Institutional Finance

Financial Crises, Risk Management and Liquidity

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Market Making – Limit Orders

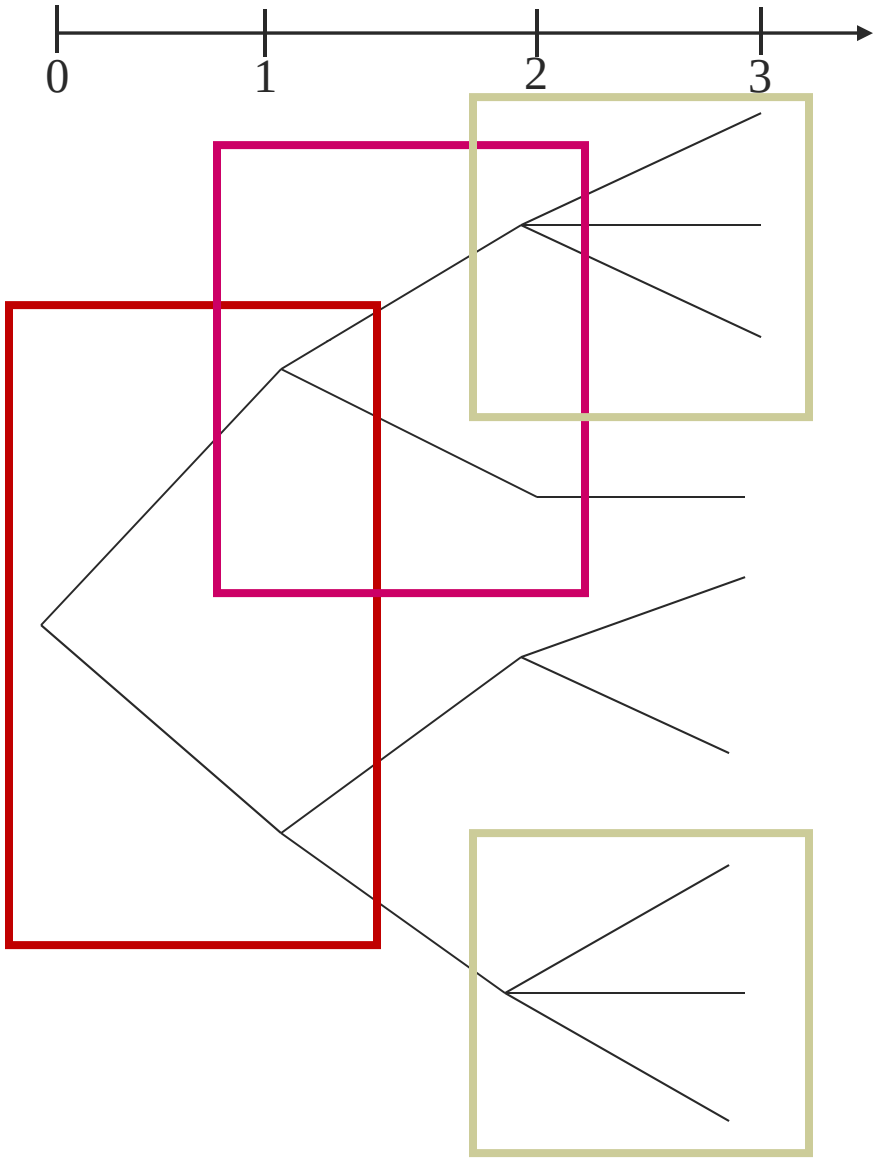
- Limit order – price contingent order
  - Limit buy order: “buy as soon as price drops to $x.” bid
  - Limit sell order: “sell as soon as price rises to $x.” ask

  - Stand ready to trade at a certain price
    - Grant somebody else the option to execute a transaction
- Stop orders
  - Stop sell order: “sell as soon as price drops to $x.” (cut losses!)
  - Stop buy order: “buy as soon as price rises to $x.”
- Market orders – non-contingent order

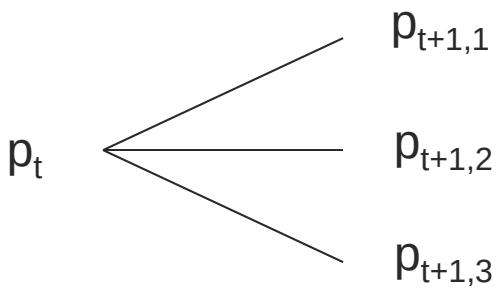
Market Making

- Market maker
  - NYSE: "monopolistic" specialist
    (all orders go through him)
  - NASDAQ: multiple competing "dealers"
  - ECNs: (pure electronic limit order book)
  - OTC/upstairs mrkt: bilateral relationship
  - Black pools:
    - After various mergers, distinction is less black and white

