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The Effects of High Frequency Trading in a Multi-Asset Model

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Overview

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-High frequency traders have largely replaced human liquidity providers in US equity markets.

-This has increased market efficiency, reduced transaction costs, and increased volumes.

We develop a model that can explain how and why this has occurred:

-Similar to the Glosten and Milgrom (1985) model, but with multiple securities.

-We add an automated market maker who trades across securities and understands the relationships between their end-of-period values.

-This new participant:

1. Transacts the majority of orders.
2. Makes prices more efficient.
3. Increases informed and decreases uninformed traders transaction costs.

-As a result:

1. Volumes increase.
2. Overall transaction costs are reduced

Intro

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-US equity markets have changed dramatically over the last ten years.

-Now, most orders are sent and matched electronically, whereas before, the bulk of orders were sent and matched manually.

-Not only do computers aide humans in finding each other, *now most trades themselves are computer driven.*

The Decline of Floor Trading

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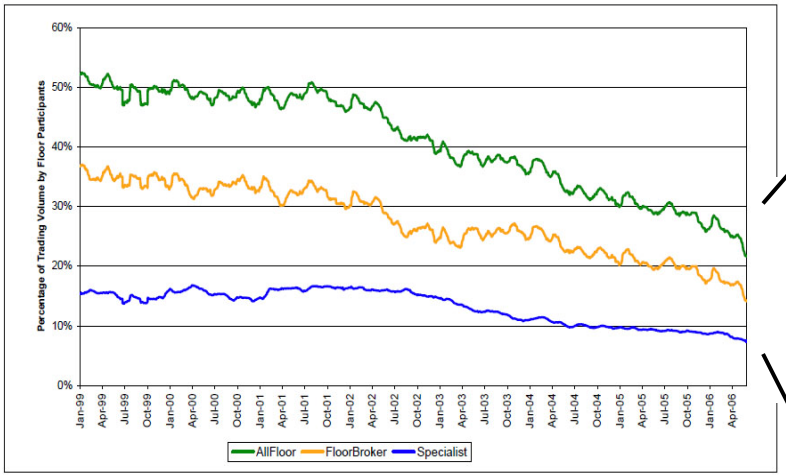
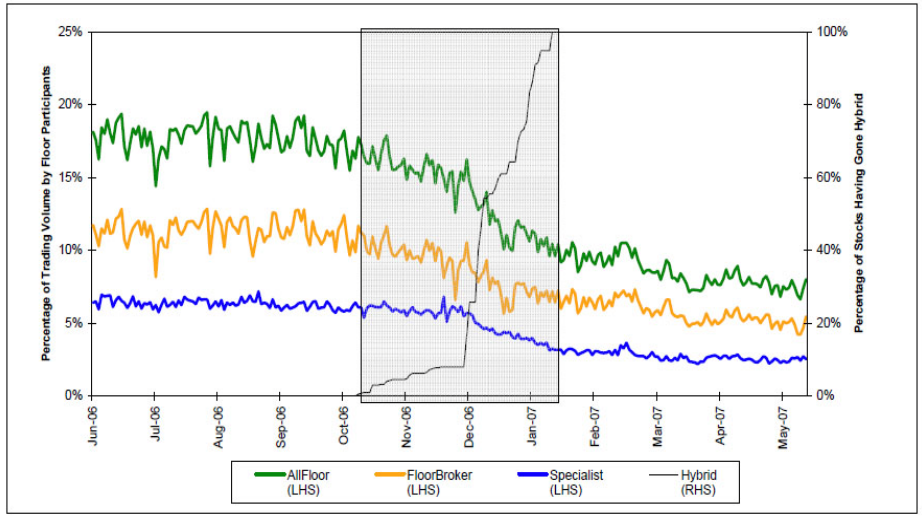
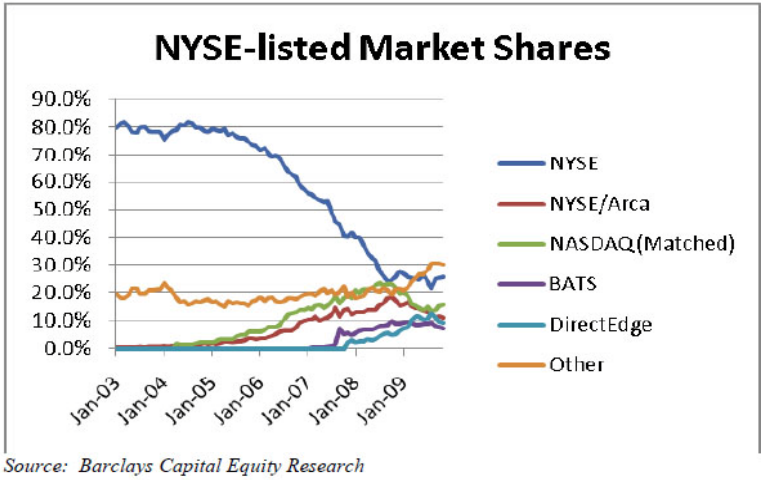


