dealer market.
· liquidity (supplier : dealer
demander : consumer, trader
호가시장.

Lecture 8. Limit Order Markets

purchase.
(시장가주문 demander
지정가주문 suplior)

1. Introduction

liquidity demand, supply 구분명확X.
dealer mkt은 역할이 구분되어 있음.

A limit order market (LOM) features unclear distinction between liquidity suppliers and demanders, in that traders can decide whether to supply liquidity with limit orders or consume it with market orders. So, theoretical LOM models concentrate on explaining the trader's problem of order choice between limit and market orders.

Remark 1.1. The previous models for dealers might be applied to LOMs by considering that a limit order is a dealer quote by another name. Those models, however, require a sharp division between liquidity suppliers (i.e., dealers) and demanders (i.e., traders), which is inconsistent with the reality of LOMs.

symmetric

2. The Cohen, Maier, Schwartz, and Whitcomb (1981) Model CMSW

information trade (X)
assymetric X.
liquidity(O).

trader의 portfolio optimum level.

Suppose that a trader corrects his portfolio imbalance by either (a) submitting a market order, (b) submitting a limit order, or (c) doing nothing. There is a security with payoff $X \sim N(\mu_X, \sigma_X^2)$. The trader initially holds n shares and has exponential utility $U(W) = -e^{-\alpha W}$, where $W \sim N(\mu_W, \sigma_W^2)$: that is,

$$E[U(W)] = -\exp\left(-\alpha\mu_W + \frac{\alpha^2\sigma_W^2}{2}\right).$$

a is a constant that represents the degree of risk preference (a>0 for risk aversion, a=0 for risk-neutrality, or a<0 for risk-seeking).

2.1. *Limit Order Submission* (Buy) sell은 정확히 반대.

The expected utility of placing a limit buy order at a price L, denoted by $E[U_{Limt}(L)]$, is

이부분이 중요 이여요.

체결 안 될 확률

$$E[U_{Limt}(L)] = P_{Hit}(L)E[U_{Hit}(L)] + (1 - P_{Hit}(L))E[U_{Base}], \tag{2.1}$$

where $P_{Hit}(L)$ is the execution probability of the limit buy order, $E[U_{Hit}(L)]$ is the expected utility when the limit buy order is hit, and $E[U_{Base})]$ is the expected utility when the limit buy order is not hit.

L
시장가 vs 지정가

non-execution risk : 체결이 안될 위험.

favorable price를 얻기 위해 non-execution risk 감수.

- When the limit buy order is hit, his wealth is $W = (n+1)X - L$. Since $W \sim N((n+1)\mu_X - L, (n+1)^2\sigma_X^2)$, it shows

  지정가 매수주문이 체결되었을 때.

$$E[U_{Hit}(L)] = -\exp\left(-\alpha\left((n+1)\mu_X - L\right) + \frac{\alpha^2(n+1)^2\sigma_X^2}{2}\right).$$

- When the limit buy order is not hit, his wealth is $W = nX$. Since $W \sim N(n\mu_X, n^2\sigma_X^2)$, it shows

$$E[U_{Base}] = -\exp\left(-\alpha n\mu_X + \frac{\alpha^2 n^2\sigma_X^2}{2}\right).$$

Definition 2.1. A continuous random variable X is said to have an *exponential distribution* with parameter $\lambda > 0$ if its probability density function is

arrival process modeling 할 때 많이 사용.

시장가 주문 직후 시장가

지정가 주문 체결.

$$f(x) = \begin{cases} \lambda e^{-\lambda x} & \text{if } x \geq 0 \\ 0 & \text{otherwise.} \end{cases}$$

- For an exponentially distributed X, the cumulative distribution function is

$$F(x) = \begin{cases} 1 - e^{-\lambda x} & \text{if } x \geq 0 \\ 0 & \text{otherwise.} \end{cases}$$

limit buy (L) 체결되려면 seller의 매도시장가, C가 L보다 작아야 거래됨.

이 가격은 돼야 ~한다.

Let C denote the minimum reservation price across all sellers in the market. The limit buy order priced at L will be executed if $C \leq L$, since there is at least one seller who submits a market order to sell at price L.

