Securities Trading: Principles and Procedures

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Revised problems for Fall 2025.
Keyed to chapters in STPPms14c.

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Chapter 1. Introduction

Chapter 2. Elements of a securities market

Terms and concepts

Exchanges; listing; brokers (retail, prime, discount, full-service); "make or take"; hit the bid/lift the offer; active vs. passive/resting/standing; liquidity (immediacy, breadth, depth, resiliency); transparency (pre- and post-trade), latency; SEC; 1933 Act; primary market; 1934 Act; secondary market; CFTC; FINRA; types of traders (liquidity, arbitrage, hedgers, day traders); custody; clearing; settlement

Problems and sample exam questions

Problem 2.1 Liquidity in a market is sometimes characterized as immediacy + tightness + depth + resiliency. In this statement, "tightness" means _____.

a. The price quickly bounces back after a large trade.
b. The bid-ask spread is small.
c. Orders are handled promptly.
d. The brokers keep in very close contact with their customers.

Problem 2.2 A prime broker _____

a. monitors and regulates the operations of other brokers
b. ensures that a stock always has a bid and ask
c. mostly services smaller retail accounts
d. mostly services institutional accounts

Problem 2.3 The choice of whether to "make or take" most closely refers to

a. buying or selling
b. trading or monitoring the market
c. using a market order or a limit order
d. using a retail or a prime broker

Problem 2.4 In a mutual fund, the custodian would typically _____. (Indicate all answers that are correct. There may be more than one.)

a. Make decisions about investment allocations.
b. Market the fund to prospective investors.
c. Be an employee or partner of the fund management company.
d. Hold the securities on behalf of the fund investors.

Problem 2.5 An exchange usually earns most of its profits from

a. Fees paid by listed corporations
b. Compiling and selling information about listed firms' financial plans.
c. Charging for trades that are executed on exchange systems.
d. Selling timely market information (such as bids, offers, and last sale reports).

Problem 2.6 One innovation associated with Robinhood's retail brokerage is ____

a. Financial research.
b. Fractional shares
c. Development of online trading screens.
d. Shareholder activism

~~Problem 2.7 For a corporation trying to sell stock, investors' expectations of a liquid secondary market ____ demand in the primary market because ____.~~

~~*a.* weakens; investors who believe that they can easily purchase in the secondary market will be more inclined to wait, leading to lower demand for the initial offering.~~
~~*b.* strengthens; investors will buy more confidently if they believe that they can easily re-sell their shares.~~
~~*c.* Weakens; anyone who wants to buy the shares will buy them first in the secondary market.~~
~~*d.* Strengthens; market makers in the secondary market will have an incentive to keep the price of the stock high.~~

Answers

Answer to problem 2.1 b

Answer to problem 2.2 d

Answer to problem 2.3 c

Answer to problem 2.4 d (Answers a and b are reasonable, but wrong. Answer c gets at the heart of the custodian's role. That is, a custodian is supposed to be sufficiently independent that they would not be under any pressure to accommodate a request by the fund manager that might not be in the interests of the beneficial owners.)

Answer to problem 2.5 d

Answer to problem 2.6 b

~~Answer to problem 2.7~~ b
~~The existence of a liquid resale market provides a valuable exit path if the initial buyer has a change of heart; *a* is plausible, but most investors would probably prefer the IPO to capture the opening "pop" in price; c gets the sequencing wrong (the secondary market comes after the primary market); d is wrong (boosting the stock price is not the function of market makers).~~

Chapter 3. Floor markets

Terms and concepts

Prohibition of off-exchange trading; open outcry procedures (bidding, asking, accepting the bids and asks of others); confidentiality of customer orders. Note that certain topics in Chapter 3 (dual trading, trade-throughs, and crosses) are discussed in later chapters.

Problems and sample exam questions

Problem 3.1 On the CME floor, Bao is the first bidder at 10.20. Then Cathy starts bidding 10.20. Then Dev trades with Cathy. Is this permissible by CME rules? Discuss.

Problem 3.2 On the CME floor, Bao is the first bidder at 10.20; he has repeated this bid loudly and frequently. Then Cathy bids 10.19. Dev hits Cathy's bid, trading at 10.19. Who, if anyone, is at fault? Discuss.

Problem 3.3 In a floor market (like the CME), Renée is asking $10.50; Pamela is asking $10.55. Quinn says to Pamela, "Buy it," (lifting Pamela's ask, buying from Pamela at $10.55). Renée protests the trade-through.

a. Can Renée force Quinn to buy from her at $10.50? Why/Why not?
b. Can Renée break the trade between Quinn and Pamela?

Answers

Answer to problem 3.1
This is permissible. There is no time priority on the floor. The trade occurs *at* Bao's price, but it does not trade *through* Bao's price.

Answer to problem 3.2
Cathy violated the rule that says "… A bid shall be made only when it is the best [highest] bid available in the pit …" [Rule 521, though you don't need to give the number]. When Dev hits Cathy's bid, he's caused a trade-through. Although Cathy's inferior bid contributed to the confusion, Dev's decision to hit it was the main cause of the trade-through, and would be regarded as the more serious offense.

Answer to problem 3.3
There are three possible remedies, and they are decided upon by Quinn and Pamela (not Renée). For example, Quinn and Pamela can simply break their trade. Or, they can reprice their trade to $10.50. In either case, a trade-through has been prevented. ($10.50 matches Renee's price, but doesn't go through it.) In neither case does Renée sell at her asking price ($10.50, case a). In case b, Quinn doesn't have to break the trade with Pamela, if Quinn is also willing to buy from Renee at $10.50.

Chapter 4. Limit order markets

Terms and Concepts

Operations of a limit order book; priority (price, visibility, time); undisplayed/hidden orders; matching (execution) procedures; "top of the book"; "walking through the book"; order qualifiers (IOC, AON, FOK); market orders, marketable and non-marketable limit orders.

Problems and sample exam questions

Problem 4.1 Constructing the book under price-time priority. Build the bid side of the book from the following limit buy orders.

Priority (1=top)	Trader	Arrival Sequence	Quantity	Price
	Amy	1	100	20.02
	Brian	2	400	20.05
	Chad	3	200	20.07
	Dana	4	100	20.06
	Emily	5	300	20.07
	Frank	6	300	20.05

Problem 4.2 Constructing the book. Under price-visibility-time priority, build the offer side of the book from the following sell orders.

Priority (1=top)	Trader	Arrival Sequence	Quantity	Price	Display?
	Amy	1	100	10.10	Y
	Brian	2	400	10.02	Y
	Chad	3	200	10.01	N
	Dana	4	100	10.02	Y
	Emily	5	300	10.01	Y
	Frank	6	300	10.10	N
	Gina	7	200	10.00	N

Problem 4.3 Order outcomes. The state of the book is:

	Trader	Sequence	Price	Quantity	Display
	Irina	5	16.00	1,000	Y
	Gina	2	15.07	500	Y
	Esteban	1	15.07	100	Y
	Dmitri	4	15.05	300	N
Sell	Alice	3	15.05	200	Y
Buy	Bruce	2	15.03	400	N
	Hans	1	15.01	300	Y
	Cho	3	15.00	200	Y
	Frank	4	15.00	300	N
	Jing	5	14.50	2,000	Y

For each of the following incoming orders, describe the outcome (executions if any, and any changes in the prices, quantities and trader names at the BBO). The incoming orders represent different scenarios (not sequential arrivals).

a. Kathy: "Buy 300, limit 15.05."
b. Lane: "Buy 600, limit 15.10."
c. Maureen: "Buy 600, limit 15.05."
d. Ollie: "Sell 500, limit 15.00."
e. Petra: "Sell 500, limit 15.02."
f. Rama: "Sell 500, limit 15.02, IOC."
g. Sydney: "Sell 800, limit 15.01, FOK."

Problem 4.4 A market receives the following buy orders. How are they ranked? That is, in what order will they be executed (1=first, 2=second, …, 5=last)

Rank	Direc-tion	Price	Time	Quantity	Visibility	Trader
	Buy	$10.00	11:01	200	D	Andy
	Buy	$10.05	11:02	1,000	H	Beth
	Buy	$10.05	11:10	300	D	Cathy
	Buy	$10.10	11:08	500	D	David
	Buy	$10.20	11:08	100	D	Emma

Problem 4.5 A market receives the following buy orders. How are they ranked? That is, in what order will they be executed (1=first, 2=second, …, 5=last)

Rank	Direction	Price	Time	Quantity	Visibility	Trader
	Buy	$20.00	11:01	200	D	Andy
	Buy	$20.00	11:02	100	D	Beth
	Buy	$20.50	11:08	300	D	Cathy
	Buy	$20.40	11:09	500	D	David
	Buy	$20.45	11:15	100	D	Emma

Problem 4.6 A market receives the following sell orders. How are they ranked? That is, in what order will they be executed (1=first, 2=second, …, 5=last)

Rank	Direction	Price	Time	Quantity	Visibility	Trader
	Sell	$20.00	11:01	200	D	Andy
	Sell	$20.00	11:02	100	D	Beth
	Sell	$20.50	11:08	300	D	Cathy
	Sell	$20.45	11:09	500	D	David
	Sell	$20.45	11:15	100	D	Emma

Problem 4.7 A market receives the following sell orders. How are they ranked? That is, in what order will they be executed (1=first, 2=second, …, 5=last)

Rank	Direction	Price	Time	Quantity	Visibility	Trader
	Sell	$20.30	11:01	200	H	Andy
	Sell	$20.30	11:02	1,000	D	Beth
	Sell	$20.30	11:08	300	H	Cathy
	Sell	$20.30	11:09	500	D	David
	Sell	$20.30	11:15	100	D	Emma

Problem 4.8 A market receives the following sell orders. How are they ranked? That is, in what order will they be executed (1=first, 2=second, …, 5=last)

Rank	Direction	Price	Time	Quantity	Visibility	Trader
	Sell	$20.30	11:01	200	H	Andy
	Sell	$20.30	11:02	1,000	D	Beth
	Sell	$20.50	11:08	300	D	Cathy
	Sell	$20.45	11:09	500	D	David
	Sell	$20.45	11:15	100	H	Emma

Problem 4.9 The book in XYZ is

Direction	Price	Time	Quantity	Visibility	Trader
Sell	$10.10	9:50	300	D	Maura
Sell	$10.06	9:51	200	D	Oliver
Sell	$10.05	9:52	400	D	Petra
Buy	$10.01	9:44	100	D	Rob
Buy	$9.98	9:45	500	D	Sandy
Buy	$9.90	9:48	200	D	Trevor

Wendy enters an order: “Buy 500 shares limit 10.06”. What executions occur; what are the new bid and offer quotes?

Problem 4.10 The book in XYZ is

Direction	Price	Time	Quantity	Visibility	Trader
Sell	$10.10	9:50	300	D	Maura
Sell	$10.06	9:51	200	D	Oliver
Sell	$10.05	9:52	400	D	Petra
Buy	$10.01	9:44	100	D	Rob
Buy	$9.98	9:45	500	D	Sandy
Buy	$9.90	9:48	200	D	Trevor

At 10am Yuri submits an order: "Buy 500 shares limit 10.05." What executions occur? What does the new book look like?

Problem 4.11 The book in XYZ is

Direction	Price	Time	Quantity	Visibility	Trader
Sell	$10.10	9:50	300	D	Maura
Sell	$10.06	9:51	200	D	Oliver
Sell	$10.05	9:52	400	D	Petra
Buy	$10.01	9:44	100	D	Rob
Buy	$9.98	9:45	500	D	Sandy
Buy	$9.90	9:48	200	D	Trevor

At 10am Zelda submits an order, "sell 600 shares limit 9.98." What executions occur? What does the new book look like?

