3. BATCH MARKETS

3.1 Introduction

The perspective here is: multiple buyers, multiple sellers.

All trading takes place at a single instant (not necessarily at a single price)

Coordination

Most markets with many buyers and sellers are completely fragmented.

> Example: used car market.
>
> Buyers and sellers find each other in many ways, and arrive at many different kinds of bargains.

A batch market is coordinated in:

> time and place
>
> standardized procedures

This coordination helps batch markets achieve "orderly" and efficient trading.

We'll be looking at markets that have achieved this level of coordination.

3.2 Mechanisms

Single-price double-sided auction

Buyers and sellers submit orders that specify price and quantity.

Supply and demand curves are constructed; market clearing quantity and price determined.

Variations

- Some markets accept unpriced "market" orders.
- Prior to the clearing, do traders know the market-clearing price?
- Prior to the clearing, do traders know the full supply and demand curves.

- Can traders submit new orders at any time?
- Can traders cancel orders at any time?

Matching markets

Buyers and sellers are matched (paired off). Priority usually goes to

- most aggressively priced orders (lowest-priced sell orders; highest-priced buy orders)
- oldest orders

The trade price for a particular matching is determined by rules.

Trades generally occur at multiple prices.

3.3 London gold market

Formally: London Bullion Market Association

"An over-the-counter market not an exchange": all trades are principal-to-principal. No transfer of credit risk; no regulation by the Association.

Minimum size of a trade is 1,000 oz gold (approx. $400,000 at current prices)

Procedure

Five representatives of firms meet twice each day at offices of N.M. Rothschild.

The chairman calls out price

Reps state their net supply/demand at that price.

These are net over the firm's customers

If there's an imbalance, chairman tries another price.

If a Rep wants to change his/her amount, signals by raising the UK flag.

As the price changes, rep may contact customers, who may revise

When a price is found at which supply=demand and no flags are raised, the market clears.

The process is a real-world approximation to the "Walrasian tatonnement" procedure featured in classic economic models of supply and demand.

3.4 The Itayose procedure used to open the Tokyo Stock Exchange

Orders:

Market orders specify a quantity but no price. ("Buy 100 shares at the market".)

Limit orders specify a quantity and a price. ("Buy 100 shares at a price no higher than ¥450.")

Supply and demand curves are constructed.

At the single market clearing price:

(a) All market orders execute

(b) All limit buy orders priced above the clearing price execute. All limit sell orders priced below the clearing price execute.

(c) For limit orders priced at the market clearing price, either

(i) All buy orders execute and at least one sell order.
or

(ii) All sell orders execute and at least one buy order.

Example:

Suppose that we have the following orders:

Offer (sell)		Price	Bid (buy)	
Aggregate	**Quantity**		**Quantity**	**Aggregate**
	6,000	**Market orders**	4,000	
44,000	8,000	502	1,000	5,000
36,000	20,000	501	7,000	12,000
16,000	4,000	500	10,000	22,000
12,000	2,000	499	8,000	30,000
10,000	4,000	498	30,000	60,000

Note: A trading unit is 1,000 shares.

We tentatively try a clearing price of 500:

Offer	Price	Bid	
6,000	**M.O.**	*4,000*	First, according to requirement (a), the market orders of 4,000 shares to buy and 6,000 shares to sell are matched, leaving sell orders of 2,000 shares.
8,000	502	1,000	
20,000	501	7,000	
4,000	**500**	10,000	
2,000	499	8,000	
4,000	498	30,000	

Offer	Price	Bid	Next, according to requirement (b), the market sell orders of 2,000 shares and sell orders of 6,000 shares at limit prices of 499 yen or less are matched with the buy orders of 8,000 shares at limit prices of 501 yen or more. Thus so far, 12,000 shares have been matched in total.
2,000	**M.O.**		
8,000	502	*1,000*	
20,000	501	*7,000*	
4,000	**500**	10,000	
2,000	499	8,000	
4,000	498	30,000	

Offer	Price	Bid	
	M.O.		Finally, the sell orders of 4,000 shares at a limit price of 500 yen are matched with the buy orders of 10,000 shares at a limit price of 500 yen. Although this still leaves buy orders of 6,000 shares at 500 yen, this satisfies requirement (c).
8,000	502		
20,000	501		
4,000	**500**	*10,000*	
	499	8,000	
	498	30,000	

Offer	Price	Bid	
	M.O.		
8,000	502		Thus the opening price is determined at 500 yen and transactions of 16,000 shares are completed at 500 yen.
20,000	501		
	500	6,000	
	499	8,000	
	498	30,000	

Now, just as a precaution let's double-check by using 501 yen as the opening price.

