstructure approaches require that uninformed traders must trade. Easley and O’Hara [1987], for example, note that “If trades were solely information-related, any uninformed trader would do better to leave the market rather than face a certain loss trading with an informed trader. To avoid this no-trade equilibrium, we assume that the uninformed trade (at least partially) for liquidity reasons. This exogenous demand arises either from an imbalance in the timing of consumption and income or from portfolio
considerations”.¹ This approach motivates our specification of the “liquidity traders” in the experiment, who need to trade for an exogenous reason (that in an actual market would corresponds to portfolio rebalancing, consumption, etc.).

In contrast, models following the “noise trader approach to finance” presume that noise trading reflects irrational decision-making. Shiller [1984; 1990], for example, argues that noise traders rely on “popular models” that are wrong and subject to fads. Shleifer and Summers [1990] develop this further, arguing “Some investors are not fully rational, and their demand for assets is affected by beliefs or sentiments that are not fully justified by fundamental news.” DeLong, Shleifer, Summers and Waldman [1990] model noise traders as those who misperceive the future value of the security. What can lead to such misperceptions are a wide range of behavioral phenomena, such as overconfidence, anchoring, representativeness, conservatism, belief perseverence, and the availability bias (see Barberis and Thaler [2003]). Because of these behavioral factors, noise trading in this literature can exhibit specific strategies that depend on past returns such as positive-feedback trading (see, for example, Shiller [1994]; DeLong, Shleifer, Summers and Waldman [1990b]).²

While the limits-to-arbitrage literature features noise traders who trade on the basis of mistaken fundamental information as well as noise traders who trade based on rules in the spirit of technical analysis (e.g., looking at past prices of the security), we chose to focus the experiment on the latter type of noise traders. Most importantly, we do not assign trading motives to these traders but rather seek to examine whether noise trading arises endogenously in the market from the behavior of traders who do not have private information about fundamentals and are not given any trading targets. These

¹ Glosten and Milgrom [1985; pg. 77] note that such trading “may arise from predictable life cycle needs or from less predictable events such as job promotions or unemployment, deaths or disabilities, or myriad other causes.”
² The literature on heterogeneous agents also focuses on noise traders as trend chasers. These models (see for example Brock and Hommes [1998]; Lux [1995]; Lux and Marchesi [2000]) investigate bubbles and crashes, and feature fundamental traders versus noise traders. In these models, it is the noise traders who induce the aberrant market behavior.
“uninformed traders” that we have in our markets are free to pursue whatever trading strategies they find appealing in order to make money.

Conceptually, these unconstrained uninformed traders could exhibit different behaviors. For example, they might act as skillful technical traders who exploit information in the order book to earn a profit by quickly trading on price trends similar to SOES bandits in the analysis of Harris and Schultz [1998]. They might also rationally supply liquidity to the market, earning a profit by adding risk-bearing capacity and providing a service to the liquidity traders (i.e., acting as market makers as in Grossman and Miller [1988]). Such traders would not be considered “noise traders” because they do not fit the basic definition in Black [1986] and the REE models in that they do not lose money on average (and hence would not enable informed traders to make profit on average and resolve the Grossman-Stiglitz conundrum).

Alternatively, the uninformed traders might behave as irrational “noise traders” who act as if they have information when they do not (Black [1986]). They could follow various technical trading rules such as positive-feedback trading strategies (e.g., De Long et al. [1990b]) or possibly behaving as contrarians. These noise traders would be expected to lose money on average, and could have varying effects on market liquidity and efficiency that depend on the strategies they employ.

Our experimental design specifically aims to examine the behavior and market impact of these unconstrained uninformed traders while distinguishing them from traders driven by exogenous liquidity shocks, whom we call “liquidity traders.” We do so by creating a laboratory market that includes informed traders who are given private information about each security’s liquidating dividend, liquidity traders who must achieve a predetermined trading position in each market period, and uninformed traders.

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3 There is an empirical evidence that individual investors in various countries trade in a contrarian fashion (e.g., Choe, Kho, and Stulz [1999], Grinblatt and Keloharju [2000, 2001], Richards [2005], Kaniel, Saar, Titman [2006]). For experimental evidence consistent with contrarian behavior see Bloomfield, Tayler, and Zhou (2007).
who have neither information nor trading targets (and can therefore pursue any trading strategy they choose, but lack any objective informational advantage).

We have three goals in this study. Our first is to examine the behavior of the uninformed traders, whether it differs from that of the liquidity traders, and whether it gives rise to “noise trading.” Second, we are interested in how these uninformed traders impact various market outcomes. In particular, we investigate market liquidity and the informational efficiency of prices. Our third goal is to examine how securities transaction (Tobin) taxes affect the behavior of traders and overall market activity.\(^4\)

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\(^4\) Proponents of the tax often claim that noise trading is destabilizing because it moves prices farther away from true values, and that the tax would improve the efficiency of prices without harming liquidity. In our experimental markets it is straightforward to test for the impact of transaction taxes on informational efficiency and liquidity because we know the securities’ “true value” and whether specific trades move prices toward or farther away from this value. Arguments on the potential costs and benefits of a securities transaction tax can be found in Schwert and Seguin [1993], Pollin, Baker, and Schaberg [2002], and Haberman and Kirilenko [2003].
References


Addendum 2
Experimental Instructions

A detailed discussion of the experimental design is provided in the paper. In this addendum we make available the written instructions participants received in the experiment.