Problem 4.12 The book in XYZ is

Direction	Price	Time	Quantity	Visibility	Trader
Sell	$10.10	9:50	300	D	Maura
Sell	$10.06	9:51	200	D	Oliver
Sell	$10.05	9:52	400	D	Petra
Buy	$10.01	9:44	100	D	Rob
Buy	$9.98	9:45	500	D	Sandy
Buy	$9.90	9:48	200	D	Trevor

At 10am Arturo submits an order, "sell 600 shares limit 10.01 IOC." What executions occur? What does the new book look like?

Answers

Answer to problem 4.1

Priority (1=first, top)	Trader	Arrival Sequence	Quantity	Price
1	Chad	3	200	20.07
2	Emily	5	300	20.07
3	Dana	4	100	20.06
4	Brian	2	400	20.05
5	Frank	6	300	20.05
6	Amy	1	100	20.02

Answer to problem 4.2

Priority (1=first, top)	Trader	Sequence	Quantity	Price	Display
1	Gina	7	200	10.00	N
2	Emily	5	300	10.01	Y
3	Chad	3	200	10.01	N
4	Brian	2	400	10.02	Y
5	Dana	4	100	10.02	Y
6	Amy	1	100	10.10	Y
7	Frank	6	300	10.10	N

Note: The offer side of the book is often displayed on a screen in reverse order: the "top" of the book is displayed on the bottom.

Answer to problem 4.3
Prior to the receipt of any new orders, the market is 15.01 bid for 300 shares (Hans), 200 shares offered at 15.05 (Alice). On the bid side, although Bruce's bid is higher, the order is not visible.

a. Kathy buys 200 from Alice @ 15.05; Kathy buys 100 from Dmitri @ 15.05; the market is 15.01 bid for 300 shares (Hans), 100 offered at 15.07 (Esteban). Esteban's order sets the best offer because Dmitri's offer is hidden. A market's bid and offer reflect only visible interest (from the order book or, if available, from floor traders or market makers).

b. Lane buys 200 from Alice @ 15.05; Lane buys 300 from Dmitri @15.05; Lane buys 100 from Esteban @ 15.07; the market is 15.01 bid for 300 (Hans), 500 offered at 15.07 (Gina).

c. Maureen buys 200 from Alice @ 15.05; Maureen buys 300 from Dmitri @ 15.05; Maureen has 100 shares left to buy, so the market is 15.05 bid for 100 (Maureen), 100 offered at 15.07 (Esteban).

d. Ollie sells 400 to Bruce @ 15.03; Ollie sells 100 to Hans @ 15.01; the market is 15.01 bid for 200 (Hans), 200 offered at 15.05 (Alice)

e. Petra sells 400 to Bruce @ 15.03; her remaining 100 shares are added to the book on the sell side (at 15.02); the market is 15.01 bid for 300 (Hans), 100 offered at 15.02 (Petra).

f. Rama sells 400 to Bruce @ 15.03. Rama's remaining 100 shares can't be executed, and (because of the IOC) they are canceled; the market is 15.01 bid for 300 (Hans), 200 offered at 15.05 (Alice)

g. Only 700 shares are available at 15.01 or better, so Sydney's entire order is cancelled. The market is (still) 15.01 bid for 300 (Hans), 200 offered at 15.05 (Alice).

Answer to problem 4.4

	Direction	Price	Time	Quantity	Visibility	Trader	Why?
1	Buy	$10.20	11:08	100	D	Emma	Price
2	Buy	$10.10	11:08	500	D	David	Price
3	Buy	$10.05	11:10	300	D	Cathy	Visibility
4	Buy	$10.05	11:02	1,000	H	Beth	Price
5	Buy	$10.00	11:01	200	D	Andy	

Answer to problem 4.5

	Direction	Price	Time	Quantity	Visibility	Trader	Why?
1	Buy	$20.50	11:08	300	D	Cathy	Price
2	Buy	$20.45	11:15	100	D	Emma	Price
3	Buy	$20.40	11:09	500	D	David	Price
4	Buy	$20.00	11:01	200	D	Andy	Time
5	Buy	$20.00	11:02	100	D	Beth	

Answer to problem 4.6

	Direction	Price	Time	Quantity	Visibility	Trader	Why?
1	Sell	$20.00	11:01	200	D	Andy	Time
2	Sell	$20.00	11:02	100	D	Beth	Price
3	Sell	$20.45	11:09	500	D	David	Time
4	Sell	$20.45	11:15	100	D	Emma	Price
5	Sell	$20.50	11:08	300	D	Cathy	

Answer to problem 4.7

	Direction	Price	Time	Quantity	Visibility	Trader	Why?
1	Sell	$20.30	11:02	1,000	D	Beth	Time
2	Sell	$20.30	11:09	500	D	David	Time
3	Sell	$20.30	11:15	100	D	Emma	Visibility
4	Sell	$20.30	11:01	200	H	Andy	Time
5	Sell	$20.30	11:08	300	H	Cathy	

Answer to problem 4.8

	Direction	Price	Time	Quantity	Visibility	Trader	Why?
1	Sell	$20.30	11:02	1,000	D	Beth	Visibility
2	Sell	$20.30	11:01	200	H	Andy	Price
3	Sell	$20.45	11:09	500	D	David	Visibility
4	Sell	$20.45	11:15	100	H	Emma	Price
5	Sell	$20.50	11:08	300	D	Cathy	

Answer to problem 4.9
Wendy buys 400 shares from Petra, and 100 shares from Oliver. The market is 10.01 bid, offered at 10.06.

Direction	Price	Time	Quantity	Visibility	Trader
Sell	$10.10	9:50	300	D	Maura
Sell	$10.06	9:51	100	D	Oliver
Buy	$10.01	9:44	100	D	Rob
Buy	$9.98	9:45	500	D	Sandy
Buy	$9.90	9:48	200	D	Trevor

Answer to problem 4.10
Yuri buys 400 shares from Petra; Yuri's 100 remaining shares are added to the book on the bid side:

Direction	Price	Time	Quantity	Visibility	Trader
Sell	$10.10	9:50	300	D	Maura
Sell	$10.06	9:51	200	D	Oliver
Buy	$10.05	10:00	100	D	Yuri
Buy	$10.01	9:44	100	D	Rob
Buy	$9.98	9:45	500	D	Sandy
Buy	$9.90	9:48	200	D	Trevor

Answer to problem 4.11
100 shares execute against Rob; 500 shares execute against Sandy. The new book is:

Direction	Price	Time	Quantity	Visibility	Trader
Sell	$10.10	9:50	300	D	Maura
Sell	$10.06	9:51	200	D	Oliver
Sell	$10.05	9:52	400	D	Petra
Buy	$9.90	9:48	200	D	Trevor

Answer to problem 4.12
100 shares execute against Rob; Arturo's remaining 500 shares are cancelled. The new book is:

Direction	Price	Time	Quantity	Visibility	Trader
Sell	$10.10	9:50	300	D	Maura
Sell	$10.06	9:51	200	D	Oliver
Sell	$10.05	9:52	400	D	Petra
Buy	$9.98	9:45	500	D	Sandy
Buy	$9.90	9:48	200	D	Trevor

Chapter 5. Multiple markets

(Also see Ch. 20 Reg NMS.)

Terms and concepts

Fragmentation and consolidation; types and purposes of linkage systems (market data/information, access, routing); direct (market) access; the Consolidated Trade System; the Consolidated Quote System; the National Best Bid and Offer (NBBO); trade-through; trade-through prevention provisions of Reg NMS.

Problems and sample exam questions

Problem 5.1 Ticker EAS is traded on the Gulf, Pacific and Atlantic stock Exchanges. The sequence of bids in the consolidated record is:

Time	Exchange	Bid
10:00:01	Atlantic	23.33
10:00:02	Pacific	23.32
10:00:03	Gulf	23.34
10:00:04	Pacific	23.40
10:00:05	Gulf	23.45
10:00:06	Pacific	23.44
10:00:07	Atlantic	23.43
10:00:08	Gulf	23.40

Construct the NBB at each time.

Problem 5.2 Protected quotes. Exchanges *A* and *B* have the following limit orders (displayed/visible, unless otherwise indicated).

Price	Exchange *A*	Exchange *B*
50.10	100 sh, hidden	
50.09	300 sh	
50.08		200 sh
50.07	400 sh	500 sh

a. Which orders are protected (against trade-throughs)?

b. If Exchange *A* receives an order, "Sell 500 shares, limit 50.07", what are its obligations? (Assuming that A would like to execute as much of the order as possible, how should A proceed? What must A do? What are A's options?)

c. If Exchange *B* receives an order, "Sell 500 shares, limit 50.07," what are its obligations?

Answers

Answer to problem 5.1
The NBB is the maximum across this set.:

Time	Exchange	Bid	NBB	Atlantic	Pacific	Gulf
10:00:01	Atlantic	23.33	*23.33*	*23.33*		
10:00:02	Pacific	23.32	*23.33*	*23.33*	*23.32*	
10:00:03	Gulf	23.34	*23.34*	*23.33*	*23.32*	*23.34*
10:00:04	Pacific	23.40	*23.40*	*23.33*	*23.40*	*23.34*
10:00:05	Gulf	23.45	*23.45*	*23.33*	*23.40*	*23.45*
10:00:06	Pacific	23.44	*23.45*	*23.33*	*23.44*	*23.45*
10:00:07	Atlantic	23.43	*23.45*	*23.43*	*23.44*	*23.45*
10:00:08	Gulf	23.40	*23.44*	*23.43*	*23.44*	*23.40*

Answer to problem 5.2

Price	Exchange *A*	Exchange *B*
50.10	100 sh, hidden	
50.09	***300 sh***	
50.08		***200 sh***
50.07	400 sh	500 sh

a. The protected orders are indicated above in bold. The top of each market's visible book. Hidden orders are not protected.

b. Before doing anything, A must check the protected quotes at other exchanges. Exchange A can execute 400 shares without trading through B's bid. It can send the remaining 100 shares to B for execution, or it can return them [to the order submitter], unexecuted. The last option (return the unexecuted portion of the order) is available to give A (or A's customer) some flexibility in avoiding the obligation to route to another exchange. In fact, there is an order qualifier (like IOC or FOK) to handle this situation. The customer can send an order marked "DNR" (do not route [away]).

c. Before doing anything, B must check the protected quotes at other exchanges. B cannot execute anything without trading through A's protected bid. So, it can return the entire order to the customer, unexecuted. Or it can send 300 shares to A and execute 200 shares against its own orders.

Interestingly, in this case, there will be an apparent trade-through. On Exchange A, there will be an execution of 100 sh at 50.10, and 200 sh at 50.09; 100 sh will remain at 50.09. Exchange B executes 200 sh at 50.08. This looks like a trade-

through of A's 100 sh at 50.09. For purposes of the regulation, though, it is not considered a trade-through, because B is not responsible for A's hidden orders. B simply had to send enough to satisfy A's protected (visible) bids. This satisfies the requirement that B tried to avoid a trade-through.

Chapter 6. Auctions

Terms and concepts

Single-price call auctions, procedures; deadline effects; bid shielding; collusion; shilling; randomization; Nasdaq opening procedures (reference price, matched volume, imbalance); imbalance-only orders; direct listings; hybrid auctions.

Problems and sample exam questions

Problem 6.1 Clearing. In an opening cross, the system receives the following on-open orders:

Trader	Order
Dave	Buy 200 shares, limit 20.10
Amy	Buy 200 shares, limit 20.00
Cathy	Buy 100 shares, limit 19.95
Brian	Buy 200 shares, limit 19.90
Ira	Sell 100 shares, limit 19.80
Gabe	Sell 200 shares, limit 19.90
Haley	Sell 300 shares, limit 19.95
Fiona	Sell 100 shares, limit 20.10

a. Construct the supply and demand schedules. At an indicative price of 20.00, what is the matched volume? What is the imbalance (direction and size)?

b. The clearing price is set to first maximize the matched volume and then minimize the net imbalance. What is the indicative clearing price? What are the matched volume and imbalance at the clearing price?

c. At the clearing price, who trades? What are the buyers' and sellers' trading profits?