Offer	Price	Bid	
6,000	**M.O.**	*4,000*	According to requirement (a) and as explained above, the market orders are matched leaving sell orders of 2,000 shares.
8,000	502	1,000	
20,000	**501**	7,000	
4,000	500	10,000	
2,000	499	8,000	
4,000	498	30,000	

Offer	Price	Bid	
2,000	**M.O.**		Then, assuming an opening price of 501 yen, the remaining market sell orders of 2,000 shares and sell orders of 10,000 shares at limit prices of 500 yen or less are matched with the buy orders of 1,000 shares at limit prices of 502 yen or more. However, with only 1,000 shares on the bid side it is impossible to execute all the market sell orders. Thus meaning the Itayose requirements cannot be meet at 501 yen.
8,000	502	*1,000*	
20,000	**501**	7,000	
4,000	500	10,000	
2,000	499	8,000	
4,000	498	30,000	

3.5 The economics of the single-price clearing

Construction of supply and demand curves

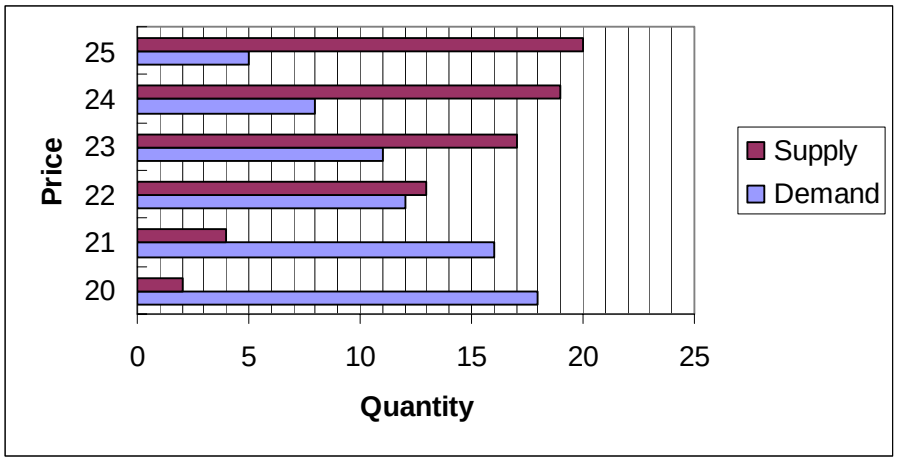
Suppose we have a set of buy orders. We construct the demand curve by cumulating from high prices to low:

Price	Demand	To Buy	Name			
20	18	2	Ira			
21	16	2	Hannah		Demand	Price
21	14	2	George		18	20
22	12	1	Florence		16	21
23	11	2	Ed		12	22
23	9	1	Diane		11	23
24	8	3	Charlie		8	24
25	5	2	Beth		5	25
25	3	3	Abe			

To construct the supply curve, cumulate sell orders from low prices to high:

			Price	Supply	To Sell	Name
			20	2	2	Alice
Price	Supply		21	3	1	Brian
20	2		21	4	1	Cathy
21	4		22	7	3	David
22	13		22	9	2	Ellen
23	17		22	13	4	Floyd
24	19		23	14	1	Gina
25	20		23	17	3	Henry
			24	19	2	Iris
			25	20	1	John

A plot of the supply and demand curves:



At any given price, trade volume is the minimum of the demand and supply.

Trade volume is maximized at price=22

At the volume-maximizing price, who is eligible to trade?

On the demand side:

Price	Demand	To Buy	Name
20	18	2	Ira
21	16	2	Hannah
21	14	2	George
22	***12***	***1***	***Florence***
23	***11***	***2***	***Ed***
23	***9***	***1***	***Diane***
24	***8***	***3***	***Charlie***
25	***5***	***2***	***Beth***
25	***3***	***3***	***Abe***

On the supply side:

Price	Supply	To Sell	Name
20	***2***	***2***	***Alice***
21	***3***	***1***	***Brian***
21	***4***	***1***	***Cathy***
22	***7***	***3***	***David***
22	***9***	***2***	***Ellen***
22	***13***	***4***	***Floyd***
23	14	1	Gina
23	17	3	Henry
24	19	2	Iris
25	20	1	John

At 22, supply=13; demand=12.

What is the rule for allocation among the sellers: pro rata? time priority?