Figures from Hendershott and Moulton (2010).





Source: Barclays Capital Equity Research

Figure from Angel, Harris, and Spatt (2010).

-A decade ago, NYSE listed stocks traded primarily at the NYSE in a manual fashion.

-Over the last 10 years, the NYSE has become more automated (2002 OpenBook, 2003 Autoquote, 2006 Hybrid)

-In 2005, Regulation NMS eliminated the trade-through protection for manual quotes.

Is Automated Trading Good or Bad?

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-Regulators in the US and Europe are worried about the rapid increase of **high frequency** automated trading (the May 6, 2010 Flash Crash).

-Recent empirical research suggests that automated trading has been beneficial for markets, but no one has offered an explanation for why.

What Happens When Trading is Automated?

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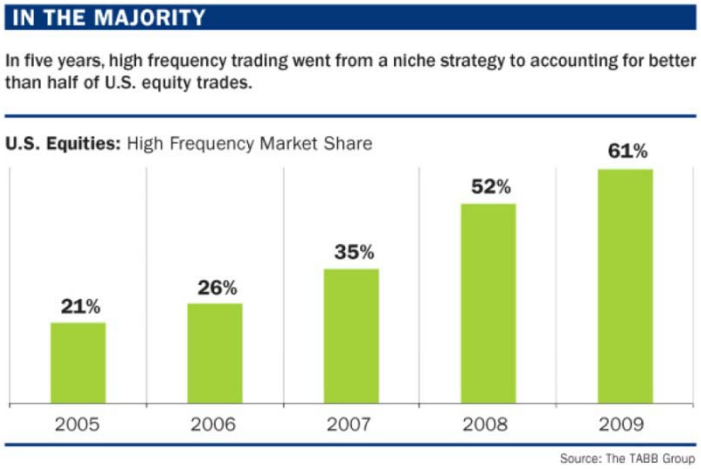
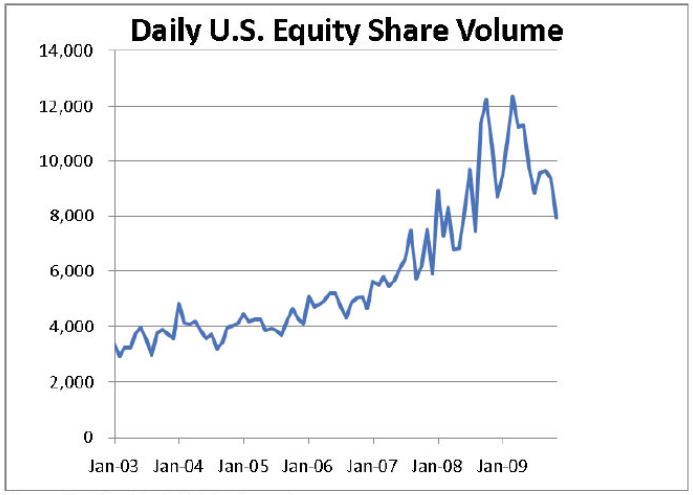


Machines dominate

Figure from *The Lowdown On High Frequency Trading*, Futures Magazine (2010).