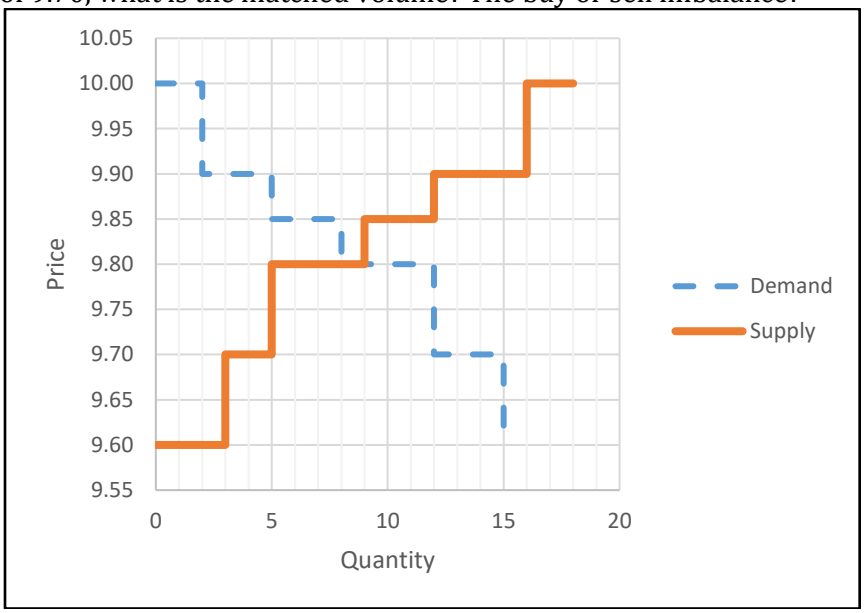
d. Now suppose that prior to the single-price clearing, Brian and Gabe met and traded. (Brian bought 200 shares; Gabe sold 200 shares at 19.90.) Brian and Gabe don't submit orders to the opening auction, but all other orders remain the same.

  i. What is the new clearing price?

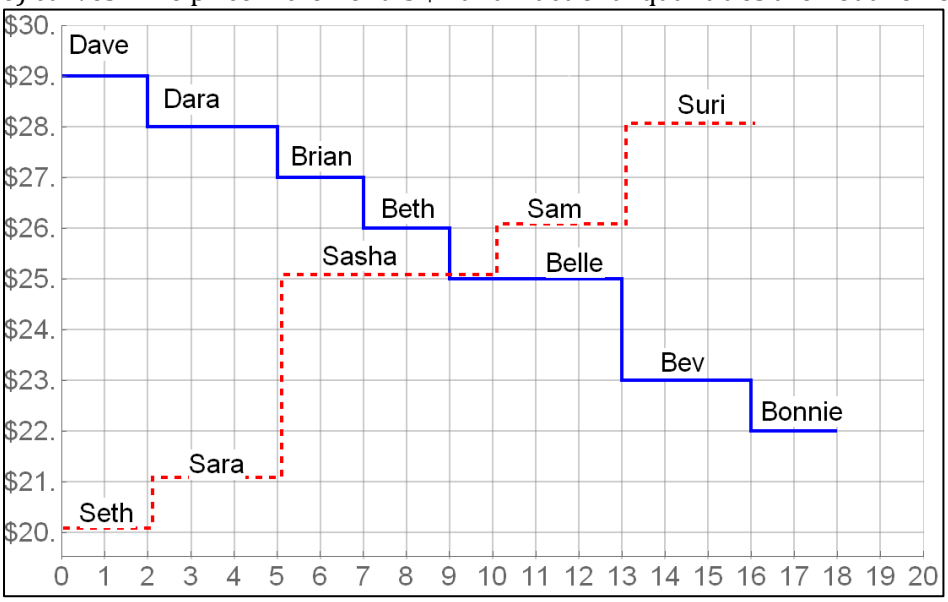
  ii. What are the total buyers' and sellers' trading profits?

  iii. What is the efficiency of the new allocation relative to the allocation determined in parts b and c?

Problem 6.2 From orders entered for an opening auction, an exchange constructs the following demand and supply schedules. What is the market clearing price? At the clearing price, what is the matched volume? The buy or sell imbalance? The NYSE disseminates information based on a reference price that may differ from the clearing price. At a reference price of 9.70, what is the matched volume? The buy or sell imbalance?



Problem 6.3 The Back to the Futures Exchange is considering opening with a single-price double auction format. From the limit orders submitted to its brokers at the start of today's trading, the exchange constructs the following demand (solid line) and supply (dashed line) curves. The price increment is $1 and fractional quantities are not allowed.



a. From this diagram, Beth's limit order is buy/sell (circle one) ___ contracts, limit $____; Sara's order is buy/sell (circle one) ___ contracts, limit $___.

b. At an indicative price of $27, the matched volume would have been ___ contracts and there would have been a buy/sell (circle one) imbalance of ___ contracts.

c. The exchange plans to maximize matched volume, and if two prices have the same matched volume, the clearing price will minimize the net imbalance.

i. Under this rule, the clearing price would have been ____ with a matched volume of ___ contracts and there a buy/sell (circle one) imbalance of ___ contracts.

ii. The total buyers' profits are ___; the total sellers' profits are ____.

d. When floor trading actually started today, Dave bought two contracts from Seth at $28. Following Dave and Seth's trade, If Sara is the seller in the next trade, who are her potential counterparties? That is, among the remaining buyers (Dara, Brian, Beth, Belle, Bev, and Bonnie), which of them could trade with Sara at a price that would not result in a loss for either side?

e. Suppose that at the start of trading, the only three trades are the following

Buyer	Price	Quantity	Seller
Dave	$28	2	Seth
Dara	$27	3	Sasha
Brian	$26	2	Sam

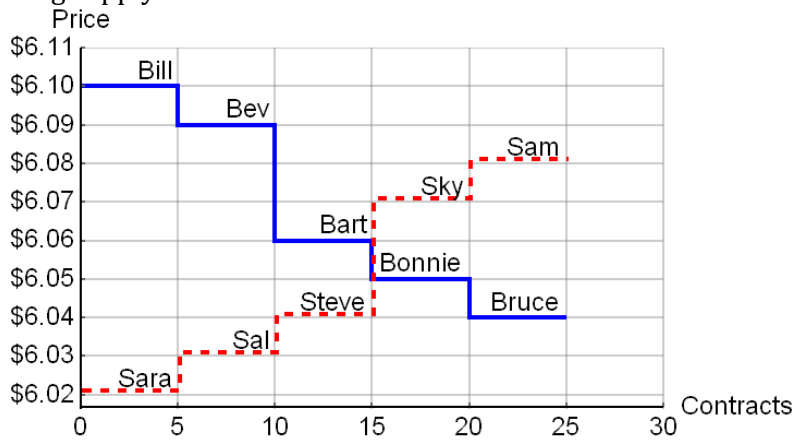
What is the efficiency of these trades, relative to the proposed single-price auction?

Problem 6.4 In most of the world's stock markets, the only firms that trade continuously are the largest ones. Most firms trade once or twice a day in single-price call auctions. What are some pros and cons of this arrangement?

Problem 6.5 At the opening, the Vertex Exchange has the following buy and sell orders

Buyers				Sellers		
	Quantity	Limit Price		Quantity	Limit Price	
Bill	5	$6.10		5	$6.02	Sara
Bev	5	$6.09		5	$6.03	Sal
Bart	5	$6.06		5	$6.04	Steve
Bonnie	5	$6.05		5	$6.07	Sky
Bruce	5	$6.04		5	$6.08	Sam

Vertex uses a computerized auction to open the market. From these orders, it constructs the following supply and demand functions:



a. Vertex sets an opening price of $6.06. Bill, Bev, and Bart each buy 5 contracts; Sara, Sal and Steve each sell 5 contracts. What are the total (buyers' + sellers') profits with this set of trades?

b. Now suppose that Vertex has computer problems, and the brokers have to go back to old way of doing things. But they've forgotten how to trade in a floor market, so they just strike a deal with the first person they meet. In this process, Bill buys from Sara @ $6.09, Bev buys from Sky at $6.07, and Bart buys from Steve at $6.05. These are the only trades, and all trades are for five contracts. Now, with these trades, what are the total profits? What is the efficiency relative to the auction?

c. The Marketing Director of Vertex wants to advertise: "No more bad news! Vertex is the market where EVERYBODY trades at a profit!" Keeping the same set of orders, match up buyers and sellers so that everyone trades at a profit. For each trade, identify the buyer, the seller and the price. (Hint: the trades won't be at the same price.) What are the total profits? What is the efficiency relative to the auction in part a?

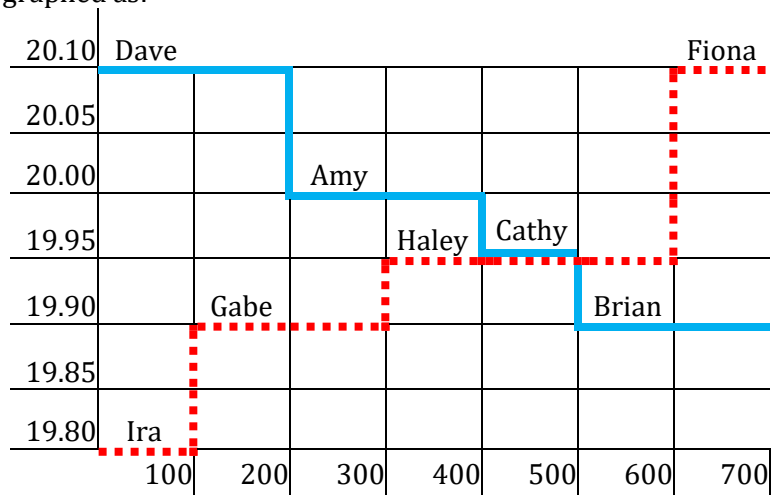
Answers

Answer to problem 6.1

a. The cumulative demand and supply schedules constructed from these orders are:

Demand:					Supply:			
Buyer	Price	Quantity	Cum		Buyer	Price	Quantity	Cum
Dave	$20.10	200	200		Ira	$19.80	100	100
Amy	$20.00	200	400		Gabe	$19.90	200	300
Cathy	$19.95	100	500		Haley	$19.95	300	600
Brian	$19.90	200	700		Fiona	$20.10	100	700

They are graphed as:



At an indicative price of 20.00: Dave and Amy are buyers (for 400 shares); Ira, Gabe and Haley are sellers (for 600 shares). The matched volume is 400, and there's a net sell imbalance of 200.