For the moment, suppose Floyd only gets to sell 3 contracts.

The traders' surplus

In an auction, a buyer's profit was his/her "value", less what she paid.

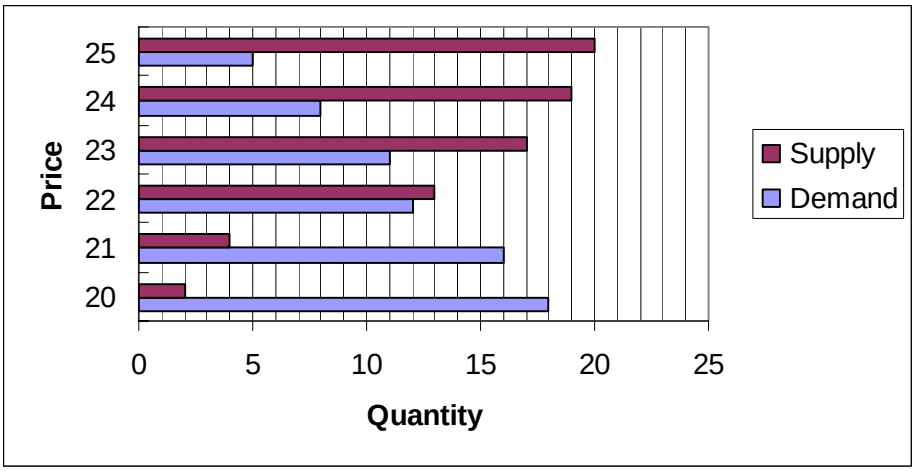
The value was the most a buyer would willingly pay.

In the auction, the quantity was "one object"

The analogous concept here is the buyer's surplus:

(Max price – actual trade price) x Quantity

- The buyers' surplus



2 buyers were willing to pay 25 for 5 contracts; they actually paid 22:
Surplus = 5 x (25–22) = 15;

1 buyer was willing to pay 24 for 3 contracts:
Surplus = 3 x (22–22) = 6

2 buyers were willing to pay 23 for 3 contracts:
Surplus = 3 x (23–22) = 3

Total buyers' surplus = 15 + 6 + 3 = 24.

- Seller's surplus

1 seller was willing to accept 20 for 2 contracts; she actually received 22; surplus = 2 x (22–20) = 4;

2 sellers willing to receive 21 for 2 contracts; surplus = 2 x (22–21) = 2

Total sellers' (producers') surplus = 4 + 2 = 6

- The total surplus

Total surplus (buyers' + sellers') = 30

No other feasible single price yields a higher total surplus. (Verify)

But as long as we keep the identities of the buyers and sellers the same, any set of prices for bilateral deals also yields the same surplus.

Alternative matchings

A matching is a pairing of buyers and sellers.

We can construct many alternative matchings that favor/disfavor particular traders

Here's a matching where the entire surplus accrues to the sellers:

Price	Demand	To Buy	Name
20	18	2	Ira
21	16	2	Hannah
21	14	2	George
22	***12***	***1***	***Florence***
23	***11***	***2***	***Ed***
23	***9***	***1***	***Diane***
24	***8***	***3***	***Charlie***
25	***5***	***2***	***Beth***
25	***3***	***3***	***Abe***

Price	Supply	To Sell	Name
20	***2***	***2***	***Alice***
21	***3***	***1***	***Brian***
21	***4***	***1***	***Cathy***
22	***7***	***3***	***David***
22	***9***	***2***	***Ellen***
22	***13***	***4***	***Floyd***
23	14	1	Gina
23	17	3	Henry
24	19	2	Iris
25	20	1	John

Abe buys 3 at 25; Alice sells 2 at 25 (seller's surplus=10); Brian sells 1 at 25 (surplus=4)

Beth buys 2 at 25; Cathy sells 1 at 25 (surplus=4) David sells 1 at 25 (surplus=3); David has 2 remaining.

Charlie buys 3 at 24; David sells 2 at 24 (surplus=4). Ellen sells 1 at 24 (surplus=2)

Diane buys 1 at 23; Ellen sells 1 at 23 (surplus=1)

Ed buys 2 at 23; Floyd sells 2 at 23 (surplus=2)

Florence buys 1 at 22; Floyd sells 1 at 22 (surplus=0).

Buyers' surplus=0; sellers' surplus=30

3.6 The role of a coordinated clearing

Why might a single-price batch be preferable to unrestricted bilateral trade?

