Liquidity and Crises in Financial Markets

OTC Markets II

U of Basel, HS 2012

So far we have:

- frictional trading in OTC markets leads to illiquidity
- price includes an illiquidity discount
- turnover is slow

There is a role for intermediation.

Extending the model

unit mass of dealers or market makers (MM)

investors meet MM with Poisson intensity ρ

MM are outside option for buying and selling assets

Interdealer market:

- MM can continuously buy and sell assets
- MM cannot hold inventories
- all MM are identical

Trading patterns

Dealers trade among each other at price M.

MM buy from low owners with frequency $\rho\mu_{lo}$ at the ask price A.

MM sell to non-owners with frequency $\rho\mu_{hn}$ at the bid price B.

In steady state $s < \mu_h$, so that there is excess demand for assets.

Total dealer transactions are then given by

$$\rho \min\{\mu_{lo}, \mu_{hn}\} = \rho\mu_{lo}.$$

Flows need to be adjusted:

$$\dot{\mu}_{lo}(t) = -2\lambda\mu_{hn}(t)\mu_{lo}(t) - \rho\mu_{lo} - \lambda_u\mu_{lo}(t) + \lambda_d\mu_{ho}(t)$$

Value functions needs to be adjusted:

$$\begin{aligned} V_{lo}(t) = \frac{1}{1+r\Delta}\,[&(1-\delta)\Delta + \lambda_u\Delta V_{ho}(t+\Delta) \\ &+ 2\lambda\mu_{hn}(t+\Delta)\Delta(V_{ln}(t+\Delta)+P) + \rho\Delta(V_{ln}(t+\Delta)+B) \\ &+(1-\lambda\Delta-\rho\Delta-2\lambda\mu_{hn}(t+\Delta))V_{lo}(t+\Delta)+o(\Delta)] \end{aligned}$$

Hence:

$$rV_{lo} = (1-\delta)+\lambda_u(V_{ho}-V_{lo})+2\lambda\mu_{hn}(P+V_{ln}-V_{lo})+\rho(V_{ln}+B-V_{lo})+\dot{V}_{lo}$$

Homework: derive other flows and value functions.

Prices

Nash Bargaining with bargaining power summarized by $z \in [0,1]$ for MM.

Ask price

$$A = (V_{ho} - V_{hn})z + M(1-z)$$

Bid price

$$B = (V_{lo} - V_{ln})z + M(1-z)$$

Interdealer Market Equilibrium

We have that $M = A$.

- excess demand by dealers: $\mu_{hn} > \mu_{lo}$
- thus dealers that meet sellers make positive profits: $M > B$

Prices for sellers depend on relative bargaining power

$$P \geq B \text{ if and only if } z \geq (1 - q)$$

Homework: Prove the last relationship.

Comparative Statics

Bid-ask spread $A - B$ is

- increasing in z
- decreasing in λ
- (tends to) decreasing in ρ.

Idea: when search frictions decrease, MM loses bargaining power due to *sequential competition*.

Do we achieve Walrasian pricing?

- for $\rho \to \infty$ ...
- ... unless $z = 1$.

Why? Transactions tend to be always with monopolistic MM. Hence, bilateral trading on the market is less of an outside option.

Liquidity Crisis

Weill (2007) – Leaning against the Wind

Idea: market makers take away pressure by building up inventories.

Selling pressure (crisis): initial state is $\mu_{lo}(0) + \mu_{ln}(0) = 1$.

The law of motion is now given by

$$\dot{\mu}_h(t) = \lambda_u - (\lambda_u + \lambda_d)\mu_h(t),$$

with $\mu_h(0) = 0$.

For $t \to \infty$, we have $\mu_h(t) \to \mu_h(SS) = \frac{\lambda_u}{\lambda_u + \lambda_d}$.

Dealers and Inventories

Investors can now trade only with MM.

MM:

- zero marginal utility for holding the asset ($\delta = 1$)
- hold inventory $I(t) \geq 0$
- meet investors at rate ρ

Hence: $\mu_{lo}(t) + \mu_{ho}(t) + I(t) = s$

Profits by buying low, selling high over time.

Competition leads to zero expected profits over time.

Inventory change:

$$\dot{I}(t) = u_l(t) - u_h(t)$$

Gross flows:

$$\begin{aligned} -\rho\mu_{ln}(t) \leq \quad & u_l(t) \quad \leq \rho\mu_{lo}(t) \\ -\rho\mu_{ho}(t) \leq \quad & u_h(t) \quad \leq \rho\mu_{hn}(t) \end{aligned}$$

Why are inventories wasteful?