Event tree



One-period Snapshot



p_{t+1} is random variable

Setting Bid and Ask Prices

1. **Market Maker faces only liquidity traders (practice)**
   - Fundamental stays constant
     - p_t is driven by random liquidity needs of liquidity traders

ask

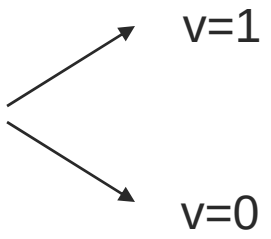
bid

   - Fundamental follows random walk
     - $v_{t+1} = v_t + \varepsilon_{t+1}$, where $E[\varepsilon_{t+1}]=0$
     - Differences:
       - One has to adjust bid and ask price in each period (cancel old limit orders and set new limit orders)
       - Asset volatility
     - What determines bid-ask spread?
       - Monopolistic power of market maker (Bertrand competition if there are multiple market makers)
       - Volatility of asset if market makers are risk averse
       - Stochastic process of liquidity traders needs

Setting Bid and Ask Prices

2. Market Maker faces informed traders

- Only informed traders - extreme case
  - v = 0 or 1 with equal probability
  - all traders are informed traders (know whether v =0 or 1)
  - What is the ask price? What is the bid price? set by uninformed market maker
    - Suppose ask: a = ¾ and bid: b = ¼ .
    - Does the market make or lose money with a bid ask spread of ½
    - **Market Break-Down – No Trade!**
- Liquidity traders and informed traders [See Glosten-Milgrom (1985)]

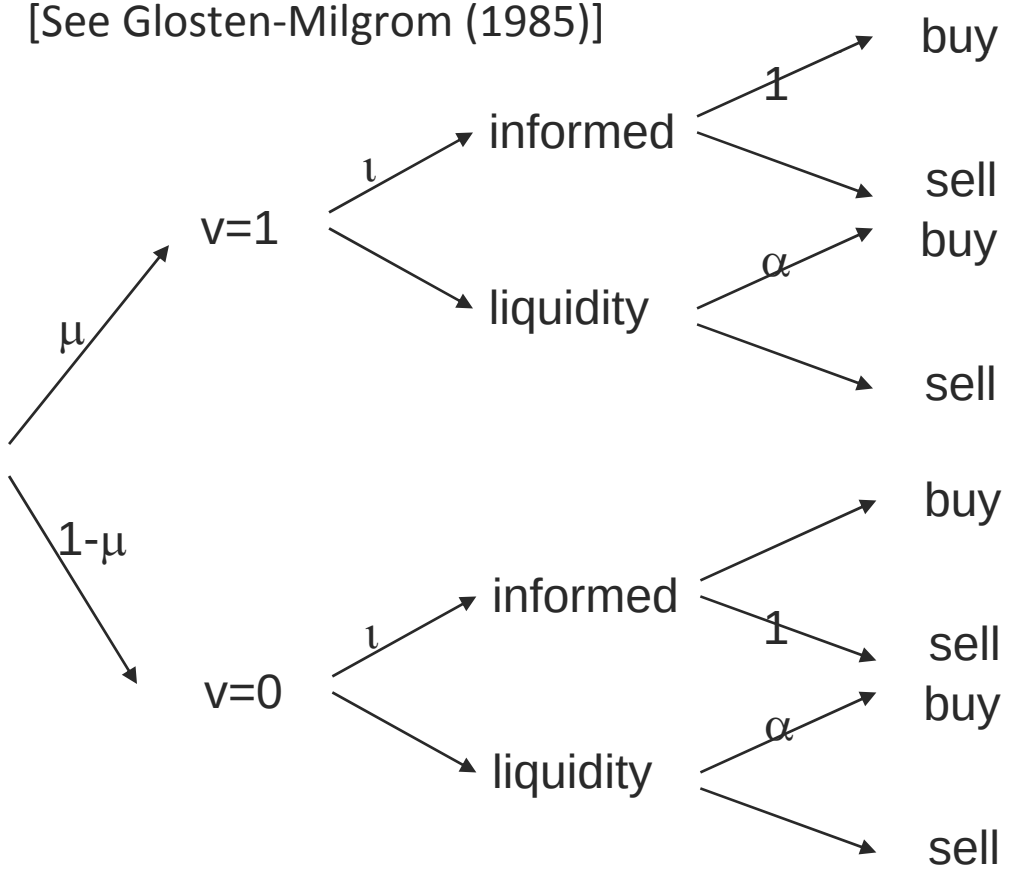


Setting Bid and Ask Prices

2. Market maker faces

- Liquidity traders and informed traders

[See Glosten-Milgrom (1985)]



a = E[v|buy order]
b = E[v|sell order]

Bayesian updating!