With unrestricted bilateral trading, the "wrong" agents might transact.

Suppose Iris offers at 23 & Ed says "Done"

Ed gets a "bad" price

Traders who would otherwise have sold at 22 won't be able to.

This is economically inefficient. (The outcomes have a lower total surplus)

3.7 Other single-price clearings

World-wide, the single-price clearing is one of the two dominant market mechanisms. (The other is the electronic limit order book.)

- Euronext

  Euronext is the for-profit corporation that runs many European stock markets (Paris, Brussels, Amsterdam, Lisbon, etc.)

  Active securities trade continuously (roughly between 9am and 5pm)

  Single price clearings are used to open and close the continuous trading sessions

  Most securities have "double fixings" (two single-price clearings without continuous trading in between)

- New York Stock Exchange

  The NYSE open and close are single-price clearings.

- Single-price clearings are also used in Toronto, Tel Aviv, etc.

3.8 Priority matching: An alternative to the single-price clearing

Start with the same set of orders:

Price	Demand	To Buy	Name
20	18	2	Ira
21	16	2	Hannah
21	14	2	George
22	***12***	***1***	***Florence***
23	***11***	***2***	***Ed***
23	***9***	***1***	***Diane***
24	***8***	***3***	***Charlie***
25	***5***	***2***	***Beth***
25	***3***	***3***	***Abe***

Price	Supply	To Sell	Name
20	***2***	***2***	***Alice***
21	***3***	***1***	***Brian***
21	***4***	***1***	***Cathy***
22	***7***	***3***	***David***
22	***9***	***2***	***Ellen***
22	***13***	***4***	***Floyd***
23	14	1	Gina
23	17	3	Henry
24	19	2	Iris
25	20	1	John

In a matching procedure, buyers and sellers are paired off.

Abe (the most aggressive buyer) gets paired with Alice (the most aggressive seller) for 2 contracts. Trade price is the average of Abe's price (25) and Alice's price (20) = 22.50.

Next, Abe is paired with Brian for 1 contract. Trade price is average of 25 and 21 = 23.

Beth and Cathy are paired for one contract, etc.

- Advantages

  No "inefficient" trades occur

- Disadvantages

  Order strategy is difficult to figure out: The order price affects the final trade price.

  Brokers' customers see multiple prices at one time.

3.9 The open on Nasdaq's SuperMontage

Nasdaq is the corporation that operates the U.S. over-the-counter stock market.

SuperMontage is Nasdaq's principal computer system for transmission of information and orders.

> Starting at 9:29:30 a.m., ET, NASDAQ clears out any locked-or-crossed market … by executing (or delivering for execution) the oldest most aggressively priced order/quote against the oldest most aggressively priced order/quote on the opposite side of the market. The execution will occur at the price of the newer order; thus, the price improvement will go to the older order. SuperMontage will continue to clear locked and/or crossed conditions in this manner until market is no longer locked-or-crossed.
>
> (Section XII, SuperMontage Functional Summary)

When one trader's bid is equal to another trader's offer price, we have a *locked market*.

Whe one trader's bid is above another trader's offer price, we have a *crossed market*.

- Example

A bid for 100 shares at $90.50 entered at 9:00 AM.

100 shares offered at $90.00 entered at 9:01 AM

These orders are crossed. In the open, the trade will occur at $90.00 (*not* the average of the two prices)

The earlier order gets the better price. (The buyer pays $90.00, rather than $90.50.)

Why give priority to the earlier order?

3.10 Batch procedures in security markets

Batch markets concentrate (in time) buying and selling interest.

They maximize market participation.

This is thought to stabilize prices and make them less subject to manipulation.

"Less subject" to does not mean "impervious"

How can we manipulate the market?

In the previous example, if Ed had demanded two more units, the closing price would have been 23 instead of 22.

If Cathy or Brian had put in orders to sell nine more units at 21, the clearing price would have been 21.

Usually, to profit from the manipulation, you have to reverse (unwind) your initial trade.

Ed has driven the price up, but to profit from the trade, he has to sell off units (which will drive the price down).

An important exception occurs if the closing price is being used as a settlement price for a cash-settled derivative or other transaction.