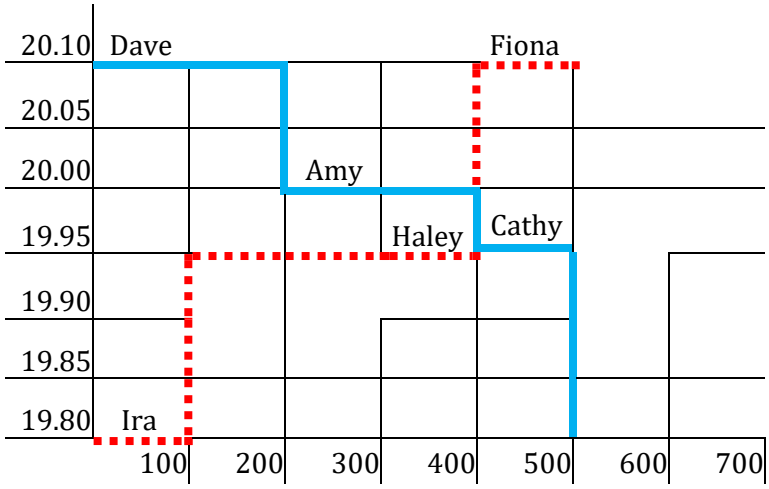
b. The clearing price is 19.95. At that price, matched volume is 500 shares, and there's a net sell imbalance of 100 shares. Dave, Amy and Cathy buy; Ira, Gabe and Haley sell, but Haley can only sell 200 shares.

c. Each block in the graph is worth $100\ sh \times \$0.05\ per\ sh = \$5$. So, the profits are:

Dave	$30
Amy	$10
Cathy	$0
Ira	$15
Gabe	$10
Haley	$0

The total sellers' profits are $25; the total buyers' profits are $40; the overall total is $65.

d. With Brian and Gabe out, the supply and demand curves constructed from the remaining orders are:



The new clearing price is 20.00 (Dave and Amy are buyers; Ira and Haley are sellers.) At 20.00, the matched volume is 400 shares; the net imbalance is zero. (At 19.95, the matched volume would also be 400 shares, but there would be a buy imbalance from Cathy.)

The profits are:

Dave	$20
Amy	$0
Ira	$20
Haley	$15

For a total of $55. Relative to the original outcome, this represents efficiency of $55/65 = 85\%$.

Answer to problem 6.2

The market-clearing price is the price at which the supply and demand schedules cross: 9.80. At that price, we have buyer (demand) for 12 units and seller (supply) of 9 units. The matched volume is the minimum of the two: 9 units. There is a buy imbalance of 3 units. At a reference price of 9.70, the matched volume is 5 (the minimum of 5 and 15) and there's a buy imbalance of 10 units.

Answer to problem 6.3

a. Beth's limit order is buy two contracts, limit $26; Sara's order is sell three contracts, limit $21.

b. At an indicative price of $27, the matched volume would have been 7 contracts and there would have been a sell imbalance of 6 contracts.

c. The exchange plans to maximize matched volume, and if two prices have the same matched volume, the clearing price will minimize the net imbalance.

  i. Under this rule, the clearing price would have been $25 with a matched volume of 10 contracts and a buy imbalance of 3 contracts.

  ii. The total buyers' profits are 23; the total sellers' profits are 22.

d. All of the remaining buyers have limit prices greater than Sara's sell limit price (21). Any of them could trade with Sara.

e. The buyer's profits are 2 (Dave) + 3 (Dara) + 2 (Brian) = 7.
The seller's profits are 16 (Seth) + 6 (Sasha) + 0 (Sam) = 22.
The total profits are 29, for an efficiency of 29/(22+23) = 29/45=64%

Answer to problem 6.4

- Auction prices are more stable and reliable, less prone to manipulation because they attract a large number of buyers and sellers at a single point in time. This is good for traders who don't have a strong urgency in their trades and can wait for the next call auction.
- Other types of traders prefer markets where they can trade continuously. Hedgers may need to trade quickly to reduce risk; speculators may want to trade in advance of real or imagined predicted changes in the stock price.
- In addition, continuous trading is also favored by management of the listed company, since index membership is often limited to issues that have continuously available price data.

Answer to problem 6.5

$$16 \times 5 \times 0.01 = \$0.80$$

a. $$1(Bill) + 7(Sara) + 2(Bev) + 0(Sky) + 1(Bart) + 1(Steve) = 12$$

b. $$12 \times 5 \times 0.01 = \$0.60 \rightarrow efficiency = \frac{0.6}{0.8} = 75\%$$

c. Bill/Sam trade 5 contracts @ 6.09, Bev/Sky @ 6.08, Bart/Steve @ 6.05, Bonnie/Sal @ 6.04, Bruce/Sara @ 6.03. Each trader makes $0.01 on each contract, so

$$Profits = 10 \times 5 \times 0.01 = 0.50; efficiency = 0.5/0.8 = 62.5\%$$

Chapter 7. Dealers in public limit-order markets

Terms and concepts

The broker/dealer conflict of interest; designated market makers; contract market makers; NYSE specialist affirmative obligations (price continuity, maintaining a narrow bid and ask spread, crossing public buyers and sellers, public priority) and negative obligations (trading in a destabilizing fashion); Designated market makers (DMMs); parity.

Problems and sample exam questions

Problem 7.1 The principle of public priority prevents an NYSE specialist (market maker) from ___ (Mark each one True or False).

a. Bidding or offering more aggressively than public customers.
b. Buying or selling to public customers.
c. Buying at a price bid by a public customer.
d. Lifting a customer offer.

Problem 7.2 An NYSE specialist was required to ___ (Mark each one True or False)

a. Always quote a bid and an offer.
b. Always ensure that the day's trading volume in a stock was non-zero.
c. Support the stock price so that it didn't decline below the day's opening price.
d. Avoid losses when trading on the Exchange's account.

Problem 7.3 The broker-dealer conflict of interest refers to the inherent conflict in

a. Advising a customer which securities to buy, while underwriting many of those same securities.
b. Acting as an agent for the customer's order, and also as a trading counterparty to the customer.
c. Making a market in two different securities that might be in a customer's portfolio at the same time.
d. Quoting different bid and ask prices to different customers.

Problem 7.4 On a European stock exchange, the contract market-maker for FRN stock would be paid by ___.

a. The exchange
b. The FRN Corporation
c. Public sellers of the stock.
d. The brokers for public customers.
e. The national government.

Answers to problems

Answer to problem 7.1

a. False
b. False
c. True (This is the essence of public priority: the specialist would have to yield to public interest at the same price.)
d. False (If the specialist were to start a price trend by successively lifting customer offers, this could be considered to be trading in a destabilizing fashion. This would be against the rules, but it is not "public priority".)

Answer to problem 7.2

a. True (The specialist might be entering a bid/offer on behalf of someone else, such as an order in the book. But if there were no orders on the book, the specialist would have to bid/offer on his own account.)
b. False
c. False
d. False (The specialist was trading with his own money; he was not an employee of the exchange.)

Answer to problem 7.3 b

Answer to problem 7.4 b

Chapter 8. Dark Markets

Terms and concepts

Dark trades vs. dark markets; lit markets; hidden orders; internalized executions; crossing sessions; continuous dark pools; midpoint matches; spoofing; leakage; pros and cons of dark trades; regulatory concerns; recent cases (Pipeline/Millstream; UBS; Barclays).

Problems and sample exam questions

Problem 8.1 In each of the following situations, determine if the trade is regarded as "dark", and why or why not? In all cases, the NBBO is 10.00 bid, offered at 10.10.

a. A NASDAQ market maker in SPQR, whose own offer is 10.15, receives a customer order to buy 100 shares at the market. He routes the order to an exchange offering 10.10, where the order is executed at 10.10.

b. A NASDAQ market maker in SPQR, whose own offer is 10.15, receives a customer order to buy 100 shares at the market. He sells 100 shares to the customer at the NBO, 10.10.

c. The INET book receives an order to buy 100 shares limit 10.20. The order executes against a hidden limit order priced at 10.09.

d. Pension fund LSM and mutual fund EFT are paired off in the Credit Suisse Crossfinder system. LSM buys 10,000 shares; EFT sells, and the trade is priced at the NBBO midpoint of 10.05

Problem 8.2 Credit Suisse's Crossfinder® is a dark pool for US equities. This means that it ____.

a. doesn't report trades

b. doesn't display visible bids and offers

c. can't deny access to any potential customer.

d. Only operates at night.

e. isn't required to make any regulatory filings.

Problem 8.3 What is FINRA's Trade Reporting Facility, and what does it do?

Problem 8.4 In November 2010, the Canadian counterpart of the SEC released a policy statement on dark liquidity. Among their recommendations:

> An exemption to the pre-trade transparency requirements [that an executing market must be posting an accessible quote at the execution price] should only be available when an order meets or exceeds a minimum size … This minimum size threshold for posting passive Dark Orders would apply to all marketplaces (whether transparent or a Dark Pool) regardless of the method of trade matching (including continuous auction, call or negotiation systems), and for all orders whether client, non-client or principal.

What concerns might have motivated this sort of recommendation?

Answers

Answer to problem 8.1

a. Not dark. The order is executed by someone whose visible quote is 10.10.

b. Dark. The MM is matching a price that he himself is not posting. (Note that this would have been considered a dark trade even if the MM sold to the customer at a price slightly better than NBO, like $10.0999. In fact, MMs sometimes do this to demonstrate that they are offering their customers price improvement. Here, the price improvement is a trivial $0.0001.)
c. Dark
d. Dark. There are no visible quotes are the execution price.

Answer to problem 8.2
b (*a* is wrong because trades must be reported; *c* is wrong because dark pools can discriminate against particular customers; *e* is wrong because dark pools *are* regulated, they're just not regulated as strictly as exchanges.)

Answer to problem 8.3
The Trade Reporting Facility (TRF) is a trade reporting system used mainly by dark pools and dealers (for their internalized orders). Trades reported here show up on the Consolidated Trade System with exchange code "D".

Answer to problem 8.4
The regulators would have been concerned about the deterioration of the visible market. As more trading activity goes dark, the visible market becomes thinner. Spreads get wider, and prices more volatile. Since the dark markets are often driven by the visible prices, the quality of pricing in the dark markets suffers as well.

Chapter 9. Dealer markets

Terms and concepts

Dealer/over-the-counter/quote-driven markets; request for quote; prime brokerage; indicative/firm quotes; last-look; Basel III; Volcker Rule; FX pricing conventions (quote and base currencies); TRACE; on/off the run;

Problems and sample exam questions

Problem 9.1 In the FX market the ABC bank, acting as a ____, allows the HIJ hedge fund to submit orders to a trading system under ABC's name.
a. Designated market maker
b. Prime broker
c. Dual trading broker
d. Dark pool

Problem 9.2 In the EUR/SEK market (SEK = Swedish Krona) a dealer is bidding 10.18 and asking 10.19. A customer can exchange €1,000 for about ___ SEK.
a. 98.24
b. 98.14
c. 10,190
d. 10,180

Problem 9.3 Most dealer markets do not have last sale (trade) reporting. The US corporate bond market is an exception. For each trade, the TRACE system publically reports (mark true/false):

a. The names/identities of any dealers involved in the trade
b. The names/identities of any customers involve in the trade.
c. The buyer and seller types (dealer, customer, or trading system)
d. The trade price and quantity (number of bonds)

Problem 9.4 The US corporate bond market is a dealer market. It is unusual, though, in that it has trade reporting (we see trade prices), and the trades are labeled dealer-to-dealer or dealer-to-customer. How does this information help a customer determine whether she pays a fair price when she buys a bond and receives a fair price when she sells?

Problem 9.5 In most dealer markets a dealer can make different bids and asks for different customers. What are some customer characteristics that might lead a dealer to give better or worse prices?

Problem 9.6 Many trading systems in current dealer markets feature a trading process known as RFQ. What does an RFQ functionality accomplish, and what is its purpose?

Problem 9.7 The International Standards Organization (ISO) specifies 3-letter codes for currencies (like EUR or USD). Most currencies have one code. The Chinese yuan has two. Why?

Problem 9.8 On November 20, 2020, the US Treasury bond that matures on Nov 15, 2050 was the "on-the-run 30-year bond". What does this mean and what is the significance of this designation?

Problem 9.9 In the foreign exchange (FX) market, *last-look* refers to ___.

a. The customers' option to refuse to trade with any of the dealers that have responded to their request for a quote.
b. The dealer's option to retract a bid or offer after the customer has already hit or lifted it.
c. A dealer's option to drop customers whose trades have caused losses for the dealer.
d. The dealer's obligation to honor a previously-made bid or ask while the customer calls around in search of a better price.

