# *Market Makers & Liquidity in Demand Responsive Transit Markets*

## *How to facilitate transactions on the DRT Exchange*

# The Problem

- On Earth in the years 2003 – 2020, in any given city or town at any time, a large number of cars, buses and vans are travelling around with unoccupied spare seats.

- This creates traffic congestion and burns more fuel overall than necessary.

- A demand responsive transit exchange exists to solve the problem of these "empty seats travelling" by encouraging people to share rides in the same vehicle dynamically and in real-time (2 – 10 minutes ahead)

# The Market Formation Problem

- *The market formation problem is one that plagues ridesharing initiatives.*
- *When a person needs a ride, there is a low likelihood of finding an exact ridematch: someone else going from the same place to the same place at that exact time.*
- *Meaning that people often abandon attempts to share for want of enough suitable vehicles to transport them*

# The Market Formation Problem

- *And that drivers are very unlikely to want to subscribe to a system that cannot get them enough paying passengers in their shuttle to cover costs*

- **This is where the <span style="color:red">Market Maker</span> comes in**

- *The **Market Maker** is a market participant otherwise known as a speculator who pays the drivers a minimum amount per seat per ride and takes the risk of filling the empty seats with paying customers*

# What is a Market Maker?

- *The difference between the price the Market Maker pays the drivers per seat and the price it charges the customers per seat is also known as the spread*

- *You may be familiar with this concept from foreign exchange markets or high street bureaux de change*

- *It is why large-scale starvation was largely ended in North America and Europe from the 1840s onwards*

# What is a Market Maker?

- *By using the same concepts from commodity exchanges, aeronautical engineering and applied mathematics there is a solution to the "market formation problem"*

- *Using historical trip data (a corollary for historical volatility), vehicles can be prepositioned at areas of the highest probability of ridematch*

- *Also using genetic algorithms to find the best solution for a group of people through a city's road network*

# What is a Market Maker?

- *Because it is unclear that a market maker will absolutely fill each car every time, it charges a higher % of earnings to the driver for easier trips in order to smooth out its inevitable losses for the less good times*

- *By doing this the Market Maker offers "assuredness of completion" providing* **liquidity** *to the rideshare market, smoothing the path to successful trades*

# What is Liquidity?

- *Liquidity is a measure of how easy it is to find a buyer for a seller and vice versa.*

- *If you were selling your house and you could do it easily and quickly (in minutes) we would say that this was a highly liquid market (high liquidity).*

- *On the other hand, if you found it hard or nigh on impossible to even get viewers, even at a low price, this is called a lack of liquidity*

# Matching Buyers and Sellers

- *The best way to match buyers and sellers is to provide a platform and a mechanism for those two participants to find one another*

- *This is what most online marketplaces are: continuous auctions*

- *Some auction platforms are not constrained in time like the rideshare market is. If it takes a few days or even months to find a buyer for a seller (or vice versa) it is no problem.*

# Matching Buyers and Sellers

- *It is the ultimate problem, however, in the rideshare market and is why old methods to promote such markets will fail in real-time dynamic ridesharing.*
- *A new approach, encapsulating marketing, marketing operations and psychology is vital to enable customers to make the shift*
- *Managing perceptions is vital too: too many no-shows (even as few as 2) will kill any rideshare attempt*

# Cost, Value and Price

- *Cost is independent to the purchaser – it is a function that the supplier is concerned with although it will inevitably (eventually) finally have some bearing on price.*

- *Price is a variable the supplier chooses and is based on, amongst other things, purchaser perception and marketing strategy.*

- *Value is a quality, purely in the mind of the purchaser, but it will be compared to other offerings on the market.*

# Price Discovery

- *The key point about a free market is that prices tend to their "natural" level. In the absence of non-Nash competition, there can never be a "rip-off" price*

- *Large-scale players such as Uber have tried to crush out all competition in the market by raising huge rounds of financing and supplying a product at an enormous loss for up to 10 years in order to win in the end*