Welcome!
This experiment has two parts. The first part is devoted to training. In the second part, you will trade 24 securities that will affect your final payment.

For the second part:
- Your market will include either
  - 4 informed traders, 4 target traders and 4 free traders, OR
  - 4 informed traders and 4 target traders, with no free traders.
  Your computer screen will tell you which market you are in.

- Your payment for the study will depend on your performance in this session. Specifically, we calculate winnings as follows:

  \[
  \text{Payment in US$} = 40 + (\text{Gain or Loss in Lab$} + 2000 \text{ Lab$}) \times 0.01 \quad (\text{US$/Lab$}).
  \]

  Your minimum payment is $5. If you are above the minimum, every $1,000 you gain or lose in Lab$ is equivalent to a gain or loss of $10 in US$.

Liquidating Dividends
The liquidating dividend of each security is distributed over the interval [0,100] according to the bell-shaped distribution in the figure below. Note that extreme dividends are less likely than dividends close to 50.
Types of Traders
In this session, the market includes three types of traders:

- **Informed Traders** know that the liquidating dividend is inside a certain range of numbers. We draw a random number “x” that can be any integer between -10 and +10. Two informed traders learn the dividend value plus x and the other two informed traders learn the dividend value minus x.

For example, say that the value of the dividend is 61 and we drew an x=6.

Two informed traders would see on the screen:

<table>
<thead>
<tr>
<th>Min Dividend</th>
<th>57</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expected Dividend</td>
<td>67</td>
</tr>
<tr>
<td>Max Dividend</td>
<td>77</td>
</tr>
</tbody>
</table>

The two other informed traders would see:

<table>
<thead>
<tr>
<th>Min Dividend</th>
<th>45</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expected Dividend</td>
<td>55</td>
</tr>
<tr>
<td>Max Dividend</td>
<td>65</td>
</tr>
</tbody>
</table>

- **Target Traders** are forced to end trading with a share balance exactly equal some “target” number of shares, or else they are penalized. Throughout the session, the target is 20 or 30. Two of the traders will have positive targets (they will need to buy shares) and two will have negative targets (they will need to sell shares). The (Sell 20, Buy 30) and (Buy 20, Sell 30) combinations are twice as likely as the (Sell 20, Buy 20) and (Sell 30, Buy 30) combinations.

- **Free traders** are not told either random number, and do not have any trading target.

**Target and Free traders will always see the following for their information:**

<table>
<thead>
<tr>
<th>Min Dividend</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expected Dividend</td>
<td>50</td>
</tr>
<tr>
<td>Max Dividend</td>
<td>100</td>
</tr>
</tbody>
</table>

Remember that the dividend and market price are not necessarily the same thing. A security’s market price is determined by the amount traders are pay or accept, and may change as trading progresses. A security’s dividend is determined by the random draw from the bell-shaped distribution before trading begins, and never changes.

**How to Trade in an Electronic Limit Order Book Market**
Trading sessions are 120 seconds long (except for the practice security). All traders trade shares by entering orders that others can “take” or by “taking” orders that others have
entered. All orders are for one share, but you can enter and take multiple orders at each price.

- **Entering a Bid** A bid is an order to **buy** a share at a stated price. You will buy at that price if someone else chooses to take your bid, and sells a share to you at the price you indicated.

- **Entering an Ask.** An ask is an order to **sell** a share at a stated price. You will sell at that price if someone else chooses to take your ask, and buys a share from you at the price you indicated.

- **Taking a Bid or Ask.** If you click on the “SELL 1” button on the BID column, you will sell a share at the highest bid. If you click on the “BUY 1” button on the ASK column, you will buy a share at lowest ask.

- **Removing a bid or ask.** You can remove (cancel) a bid or ask that you entered, simply by **right-clicking** on it.

Note that the price graph used on the computer screen shows an initial range from $25 to $75. However, dividends could be as low as 0 or as high as 100. You can enter and see orders for prices outside the initial range by clicking on the up- and down-arrows between the graphs.

**Some Trading Restrictions**
The following rules keep you from entering or taking any orders you please.

- Target Traders can only trade in the direction of their targets. If your target requires you to buy shares, you cannot sell shares. If your target requires you to sell shares, you cannot buy shares.

- You can’t trade with yourself. Requests to take your own order will be rejected.

- You can never enter a bid at a price greater than your own ask, or an ask at a price less than your own bid. Doing so would be like trying to trade with yourself.

- You can’t enter a bid higher than an existing ask or an ask lower than an existing bid. If you are willing to buy at the lowest ask, simply click the “BUY 1” button. If you are willing to sell at the highest bid, simply click the “SELL 1” button.

