FUNDING INVESTMENTS
FINANCE 738, Spring 2008, Prof. Musto
Class 4 – Market Making

*Only Game In Town*, by Walter Bagehot (actually, Jack Treynor)

Seems like any trading idea would be worth trying
- Tiny amount of truth implies a tiny expected profit

But your trades cost money, due to the market maker’s spread
- Buy at the ask, sell at the bid, and ask > bid

Focus of the article is on *why* there’s a bid/ask spread
- Not simply the market maker’s profit
- Even if the market maker were just breaking even, there would still be a spread between the bid and the ask

Conclusion is, the bid/ask spread allows the market maker to recoup his losses to informed traders with profits off of others
- Liquidity traders – invest when they get money, sell when they need money, don’t think they have special insight into where the stock’s going
- Misinformed traders – think they have special insight when they really don’t
  - Lots of this when the market has been going up
  - Misattributing their trading profits to their skill
  - Explanation for higher trading volume near market peaks

What we’re going to do
- Build a simple, reduced-form model of the market-maker’s pricing problem to see how spreads relate to the incidence of informed trading
- Cover strategies for trading inside spreads
- Look at some evidence on actual trading by retail investors
Pricing Problem of a Market Maker

First, some terminology

• *Limit Order*: An order to trade a particular number of shares at a particular price
  - You could submit a limit order to sell 500 shares of GM at 43
    - If and when the price rises to 43, you’ll sell your shares
    - If it doesn’t rise to 43, you won’t sell

• *Market Order*: An order to trade a particular number of shares at whatever the price is right now

A market maker provides liquidity for a security by posting limit orders to buy and sell

• Market maker’s limit order to buy shares is called his *bid* price
• Limit order to sell shares is called his *ask* price (or his *offer* price)
• Both the bid and ask are for stated numbers of shares, called the *depths*
  - For example, the bid price for GM could be 24.05, and the depth could be 5000 shares
  - If you want to sell up to 5000 shares, you can do that right now for 24.05/share. If you want to sell more than that, the market maker is not obliged to give you 24.05/share for the extra shares, and he’ll probably give you less.

Suppose you make a market in GM stock, so you have to post

• *Bid* – price at which you will fill the next order if it is a sell order
  - You pay the Bid, you get one share
• *Ask* – price at which you will fill the next order if it is a buy order
  - You get the Ask, you lose one share

To keep it simple, let’s say all orders are for one share

Everybody knows that, tomorrow, GM will be either 0 or 1

• Could just as easily say that GM will be either 24 or 25, or either 24.13 or 24.22
• Easier to follow the math if we just say 0 or 1
There are two types of traders that submit orders to you

- **Informed** – traders who *already* know, *today*, what GM will be worth *tomorrow*. They buy if the ask is below what GM will be worth, and they sell if the bid is above what GM will be worth
- **Uninformed** – traders who *don’t* know. As far as they’re concerned, there’s a \( \frac{1}{2} \) chance that GM will be worth 0, and a \( \frac{1}{2} \) chance that GM will be worth 1. They buy if they get money, and sell if they need it.
  - Those who trade on no information are often called *noise traders*
    - Standard statistical term for uncorrelated activity

- You are uninformed
- Fraction \( f \) of all traders are informed
- You can’t tell if a trade came from an informed or uninformed trader

Finally, to keep it maximally simple, let’s say that, due to competition, the best you can do as a market maker is break even

- Could just as easily say there’s a positive maximum profit you can make

So the question is, at what bid and ask do you break even?

- Expected profit from filling a buy order at the Ask is 0
- Expected profit from filling a sell order at the Bid is 0

We can solve this algebraically
Setting the Ask Price

If a buy order comes in, you sell a share of GM for the Ask. So what you want to know is,
• What is GM’s expected value if the trader was informed?
• What is GM’s expected value if the trader was uninformed?