Prices are more efficient

Hendershott and Riordan (2009) show that automated trades and quotes in DAX stocks contribute more to the discovery of the efficient price.



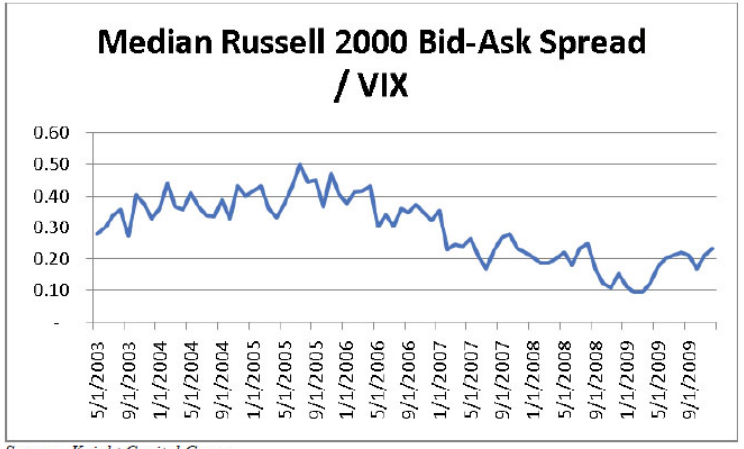
Source: Barclays Capital Equity Research

Volumes increase

Figure from Angel, Harris, and Spatt (2010).

Transaction costs are reduced

Figure from Angel, Harris, and Spatt (2010).



Source: Knight Capital Group

Questions

Why does automated trading dominate floor trading?

Why are prices more efficient?

Who benefits and who is harmed?

Why do transaction costs decrease and volumes increase?

We develop a model that helps answer these questions.

Intuition of Model

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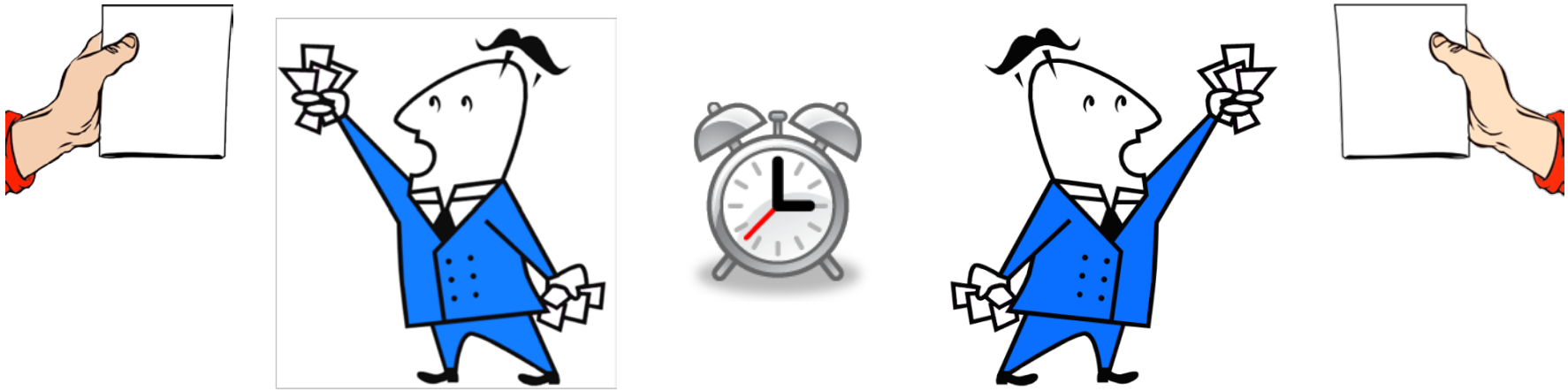
Automated systems allow securities/exchanges to be more tightly connected so that liquidity flows easily between assets.

Traditional market makers connect individuals through time, i.e., someone trading in the morning to someone trading later in the day.