**Trading Gains and Losses.** You start each security with no cash and no shares. However, negative cash and share balances are permitted. Thus, you can buy shares even if you don’t have money to pay for them (“borrowing”), and you can sell shares you don’t own (“short selling”).

After trading a security, the shares you own pay the liquidating dividend. If you have a positive balance of shares, the dividend is added to your cash balance for each share you own. If you have a negative balance of shares, the dividend is subtracted from your cash
balance for each share you own. The resulting number is your trading gain (if positive) or trading loss (if negative).

All traders make money every time they buy a share for less than true dividend or sell a share for more than true dividend. For example, buying a share worth $30 at a price of $23 creates a gain of $7. Selling that share at that price creates a loss of $7.

**Trading taxes.** For half of the securities in the session, there is a trading tax equal to $2 for every share you buy or sell. Thus, if you buy a share worth $30 at a price of $23 (as in the example above), your net gain after tax is only $5. Selling that share at that price creates an after-tax loss of $9. You will always know whether the trading tax is in force.

**Penalties for Target Traders.** Target traders also may incur penalties for failing to achieve their targets. The penalty is $100 laboratory dollars for each share you exceed or fall short of your target. This penalty is large enough that target traders are always better off trading enough to hit their target, even if they must buy at very high prices or sell at very low prices to do so. For example, a trader who needs to buy 20 shares will incur a penalty of 100 Lab$ if she ends trading in a security with either 21 shares or 19 shares. *Caution: You are penalized for exceeding your target (buying or selling more shares than required). Because you can only buy or only sell, you cannot “undo” your trades to get back to a target you have exceeded.*
How to use the Trading Interface (Order Entry Graphs)

Two ways to BUY:
- **Enter a Bid**: Left-Click a price on the right side of the BIDS graph places an order in the order book. You will buy a share at that price is someone else clicks the “Sell 1” button when you have the highest bid in the book. If there are several shares at the highest bid, the first shares to be submitted to the limit order book are executed first.
- **Take an ask**: Click the “Buy 1” button to buy 1 share at the highest bid price in the book. Your transaction will be executed immediately.

Two ways to SELL:
- **Enter an Ask**: Left-Click a price on the right side of the ASKS graph places an order in the order book. You will sell a share at that price is someone else clicks the “Buy 1” button when you have the lowest ask in the book. If there are several shares at the lowest ask, the first shares to be submitted to the limit order book are executed first.
- **Take a Bid**: Click the “Sell 1” button to sell 1 share at the highest bid price in the book. Your transaction will be executed immediately.

Delete a Bid or Ask: Right Click on the right side of the BIDS or ASKS graph to remove an order at that price (you need to place the cursor on the price).

Scrolling the graphs.
Use the buttons between the order entry graphs to:
- Scroll higher in both graphs (up arrow)
- Scroll lower in both graphs (down arrow)
- Set the boundaries of both graphs to be equal (“RESET”)

Reading the Information on the Right Side of the Screen

Information about YOUR trades:
- “# of Buys” indicates the number of times you bought a share, whether by taking someone’s ask or having them take one of your bids.
- ”My Buy Price” indicates the average price at which you bought shares.
- “# of Sells” indicates the number of times you sold a share, whether by taking someone’s bid or having them take one of your asks.
- ”My Sell Price” indicates the average price at which you sold shares.

Information about MARKET trades:
- # of Buys indicates the number of times someone clicked the “Buy 1” button, taking the lowest ask; the average price of those trades is also reported.
- # of Sells indicates the number of times someone clicked the “Sell 1” button, taking the highest bid; the average price of those trades is also reported.
Addendum 2
Descriptive Figures

The paper focuses on particular hypotheses about the behavior of uninformed traders and how they relate to the concept of “noise traders.” The statistical analysis of these hypotheses and our findings are discussed in the body of the paper and presented in tables (2 through 7) and figures (2 through 5) in the paper. In this addendum, we provide several descriptive figures without analysis for the sake of completeness. Panel A provides information about the use of market and limit orders by the three trader types, and on the breakdown of trades of each trader type between market and executed limit orders. Panel B shows the behavior of volume and pricing errors over the 24 securities traded in a session. This information is presented separately for four experimental regimes: no uninformed traders / low security value extremity (LNLE); no uninformed traders / high extremity (LNHE); uninformed traders / low extremity (HNLE); uninformed traders / high extremity (HNHE). Panel C provides very detailed information to interested readers about price behavior in all of our experimental markets. The panel shows transaction prices (as circles) and true values (as lines) for all securities traded by each of the twelve cohorts.

Panel A: Use of Market and Limit Orders for each Trader Type
Panel B: Volume and Pricing Errors over the 24 Securities in a Session

**Volume across Securities**

- Shares
- Securities: LNLT, LNHT, HNLT, HNHT

**DEVP across Securities**

- Dollars
- Securities: LNLT, LNHT, HNLT, HNHT
Panel C: Transaction Prices (circles) and True Values (lines) for all Securities Traded by all Cohorts (1 through 12)