Trader was informed
Obviously, the trader buys when he knows GM will be worth 1
• Your expected profit from filling a buy order from an informed trader is \(\text{Ask} - 1\) (\text{get Ask, lose a share worth 1})

Trader was uninformed
Uninformed trades are unrelated to where GM is going
• When uninformed buys, GM is going to 1 half the time, and to 0 half the time, so the expected value of GM, given that an uninformed trade came in, is \(\frac{1}{2}\)
• Your expected profit from filling the buy order of an uninformed trader is \(\text{Ask} - \frac{1}{2}\) (\text{get Ask, lose a share with expected value} \(\frac{1}{2}\))

You don’t know whether the trader was informed, but you do know how many traders in general are informed. The fraction \(f\) of traders are informed and the rest, \(1-f\), are uninformed, so your expected profit is

\[f[\text{Ask} - 1] + (1-f)[\text{Ask} - \frac{1}{2}] = \text{Ask} - \frac{f}{2} - \frac{1}{2}\]

If you’re breaking even, this has to equal zero

\[\text{Ask} - \frac{f}{2} - \frac{1}{2} = 0 \quad \rightarrow \quad \text{Ask} = \frac{1}{2} + \frac{f}{2}\]
Setting the Bid Price

Math is exactly the same, just the other way around

\[ \text{Bid} + \frac{f}{2} - \frac{1}{2} = 0 \rightarrow \text{Bid} = \frac{1}{2} - \frac{f}{2} \]

To summarize

- Market maker centers the bid and ask on the expected value of the stock
- \( \text{Bid} - \text{Ask} = f \), the incidence of informed trading

**Result #1** – *When one group trades at the expense of the market maker, the rest lose on average by paying the spread*

**Result #2** – *Spreads increase with the incidence of informed trading*

For example, let’s say that 20% of all trades come from informed traders

- \( f = 0.2 \)
- So Bid = 0.4, Ask = 0.6

With 80% of trades coming from informed traders,

- Bid = 0.1, Ask = 0.9

This has nothing to do with market makers running profits, it’s just their way to recoup losses to informed traders picking them off.

Easy to confirm that securities with less public information have wider spreads

- Smaller stocks
- Junk bonds vs. Investment Grade
- Corporate vs. Treasury bonds
Here’s the quote for a big stock:

And a little one:
Notice, we’ve assumed that the liquidity traders, who buy when they have money and sell when they need it, are completely price-insensitive
• Sell at the Bid, no matter how low, and buy at the Ask, no matter how high

This is obviously unrealistic; anybody would avoid paying big spreads whenever possible
• Though, keep in mind, if there are informed traders making profits on average, there have to be traders losing money on average
  • Maybe they know it, maybe they don’t

To add some realism, let’s say that liquidity traders won’t sell below ¼ or buy above ¾
• At prices worse than those, they’d raise money some other way in a cash crisis, and they’d invest somewhere else if they got money

In the $f=0.2$ scenario, this is no problem
• Can sell at Bid=0.4>0.25 and buy at Ask=0.6<0.75
But in the $f=0.8$ scenario, it is a problem
• Now Bid=0.1<0.25 and Ask=0.9>0.75
At this big spread, liquidity trading dries up!

The market maker has two choices
• Quote a spread that liquidity traders will pay, i.e. Bid = ¼ and Ask = ¾ , and lose money on average
• Quote a spread that liquidity traders won’t pay, but doesn’t lose money on average
With only informed traders trading against him, the market maker would have to quote Bid = 0 and Ask = 1, and nobody would bother trading

**Result #3 – If liquidity traders are price-sensitive enough, market makers can’t make a market (can’t recoup their losses to the informed)**

Now let’s take the point of view of a liquidity trader. If market makers can’t tell that your trades are uninformed, they have to defend themselves by charging a spread (i.e. impute the possibility that you are informed)

Your challenge: Show the market maker that you are not trading on information.
Here’s one idea: commit to trade, not today, but on some future date.

Suppose you’re liquidating a block of 100,000 shares for someone who needs the cash, but not immediately (liquidating an estate, maybe)
• Market maker would worry that you’re selling that big block because you know something adverse, and you’ll only get the going bid (or worse, since it’s such a big block)

A solution: offer to sell it a little above the bid, but not today’s bid, next week’s bid

So let’s say the stock is trading 30.1-30.5 today. Your offer would be to sell at a small amount, say 0.1, over whatever the bid price is a week from now. If it’s trading at 26.2 to 26.6 in a week, you sell at 26.3.

This would increase, in expectation, your selling revenue by 0.1 per share. But why would the market maker accept this deal? How have you shown him that this trade is not informed?

The idea is that, by a week from now, all information that is currently private will have become public, and therefore imputed into the stock price.
• So if you currently have private information indicating that the stock is overvalued, you can’t benefit from it with this trade; the price you get will incorporate that information

Notice, you’d have to commit in advance to whether you’ll be buying or selling in a week. Why?