# Price Discovery

- *China expressly forbids this strategy, enshrined in law by the "anti-unfair competition act"*
- *Without ridesharing, such an approach is doomed to create enormous and unrecoverable losses for the player engaging in it.*

# Value Discovery

- *With a dynamic pricing model, the system will enable discovery of just how much people value usage of a road at a particular time.*

- *With options to share transport to reduce costs, value determinations will be made by all road-users.*

- *Once true road pricing and congestion costs are internalised, the value of travelling singly may be outweighed by cost considerations ceteris paribus*

# bid / ask spread

- Stock markets are profit making organizations. Brokers, specialists, and market makers all participate in the markets to turn a profit.
- They trade only when they expect to make profits. Those profits are the price that investors and other traders pay in order to execute their orders when they want to trade.
-  The most common price for referencing stocks is the last trade price, but the last price is not necessarily the price that a person can subsequently trade now or in the future.
- At any given moment during market hours there is a best or highest "bid" price from someone that wants to buy the stock and there is a best or lowest "ask" price from someone that wants to sell the stock.

# bid / ask spread

- *Additionally, that bid and ask will be for a specific number of shares.*
- *The Bid-Ask Spread, also known as the Bid-Offer Spread, is the quote of the price at which participants in a market are willing to buy or sell a good or security.*
- *Specifically, the bid price is the price at which a party is willing to purchase, while the ask (or offer) price is the price at which the same person or another party is willing to sell the same good or security.*
- *The spread between the two prices arises as valuations differ, and transactions usually occur somewhere in the middle as one party changes the price they are willing to pay or accept in order to obtain or sell the good or security.*

# bid / ask spread

- *For example, the above quotation shows participants in a market are willing to pay 1.2635 for the EURUSD, and are conversely willing to sell the same pair at 1.2638. This creates a 1.2635/38 spread, which is 3 basis points wide.*

- *Often referred to at the Bid Offer Spread, this is the amount the buy price (ask or offer price) exceeds the sell price (bid).*

| EUR/USD | |
|---|---|
| Low:1.2621 | High:1.2642 |
| 1.26 **35** | 1.26 **38** |
| Sell | Buy |

# Source of the Bid Ask Spread

- **Every** market has a spread. Whether foreign exchange (FX), equities, futures or your local boutique, the market maker will practically always charge a higher price than the one originally paid.
- The size of the spread is primarily due to **liquidity** and transparency in the market. **More** buyers and sellers competing in the same space will bring **lower** bid/offer spreads.

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# Source of the Bid Ask Spread

- *When all participants have access to the same price information at the same time, few market makers are able to get away with wider than normal spreads since traders will easily find a better offer (or bid) elsewhere.*

- *Since Foreign Exchange is the world's biggest and most liquid market and as technology has given anyone with access to a computer and the internet real-time pricing information – spreads in fx are extremely low – just fractions of a cent.*

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# Auctions

- An **auction** is a _process_ of _buying and selling_ goods by offering them up for bid, taking bids, and then selling the item to the winning bidder. In _economic theory_, an auction is a method for determining the value of a _commodity_ that has an undetermined or variable _price_.

- Thus an auction is a means of determining the **fair value** of an item or service.

- There are several variations on the basic auction form, including time limits, minimum or maximum limits on bid prices, and special rules for determining the winning bidder(s) and sale price(s).

# Auction Theory

- *All of the private value auctions listed above are revenue equivalent assuming complete information, meaning that they all result in the same expected revenue for a seller.*

- *We make sure any customer can see the same information as any other customer*

- *Participants in an auction may or may not know the identities or actions of other participants. Depending on the auction, bidders may participate in person or remotely through a variety of means, including telephone and the internet. Auctions are generally funded by a fee paid by the seller to the auctioneer or auction company.*

# Auction Types

- *Vickrey*
- *English*
- *Dutch*
- *Sealed Bid First*
- *Sealed Bid Second*
- *All Pay*

# Vickrey Auction

- A **Vickrey auction** is a type of sealed-bid auction, where bidders submit written bids without knowing the bid of the other people in the auction.
- The highest bidder wins, but the price paid is the second-highest bid.
- The auction was created by William Vickrey.
- This type of auction is strategically similar to an English auction, and gives bidders an incentive to bid their true value.