Problem 9.10 In the foreign exchange (FX) market, dealers would traditionally sell to a customer and immediately buy in the interdealer market. Nowadays, the dealer who sold to a customer would probably wait and try to buy from another customer, avoiding the interdealer market. This pattern of trade is called ___.

a. internalization
b. standardization
c. intermediation
d. aggregation

Answers

Answer to problem 9.1 b

Answer to problem 9.2
d. For a given pair (like EUR/SEK) the convention is that the first currency (EUR) is the base currency; and the second currency (SEK) is the quote currency. A price quote in this market is the #units of quote currency that can be exchanged for one unit of the base currency.

Answer to problem 9.3
a. F
b. F
c. T
d. T

Answer to problem 9.4
The trade reporting system is TRACE. If the customer is selling to the dealer, she can see what the dealer receives when he re-sells the bond. If the customer is buying, she can often see the price the dealer paid when he purchased the bond. She can see compare the prices she's getting with the prices the dealers are getting (and compute the dealers' profits on her trades).

Answer to problem 9.5
The dealer is more likely to offer better prices if the customer has relationships with other dealers (competition), if the customer executes a high volume of orders, or if the customer is less likely to be informed (in possession of material nonpublic information).

Answer to problem 9.6
RFQ stands for "Request for Quote". It provides a means for a customer to obtain bids and asks for a given quantity from multiple dealers simultaneously. It is effectively an auction, placing the dealers in competition, to give the customer the best price(s).

Answer to problem 9.7
China has currency controls that limit the transfer of its currency across its border. As a result there are two markets for the yuan: a home market (where the yuan is traded against other currencies within China); and an off-shore market (where the trading and settlement takes place outside China).

Answer to problem 9.8
The on-the-run 30-year bond is simply the 30-year Treasury bond that is most-recently issued. Every time a new 30-year bond is issued, the new bond is on-the-run, until the next issue. On-the-run bonds and notes have lower bid-ask spreads and trade in much higher volumes than comparable off-the-run issues.

Answer to problem 9.9 b.

Answer to problem 9.10 a.

Chapter 10. Public Information

Problems and sample exam questions

Problem 10.1 It is 1pm. After the market close, Briarthorne is planning to announce an accounting irregularity that calls last quarter's financial statements into question. Briarthorne might move the announcement earlier, and during trading hours, if

a. The primary listing exchange believes that the announcement would increase trading volume.
b. A hurricane has hit Florida, and Briarthorne believes that this news would distract attention from their announcement.
c. There is evidence that the news may already have been leaked.
d. Briarthorne wants to discourage traders from selling the stock short.

Problem 10.2 US government economic statistics are often announced when the market is open. Immediately prior to an announcement, the bid-ask spread usually ___ and trading volume ___.

a. Widens; rises
b. Widens; drops
c. Narrows; drops
d. Narrows; rises

Answers

Answer to problem 10.1
c. There is evidence that the news may already have been leaked. (If the news is leaking, there is a danger of increased information asymmetries.)

Answer to problem 10.2
b Widens; drops (Over the period of the announcement, volatility is higher.)

Chapter 11. Circuit breakers, trading halts, and price limits

Problems and sample exam questions

Problem 11.1 Limit-up/limit-down procedures in US equity markets ____.

a. Set price limits for individual stocks. These limits can trigger trading halts.
b. Govern when a market center can accept limit buy and sell orders.
c. Limit retail investors' profits and losses over the day to ±5% of the prior day's closing price.
d. Specify limits such that all trades occurring outside of those limits can be broken (cancelled) by either the buyer or the seller.

Problem 11.2 Circuit breakers in US equity markets.

a. Force orders to be routed from dark to lit markets.
b. Are triggered only when the S&P index declines by a pre-set amount.
c. Are triggered when the S&P index declines or increases by pre-set amounts.
d. Are pre-emptively used in advance of US Presidential news conferences.

Problem 11.3 A trading halt can help to achieve a fair and orderly market by ensuring that ____.

a. the issuer of the security can formulate a plan to buy or sell (as needed) to stabilize the market.
b. traders who are trying to hedge with the security can take a rest from constantly trading.
c. the issuer of security can stabilize the price by releasing some kind of good news (in the case of price drops) or negative news (in the case of price jumps).
d. more people will be aware of any recent news announcements

Problem 11.4 Under the limit-up/limit-down rule, a trading pause would start as soon as

a. The (National Best) bid drops below the reference band.
b. *a* AND the (National Best) offer drops to the lower reference band
c. *a* AND *b* AND the NBO remains at the lower reference band for fifteen seconds.
d. *a* AND *b* AND *c* AND there have been no executions at the NBO within the fifteen seconds.

Problem 11.5 Under the limit-up/limit-down rule, the trading pause lasts for

a. fifteen seconds
b. five minutes
c. fifteen minutes
d. one hour

Problem 11.6 When the NBO is above the LULD reference band and the NBB is within the band, the market is _____.

a. Crossed
b. Locked
c. In a straddle state
d. In a limit state

Problem 11.7 *New 2025F* When the NBO is above the LULD reference band and the NBB is *at* (the upper limit of) the reference band, the market is in a *limit state* and the NBB is a *limit quote*. The market exits the limit state if (within the fifteen second clock) … *There may be multiple correct answers*

a. Any bid at the NBB is executed in part or in whole.
b. Any offer at the NBO is executed in part or in whole.
c. All bids at the NBB are executed in their entirety.
d. All bids at the NBB are cancelled.

Problem 11.8 New 2025F The LULD procedures differ from the price limits in futures exchanges because ____.

a. They involve bid and ask quotes (not just trades).
b. They provide conditions under which a reopening auction might occur.
c. LULD can prevent trades from occurring even in cases where the buyer and seller might both prefer to trade.
d. LULD procedures restrict price drops but not price rises; the price limits in futures markets are symmetrical (applying to both drops and rises).

Answers

Answer to problem 11.1 a

Answer to problem 11.2 b

Answer to problem 11.3 d

Answer to problem 11.4 d

Answer to problem 11.5 b

Answer to problem 11.6 c

Answer to problem 11.7 *c or d*

To exit the state, the NBB has to move back within the limits. This can happen if all bids are executed or cancelled (*c* or *d*). In either case, we'd move to the next lower available bid (which would be within the limits). This might be from a limit order book or from a market maker at the primary listing exchange.

Answer to problem 11.8 *a, b Not c or d.*

c is not a difference: it applies to both LULD and futures price limits. In the case of *d*, both LULD and futures price limits are symmetrical.

Chapter 12. Securities Class Action Lawsuits.

Problems and sample exam questions

Problem 12.1 A typical class-action securities lawsuit alleges misstatements that inflated the price of the stock. In such a case, purchasers of the stock recover damages in the form of payments made by ____.

a. the people who sold them the shares
b. the corporation itself
c. the directors
d. the employees who aided or abetted the misstatement.

Problem 12.2 An investor class-action lawsuit alleges that management lied about the rate of recent sales growth. In this context, establishing "reliance" means that an investor must establish that _____.

a. They relied on management's misstatements in assessing the intrinsic value of the company.
b. Management relied on the principle of market efficiency to ensure that the incorrect information would actually inflate the stock price.
c. Investors who suspected misinformation relied on a liquid market when selling their holdings.
d. They relied on the price, which reflected management's misstatements.

Problem 12.3 In investor class-action lawsuits, a corrective disclosure is a public statement ____

a. By management that corrects inaccurate reports in the media.
b. By the auditor that clarifies a company's financial statements.
c. By management that corrects previous misstatements by management.
d. By the SEC that notifies investors that a company is under investigation.

Problem 12.4 In an investor class action lawsuit, the company announced on September 3, 2015 that previously-reported results for calendar year 2014 were overstated. In the event study used to quantify the economic value of the misinformation, the event window would be ___

a. The period of time that contains the market's reaction to the announcement.
b. The period of time over which investors were at least partially misinformed.
c. Calendar year 2014.
d. September 3, 2015.

Problem 12.5 In a daily event study of a public announcement, we might want to begin the event period before the actual date of the announcement if

a. We suspect that the announcement may have been leaked.
b. We suspect that management might have deliberately delayed the announcement.
c. The announcement was made 30 minutes after the close of normal trading hours (4:00pm).
d. The announcement was made 30 minutes before the market opened at 9:30am.

Problem 12.6 In an investor class-action lawsuit, to establish causation and damages, we usually look for a sharp drop in the stock price at the time of the corrective disclosure. What other evidence might be used?

Problem 12.7 In November 2018, a class action securities lawsuit was filed against Fitbit, Inc. The complaint noted "… (1) that the Company was struggling to transition its mission and differentiate itself from Apple Inc. and other competitors; (2) that, as such, the Company was experiencing increased competition; (3) that, as a result, demand and sell-through for the Company's existing and new products were being negatively impacted; (4) that, as a result, the Company's sales and financial results were weakening, and growth was slowing …" The basis for the lawsuit is most likely that management did not ___

a. Effectively transition its mission.
b. Respond to the increased competition.
c. Take steps to increase demand for new products.
d. Adequately disclose its condition to investors.

Problem 12.8 The "fraud on the market" principle is used to assert that misinformation affects investors ___.

a. through their reliance on the stock price
b. only if they directly rely on the misinformation in formulating their purchase/sale decision.
c. because managers who lie about material information will usually be engaging in insider trading.
d. because market forces eventually cause the truth to be revealed.

Problem 12.9 Ninety percent of ABC's profits derive from sales to XYZ, and ABC has extended substantial trade credit to XYZ. Over the weekend, XYZ announces that a massive accounting fraud has left the firm close to insolvency. On Monday morning ABC's stock is sharply down from Friday's closing price, but XYZ's stock is essentially unchanged. ABC's management issues a statement that the decline is due to the financial difficulties of XYZ, their main customer. Discuss the validity of this claim.

Problem 12.10 By the principle of market efficiency, the stock price change immediately after a corrective disclosure …

a. Is always negative.
b. Measures the losses of investors who held the stock at some point during the class period.
c. Always occurs on the day of the disclosure.
d. Measures the portion of the stock's price caused by the original incorrect information.

The next two questions refer to the following situation.

- APX first reported its 2013 IV (fourth quarter) earnings on January 29, 2014.
- On Monday, March 3, 2014, APX closed down 2% from the previous Friday. After the market close, APX discloses that previously reported 2013 IV results can't be relied upon and are likely to be revised.
- On Tuesday, March 4, APX closes down 18% from the previous day. Also on Tuesday, after the market close, APX discloses that 2013 IV earnings were overstated by $0.30 per share.
- On Wednesday, March 5, APX closes down 8% from the March 4 close.

Problem 12.11 Randolph and Mortimer Duke immediately file a law suit alleging that the accounting fraud cost them 28% of their investment in APX (the sum of the Monday, Tuesday and Wednesday declines). APX hires an expert. Using market data prior to June, 2014, the single-index model is specified for daily returns as $r_{APX} = \alpha_{APX} + \beta_{APX} r_M + e$ where the expert's estimated parameters are $\alpha_{APX} = 0$; $\beta_{APX} = 1.3$. The daily returns on APX and the market ("M") during the week are:

Date	r_{APX}	r_M
Monday, March 3	-2.0%	-4.0%
Tuesday, March 4	-18.0%	-5.0%
Wednesday, March 5	-8.0%	-1.0%
Thursday, March 6	+3.0%	-1.0%
Friday, March 7	6.0%	5.0%

What case could the expert make to refute the Duke claim? What number might she suggest as an alternative to the 28% loss?