Bayesian Updating

- Bayes' Rule

$$Pr[x|y] = \frac{Pr[y|x]Pr[x]}{Pr[y]}$$

- Example: a = E[v|buy] =1*Pr[v=1|buy] + 0*…
  - Pr [buy|v=1] = ι*1 + (1 - ι) α
  - Pr [buy|v=0] = ι*0 + (1 - ι) α
  - Pr [buy]= Pr [buy|v=1] μ + Pr [buy|v=0] (1 -μ)

$$Pr[v = 1|buy] = \frac{Pr[buy|v=1]Pr[v=1]}{Pr[buy]}$$
$$Pr[v = 0|buy] = 1 - Pr[v = 1|buy]$$

Noise, noise, noise, …

- Asymmetric information causes adverse selection
  - Informed traders
    - buy only if asset is undervalued and
    - sell only if asset is overvalued
    - Market maker loses (even with bid ask spread)
  - noise traders
    - Market makers wins from them (due to bid-ask spread)
- Fellow students might be noise traders …
  - 1 signal for every 3-4 time of trading (why?)
  - Assuming that others are rational is dangerous: (see e.g. Keynes Beauty contest game)

Profits & Positions in simulations

- Relative profits
  - Market Markers should do well when fundamentals are relatively flat
    - Sim 1, 2, and 3
  - Market takers should do well otherwise
    - Sim 4 (too much gambling on Sim 5)
- Market maker's positions
  - Move against the price …

Where will this head …

- Only trade after buying and receiving an extreme signal
- No noise traders
- Market makers face more adverse selection and set wider bid-ask spread
- Ultimately, **Market Breakdown**
- Nobody bids for market making rights (zero value for privilege)

Example of Market Breakdown

- Risk-neutral competitive market makers
- v is distributed with pdf $f(v) = \frac{2}{(v+1)^3}$
  - i.e. cdf is $F(v) = 1 - \frac{1}{(v+1)^2}$
  - $E[v] = 1, E[v|v \geq x] = 2x + 1, E[v|v \leq x] = x/(x+2)$
- α = prob. of informed trader
- Noise traders' private valuation has pdf of *f*(*v*) (indep. of *v*).

$$\begin{aligned} a &= E\left[v|\text{buy order}\right] \\ &= P\left(\text{info}\right) E\left[v|\text{info buy order}\right] + P\left(\text{uninfo}\right) E\left[v|\text{uninfo buy order}\right] \\ &= \alpha E\left[v|v \geq a\right] + (1-\alpha) E\left[v\right] \\ &= \alpha\left(2a+1\right) + (1-\alpha) \end{aligned}$$

- Ask price: a = 1/(1-2α), if α < 1/2
  market breaks down for larger α
  - Homework: Analysis for bid

Hint: $b = \frac{-1+\sqrt{9-8\alpha}}{2}$

Limit order

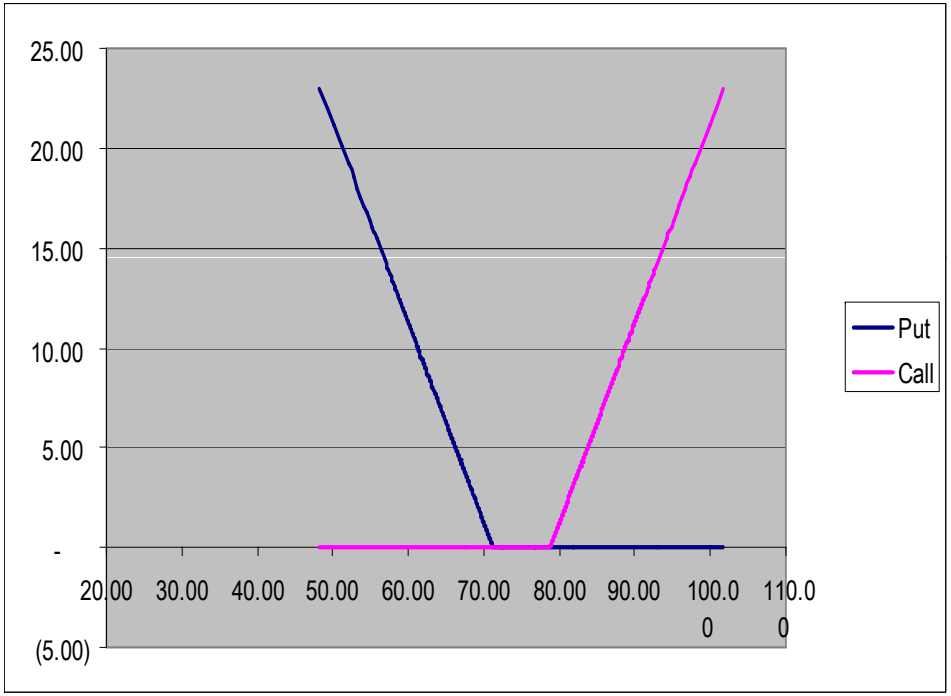
- Granting an option (selling an option) "pick on me when you want"
  - One has to charge an "option premium"
  - Market making rights are worthless when there are no noise/liquidity traders
    - Lose to informed traders
    - Gain from noise traders