# *Vickrey Auction*

- *Vickrey's original paper considered only auctions where a single, indivisible good is being sold. In this case, the terms Vickrey auction and second-price sealed-bid auction are equivalent, and are used interchangeably.*

- *When multiple identical units (or a divisible good) are being sold in a single auction, the most obvious generalization is to have all bidders pay the amount of the highest non-winning bid. This is known as a [uniform-price auction](#).*

- *The uniform-price auction does not, however, result in bidders bidding their true valuations as they do in a second-price auction unless each bidder only has demand for a single unit.*

# Vickrey Auction

- *A generalization of the Vickrey auction that maintains the incentive to bid truthfully is known as the Vickrey-Clarke-Groves (VCG) mechanism. The idea in VCG is that each player in the auction pays the opportunity cost that their presence introduces to all the other players.*

- *For example, suppose that we want to auction two apples, and we have three bidders.*

- *Bidder A wants one apple and bids $5 for that apple. Bidder B wants one apple and is willing to pay $2 for it. Bidder C wants two apples and is willing to pay $6 to have both of them, but is uninterested in buying only one without the other.*

# Vickrey Auction

- First, we decide the outcome of the auction by maximizing bids: the apples go to bidder A and bidder B.
- Next, to decide payments, we consider the opportunity cost that each bidder imposed on the rest of the bidders.
- Currently, B has a utility of \$2. If bidder A had not been present, C would have won, and had a utility of \$6, so A pays \$6−\$2 = \$4.
- For the payment of bidder B: currently A has a utility of \$5 and C has a utility of 0. If bidder B had been absent, C would have won and had a utility of \$6, so B pays \$6−\$5 = \$1.
- The outcome is identical whether or not bidder C participates, so C does not need to pay anything.

# Vickrey Auction

- *Vickrey auctions are much studied in economic literature, but are not particularly common in practice. One market in which they have been used is stamp collecting. eBay's system of proxy bidding is similar, but not identical, to a Vickrey auction.*

- *A slight generalized variant of a Vickrey auction, named generalized second-price auction, which is different from the VCG mechanism, is known to be used in Google's and Yahoo!'s online advertisement programmes.*

# English Auction

- *In some cases, bids may be made absentee, by leaving them with the auctioneer, or by phone or by Internet (in which case live bids may also be visible online).*

- *A variant popular in the time of Samuel Pepys was 'auction by candle' in which the winning (highest) bid was the last one to be made before a small piece of lit candle died out.[2]*

- *Such auctions can be vulnerable to collusion: Two or more bidders act together to win the auction. Following the auction result, the "loser" threatens to sue the winner, who then proposes a settlement.*

- *The settlement is actually the pre-agreed reward for the loser's cooperation. This strategy was described by the economist Susan Athey.*

# English Auction

- *English auction: This is the type of auction commonly used by the English auction houses like Sotheby's, Christie's, and Phillips.*
- *Participants bid openly against one another, with each bid being higher than the previous bid. The auction ends when no participant is willing to bid further, or when a pre-determined "buy-out" price is reached, at which point the highest bidder pays the price.*
- *The seller may set a 'reserve' price and if the auction fails to have a bid equal to or higher than the reserve, the item remains unsold. If there is no reserve price, the auction is called absolute.*

# *Dutch Auction*

- *In the traditional Dutch auction the auctioneer begins with a high asking price, which is lowered until some participant is willing to accept the auctioneer's price, or a predetermined minimum price is reached. **The winning participant pays the last announced price.***