Problem 12.12 The Dukes also present the following records of their purchases and sales:

Date	Shares bought (sold)	Net holdings
September 1, 2013	10,000	10,000
December 29, 2013	(9,000)	1,000
January 5, 2014	5,000	6,000
February 1, 2014	2,000	8,000
March 7, 2014	(8,000)	0

On the basis of these records, they claim that their 28% loss applies to the 17,000 shares they purchased before or during the period affected by the alleged fraud. What alternative number might APX's expert suggest?

Answers

Answer to problem 12.1 b. This is one of the drawbacks of the process: it is essentially a transfer from one group of shareholders to another group of shareholders (plus the lawyers and consultants).

Answer to problem 12.2 d. Under market efficiency, the reliance is indirect, via the market price.

Answer to problem 12.3 c. The fraud on the market principle allows plaintiffs to substitute indirect reliance (through the price) for direct reliance.

Answer to problem 12.4 a. The event period would probably include the date of the announcement, but the market reaction might have started before or continued after that date.

Answer to problem 12.5 a. If there is no leakage, the impact of the announcement shouldn't appear before the announcement.

Answer to problem 12.6 We usually try to rule out other explanations for the drop. We can eliminate market-wide explanations by focusing on the error in a market model linear regression. We can rule out alternative industry-based explanations if the model also includes the return on an industry index.

Answer to problem 12.7 d. The essence of a 10b-5 lawsuit is failure to disclose to investors, not any other lapse in business judgement.

Answer to problem 12.8 a. This answer describes indirect reliance.

Answer to problem 12.9 XYZ would have no reaction if their problems were widely known in the market prior to their announcement. But if this were the case, ABC's shareholders wouldn't have been surprised, either. The drop in ABC must be due to some other information.

Answer to problem 12.10 d. ("a" is wrong because the company might have denied the existence of good news; "b" is wrong because the stock price might change during the class period for reasons having nothing to do with the misinformation; "c" is wrong because when a disclosure is made after the market is closed, the price can't react until the following day.)

Answer to problem 12.11 The corrective disclosures did not occur before the market close on Monday, so Monday's return is not relevant. APX declined on Tuesday and Wednesday, but so did the market. To isolate the part of the return that might be due to company-specific news, we focus on the residuals in the regression (the company-specific components of the return).

Date	r_{APX}	r_M	$e = r_{APX} - \beta_{APX} \times r_M$
Monday, March 3	-2.0%	-4.0%	…
Tuesday, March 4	-18.0%	-5.0%	$-18 - 1.3 \times (-5) = -11.5\%$
Wednesday, March 5	-8.0%	-1.0%	$-8 - 1.3 \times (-1) = -6.7\%$
Thursday, March 6	+3.0%	-1.0%	$3 - 1.3 \times (-1) = 4.3\%$
Friday, March 7	6.0%	5.0%	…

If the company-specific returns on Tuesday and Wednesday are attributed to the corrective disclosures, the damages would be based on return of $-11.5\% - 6.7\% = -18.2\%$. But the following day (Thursday), the stock recovered on a day when the market was down. So the expert

might also argue that there were over-reactions on Tuesday and Wednesday. Including Thursday's gain, the damages would be calculated on a return of -13.9% ($= -18.2 + 4.3$).

Answer to problem 12.12 The period over which the earnings accrued (in an accounting sense) isn't relevant here. What matters is the information that management reported (or mis-reported) to the market. Since they first reported 2013 IV earnings on January 29, what matters is the net number of shares that were purchased during the period covered by the mis-information, that is January 29 to March 6. This is 2,000 shares.

Chapter 13. Private Information

Problems and sample exam questions

Problem 13.1 In "The Only Game in Town", Treynor argues that the bid-ask spread is caused mainly by dealer/specialist's

a. exposure to losses from informed traders
b. monopoly power
c. exposure to risk arising from company news announcements
d. fixed costs of maintaining a trading operation.

Problem 13.2 An increased likelihood of asymmetric information (insider trading) in a market would normally cause an increase in _____. (Indicate all that are true; there may be more than one.)

a. total trading volume
b. the bid-ask spread
c. the impact of a buy order on subsequent prices
d. trading costs for uninformed traders

Problem 13.3 Retail order flow is more desirable *to a market maker* because, relative to institutions/institutional orders, ____.

a. Retail traders are less likely to be informed (in possession of non-public information).
b. Retail traders are more likely to use order splitting strategies.
c. Retail traders are more likely to direct their orders to specific trading venues.
d. Retail orders are usually subject to payment for order flow arrangements.

Problem 13.4 At the end of the day, SLK stock will be worth 100 (an 80% probability) or 110 (a 20% probability). A market-maker believes that 90% of her incoming traders are uninformed, and equally likely to buy or sell; the remaining 10% know SLK's end-of-day value. The market maker is trying to set her ask price. At what value of the ask does she just break even?

Problem 13.5 Before posting her ask price, the market maker notices that the date is April 15. Uninformed traders are more likely to be selling stock to pay their taxes. She now figures that there is only a 30% probability that an uninformed trader will be buying. What is her revised ask price?

Problem 13.6 Clarence is an accountant working for a client, the ABC corporation. At a meeting to discuss the upcoming annual report, Clarence learns that ABC will shortly be making takeover bid for XYZ. The accountant buys XYZ stock. In his insider trading trial, the defense presents expert evidence establishing that the impact of Clarence's orders on the price of XYZ's stock was exactly the same as the impact of all other orders in XYZ. The defense claims that if Clarence had in fact been trading on inside information, the impact of his trades would have been larger. Could the evidence be correct? And, if so, is the defense claim correct? Discuss.

Answers

Answer to problem 13.1 a. This is the main point of Treynor's argument: the losses to the informed traders force the dealer to recover these losses by setting a wide spread to profit from the uninformed traders.. We might also argue that monopoly power plays a role. (That is, the dealer can charge a wide spread because he/she faces little competition.) But Treynor does not discuss this point.

Answer to problem 13.2 b, c, and d. There is no plausible effect that could account for answer *a*.

Answer to problem 13.3 a. Retail traders are less likely to be informed (in possession of non-public information). Market makers lose to informed traders. (Informed traders always trade in the direction of their information, buying if they have positive non-public news; selling on negative non-public news.) Market makers profit (on average) from uninformed traders. An uninformed trader is just as likely to buy as to sell; the dealer earns the spread from each pair of uninformed traders who come by. Informed traders never come by in pairs; they are always on one side of the market. Answer b is irrelevant; answer c states something that is incorrect (retail traders are less likely to know or care where their orders were sent. As for answer d, the statement is true, but it does not describe why a market maker would prefer a retail order.

Answer to problem 13.4 The market considers the following possibilities (the full table is given, but only the numbers in bold are actually needed):

End-of-day value	Trader type	Trader …	Probability
100	Uninformed	Buys	$\mathbf{0.8 \times 0.9 \times \frac{1}{2} = 0.36}$
		Sells	same
	Informed	Buys	$\mathbf{0}$
		Sells	$0.8 \times 0.1 = 0.08$
110	Uninformed	Buys	$\mathbf{0.2 \times 0.9 \times \frac{1}{2} = 0.09}$
		Sells	same
	Informed	Buys	$\mathbf{0.2 \times 0.1 = 0.02}$
		Sells	0

The probability of a buy order from the first incoming trader is

$$P(buy) = 0.36 + 0 + 0.09 + 0.02 = 0.47$$

The probability of a buy order *and* a low end-of-day value is

$$P(buy, 100) = 0.36$$

The probability of a low end-of-day value *given* a buy order is

$$P(100|buy) = \frac{P(buy, 100)}{P(buy)} = \frac{0.36}{0.47} = 0.766$$

The expected end-of-day value *given* a buy order is

$$E[V|buy] = 0.766 \times 100 + 0.234 \times 110 = 102.34$$

This is the break-even ask price.

Note

It was shown in the chapter text that when the bid and ask are set to their break-even prices, the MM's expected losses to informed traders equal the MM's expected gains from uninformed traders. The problem did not ask for this, but we can demonstrate that it holds in this situation. To be consistent with the problem, we analyze only the ask side of the market, but we could do a similar analysis for bid.

Before there are any trades, the expected value of the stock is

$$EV = 0.2 \times 110 + 0.8 \times 100 = 102.$$

If an uninformed trader buys (lifts the ask), the MM's expected profit is $102.34 - 102 = 0.34$. If an informed trader buys, the MM's expected profit is $102.34 - 110 = -7.66$ (that is, a loss).

Now what are the probabilities of informed and uninformed traders? You might think that they are numbers given in the problem, a 90% chance of uninformed and a 10% chance of informed. But these are the unconditional probabilities. If her ask has been lifted, the MM will know more than she did at the start of the day. Incorporating this knowledge, the MM computes the conditional probabilities:

$$P(Informed|Buy) = \frac{P(Informed, Buy)}{P(Buy)} = \frac{0.02}{0.36 + 0 + 0.09 + 0.02} = \frac{0.02}{0.47} = 0.0426$$

and

$$P(Uninformed|Buy) = 1 - P(Informed|Buy) = 0.9574$$

We can now write:

$$\underbrace{P(Inf|Buy) \times (-7.66)}_{Expected\ losses\ to\ informed} + \underbrace{P(Uninf|Buy) \times 0.34}_{Expected\ profits\ from\ uninformed}$$

$$= 0.0426 \times (-7.66) + 0.9574 \times 0.34 \approx 0$$

Finally, in the chapter and in the class PowerPoints analyses, the MM did *not* condition on her bid or ask being hit. (We used the unconditional probabilities for the arrival of informed and uninformed traders.) It did not matter in those situations; here it does.

Answer to problem 13.5
The complication here changes the relative probabilities of uninformed buys and sells.

End-of-day value	Trader type	Trader …	Probability
100	Uninformed	Buys	$\mathbf{0.8 \times 0.9 \times 0.3 = 0.216}$
		Sells	$0.8 \times 0.9 \times 0.7 = 0.504$
	Informed	Buys	$\mathbf{0}$
		Sells	$0.8 \times 0.1 = 0.08$
110	Uninformed	Buys	$\mathbf{0.2 \times 0.9 \times 0.3 = 0.054}$
		Sells	$0.2 \times 0.9 \times 0.7 = 0.126$
	Informed	Buys	$\mathbf{0.2 \times 0.1 = 0.02}$
		Sells	0

The probability of a buy order from the first incoming trader is

$$P(buy) = 0.216 + 0 + 0.054 + 0.020 = 0.290$$

The probability of a buy order *and* a low end-of-day value is

$$P(buy, 100) = 0.216$$

The probability of a low end-of-day value *given* a buy order is

$$P(100|buy) = \frac{P(buy, 100)}{P(buy)} = \frac{0.216}{0.290} = 0.745$$

The expected end-of-day value *given* a buy order is

$$E[V|buy] = 0.745 \times 100 + 0.255 \times 110 = 102.55$$

This is the break-even ask price. You'll notice that the asking price here is 102.55>102.34 (the ask with 50/50 uninformed buying/selling). In the present situation a buy is a stronger signal: the number of informed buyers is the same, but there are fewer uninformed buyers. This means that the proportion of informed buyers is larger.

Answer to problem 13.6 The evidence could well be correct: Orders move security prices due to the markets' beliefs in the *likelihood* of insider trading – not the actuality. All orders move prices in the same way because the market can't tell who is informed and who isn't. The construction the defense puts on this claim, however, is false. Just because the market couldn't tell, at the time of his trades, whether or not Clarence had information, it doesn't rule out the possibility that he actually did.

Chapter 14. Insider Trading

Problem 14.1 In support of the idea that insider trading laws should be abolished, all of the following arguments are advanced, except ____.

a. Insider trading increases the informational efficiency of stock prices.
b. Insider trading is simply a way of compensating managers.
c. Insider trading will encourage managers to quickly publicize specific corporate developments.
d. Any limits to insider trading by managers are best addressed in their employment contracts.