∵ C > L 이 필요하므로

- Assume that C is exponentially distributed with density $f(c) = \lambda \exp(-\lambda(c-\theta))$ for $c - \theta \geq 0$: i.e., $F(c) = \Pr(C \leq c) = 1 - \exp(-\lambda(c-\theta))$. Then, the execution probability of the limit buy order is

$$P_{Hit}(L) = \Pr(C \leq L) = 1 - \exp(-\lambda(L-\theta)) \tag{2.2}$$

  for $L \geq \theta$.

Finally, one computes the expected utility of a limit buy order strategy in (2.1) using the exponential execution probability in (2.2): i.e.,

$$\begin{aligned} E[U_{Limt}(L)] &= P_{Hit}(L)E[U_{Hit}(L)] + (1 - P_{Hit}(L))E[U_{Base})] \\ &= (1 - \exp(-\lambda(L-\theta))) \times \left(-\exp\left(-\alpha\left((n+1)\mu_X - L\right) + \frac{\alpha^2(n+1)^2\sigma_X^2}{2}\right)\right) \\ &\quad + \exp(-\lambda(L-\theta)) \times \left(-\exp\left(-\alpha n \mu_X + \frac{\alpha^2 n^2 \sigma_X^2}{2}\right)\right). \end{aligned} \tag{2.3}$$

$\frac{\partial E(U_{Limit}(L))}{\partial L}$

short selling

One finds the optimal L^* to maximize (2.3) via a numerical method.

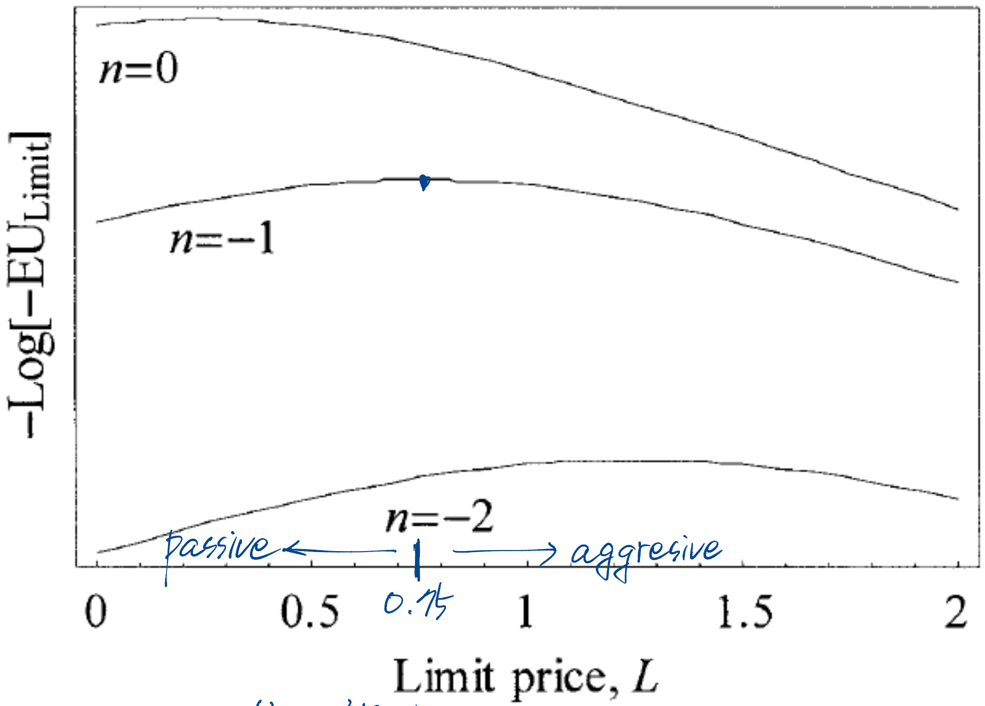
Example 2.2. Suppose that $\alpha = 1$, $\mu_X = 1$, $\sigma_X^2 = 1$, $\lambda = 1$, and $\theta = 0$. One depicts the expected utility in (2.3) as a function of buy limit price $L \in [0, 2]$ for initial holdings $n = 0, -1$, and -2. For a trader shorting one unit ($n = -1$), for instance, it shows that $E[U_{Limit}(L)]$ is maximized at $L^* = 0.75$. In this case, it shows

$$\begin{aligned} E[U_{Hit}(0.75)] &= -\exp(0.75) = -2.12 \\ E[U_{Base}] &= -\exp\left(1 + \frac{1}{2}\right) = -4.48 \\ P_{Hit}(0.75) &= 1 - \exp(-(0.75)) = 0.53 \\ E[U_{Limit}(0.75)] &= 0.53 \times (-2.12) + 0.47 \times (-4.48) = -3.23. \end{aligned}$$

doing nothing 보다

L* = 0.75에 지정가 매수하면 utility가 더 높음.