My choice of a week in this example is arbitrary; the scheduled trade could as easily be in a day or a month.
• The period would have to be calibrated to the market-maker’s concerns about private information

This strategy of arranging future trades at future market prices is sometimes known as *Sunshine Trading*
Suppose you just wanted to hold the S&P 500. But instead of paying Vanguard for the S&P return, you think you can save a little money by just buying it yourself

- Buy each of the 500 stocks, according to its weight in the S&P

Setting aside all the time and aggravation, and the practical difficulties trading small lots and odd lots, you have a problem with the price that market makers will charge you

- For each stock, the market maker for that stock will wonder, why are you buying? What might you know?
- You’re just buying it because it’s in the index, but they don’t know that
- So for each of the 500 stocks, you’ll be paying the going spread to get into the stock, and you’ll have to pay it, eventually, to get out

Vanguard doesn’t have that problem

- Traders for the index funds have the advantage that the market knows they’re just trying to track the index, so there is no private information incorporated into their trades
- Market makers are accordingly more willing to trade within the spread

So if you try to put together the index yourself, in addition to all the other aggravation, you have the basic disadvantage that market makers don’t know how little information there is in your purchases of the individual stocks

These days, the Vanguard traders have a little private information, when it comes to stocks being added to the S&P 500

- Historically, stocks have gone up in price when added to the S&P 500
- Vanguard has to buy a huge amount of a stock being added
  - S&P announces an addition a week in advance, giving Vanguard and others the chance to spread their purchases over time, rather than bid up the stock at the exact moment of addition
The trading advantage is *especially* significant with small-cap index funds
- Very little research coverage of small stocks, so very little of the price-relevant information is public
- So the danger of informed trading is relatively high, so spreads are really high

Dimensional Fund Advisors (DFA) runs a “microcap” fund, which aims to hold an index of the 9th and 10th deciles (i.e. bottom two) of stocks, by market capitalization
- These are the tiniest stocks; you would never be able to trade at the kind of prices they get

*Noise Traders?*

Who are these noise traders, making trades whose expected losses offset the expected gains that informed traders make off of market makers?
- Logical suspects are retail investors
- But could it be that their trades *lose* money, on average?

How to find out?
- Look at the trades by a large sample of retail investors
- Track those trades into the future; how did they do?

Here’s what we find in a sample of 10,000 traders at a very large, nationwide discount brokerage:

*From “Do Investors Trade Too Much?”* (T. Odean, *AER 1999*):

<table>
<thead>
<tr>
<th>Panel A: All Transactions</th>
<th>n</th>
<th>84 trading days later</th>
<th>252 trading days later</th>
<th>504 trading days later</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchases</td>
<td>49,948</td>
<td>1.83</td>
<td>5.69</td>
<td>−24.00</td>
</tr>
<tr>
<td>Sales</td>
<td>47,535</td>
<td>3.19</td>
<td>9.00</td>
<td>27.32</td>
</tr>
<tr>
<td>Difference</td>
<td>−1.36</td>
<td>−3.31</td>
<td>−3.32</td>
<td></td>
</tr>
<tr>
<td>N1</td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.001)</td>
<td></td>
</tr>
<tr>
<td>N2</td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.002)</td>
<td></td>
</tr>
</tbody>
</table>

These are percentage returns, so the stocks the investors *purchase* return 1.83% on average over the next 4 months, whereas the stocks they *sell* return 3.19% over the same period. Whoops
Of course *some* retail investors are very good at what they do, but on average one makes money (gross of transactions costs) by making the opposite of the trades that discount-brokerage customers make

- Which is what market makers do

Here’s another perspective on noise trading. How do the investors who trade the *most* do relative to other investors? Here’s what we see in a sample of 78,000 discount-brokerage customers:

*From “Trading is Hazardous to your Wealth” (Barber & Odean, JF ’00):*

![Figure 1. Monthly turnover and annual performance of individual investors.](image)

- Investors are sorted into five equal-sized groups by their portfolio turnover
  - Lowest quintile hardly trades at all
  - Highest quintile has turnover of more than 20%/month
As you go from low to high turnover
- Performance *gross* of commissions hardly changes
  - About the same as the S&P 500
- But performance *net* of commissions drops dramatically
  - Indication is that on average, the investors are getting no extra performance for the extra commissions they are paying
  - Even though this is a discount brokerage, with low commissions, the effect on wealth is substantial

Another question for the discount brokerage data: who makes these trades, men or women?