Problem 14.2 Chiarella was a financial printer who learned the identities of target firms and bought their stock before the announcement of the takeover bid. He was ultimately _____, on the grounds that ____.

a. Convicted; he misappropriated information from his employer (the printing company).
b. Found innocent; he had no fiduciary responsibility to the target companies.
c. Convicted; he was simply trading on the basis of material non-public information.
d. Found innocent; his trades had no material impact on the bidding company.

Problem 14.3 O'Hagan was an attorney who learned the identity of a client's takeover target, and bought shares prior to the announcement. On charges of insider trading he was ultimately ____ on the grounds that _____.

a. Found innocent; he had no fiduciary obligation to the target company or its shareholders.
b. Found innocent; he did not pay anything to acquire the information.
c. Found innocent; he did not misappropriate any information from the target company.
d. Convicted; he misappropriated information from this employer.

Problem 14.4 Raymond Dirks was a securities analyst and a tippee (someone who received information from a tipper, in this case Ronald Secrist). The SEC accused Dirks of insider trading in Equitable Funding, but the Supreme Court said that it wasn't insider trading because ___.

a. Secrist's information concerned a fraud that the SEC should have detected, but didn't.
b. Secrist did not receive any personal benefit in exchange for passing along the information.
c. Dirks was not did not benefit in any way from the information.
d. Dirks did not owe any duty of confidentiality to Secrist.

Problem 14.5 Newman was convicted of insider trading on information that originated in the Dell investor relations department. In reversing his conviction, the appeals court noted that the SEC did not convincingly establish that ___. (Possibly more than one correct answer.)

a. Newman actually traded on the basis of the information.
b. Newman was aware that the information was obtained in violation of a duty confidentiality.
c. Newman knew that the tipper (at Dell) received some sort of benefit.
d. Newman knew that the information was accurate.

Problem 14.6 Consider the following situation.

- IceMountain (ICE) and SlipperySlope (SSL) are both publicly-traded companies that manufacture snowboards.
- ICE has done extensive tests of both firms' products; this testing clearly indicates that ICE boards are better.
- Next week, Downhill Magazine will release its annual review of snowboards.
- Mike, the president of ICE, is certain that Downhill's review will confirm the ICE tests, and the price of SSL will drop. He sees an opportunity.
- He plans to sell short, in his personal account, 10,000 shares of his competitor, SSL, just before the review is released.

How might the principles of disclose-or-abstain, fiduciary duty, and misappropriation apply in this situation?

Problem 14.7 Basam Salman traded on information passed along to him by his brother-in-law Maher Kara (an investment banker at Citigroup). Salman appealed his insider trading conviction on the grounds that ____.

a. Nobody who simply received information could be considered an insider.
b. Kara did not tell him that the information shouldn't be used for trading.
c. Kara did not receive any financial benefit in exchange for the information.
d. Kara did not, personally, trade.

Problem 14.8 A 10b5-1 plan establishes a regular schedule for _____.

a. Corporate news announcements.
b. Purchases or sales of stock by a director, officer or major shareholder.
c. Release of quarterly financial statements.
d. Periods where insiders are permitted to trade on material nonpublic information.

Problem 14.9 Ronald Secrist passed information about Equity Funding to Raymond Dirks. The Supreme Court decided that Dirks did not engage in insider trading because

a. It was widely known that Equity Funding was poorly managed.
b. Secrist did not derive a personal benefit from passing the information.
c. Dirks had no duty of confidentiality to Equity Funding shareholders.
d. Dirks disclosed to the SEC the information he received from Secrist.

Problem 14.10 "Insider trading increases the informational efficiency of stock prices." Why was this argument advanced? What are the counter-arguments (that insider trading *doesn't* increase the information efficiency of stock prices)?

Problem 14.11 Manne argued that allowing managers to trade on material non-public information was a good way to compensate them. What are the counterarguments?

Answers

Answer to problem 14.1 c. Managers might actually have an incentive to delay, so they can make their trades.

Answer to problem 14.2 b. Found innocent; he had no fiduciary responsibility to the target companies. Note: it might have been argued that he had misappropriated information from his employer (the printing company), as in the O'Hagan case. But this argument was not originally presented to the jury.

Answer to problem 14.3 d.

Answer to problem 14.4 b.

Answer to problem 14.5 b, c.

Answer to problem 14.6 By strict disclose or abstain, Mike can't trade (he has material non-public information); it doesn't matter that it's not about *his* company. He has no fiduciary duty to SSL, but he does have a fiduciary duty to ICE. ICE produced the information that he's planning to use in his trading; the information properly belongs to ICE shareholders. In using the info to trade, he is misappropriating the info from the shareholders.

Answer to problem 14.7 c.

Answer to problem 14.8 b. These plans have to be written, but they don't have to be filed with the SEC and they can be modified. There is evidence that insiders exploit this flexibility to make trading profits.

Answer to problem 14.9 b. (c and d happen to be true, but neither is the reason Dirks was cleared.)

Answer to problem 14.10 The argument, first advanced by Henry Manne, is that managers produce information, and if they can trade on it, the price will more accurately reflect their information. This might not happen, though, because managers might not be able to trade in sufficient quantity to move the price to its correct value. The process might also be noisy, as investors would have to infer their information indirectly, via trades. There may also be other consequences: managers may advance or delay the announcement of their information in a way that interferes with corporate plans; they may try to produce (and profit from) *negative* information.

Answer to problem 14.11 See Bainbridge (2012), pp. 27-28.

Chapter 15. Complex Orders

Problems and sample exam questions

Problem 15.1 When the last sale price of PQR is $42, I enter a stop loss order trailing by $3. In which of the following situations does my order get triggered? Circle all that apply.

a. The trade at $42 is followed by trades at $40, $41 and $39.
b. The trade at $42 is followed by trades at $40, $43 and $41.
c. The trade at $42 is followed by trades at $40, $44 and $41.
d. The trade at $42 is followed by trades at $40, $44, $43, $44, $43 and $41.

Problem 15.2

"This year's volatile stock market is driving investors to a trading technique designed to trim their losses. Yet it can also backfire on those who are in the market for the long term. The practice -- known as a "stop-loss order" -- calls for an individual stock to be automatically sold when its share price falls by a certain percentage or hits a designated price. [But] consider what happened to the Stockbusters investment club, a group of about 25 Dallas women that has been meeting and picking stocks together for two decades. Earlier this year, the club members studied and then agreed to buy two energy company stocks, XTO Energy Inc. and Chesapeake Energy Corp. [The] members put in a stop-loss order calling for the shares to be automatically sold if the prices dropped by 10%. Before the next monthly meeting, both stocks had been sold. Both then rebounded within weeks and continued to gain. "That didn't go well," says Nanci Roberts, the club's treasurer. Jeremy Siegel, finance professor at the Wharton School … thinks long-term investors should avoid stop-losses altogether. Instead, he recommends a different tack: buying a 'put,' an option to sell the stock at a certain price on a certain date." When protecting an investment raises risks (Karen Blumenthal. Wall Street Journal. (Eastern edition). New York, N.Y.: Jun 18, 2008. pg. D.1)

What is the equivalent option strategy for a stop-buy order? What are the pros and cons of using options instead of a stop orders?

Problem 15.3 Why can't a visible limit order be pegged to the same-side quote with an aggressive offset? (Consider, for example, a buy order pegged to the bid plus a penny.)

Problem 15.4 David enters an order to buy XYZ limit 50, with a discretionary price of 50.10. (That is, if the market offer drops to 50.10, David would like to buy at that price, canceling the original $50.00 limit order.) If David is willing to buy at 50.10, why doesn't he simply post this as his visible limit price?

Problem 15.5 With ABC trading around $55, an investor enters a stop loss order: "sell 200 shares stop $52, limit $50." This is equivalent to _____.

a. "Sell 200 shares limit $50."
b. "Sell 200 shares limit $52."
c. "Sell 200 shares at the market."
d. None of the above.

Problem 15.6 Stock XYZ is 20.10 bid, offered at 20.18. At 10:00am I enter an order to buy, un-displayed, pegged to the midpoint, with a discretionary offset of $0.03. In the following sequence of quotes, when does my order first execute (if at all)?

Time	Bid	Offer	*Mid*	*Distance to Offer*
10:01	20.10	20.29	*20.195*	*0.095*
10:02	20.18	20.29	*20.235*	*0.055*
10:03	20.19	20.29	*20.240*	*0.050*
10:04	20.20	20.29	*20.245*	*0.045*
10:05	20.21	20.29	*20.250*	*0.040*
10:06	20.22	20.29	*20.255*	*0.035*
10:07	20.23	20.29	*20.260*	*0.030*
10:08	20.24	20.29	*20.265*	*0.025*
10:09	20.25	20.29	*20.270*	*0.020*
10:10	20.26	20.29	*20.275*	*0.015*

Problem 15.7 A trader who enters a reserve order is most likely

a. a market-maker
b. an informed trader
c. a buyer or seller of a large quantity
d. a retail trader

Answers

Answer to problem 15.1

a. The trade at $42 is followed by trades at $40, $41 and $39.
The stop price is initially set at $42 - 3 = 39$, and since the stock is falling, the stop price doesn't change. The stop is triggered (elected) at the last trade, 39.

b. The trade at $42 is followed by trades at $40, $43 and $41.
As in part a, the stop price is initially 39. But when the price rises to 43, the stop price goes to $43 - 3 = 40$. Since the trade price doesn't drop to 40, the stop is never triggered.

c. The trade at $42 is followed by trades at $40, $44 and $41.
As in parts a and b, the stop price is at 39 (and it is not changed by the trade at 40). With a trade at 44, the stop price rises to $44 - 3 = 41$. The trade at 41 elects the order.

d. The first trade at 44 sets the stop price to 41. The order is not elected until the trade at 41 (the last trade in the sequence).

Answer to problem 15.2
A stop-buy order is used to purchase stock when the price has *increased* to the stop price. The corresponding option strategy would be the purchase of a call option with the exercise price equal to the stop price.
Puts and calls are better than stop orders because they avoid the problem of regret (a stock that rebounds after triggering a stop-loss sale, or a stock that falls back after triggering a stop-buy purchase). Puts and calls are, however, costly. They also expire: if you're planning on using one to provide on-going insurance, new options must be purchased to replace expiring ones.

Answer to problem 15.3 Once the pegged buy order becomes the visible bid, it tries to better itself. This is unstable, and ends only when the buy limit price reaches the offer (and achieves execution).

Answer to problem 15.4 Posting a visible bid of $50.10 may encourage other buyers to match that price. These buyers may end up purchasing while David's order goes unexecuted. Even worse, a showing of visible interest at $50.10 might induce sellers to reprice their orders higher.

Answer to problem 15.5 d. (The straight limit orders in a and b would probably execute immediately because the limit prices are lower than the current market price. The market order would also execute immediately.

Answer to problem 15.6 At 10:07 the offer is within $0.03 of the midpoint price, and the pegged limit order is replaced with a marketable order (buy limit $20.29).

Answer to problem 15.7 c.

Chapter 16. Transaction Cost Analysis (TCA)

Problems and sample exam questions

Problem 16.1 Cost computations. The NBBO / Bid-ask midpoint record for XYZ is:

Time	NBB	NBO	BAM	Spread
11:01:00	35.05	35.10	35.075	0.05
11:02:00	34.94	34.99	34.965	0.05
11:03:00	34.83	34.86	34.845	0.03
11:04:00	34.77	34.81	34.790	0.04
11:05:00	34.77	34.85	34.810	0.08
11:06:00	34.74	34.78	34.760	0.04
11:07:00	34.75	34.78	34.765	0.03
11:08:00	34.80	34.86	34.830	0.06
11:09:00	34.72	34.75	34.735	0.03
11:10:00	34.75	34.83	34.790	0.08
11:11:00	34.66	34.69	34.675	0.03
11:12:00	34.74	34.78	34.760	0.04
11:13:00	34.82	34.88	34.850	0.06

What are the effective cost, realized cost, price improvement and price impact for the following trades?

a. An order arriving at 11.02:44, buy 100 shares limit 35.00, is executed at 34.98.

b. An order arriving at 11:07:02, sell 100 shares limit 34.70, is executed at 34.73.