Since $E[U_{Limit}(0.75)] > E[U_{Base}]$, submitting a limit buy order at $L^* = 0.75$ is preferable to doing nothing when $n = -1$.



passive

aggressive

execution 확률이 낮지만
more favorable price than aggressive

Remark 2.3. The concavity reflects the trade-off in expected utilities arising between (a) the use of a passive limit buy order (with a low bid price) that is less likely to be executed but is more profitable if executed and (b) the use of an aggressive limit buy order (with a high bid price) that is more likely to be executed but is less profitable if executed.

execution 확률은 높지만 less favorable price.

시장가매수 주문 시 Ask에 체결.

2.2. *Market Order Submission*

Suppose that a current ask price is A (quoted by a limit order seller). If the trader submits a market buy order, he purchases with certainty, paying A, and consequently his wealth is $W = (n+1)X - A$. Since $W \sim N((n+1)\mu_X - A, (n+1)^2\sigma_X^2)$, it shows

$$E[U_{Market}(A)] = -\exp\left(-\alpha((n+1)\mu_X - A) + \frac{\alpha^2(n+1)^2\sigma_X^2}{2}\right).$$

Example 2.4. With $\alpha = 1$, $\mu_X = 1$, $\sigma_X^2 = 1$, $\lambda = 1$, $\theta = 0$, and $n = -1$, it shows

$$E[U_{Market}(A)] = -\exp(A),$$

$-e^A$

so $E[U_{Market}(A)] = E[U_{Base}]$ for $A = 1.5$. That is, the trader is indifferent between submitting a market buy order and doing nothing when $A = 1.5$. If $A < 1.5$, then $E[U_{Market}(A)] > E[U_{Base}]$, or equivalently submitting a market buy order is preferable to doing nothing.

market buy order vs doing nothing

2.3. *Choice decision between limit and market orders*

시장가 1.17

0.75 지정가

무차별.

Suppose that $\alpha = 1$, $\mu_X = 1$, $\sigma_X^2 = 1$, $\lambda = 1$, $\theta = 0$, and $n = -1$. Turning to a comparison of market and limit buy order strategies, one finds that the value of A such that $E[U_{Market}(A)] = E[U_{Limit}(0.75)]$ by solving

$$-\exp(A) = -3.23.$$

Since $A = \ln(3.23) = 1.17$, one concludes that the trader (with $n = -1$) is indifferent between submitting a limit buy order at $L = 0.75$ and submitting a market buy order when the ask quote is priced at $A = 1.17$.

$A > 1.17$ ⇒ 지정가 유리

$A < 1.17$ ⇒ 시장가 유리.

- When the ask price, approaching from above, hits 1.17, then the trader who plans to submit a limit buy order at $L = 0.75$ is pulled to the ask and switches to submitting a market buy order. CMSW refer to it as "gravitational pull." Overall, the CMSW model predicts that *as the bid-ask spread becomes narrower, an incoming order is more likely to be a market order.*

bid-ask spread 가 좁아질수록 시장가 주문을 많이 넣을 것이다.
" 넓어질수록 지정가 주문 "

2.4. *Limitation*

memoryless process

t 시점 보다 앞선 주문을 고려하지 않았음.

A limit order placed at time t is executed only if market orders arriving at time $t+k$ execute "all preceding" limit orders in the book. So, execution probability depends on (a) the current status of price-time priority when the limit order is placed and (b) incoming market/limit orders after the limit order placement.

1. book을 봐야하고 (price, time priority). 2. t시점의 의사결정이 t+k 시점의 의사결정에 영향을 줌. CMSW는 무조건 market order만 incoming 한다고 가정. but limit order도 incoming.

exponential distribution이 memory less process 이기 때문.

- Incoming orders change the price-time priority of existing limit orders in the book as follows: (a) the price priority decreases if a subsequent limit order is placed at a more favorable price, (b) the time priority increases if a subsequent market order executes against the existing orders at the same price, and (c) the price priority increases if a subsequent market order executes against the existing orders at better prices. When submitting a limit order, therefore, *a trader should take into account how his order affects the incentives of subsequent traders to submit either market or limit orders.*

limit order — trader — mkt / limit

general equilibrium

외생적. : 쉬운.