- *The Dutch auction is named for its best known example, the Dutch tulip auctions. ("Dutch auction" is also sometimes used to describe online auctions where several identical goods are sold simultaneously to an equal number of high bidders. Economists call the latter auction a **multi-unit English ascending auction**.)*

# Sealed-bid first-price auction

- *Also known as Sealed High-Bid Auction or First-Price Sealed-Bid Auction (FPSB). In this type of auction all bidders simultaneously submit bids so that no bidder knows the bid of any other participant. The highest bidder pays the price they submitted.*

# Sealed-bid second-price auction,

- *also known as a [Vickrey auction](): This is identical to the sealed first-price auction, except the winning bidder pays the second highest bid rather than their own. This is very similar to the proxy bidding system used by eBay, where the winner pays the lesser of their actual bid and the second-highest bid plus one bidding increment.*

# All-pay auction

- *[All-pay auction](): an auction in which all bidders must pay their bids regardless of whether they win the prize. The highest bidder wins the prize. The all-pay auction is often used to model lobbying (bids are political contributions), or other competitions.*

# *Technology behind an Exchange*

- *Thus a DRT exchange is a whole lot more than a "booking app".*

- *It requires as many streams of quotes as possible from the widest variety of sources*

- *It then requires a matching system to find and efficiently allocate riders to vehicles in the most efficient manner.*

- *This is an NP-hard problem that is best solved with heuristic methods like a genetic algorithm*

# Technology behind an Exchange

- And it is not only as simple as taking into account prices
- Or user proclivities
- Vehicle availability must be managed
- Liquidity is paramount as is the overall user experience
- Knowing how long to wait and when to dispatch is a function of what kind of losses the Market Makers can and will bear.

# *Bibliography*

- *Transport, A New Beginning*
- *Transit Exchange – The Underpinnings*
- *Texxi – the Market Size and Opportunity*
- *Why do DRT schemes fail*

# bid / ask spread

- Let take an example of Stock XYZ, which is currently quoted at 100 by 100 1/4. In other words someone is willing to buy XYZ at 100 and someone is willing to sell XYZ at 100 1/4. An investor that places an order to buy 100 shares of XYZ at the market will get executed at 100 1/4 while an investor the places an order to sell 100 shares of XYZ will get executed at 100. If the market maker placed both the bid and the ask and executed both orders he will earn the 1/4 point as a profit. The market maker profits by doing this over and over again throughout market hours. The market maker loses money when he/she fills an order and reverses the trade at a worse price.

- The following is an example of how a market maker can lose money. An institutional investor places a market order to buy 100,000 shares of XYZ. The specialist agrees to sell the shares at a price of 101. The market maker is now short 100,000 shares of XYZ and will make a profit if he can buy back the 100,000 shares for less than 101. However after completing the order, the same buyer places an order to buy another 200,000 shares. The market maker now has an outstanding order to buy shares yet his interest is also to buy shares back at a lower price. The term getting "bagged" is used by some to describe the market maker's situation. In other words, a trader or market maker completes a trade only to have the opposing party push the price further by transacting even more shares in the market.

- When transacting large orders, the market maker operates under the hope that the opposing party is finished transacting in that stock or that he has charged enough of a price concession to make up for any subsequent price impact from additional trades. But if the completed order is only part of a larger decision to buy more shares, the market maker can lose money as the additional buying pressure causes the stock to rise further.

- Returning to the original XYZ example, let's take an example of a person who places a buy order for 100 shares at 100 1/8. This person is attempting to save half the spread cost (1/8) by placing a limit order. If the price rises and the order is never filled the investor will either have to live without the stock or pay a higher price. If the stock subsequently goes to 101, a person who placed a market order and paid 100 ¼ is clearly better off than the person who originally placed a limit order hoping to save an 1/8, but never purchased the stock because it moved higher. Of course, we would all make the correct choice if we knew in advance what was going to happen. Therefore, the motivation for the trade must be considered when deciding whether to place a market order or a limit order. If the order is not time sensitive a limit order may end up costing less, but a market order may be the only way to get an order filled if the order is time sensitive and the price moves against you.