If we sort brokerage accounts by who is making the trading decisions, here is what we get:
*From “Boys will be Boys: Gender, Overconfidence and Common Stock Investment” (Barber & Odean, QJE 2001)*

<table>
<thead>
<tr>
<th></th>
<th>Women</th>
<th>Men</th>
<th>Difference (women–men)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of households</td>
<td>8,005</td>
<td>29,659</td>
<td>NA</td>
</tr>
</tbody>
</table>

**Panel A: Position Value and Turnover**

<table>
<thead>
<tr>
<th></th>
<th>Women</th>
<th>Men</th>
<th>Difference (women–men)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean [median] beginning position value ($)</td>
<td>18,371 [7,387]</td>
<td>21,975 [8,218]</td>
<td>−3,604*** [−831]***</td>
</tr>
<tr>
<td>Mean [median] monthly turnover (%)</td>
<td>4.40 [1.74]</td>
<td>6.41 [2.94]</td>
<td>−2.01*** [−1.20]***</td>
</tr>
</tbody>
</table>

**Panel B: Performance**

<table>
<thead>
<tr>
<th></th>
<th>Women</th>
<th>Men</th>
<th>Difference (women–men)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Own-benchmark monthly abnormal gross return (%)</td>
<td>−0.041***</td>
<td>−0.069***</td>
<td>0.028***</td>
</tr>
<tr>
<td>Own-benchmark monthly abnormal net return (%)</td>
<td>−0.143***</td>
<td>−0.221***</td>
<td>0.078***</td>
</tr>
</tbody>
</table>

What this says is,
- Women underperform the returns they *would* have gotten if they had just held onto their beginning-of-year portfolios by 0.04%/month
- Men underperform by 0.07%/month, and the 0.03%/month difference is statistically significant
Selling Winners and Holding on to Losers

A well-known regularity in stock returns is momentum

- Winner stocks (over the recent 6-12 months) have historically been more likely to be winners in the future
- Lots of institutions are momentum traders, buying recent winners and selling recent losers

Needless to say, not everybody can do this at once. And if we look at retail investors, we see the opposite tendency to hold on to losers and sell winners. You can see this by comparing the proportion of investors’ gains on paper that they realize by selling, to the proportion of their paper losses:

From “Are Investors Reluctant to Realize their Losses?” (T. Odean, JF ’98)

This table compares the aggregate Proportion of Gains Realized (PGR) to the aggregate Proportion of Losses Realized (PLR), where PGR is the number of realized gains divided by the number of realized gains plus the number of paper (unrealized) gains, and PLR is the number of realized losses divided by the number of realized losses plus the number of paper (unrealized) losses. Realized gains, paper gains, losses, and paper losses are aggregated over time (1987–1993) and across all accounts in the data set. PGR and PLR are reported for the entire year, for December only, and for January through November. For the entire year there are 13,883 realized gains, 79,658 paper gains, 11,930 realized losses, and 110,348 paper losses. For December there are 866 realized gains, 7,131 paper gains, 1,555 realized losses, and 10,604 paper losses. The t-statistics test the null hypothesis that the differences in proportions are equal to zero assuming that all realized gains, paper gains, realized losses, and paper losses result from independent decisions.

<table>
<thead>
<tr>
<th></th>
<th>Entire Year</th>
<th>December</th>
<th>Jan.–Nov.</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLR</td>
<td>0.098</td>
<td>0.128</td>
<td>0.094</td>
</tr>
<tr>
<td>PGR</td>
<td>0.148</td>
<td>0.108</td>
<td>0.152</td>
</tr>
<tr>
<td>Difference in proportions</td>
<td>−0.050</td>
<td>0.020</td>
<td>−0.058</td>
</tr>
<tr>
<td>t-statistic</td>
<td>−35</td>
<td>4.3</td>
<td>−38</td>
</tr>
</tbody>
</table>

What this says is

- In the average year, investors realize 14.8% of their paper gains, but only 9.8% of their paper losses
- The pattern is mildly in the other direction in December (consistent with realizing losses for tax write-offs)

So on average, retail investors are the opposite of momentum traders, cashing in their winners and waiting on their losers
Payment for Order Flow

Retail investors recoup some of the money they lose to their average incompetence through payment for order flow

- Institutions will pay retail brokerages to send trades their way
  - The institution will execute the trades at current market quotes
  - Why would the institution pay to do this? Because of the very low level of adverse information in the average retail trade
  - This lowers the cost of the retail brokerage, which is why it can offer brokerage services at such low prices

Payment for order flow might sound vaguely corrupt, but really it’s just monetizing investors’ cluelessness and sharing the proceeds with them