Intuition of Model

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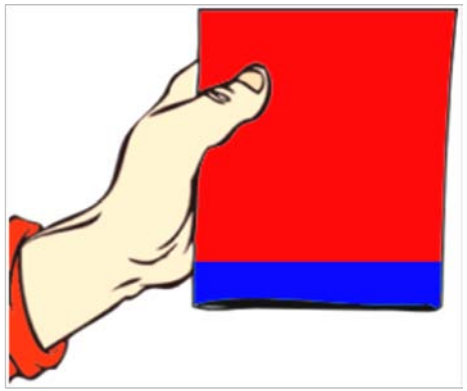
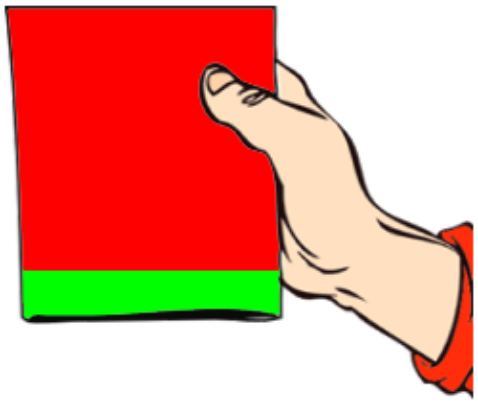
Automated market makers connect traders across securities. If two securities XYZ and ZYX are similar to each other, then a buyer in XYZ and a seller in ZYX who are trading at the same time can be connected through the trades of an automated liquidity provider willing to take the opposite side of each order.





Model

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-Multi-asset Glosten and Milgrom (1985) model.

-**Informed investors** and **liquidity traders** submit unit sized market orders to competitive risk-neutral liquidity providers.

-Each security has one **market maker** (MM) who prices incoming orders for only that security.

-An **automated market maker** (AMM) competes with individual MM's in each security. The AMM is the only participant who trades multiple securities and understands the relationships between their values.

Model

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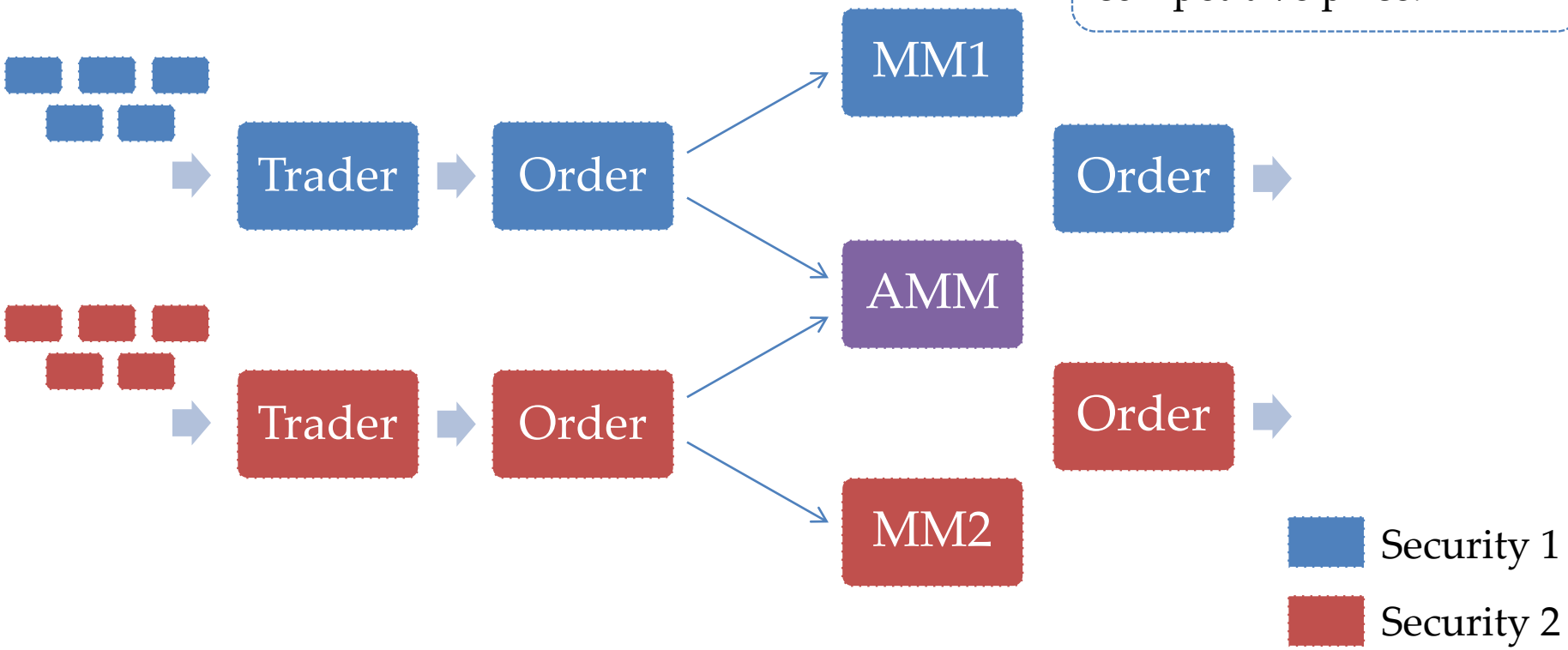
1. One trader is randomly selected for each security and places an order.

