Adverse selection in financial markets:

Articles:

Biais, B., Martimort, D., and Rochet, J. (2000), "Competing Mechanisms in a Common Value Environment", *Econometrica*, Vol. 78(4) pp799-837.

Sandås, P. (2001), "Adverse Selection and Competitive market Making: Empirical Evidence from a Limit Order Market", *The Review of Financial Studies*, Vol. 14(3) pp705-734.

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Imperfect competition under adverse selection in financial markets

Model:

Assumptions:

- Multi-principal game where liquidity suppliers offer trading mechanisms in a decentralised way. (no exclusivity imposed)

- Liquidity suppliers do not take into account the effects of their offers on the rent-efficiency trade-offs achieved by competitors. They cannot contract on the total quantity sold or on the mechanisms offered by others (otherwise, by correlation of signals, common information could be extracted costlessly by contracting on total ex post trade)

- Liquidity demanders are motivated either by private information on the underlying value of the asset and/or risk sharing.

- This is a two-dimensional adverse selection property: by assuming mean-variance utility of CARA type, we can capture these two adverse selection elements in one variable and simplify the problem.

- Securities have a common value element.

Results:

- Unique equilibrium with convex schedules (contrary to monopoly which can have concave schedules in equilibrium)

- Trading volume is below the optimum level in equilibrium (to reduce rents)

- There exists a "small trade" spread

- Oligopolists quote marginal prices above expected asset value conditional on quantity, hence with finite number of liquidity suppliers, expected profits are positive <intuition: convex schedules mean prices change in quantities, which combined with optimal response of agent yields non-infinitely elastic residual demand, mark-up between marginal cost and price reflects the elasticity of residual demand (as in monopoly case)>

- As number of liquidity suppliers goes to infinity, the expected profits of individual suppliers and of all suppliers together go to zero.

Interpretation:

- Transfer schedules can be interpreted as sequences of limit orders

$$T_i(q_i) = \int_0^{q_i} t_i(z)dz$$

- with $t_i(z)$ being the marginal price at which market maker i trades the zth unit. Convexity is required to ensure equivalence.

Game:

v (value asset) =s+ε

1. Nature chooses s (part of valuation known to the liquidity demander) and I (Inventory of liquidity demander) and this information is only learned by the Agent (A).

2. *n* liquidity suppliers simultaneously post trading mechanisms.

3. Liquidity demanders select vectors of trades and corresponding transfers with *n* market makers

4. ε, hence v is realised and consumption takes place.

Preferences:

- CARA

Ex ante efficiency:

- Obtains $q^*(\theta)=E[-I|\theta]$ (I is inventory: ex ante efficient risk sharing)

Monopoly:

- Maximise profit subject to incentive constraints (similar to continuous type model in Martimort lecture)

- Information rent increases in trade volume, hence due to conflict in allocative and redistributive roles of the mechanism, the monopolist reduces trade volume to reduce rents.

- Demand increases in θ

- Marginal prices are equal to the expected value (marginal cost) plus a monopolist mark-up depending on the distribution of types.

- This yields a discontinuity at 0: small trade spread.

- In the monopoly case, pricing schedules can either be convex or concave

Oligopolistic screening:

- Prices only contingent on trades with a particular liquidity supplier, trades conducted with rivals play the role of non-verifiable moral hazard variables.

- Define a supply correspondence in terms of marginal prices

- No revelation principle (multiple principals), as it doesn't apply to all mechanism designers simultaneously

- Incentive Compatibility constraint depends on schedules of rivals

- Maximisation problem of principal: max total profit minus informational rent of agent and profits of rivals

- Solve relaxed problem where convexity is not imposed, and check ex post that this condition holds.

Equilibrium:

- Symmetric

- $q(\theta)=0$ on $[\theta_b, \theta_a]$

- Unique

- Convex

- Monotonic

Interpretation:

- Trade volume is higher than under monopoly
- Oligopolists design mechanisms to reflect allocative, distributive, and market share objectives.
- Prices are not at break-even level due to *common value* element.
- In private value context, the Bertrand equilibrium obtains.
- In this case, the residual demand curve would be infinitely inelastic.
- Parallel with winner's curse.
- Bid-ask spread is decreasing in the number of liquidity suppliers.
- The absolute value of trade increases in the number of liquidity suppliers
- As the number of liquidity suppliers approaches infinity, the bid-ask spread remains strictly positive, but their total profit goes to zero.

Empirics:

Sandås, P. (2001), "Adverse Selection and Competitive market Making: Empirical Evidence from a Limit Order Market", *The Review of Financial Studies*, Vol. 14(3) pp705-734.