- Institutional investors incur opportunity costs as a result of not completing large orders and these costs can be a significant factor in performance. For more on opportunity costs see The Iceberg of Transactions Costs from The Plexus Group. The Plexus icebergs refer to costs incurred by institutional investors, which typically trade hundreds of thousands or even millions of shares at a time.

- Institutional investors face the challenge of completing massive orders at a minimum cost. An institutional investor that exposes an order for a large number of shares can expect the price to jump immediately, so they may instead attempt to gradually work the order in small pieces over several days or weeks. Day traders will frequently try to buy or sell in advance of large working institutional orders if they can identify a large order in progress.

- Institutional investors try to reduce their costs by trading with institutional brokers that specialize in handling large block orders and by using trading systems designed match to orders with other institutional traders. These systems attempt to eliminate the spread and any price impact. For instance, ITG's POSIT matches trades several times during the day at the mid point of the bid/ask spread and the Crossing Network matches trades at the closing price. While trades completed through these system tend to have lower up front costs, traders run the risk of simply not getting their orders executed quickly or at all.

- The purpose of a market is to provide a location where buyers and sellers can transact. The more buyers and sellers at any given time, the more efficient a market will be in matching buyers and sellers with minimum effort and costs. Electronic Communications Networks (ECNs) like Instinet and Island work well when many market participants use the system simultaneously.

- The NYSE and AMEX are specialist markets. A specialist is assigned to each stock and the specialist maintains a book of current bids and asks. In specialist markets, a market maker is expected to provide liquidity (by using their own capital) for large orders when buy and sell orders do not balance. The market maker takes the risk that prices will move against his position but also has the advantage of seeing the limit orders.

- On NASDAQ there is no specialist so large orders can result in large price moves. NASDAQ uses a network of dealers connected electronically. Dealers place bid and ask prices on a continuous basis and trades are linked and executed electronically. Day traders tend to concentrate on NASDAQ stocks because orders and executions can be placed and confirmed with virtually no time delays. Orders placed on the NYSE may take several seconds or more to be processed through the specialist system.

- Generally, the more liquid the stock the smaller the spread. Penny stocks and options have notoriously large spreads. If a security has a spread of several percentage points, an investor or trader attempting to make money would have to get several percentage points of price movement just to break even on a trade using market orders. Day traders tend to trade in very liquid stocks that have very small spreads. See also Let Us Now Praise Day-traders from Money (October 1999) for further discussion on this topic.

- Just as the internet has offered individual investors the opportunity to transact in the securities market with little or no brokerage costs, new systems and software are providing direct access to the markets giving individuals the opportunity to, in effect, become market makers. Traders can buy and sell securities with the same speed as professional market makers and securities dealers.

- A difference between a professional market maker and a day trader might be that a day trader will generally open a trade and immediately try to reverse the trade while a market maker will not immediately try to reverse each trade. Over the course of the day the market maker will try to balance his book, but he will generally have more capital available and is more concerned with the average of many trades than concentrating on each individual trade during the day.

- A distinction to be made with professional market makers and day traders is when they cross the line from market making activities to taking positions in order to speculate on the direction of securities. Some day traders are truly speculators trying to outsmart the market by buying in advance of market rises and selling in advance of market declines. This however is a zero sum game where someone wins a dollar for every dollar lost by someone else. See The Winners and Losers of the Zero-Sum Game: The Origins of Trading Profits, Price Efficiency and Market Liquidity by Professor Lawrence Harris for more on this topic.

- We know that market making is a profitable business because public securities firms regularly report profits from their securities trading departments and NYSE specialist firms are very profitable. Knight/Trimark for example, is a publicly traded market making firm that makes markets in thousands of Nasdaq stocks and is very profitable. The Trimark Securities division trades NYSE- and AMEX-listed equity securities over the counter. Whether or not day traders make money is a separate question that has yet to be fully determined.