2. Order is transacted by the liquidity provider who offers the most competitive price.



Model

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-**Informed investors** know the end-of-period value of the security they trade. They buy if it is **high** and sell if it is **low.**

$$V_i^+ = p_i + r_i,$$

$$V_i^- = p_i - r_i.$$

-There is an equal probability of the value being high or low such that the expected price is p_i. The fraction of informed investors in security *i* is γ_i.

-**Liquidity traders** are equally likely to buy or sell the security they trade. They are willing to accept whatever price is set by the market maker.

-The end-of-period value of stocks are related to one another such that the probability of security *i* having a high or low value changes when conditioning on the value of other assets.

$$P(V_i) \neq P(V_i|V_j) \neq P(V_i|V_j, V_k) \neq \cdots \neq P(V_i|V_j, V_k, \ldots, V_N)$$

Results

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When the AMM competes with traditional MM's:

-The AMM transacts the majority of orders. (Proposition 1)

-The transaction costs of informed traders increase. (Proposition 2)

-The transaction costs of liquidity (or uninformed) traders decrease. (Proposition 2)

-Prices are more efficient. (Proposition 3)

Results

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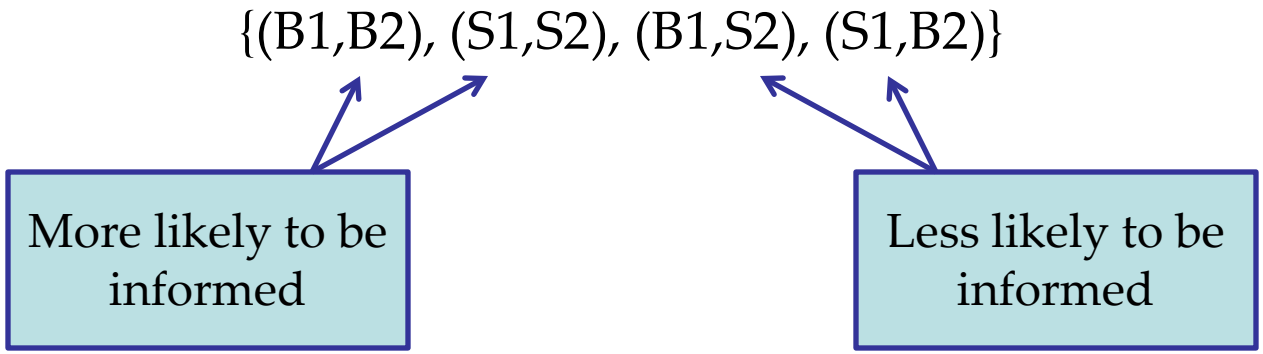
-Suppose the market consists of 2 securities whose end-of-period values are positively related.