Model used: version of Glosten (1994)

- Expected profit of market maker depends on probability of execution of order and the expected value of the asset condition al on execution.

- Probability of execution of a limit sell order is decreasing in price and in time of submission.

- Marginal bid/offer that defines the price schedule for market orders is characterised by a break-even condition

- Adverse selection cost measures how much the expected value of an asset is revised in response to a given market order quantity (represented by a price-impact function)

- Rational updating of beliefs linking market order flow to order book dynamics requires that the change in value predicted by the price impact function is on average correct.

Market institution:

Stockholm Stock Exchange has a computerised limit order book

Data:

Spread is weakly increasing in trade side for all stocks

Standard method for decomposing the bid-ask spread into an adverse selection component and an order processing component is to estimate a price impact regression:

$$P_{t+1}-P_t=a+b(I_{t+1}-I_t)+cq_{t+1}I_{t+1}+\varepsilon_{t+1}$$

- a is the expected change in value
- b represents order processing costs
- I is an indicator for market buy (+1) or sell (-1) orders
- c is the adverse selection cost component

Results of price impact regression:

Graphs: limit order book seems to display insufficient depth compared to the theoretical prediction.

→ but placer of limit order cannot condition on the size of the trade, hence this regression is not appropriate for this market institution (the trader breaks even only on average)

Model:

Let the next period's fundamental value (X_{t+1}) be related to the submitted market order as follows:

1) $E[X_{t+1}|X_t,m]=X_t+\mu+h(m)$

Where $h(m_t)=\alpha m_t$

- Assume quantity invariant order processing cost and time priority of order processing

- Construct the limit order book:

  Proceed by calculating the expected profit by starting at the lowest price above the fundamental value at which it is profitable to supply a positive quantity, and calculate the quantity a profit maximising market maker would wish to offer.

  (assume a distribution of market order quantities and a functional form for the adverse selection element in the expected fundamental value).

  Then calculate the quantity at the next price and so on.

- For the second best offer this yields:

2) $$Q_2 = \frac{p_2 - \gamma - X_t}{\alpha} - \lambda - Q_1$$

λ is the expected market order quantity
γ is the order processing cost
α is the linear adverse selection cost parameter.

Methodology:

- The limit order book must satisfy equation 2) above, which yields break even conditions for the bid and offer sides with an error term.

- These conditions on marginal orders define the slope of the price schedule offered at a given point in time.

- Combining 1 and 2 yields the updating restrictions on prices:

3) $$p_{k,t+1} - p_{k,t} - \alpha\left(\sum_{i=1}^{k} Q_{i,t+1} - \sum_{i=1}^{k} Q_{i,t}\right) - \mu - \alpha m_t = \nu_{t+1} + \varepsilon_{k,t+1} - \varepsilon_{k,t}$$

- To apply regression analysis, the author assumes that:

  1. m_t does not depend on the state of the order book (i.e. $E[m_t \varepsilon_{k,t}]=0$)

  2. any deviation from the break even conditions at time t+1 is uncorrelated to the previous time t market order (i.e. $E[m_t \varepsilon_{k,t+1}]=0$).

- These updating restrictions determine how the order book or price schedule responds to the information content in the market orders.

Results:

- Model estimating the break-even conditions and the updating conditions separately:

- Order processing costs negative for all stocks (perhaps because of heterogeneous valuations of the asset: liquidity demanders submitting limit orders)

- Price impact coefficient is positive and higher than for the standard price impact regression (adverse selection cost for the marginal unit is between 10-59% of the quoted bid-ask spread)

- These estimates are 72% lower when using only updating conditions. (discrepancy may be because of order *submission* cost, requiring higher mark-ups on low probability of execution limit orders.

- 3 out of 10 stocks reject this specification on overidentification. When testing a combined model on both types of restrictions, all stocks reject on this test.

Possible reasons for rejection:

- Assumed distribution for market order flow is a bad approximation

- The assumption of an exogenous order flow is incorrect.

Changing market conditions:

- Relative intensity of informed and liquidity trading could be changing over time (e.g. macro news)

- The distribution of market orders and their price impact would change over time.

- So condition on state variables (volatility of midquote, trading volume, volatility of market index)

- This yields positive and significant price impact of adverse selection, which is positively affected by stock-specific and market-wide volatility, and negatively by higher than average trading volume.

- Model specification still rejected for half the stocks.

Main findings:

- Price schedules exhibit too little depth relative to theoretical predictions

- Market order flow depends strongly on state variables (higher adverse selection costs for stocks with high volatility or market-wide volatility, and low trading volume)

- Deviations from model predictions fall with time elapsed since the last transaction, suggesting that order books take time to incorporate information.