Informed Trading

1. Acquiring Information
   - What is the value of information?
2. Trading based on Information
   - Trading is limited by
     - Risk-appetite (previous lecture with CARA utility)
     - Price impact
       If I trade more aggressive the market maker will learn my information and adjust the price

Endogenous info acquisition

- Value of signal (conditional on knowing realization)
  - Intermediate signals are worthless
  - Very high (go long) and very low (go short) are worth the most.
- Take expectations before knowing signal
- Payoff is very **skewed only extreme signal realizations are valuable**



- Value of strangle (put + call) use Black-Scholes
  - More valuable for higher vol.

(see Excel file)

Price Impact of Informed Trades - Strategic Trading: Kyle (1985) model

- asset return $v \sim N(p_0, \Sigma_0)$
- Agents (risk neutral)
  - Insider who knows *v* and submit market order of size *x*
  - Noise trader who submit market orders of exogenous aggregate size $u \sim N(0, \sigma^2_u)$
  - Market maker sets competitive price after observing **net** order flow $X=x+u$
- Timing (order of moves)
  - Stage 1: Insider & liquidity traders submit market orders
  - Stage 2: Market Maker sets the execution price
- Repeated trading in dynamic version

Kyle (1985) – on one page

Single informed trader	**(Competitive) Market Maker**
0) *Information*	**0)** *Information*
$v :=$ asset's payoff	$X = x + u$ batch net order flow
1) *Conjecture (pricing rule)*	**1)** *Conjecture (insider trading rule)*
$p = \mu + \lambda(x + u)$	$x = \alpha + \beta v$
2) *No Updating*	**2)** *Updating* $E[v\|x + u]$
3) *Optimal Demand*	**3)** *Price Setting Rule*
$\max_x E[(v - p)\|v]x$	$p = E[v\|x + u]$
$\max_x E[v - \mu - \lambda x\|v]x$	$p = E[v] + \frac{Cov[v,x+u]}{Var[x+u]}\{x + u - E[x + u]\}$
FOC: $x = -\frac{\mu}{2\lambda} + \frac{1}{2\lambda}v$	$p = p_0 + \frac{\beta\Sigma_0}{\beta^2\Sigma_0+\sigma_u^2}\{x + u - \alpha + \beta E[v]\}$
SOC: $\lambda > 0$	
4) Correct Beliefs	*4) Correct Beliefs*
$\alpha = -\frac{\mu}{2\lambda}$, $\beta = \frac{1}{2\lambda}$	$\mu = p_0$ Martingale, $\lambda = \frac{\beta\Sigma_0}{\beta^2\Sigma_0+\sigma_u^2}$

Kyle (1985)

- Equilibrium:

$$\lambda = \frac{1}{2}\sqrt{\frac{\Sigma_0}{\sigma_u^2}}$$

  - Illiquidity
    - decreases with noise trading, σ_u^2
    - increases with info-advantage of informed trader, Σ_0

- Multi-period version
  - Aggressive trading leads to adverse price movement
    - in current trading round
    - In any future trading around (before public announcement

In sum

- Asymmetric information causes adverse selection
  - Informed traders
    - buy only if asset is undervalued and
    - sell only if asset is overvalued
    - Market maker loses (even with bid ask spread)
  - noise traders
    - Market makers wins from them (due to bid-ask spread)
- **Market breakdown** without noise traders
- Value of information
  - is (ex-ante) highest when fundamental volatility is high (since only extreme signals pay off) – strangle analogy