-There are four order flow states (B1 denotes a buy order for security 1, etc.):



-The AMM knows which states are more likely to include informed trading! She sets worse transaction prices for the first two states and better transaction prices for the second two states.

Results

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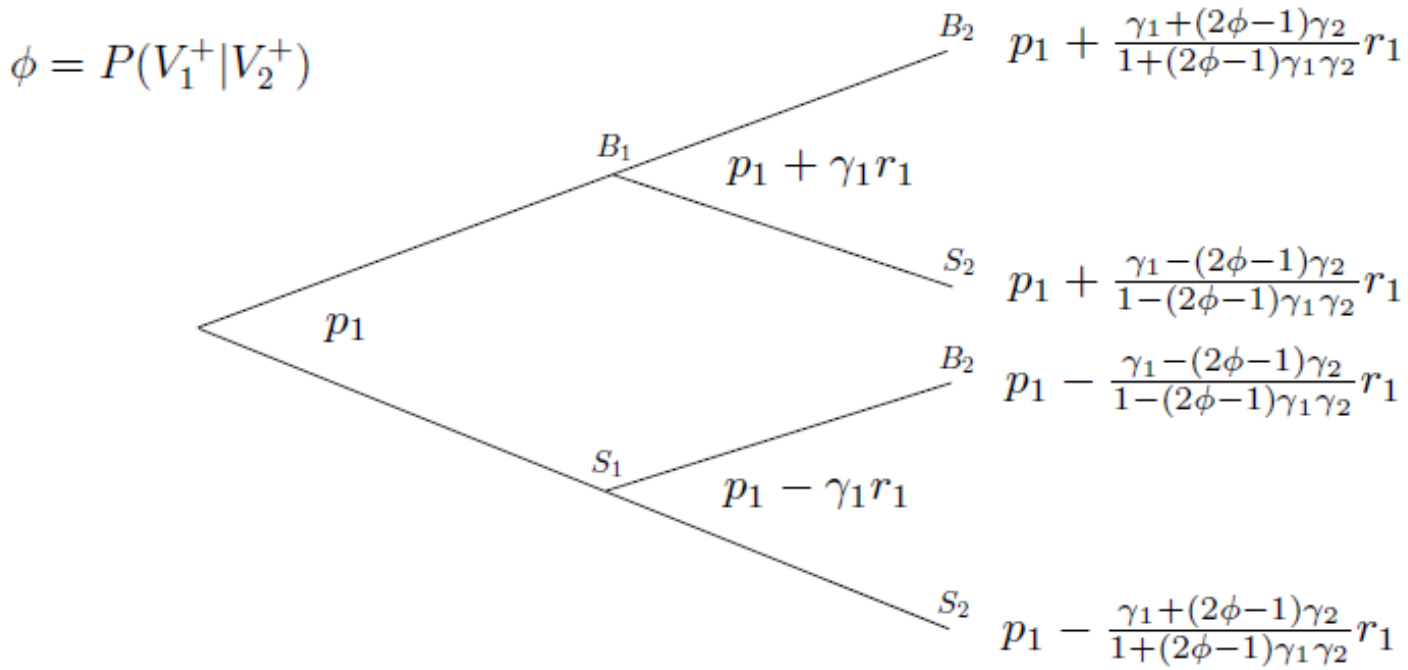

Figure 1: Diagram of the transaction prices for security 1 in the 4 possible order flow states, $\{(B_1, B_2), (B_1, S_2), (S_1, B_2), (S_1, S_2)\}$, in a two security market. The values shown at earlier nodes are not transaction prices, but are the expected price at those nodes.