3.11 "Marking the close" Baron Capital

SEC Administrative Proceeding File No. 3-11096 April 29, 2003

Note: the respondents paid fines, but did not admit or deny the allegations

The SEC's Summary:

This case involves unlawful "marking the close" by Baron Capital in securities trades executed on the floor of the New York Stock Exchange ("NYSE"). Baron Capital influenced the closing price of stock in Southern Union Company ("SUG") by ordering the execution of purchase orders in SUG at or near the close of the market during a period when the closing price of SUG determined the consideration paid by SUG in consummating a pending corporate acquisition. Baron, the CEO of Baron Capital, instructed Baron Capital's traders to purchase the stock. Schneider and Blenke, Baron Capital traders, placed the orders with a broker-dealer on the NYSE floor. Respondents' trading affected the closing price of SUG.

- SUG and Pennsylvania Enterprises (“PNT”) were planning to merge.
- PNT's shareholders would exchange their PNT shares for shares of SUG stock and cash. The number of SUG shares and amount of cash which PNT shareholders would receive depended upon the average closing price of SUG's stock for the ten consecutive trading days ending on the third day before the closing date (the "pricing period").
- … the lower SUG's average closing price during the pricing period, PNT shareholders would receive from SUG proportionately more cash and less SUG stock in order to achieve the promised $35 total value; conversely, the higher the average closing price, PNT shareholders would receive from SUG proportionately more SUG stock and less cash.
- On October 18, 1999 and during the pricing period, Baron directed Schneider and Blenke to purchase large amounts of SUG … Many of the SUG purchases occurred at or near the end of each trading day during the pricing period. A purpose of these end-of-day purchases was to raise the average closing price of SUG during the pricing period.

- K. Baron, Schneider and Blenke engaged in numerous telephone conversations in which they discussed Baron Capital's purchases of SUG during the pricing period.
- For example, on the morning of October 22, 1999, Baron instructed Blenke to "do your buying today, and the end of the day, just buy [SUG] up into the twenties. . . . You know, 20 ¼, 20 ½, something like that."
- SUG's average daily trading volume during the two weeks preceding the pricing period was 19,530 shares per day, and during the pricing period it was 70,230 shares per day. Baron Capital's purchases made up approximately 78% of the volume during the pricing period.
- The average closing price of SUG during the pricing period was $20.125 per share … In contrast, the average closing price of SUG during the ten business days immediately prior to the pricing period was $18.55 per share … if [that] had been the average closing price during the pricing period, would have required SUG to pay millions more in cash (instead of SUG stock) to the PNT shareholders than SUG paid based on the actual $20.125 average close.

3.12 Problems

4. REFERENCES

Camerer, Colin, and Richard H. Thaler, 1995, Anomalies: ultimatums, dictators and manners, Journal of Economic Perspectives 9, 209-219.

Kagel, John H., Ronald M. Harstad, and Dan Levin, 1987, Information impact and allocation rules in auctions with affiliated private values: a laboratory study, Econometrica 55, 1275-1304.

Kagel, John H., Chung Kim, and Donald Moser, 1996, Fairness in ultimatum games with asymmetric information and asymmetric payoffs, Games and Economic Behavior 13, 100-110.

Kahneman, Daniel, Jack L. Knetsch, and Richard H. Thaler, 1986, Fairness as a constraint on profit seeking: entitlements in the market, American Economic Review 76, 728-741.

Klemperer, Paul, 1999, Auction theory: a guide to the literature, Journal of Economic Surveys 13, 227-260.

Klemperer, Paul, 2002, What really matters in auction design, Journal of Economic Perspectives 16, 169-189.

Radner, Roy, and Andrew Schotter, 1989, The sealed bid mechanism: an experimental study, *Journal of Economic Theory* 48, 179-220.

Roth, Alvin E., 1995, Bargaining experiments, in John H. Kagel and Alvin E. Roth, eds., *The Handbook of Experimental Economics*, (Princeton University Press, Princeton).

Roth, Alvin E., Keith E. Murnighan, and Francoise Shoumaker, 1988, The deadline effect in bargaining: some experimental evidence, American Economic Review 78, 806-823.

Roth, Alvin E., Vesna Prasnikar, Masahiro Okuno-Fujiwara, and Shmuel Zamir, 1991, Barganing and market behavior in Jerusalem, Ljubljana, Pittsburgh and Tokyo: an experimental study, American Economic Review 81 , 1068-1095.

Rubinstein, Ariel, 1982, Perfect equilibrium in a bargaining model, Econometrica 50, 97-110.

Thaler, Richard H., 1988a, Anomalies: the ultimatum game, Journal of Economic Perspectives 2, 195-206.

Thaler, Richard H., 1988b, Anomalies: the winner's curse, Journal of Economic Perspectives 2, 191-202.