(b) bid. 9:05 9:06. (c)

partial equilibrium 이었음.

Remark 2.5. In the CMSW model, the choice decision is "exogenous" in the sense that it is immune to the choice decisions of "other" traders. In reality, however, a trader's own choice is "endogenously" made, since his choice depends on the limit order execution probability, which in turn depends on his conjecture about the choices by other traders who arrive after him. The dependence between the trader's own choice and the choices made by others in the past and in the future motivates Parlour (1998) and Foucault (1999).

내생적으로 결정. 타인의 의사결정이 앞선 trader의 영향을 받았고, 뒤의 trader의 영향을 끼침.

t 시점에 넣은 지정가 주문이 t+k 시점에 시장가가 되어 execution p가 높아지도록, t+k 시점의 trader의 의사결정의 incentive를 고려해야 함. CMSW는 이 고려를 하지 않음.

3. The Parlour (1998) Model

"CMSW 외생적 but 내생적"

3.1. *Traders*

day 1에 거래하고 day 2에 가치를 알게 됨.

A security is traded in day 1 and pays off V on day 2. On day 1, at each of the times $t = 1, \ldots, T$, a trader randomly arrives. The probability that the trader at time t is a buyer is 0.5. A

ex ante prediction.

ex post. : 확률적 의미 X.

↳ Fama ; fishing license.

1 2 . . . T

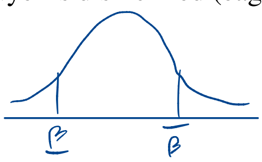
buyer has an endowment of cash to buy one share, and a seller holds one share to sell. A trader may decide to do nothing and keep his existing positions.

consumption on day 1.

- A trader arriving at time t has a utility function $U(c_1, c_2) = c_1 + \beta_t c_2$, where β_t is a time preference parameter and is randomly distributed over an interval $(\underline{\beta}, \bar{\beta})$ across traders. With a low (high) β_t, a seller is eager (disinclined) to sell and a buyer is disinclined (eager) to buy.

β 클때 ;

작을 때 ;



3.2. *Trading Mechanism*

The bid and ask prices are fixed, with $B < V < A$. The limit order book contains the number of shares on the bid and ask sides, n_t^B and n_t^A, immediately prior to the arrival of a trader at time t.

- If the order book is not empty, a market order can be executed against the book. A limit order is added to the order book, and limit orders in the book are executed in *first-in, first-out time priority* (i.e., no outbidding is allowed).

(X). BID보다 높은 가격에 매수 order 불가(가정).

A n_t^A

B n_t^B

The order book is updated upon the arrival of the trader t as

$$n_{t+1}^B = \begin{cases} n_t^B + 1 & \text{if the trader } t \text{ submits a limit buy order} \\ n_t^B - 1 & \text{if } n_t^B \geq 1 \text{ and the trader } t \text{ submits a market sell order} \end{cases}$$

and

$$n_{t+1}^A = \begin{cases} n_t^A + 1 & \text{if the trader } t \text{ submits a limit sell order} \\ n_t^A - 1 & \text{if } n_t^A \geq 1 \text{ and the trader } t \text{ submits a market buy order.} \end{cases}$$

3.3. *Optimal Strategies*

Suppose that the trader T is a seller. He never submits a limit sell order, as there is no chance for a market buy order to arrive. Instead, he submits a market sell order if the utility of selling a share (i.e., B) is greater than the utility of doing nothing (i.e., $\beta_T V$). With the distribution of β_T, one computes the probability of submitting a market sell order: i.e.,

$$\Pr(\text{Seller } T \text{ submits a market sell order}) = \Pr\left(\beta_T < \frac{B}{V}\right).$$

$B > \beta_T V$

Suppose that the trader $T-1$ is a buyer. $\boxed{\text{If } n_{T-1}^B \geq 1,}$ he never submit a limit buy order, since the order is not first in the execution queue and thus cannot be executed in the one remaining period. Instead, he submits a market buy order if the utility of buying a share (i.e., $\beta_{T-1}V$) is greater than the utility of doing nothing (i.e., A). With the distribution of β_{T-1}, the probability of submitting a market buy order is given by

$$\Pr(\text{Buyer } T-1 \text{ submits a market buy order}) = \Pr\left(\beta_{T-1} > \frac{A}{V}\right).$$