Welfare function:

$$\int_0^\infty e^{-rt}\left(\mu_{ho}(t) + (1-\delta)\mu_{lo}(t)\right)dt$$

Socially optimal to allocate as many assets to h types.

But: Opportunity cost with inventories, since MM value assets less.

Optimal Inventories

Suppose $I(t) = 0$.

We have $\mu_{lo}(t) + \mu_h(t) - \mu_{hn}(t) = s$.

Then, there is a crossing time t_s such that $\mu_{hn}(t) < \mu_{lo}(t)$ for $t < t_s$ (more sellers) and reverse if $t > t_s$ (more buyers).

Idea:

- build up I before t_s
- sell of I after t_s
- trade-off between better allocation and deadweight cost

Intuition

MM purchases some additional securities at $t_s - \Delta$ and sells them off again at $t_s + \Delta$.

Feasible? Yes.

- At $t_s - \Delta$, we have $\rho\mu_{lo}(t_s - \Delta) > \rho\mu_{hn}(t_s - \Delta)$.
- At $t_s + \Delta$, we have $\rho\mu_{lo}(t_s + \Delta) < \rho\mu_{hn}(t_s + \Delta)$.

Opportunity cost of inventory:

$$(1-\delta)2\Delta$$

Expected utility cost of search for *lo* type:

$$\delta\frac{1}{\lambda_u + \rho}$$

Buffer allocations

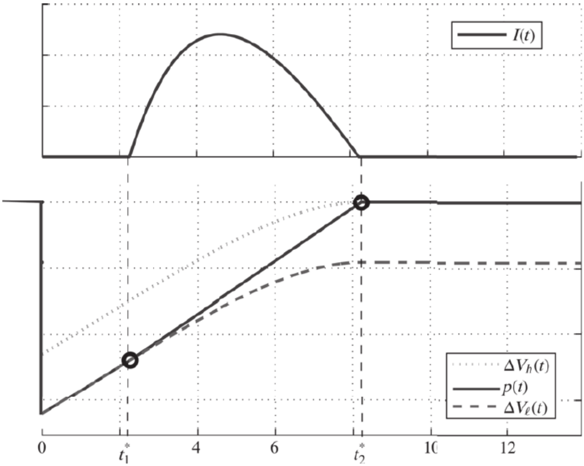

FIGURE 4

The equilibrium price path

When are inventories optimal?

At $t = 0$, it is not necessarily optimal to intervene.

- extreme excess supply
- takes a long time to get rid of an additional unit of inventory
- deadweight cost large
- "match making": $u_l(t) = u_h(t) = \rho\mu_{hn}(t)$

At t large, it is never optimal to intervene.

- excess demand
- no need to hold excess inventories
- "matchmaking": $u_l(t) = u_h(t) = \rho\mu_{lo}(t)$

Conclusion: Dealer activity is optimal only around critical time t_s.

Competitive MM

MM now buys $u_\ell(t)$ and sells $u_h(t)$ at a given price $p(t)$.

$$\max_{a,I,c,u_\ell,u_h} \int_0^\infty e^{-rt} c(t) dt$$

subject to

$$\dot{a}(t) = ra(t) + p(t)\dot{I}(t) - c(t)$$

$$\dot{I}(t) = u_\ell(t) - u_h(t)$$

$$a(t), I(t) \geq 0$$

$$a(0) \geq 0 \text{ and } I(0) = 0 \text{ given}$$

$a(t)$ can be interpreted as the capital of a MM.

Can competitive MM achieve the efficient allocation?

Equilibrium

Prices depend on the marginal investor.

Price changes over time need to take into account the incentives to trade or to delay trade.

Price dynamics differ across three regions: excess supply, inventories, excess demand

Result:

If there is enough capital ($a(0)$ is sufficiently large), competition among MM achieves the optimal allocation and MM make zero expected profits.

GRAPH

Region 1: $t \in [0, t_1]$

- lo is the marginal investor: $p(t) = V_{lo}(t) - V_{ln}(t)$
- MM has no incentive to build inventories.

$$\dot{p}(t) < rp(t) - (1 - \delta) < rp(t)$$

Region 2: $t \in [t_1, t_2]$

- MM is the marginal investor: $p(t) > V_{lo}(t) - V_{ln}(t)$
- ... and needs to make zero profits from inventories.

$$\dot{p}(t) = rp(t)$$

Region 3: $t \in [t_2, \infty)$

- hn is the marginal investor: $p(t) = V_{hn}(t) - V_{ho}(t)$
- MM has no incentives to build inventories.

$$\dot{p}(t) = 0 < rp(t)$$

Finally, note that MM makes zero profits over all intervals. ▸ GRAPH