Results

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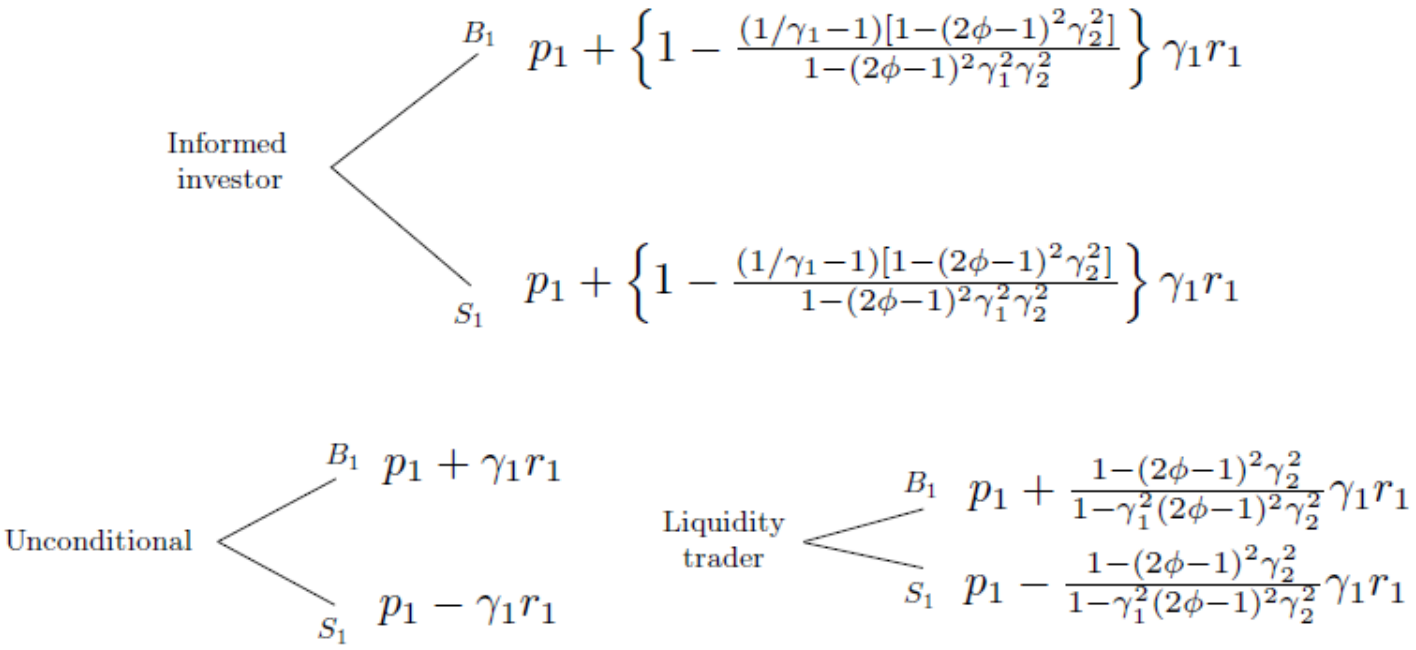

Figure 2: Diagram of the average buy and sell transaction price for informed investors, liquidity traders, and unconditional on trader type. Notice that informed investors realize a larger spread than liquidity traders, and that the spread without the automated market maker is the expected spread over both of these trader types.

Results

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EXTENSION OF MODEL: Since liquidity traders have lower transactions costs, more liquidity traders should be willing to trade. When we allow liquidity traders to have some price elasticity in their demand, then:

-Transaction volumes increase. (Proposition 4)

-Overall transaction costs are reduced. (Proposition 5)

Conclusions

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-In the model above, the AMM is able to price securities more precisely than the MMs. As a result, she **transacts the majority of order flow** and **causes prices to be more efficient**.

-The presence of the AMM has material effects on investors: **informed investors make smaller profits** and **uninformed investors lose less money**.

- Informed investors make smaller profits because they must now compete with one another across securities.
- Uninformed investors lose less money because they are able to transact through the liquidity provider to other uninformed investors in related securities.

-If the uninformed increase their trading activity due to lower transaction costs, **overall volumes increase** and **overall transaction costs are reduced**.

-These results match nicely with recently observed changes in US markets, where high frequency automated trading now dominates.