$\beta_T V > A$

T-1 T

If $n^B_{T-1} = 0$, he can submit a limit buy order, since it can be executed if the trader T submits a market sell order with the probability of $\Pr(\beta_T < B/V)$. The execution probability of a limit buy order at time $T-1$ is given by

1. T 시점의 market seller에 의존.
2. T-1 시점의 limit order book

$$\Pr(\text{A limit buy order at time } T-1 \text{ is executed}) = \begin{cases} \Pr\left(\beta_T < \frac{B}{V}\right) & \text{if } n^B_{T-1} = 0 \\ 0 & \text{if } n^B_{T-1} \geq 1. \end{cases}$$

excution prob.
① 앞으로 t+1, t+2 ...
② n^B_t, n^A_t
⇒ 비선형 X.
비선형 O.

Remark 3.1. Regarding the trader's optimal strategies, Parlour (1998) demonstrates that there are cutoffs $\underline{\beta}^{Buy}_{Limit}$ and $\bar{\beta}^{Buy}_{Limit}$ (which are functions of time, the state of the book, and the execution probabilities) such that the buyer $T-1$ does nothing if $\beta_{T-1} < \underline{\beta}^{Buy}_{Limit}$, submits a limit buy order if $\underline{\beta}^{Buy}_{Limit} < \beta_{T-1} < \bar{\beta}^{Buy}_{Limit}$, or submits a market buy order if $\bar{\beta}^{Buy}_{Limit} < \beta_{T-1}$.

앞으로 들어오게 될 시장가 주문이 지금 넣은 지정가 주문 체결될 확률 영향.

T
buyer T-1.
1. market buy
2. limit buy
3. nothing
T-2

Remark 3.2. With the distribution of β_{T-1}, one computes the probabilities that each event occurs, e.g., $\Pr(\text{Buyer } T-1 \text{ does nothing}) = \Pr(\beta_{T-1} < \underline{\beta}^{Buy}_{Limit})$. These probabilities define the execution probabilities for limit orders submitted at time $T-2$, which defines the optimal strategies of the trader (who is either a buyer or a seller) arriving at time $T-2$, and so on.

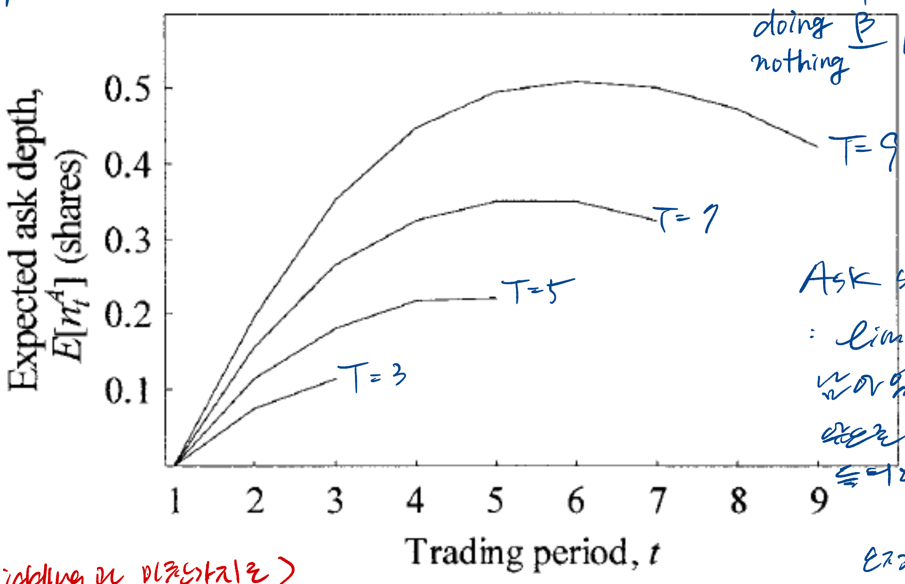
지금 book이 어떻게 구성? 지금 이후 사람들의 결정에 의해 (넘어간 오더에 의해) 정해짐.

Example 3.3. Assume that $V = 5.5$, $B = 5$, $A = 6$, and β_t are uniformly distributed over $(0,2)$. The expected ask-side depth of the order book over time for trading days of $T = 3, 5, 7$, and 9 periods is plotted. The book fills more rapidly with larger T. This is because with longer trading days, a limit order is more attractive since there are more opportunities for it to be executed. Near the end of the trading the depth drops, however.

낮은 사람. 미래에 대한 가중치가 높은 사람.

doing nothing $\underline{\beta}$ limit buy $\bar{\beta}$ market buy.

T-1 시점에 넣은 주문이 T, T+1, ... 시점의 trader들의 주문에 영향을 미침.
⇒ 어떻게 반응할지 염두하고 현재 지정가 주문을 넣는다.



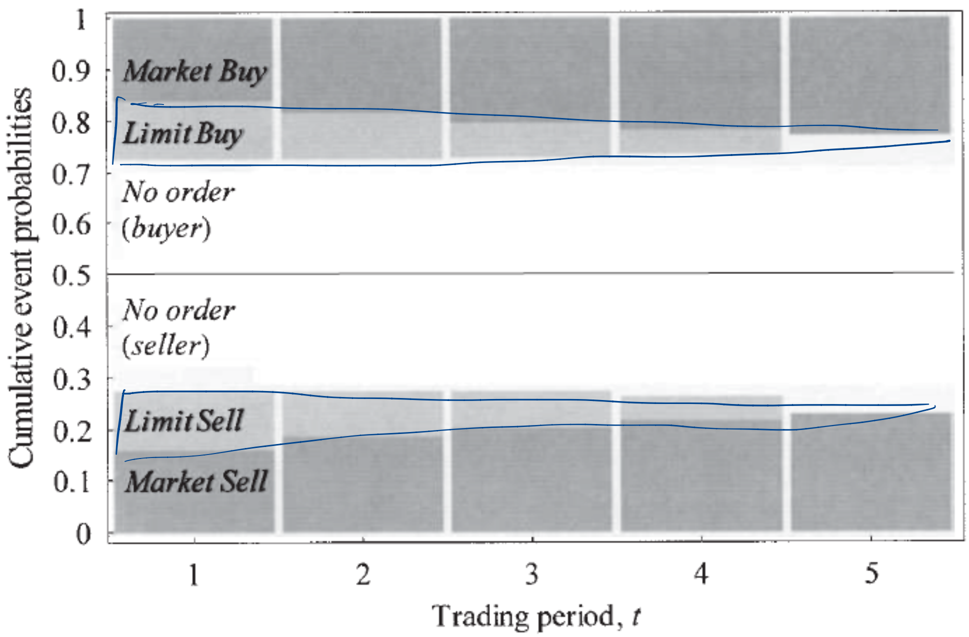
Ask side depth ↑
: limit sell order ↑
남아있는 기간이 많을 수록 앞으로 market order가 들어올 확률이 높기 때문에

BID.
priority가 낮은 주문은 고려 X. (out bidding과 비슷하지는?)
같거나 BID인 얘들. first in, first out. (time priority).

잔고 > 잔추 (limit order).

Example 3.4. Consider the model with $T = 5$. The following figure depicts the probabilities of various events at each trading opportunity. Limit order usage declines over time, while market order usage increases.

*. 앞뒤 관계에 주의하라.



3.4. Implications

exante prediction

The Parlour model provides empirical implications for the relationship between limit order usage and the state of the book. Overall, the model predicts that *both sides of the market will affect a trader's decision*. Specific predictions are as follows:

Prediction 1. There will be the order flow persistence, first observed by Biais et al. (1995), in that market sell orders are followed by market sell orders rather than market buy orders, i.e.,

$$\Pr(\text{Market Sell}_{t+1}|\text{Market Sell}_t) \geq \Pr(\text{Market Sell}_{t+1}|\text{Market Buy}_t).$$

A market buy order at time t reduces the queue at the ask and thus increases the execution probability of existing limit sell orders. So, a seller arriving at time $t+1$ is more inclined to submit a limit sell order, or equivalently, less likely to submit a market sell order.

market buy 1
⇒ limit sell $n_t^A - 1$.
⇒ priority (limit sell order).

구축효과

Prediction 2. A "crowding-out mechanism" will occur in that a limit sell order at time t, by lengthening the queue at the ask, can make a limit sell order unattractive to a subsequent trader, i.e.,

$$\Pr(\text{Limit Sell}_{t+1}|\text{Other than Limit Sell}_t) \geq \Pr(\text{Limit Sell}_{t+1}|\text{Limit Sell}_t). \tag{3.1}$$

1000 ~~10~~ ① execution prob ↑
market buy 10.

Prediction 3. A market buy order will affect a limit sell order, since the market buy order at time t consumes liquidity at the ask and thus makes more attractive for the next trader to submit a limit sell order: i.e.,

$$\Pr(\text{Limit Sell}_{t+1}|\text{Market Buy}_t) \geq \Pr(\text{Limit Sell}_{t+1}|\text{Market Sell}_t).$$

⇒ seller 입장에서 market sell 보다 limit sell 이 attractive.

∴ market buy T.
⇒ market sell T+1, ⋯ ↓
limit sell T+1, ⋯ ↑

구축효과 때문에
limit buy_t → market buy_{t+1} > limit buy_{t+1}.

Prediction 4. The longer queue at the bid will induce more limit sell orders, i.e.,

$$\Pr(\text{Limit Sell}_{t+1}|\text{Limit Buy}_t) \geq \Pr(\text{Limit Sell}_{t+1}|\text{Limit Sell}_t).$$

Suppose that a limit buy order is placed at time t. Due to the crowding out of incoming limit buy orders, as predicted in (3.1), a seller at time $t+1$ anticipates more incoming market buy orders, which makes limit sells more attractive.

palour는 이것만 고려.

non execution ↙
adverse selection risk.

informed investor knows V. If V < BID. ⇒ market sell order

4. The Foucault (1999) Model

4.1. Model Description

good news bad news

A trader arrives at each time $t = 1, \ldots, T$, where T is a random stopping time. If trading terminates, the security pays $V_T = v_0 + \sum_{t=1}^{T} \varepsilon_t$, where ε_t is an independently distributed value innovation and $\Pr(\varepsilon_t = \sigma) = \Pr(\varepsilon_t = -\sigma) = 1/2$. The trader t has the reservation price, $R_t = v_t + y_t$, where $\Pr(y_t = L) = \Pr(y_t = -L) = 1/2$. Notice that y_t is independent of v_t at all leads and lags; i.e., y_t is not informative about the value but arises from "liquidation demand."

$R_t = V_t + L$:
$R_t = V_t - L$

- If a trade is executed at a price P, a buyer (arriving when $y_t = L$) has utility $U(y_t) = (V_T + y_t) - P$ and a seller (arriving when $y_t = -L$) has utility $U(y_t) = P - (V_T + y_t)$. The order book at time t is characterized with $s_t = \{A_t, B_t\}$, where A_t and B_t are the best ask and bid prices.

seller
현재 가치보다 더 큰 가치를 갖고 있다는 믿음. ⇒ buyer.

The trader t can submit either a market order or a limit order. The market order ensures immediate execution at the unfavorable price. The limit order can be executed at the favorable price but is subject to *adverse-selection risk* as well as *nonexecution risk*. This is because limit prices are fixed over time (i.e., limit orders cannot be revised) and thus limit orders can become mispriced when new public information arrives. cancel을 못함.

cancel을 못해서 발생. 새로운 정보에 대응하지 못함.

- Consider a limit buy order submitted at time t if $\varepsilon_{t+1} = -\sigma$. Since the limit order cannot be canceled in response to the bad news, the "winner's curse" occurs, in that the execution probability increases but the gain from the trade decreases. " adverse selection risk. ← bad news

- Consider a limit buy order submitted at time t if $\varepsilon_{t+1} = \sigma$. In this case, the execution probability decreases, because the market "moves away" from a limit order.

non execution risk. ← good news

4.2. Predictions

Overall, the Foucault model argues that *the asset volatility (i.e., the volatility of an underlying value which is not directly observable) is a determinant of the mix between market and limit orders*. Specific predictions are as follows:

변수의 변동성

* 두 risk 고려하고 limit order를 냄.

uninformed limit buy order.
⇒ V↑ ⇒ 취소하고 높은가격에 limit buy order
V↓ ⇒ " 낮은 가격에 "

but monitoring 못함.
개인이 지정가 주문이 취소가 잘 안된다면 Foucalt model이 유효한 것.

non-execution
adverse-selection
(palour에서 고려 X.

1. non-execution risk   limit buy ↑   priority ↓.
2. adverse selection. (winner's curse).   good news
bad news. → limit buy 체결. (market sell orders.
but bad price.

Faucault — update 불가.

market order ↓

Prediction 1. The asset volatility will positively relate to the proportion of limit orders and will negatively relate to the fill rate (i.e., the ratio of executed limit orders to a total number of submitted limit orders). When the asset volatility is higher, limit order traders are more exposed to adverse selection risk and tend to submit less aggressive orders (to ask for a larger compensation); consequently, the cost of market order trading increases. More traders find it optimal to carry their trades using limit orders, which in turn lowers execution probabilities since market order trading is less frequent.

vol ↑ → good or bad news 발생 확률 ↑ → adverse selection risk ↑ → aggressive ×. passive 하게 주문 넣게 됨.

Prediction 2. The proportion of limit orders will be positively related to the average size of the spread. Traders shade more limit orders and use market orders less frequently when the asset volatility increases. This creates a positive correlation between the size of the spread and the proportion of limit orders.

BID-ASK spread ↑ ↓ limit order merit.

시장 장이 끝나갈 때 왜 BID-ASK spread ↑?

Prediction 3. The increase in trading costs at the end of the trading day will be negatively related to the level of competition between limit order traders. In this paper, limit order traders react to increasing nonexecution risk at the time closer to closing by posting larger spreads, so that spreads enlarge at the end of the trading day.

경쟁이 많을수록 aggressive 한 주문을 넣기에 B-A-S ↓

경쟁이 심할수록 폭은 작아짐.

nonexecution risk ↑ → aggressive → 보상 ↓ / 아예 passive → 보상 ↑ (Faucault)

∴ 어차피 체결 안될 거 아예 passive 하게 넣어서 큰 보상을 받겠다는 심리.

복잡. 생략.

Prediction 4. The average trading cost for market buy (sell) orders increases (decreases) with the ratio of buy to sell orders. If potential sellers decrease, the execution probability of a limit buy order decreases; as a consequence, potential buyers find it optimal to submit market buy orders. As the maximum ask prices at which buyers are willing to accept increase, limit sell orders are more attractive for potential sellers and thus bid prices must increase to attract market sell orders.

① mkt buy ↑ ② Ask ↑

BID ↑ limit buy 늘려야 seller 들이 market sell을 submit.

5. Empirical Findings

The evolution of a market is described by a sequence of well-defined events such as order submissions (buy or sell, market or limit) and cancellations at different prices. The event occurrence is empirically modeled via a *multinomial logit model* (순서 X.) or a *ordered choice model*. (순서 o)

discreate choice model.

- Many studies find that if the spread is wide, order choice tilts in favor of a limit order. Ellul et al. (2002), Hasbrouck and Saar (2003), and Renaldo (2004) test the Parlour model, and find that (a) the prediction that the same-side depth favors a market order is supported but (b) the prediction that the opposite-side depth favors a limit order is less clear. Smith (2000) and Hasbrouck and Saar (2003) provide mixed evidence for the Foucault model prediction regarding the effects of volatility.

CMSW atg

Remark 5.1. Parlour (1998) and Foucault (1999) discover that traders' optimal strategies depend on conjectures of other traders' strategies. To simplify the analysis, both papers assume that trades solves "static" problems in which they are allowed to take only one action (i.e., submitting a market or a limit order without the ability to return to the market and update their strategies), which is far from a nature of dynamics and reality.

static – 1번. (취소불가)
dynamic – 여러번. 취소 가능.
(e.g. Equilibrium in a Dynamic Limit order market.)

static < P : non execution. / F : (nonexecution, adverse

Prediction 4.

Seller ↓ ($\frac{b}{s}$ ↑).

limit buy ↓ execut ↓

mar buy

Ask ↑

limit sell ↑ → bid ↑

mark sell ↓ (market sell로 괜찮겠다 → mkt sell ↑?).

∴ mkt sell trader cost ↓.

- lecture 1 ~ 8 범위.

✓ 한 두 줄 짜리 문제는 X.
답을 충분히 작성.
이상한 얘기 X.
답과 관련된 내용만 충분히 기술.

내용 이해 기반.
의미하는 바가 무엇인가?
(모델).

✓ 답은 자유롭게
(한 / 영).
문제는 영어

증명 문제 출제 X.

✓ 수식입력 전혀 X.

provide economic intuition.

✓ 본인 생각 서술 X.
✓ 수식을 말로 적는다 생각.

explain why

특정 내용을 이해해야만 답을 적을 수 있음.