Problem 16.2 The NBBO record for ABX on a given day is in part:

Time	NBB	NBO
11:01	20.10	20.17
11:02	20.11	20.17
11:05	20.12	20.17
11:06	20.13	20.17
11:09	20.13	20.18

Market ZX receives a buy order at 11:03, which it executes at a price of 20.16.

a. What is the effective cost for the trade?

b. Using the (standard) five-minute benchmark, what is the realized cost for the trade?

Problem 16.3 At 10am, with the NBBO at 30.20 bid, offered at 30.28, the Pegasus Fund places an order to buy 1,000 shares limit 30.15. As the market moves away (upwards), Pegasus makes the limit order more aggressive. The order gets (partial) executions of 200 shares at $30.22 and 500 shares at $30.23. The market closes at $30.39. What is the VWAP of the executed shares? Relative to the initial bid-ask midpoint, what is the implementation shortfall of the executed shares?

Problem 16.4 Non-marketable limit orders ordinarily execute at their limit prices. A limit order submitted as a *funari* order might execute at a price worse than the limit price. Explain how this might occur.

Answers

Answer to problem 16.1

a. The quote prevailing when the order arrived was set at 11:02:00; five minutes subsequent to arrival is 11:07:44, and the prevailing quote at that point was set at 11:07:00. These quotes are in bold:

Time	NBB	NBO	BAM	Spread
11:01:00	35.05	35.10	35.075	0.05
11:02:00	**34.94**	**34.99**	**34.965**	**0.05**
11:03:00	34.83	34.86	34.845	0.03
11:04:00	34.77	34.81	34.790	0.04
11:05:00	34.77	34.85	34.810	0.08
11:06:00	34.74	34.78	34.760	0.04
11:07:00	**34.75**	**34.78**	**34.765**	**0.03**
11:08:00	34.80	34.86	34.830	0.06
11:09:00	34.72	34.75	34.735	0.03
11:10:00	34.75	34.83	34.790	0.08
11:11:00	34.66	34.69	34.675	0.03
11:12:00	34.74	34.78	34.760	0.04
11:13:00	34.82	34.88	34.850	0.06

The effective cost is $34.98 - 34.965 = 0.015$;
the realized cost is $34.98 - 34.765 = 0.215$.
The price improvement is $34.99 - 34.98 = 0.01$;
price impact is $34.765 - 34.965 = -0.200$.

b. The quote prevailing when the order arrived was set at 11:07:00; five minutes subsequent to arrival is 11:12:02, and the prevailing quote at that point was set at 11:12:00. These quotes are in bold:

Time	NBB	NBO	BAM	Spread
11:01:00	35.05	35.10	35.075	0.05
11:02:00	34.94	34.99	34.965	0.05
11:03:00	34.83	34.86	34.845	0.03
11:04:00	34.77	34.81	34.790	0.04
11:05:00	34.77	34.85	34.810	0.08
11:06:00	34.74	34.78	34.760	0.04
11:07:00	**34.75**	**34.78**	**34.765**	**0.03**
11:08:00	34.80	34.86	34.830	0.06
11:09:00	34.72	34.75	34.735	0.03
11:10:00	34.75	34.83	34.790	0.08
11:11:00	34.66	34.69	34.675	0.03
11:12:00	**34.74**	**34.78**	**34.760**	**0.04**
11:13:00	34.82	34.88	34.850	0.06

The effective cost is $34.765 - 34.73 = 0.035$;
the realized cost is $34.760 - 34.73 = 0.030$;
the price improvement is $34.73 - 34.75 = -0.02$.
The negative price improvement is a "dis-improvement." The person who sent the order probably expected to hit the bid, thereby selling at 34.75. In fact, they sold lower, at an inferior price.
If the 34.75 bid had been available at the time the order was executed, this would have been considered a trade-through. A trade-through shouldn't have occurred, but it might have if, for example, other sell orders had executed momentarily before, leaving the best bid in the book at 34.73. In this case, though, there should have been a new quote record generated that showed the lower bid.
The price impact is $34.765 - 34.760 = 0.005$.

Answer to problem 16.2

a. The effective cost uses the NBBO prevailing at the time of the trade. For a trade at 11:03, the quotes were set at 11:02. The bid-ask midpoint is $BAM = 20.14$. for a buy order the effective cost is $price - BAM = 20.16 - 20.14 = 0.02$.

b. The realized cost uses the NBBO prevailing at the time of the trade plus five minutes. In this case, we'd use the NBBO as of 11:08, which is the NBBO that was actually set at 11:06. The BAM is 20.15, and $realized\ cost = 20.16 - 20.15 = 0.01$.

Answer to problem 16.3
The VWAP of the executed trades is: $(200 \times 30.22 + 500 \times 30.23)/(200 + 500) = 30.227$. The initial bid-ask midpoint is $\frac{30.20+30.28}{2} = 30.24$. The shares are actually purchased below the midpoint: the implementation shortfall is $30.227 - 30.240 = -0.013$. With the imputed execution at the close, the VWAP is $(200 \times 30.22 + 500 \times 30.23 + 300 \times 30.39)/(200 + 500 + 300) = 30.276$. The implementation shortfall is $30.276 - 30.240 = 0.036$.

Answer to problem 16.4
If market prices move away from the limit price, the closing price might lie far above the limit price. For example, at 10am, with the bid and offer \$11.00 and \$11.05, a buyer submits a funari order to buy limit \$11.00. The price moves away, and near the close the bid and offer are \$12.00 and \$12.05. The funari order becomes a market on close order, and stock is purchased near \$12.05 (about a dollar worse than the initial limit price).

Chapter 17. Order Splitting

Problems and sample exam questions

Problem 17.1 The following table gives the daily volume profile for XYZ. A fund manager wants to sell 20,000 shares between 9:30 and noon, and seeks to sell at VWAP over that period. How many shares should she aim to sell in each of the five 30-minute intervals that span 9:30 to 12:00?

Interval	Avg volume	Share
9:30	26,000	13%
10:00	20,000	10%
10:30	18,000	9%
11:00	12,000	6%
11:30	12,000	6%
12:00	12,000	6%
12:30	12,000	6%
13:00	12,000	6%
13:30	12,000	6%
14:00	12,000	6%
14:30	12,000	6%
15:00	16,000	8%
15:30	24,000	12%
	200,000	100%

Problem 17.2 In typical order splitting models of trading strategy, whenever the trading horizon lengthens, the expected execution cost ___ and the variance of the execution cost ____.

a. rises; rises
b. falls; falls
c. rises; falls
d. falls; rises

Problem 17.3 In the typical order splitting models of trading strategy, an increase in short-term alpha causes optimal purchases to be made ____ and sales to be made _____.

a. Earlier; earlier
b. Later; later
c. Earlier; later
d. Later; earlier

Problem 17.4 Suppose that the average stock price is expected to move as:
$p_t = p_{t-1} + 0.001 \times S_t$, where S_t is the number of shares bought (or, if negative, sold), and the current price is $p_0 = \$20$.

a. What is the total cost if 600 shares are purchased in trades of 100, 200, and 300 shares?
b. What is the total cost if the three trades are optimally sized?

Problem 17.5 For MDL stock, the trader at the West Fund believes that if she makes a sale at time t of Q_t shares, the average price of the trade will be given by:

$$p_t = p_{t-1} + \alpha + 0.0002 \times q_t$$

The most recent price is $p_0 = \$10$. West has 3,000 shares to sell. Note that since this is a sale the q_t will be negative.

a. Assuming the drift $\alpha = 0$, what would be the total sale proceeds if the sale were done as a single trade of $q_1 = -3{,}000$ shares?
b. The portfolio manager would like the trade completed in three periods. The trading desk plans to execute equal amounts in each period: $q_1 = q_2 = q_3 = -1{,}000$. Still assuming that $\alpha = 0$, what would be the total sale proceeds?
c. If in fact $\alpha = 0.02$ (that is, the price is moving up), what would be the total proceeds, under the trading desk's plan?
d. If *you* know that the drift will be $\alpha = 0.02$, construct a trading plan that improves on WEST's plan. Show that this strategy has higher total proceeds. (The new strategy does not have to be the *best* strategy; it must only have higher proceeds than what you computed in part *c*.)

Answers

Answer to problem 17.1
We construct a volume profile for the intervals over which we'll be trading:

Interval	Average			
9:30	26,000	30%	of 20,000=	**5,909**
10:00	20,000	23%	of 20,000=	**4,545**
10:30	18,000	20%	of 20,000=	**4,091**
11:00	12,000	14%	of 20,000=	**2,727**
11:30	12,000	14%	of 20,000=	**2,727**
	88,000	100%		20,000

The numbers in bold are the trading targets.

Answer to problem 17.2 d. (This is the risk-return trade-off in order placement decisions.)

Answer to problem 17.3 c.

Answer to problem 17.4

a. The first 100 shares are purchased at $\$20 + 0.001 \times 100 = \$20.10$;
the next 200 shares are purchased at $20.10 + 0.001 \times 200 = \$20.30$;
the final 300 shares are purchased at $20.30 + 0.001 \times 300 = 20.60$.
The total cost is $100 \times 20.10 + 200 \times 20.30 + 300 \times 20.60 = 12{,}250$.
b. With a linear price impact, the cost is minimized by doing the trades evenly: 3 trades of 200 shares. Under this schedule:
The first 200 shares are purchased at $\$20 + 0.001 \times 200 = \$20.20$;
the next 200 shares are purchased at $20.20 + 0.001 \times 200 = \$20.40$;
the final 300 shares are purchased at $20.40 + 0.001 \times 200 = 20.60$.
The total cost is $200 \times 20.20 + 200 \times 20.40 + 300 \times 20.60 = 12{,}240$.

Answer to problem 17.5

a. $p_1 = 10 - 0.002 \times 3{,}000 = \$9.40;\ 3{,}000 \times \$9.40 = \$28{,}200$

b. $p_1 = 10 - 0.002 \times 1{,}000 \quad = \$9.80;\ \ \$9.80 \times 1{,}000 = \$9{,}800$
$p_2 = 9.80 - 0.002 \times 1{,}000 = \$9.60;\ \ \$9.60 \times 1{,}000 = \$9{,}600$
$p_3 = 9.60 - 0.002 \times 1{,}000 = \$9.40;\ \ \$9.40 \times 1{,}000 = \$9{,}400$
$Total\ proceeds = 9{,}800 + 9{,}600 + 9{,}400 = \$28{,}800$

c. $p_1 = 10 + 0.02 - 0.002 \times 1{,}000 \quad = \$9.82;\ \$9.82 \times 1{,}000 = \$9{,}820$
$p_2 = 9.82 + 0.02 - 0.002 \times 1{,}000 = \$9.64;\ \$9.64 \times 1{,}000 = \$9{,}640$
$p_3 = 9.64 + 0.02 - 0.002 \times 1{,}000 = \$9.46;\ \$9.46 \times 1{,}000 = \$9{,}460$
$Total\ proceeds = 9{,}820 + 9{,}640 + 9{,}460 = \$28{,}920$

d. If the price is moving up, a planned sale should do more trading later. Shifting any small part of the sale from period 1 to period 3 will do this.
For example, $q_1 = 900, q_2 = 1{,}000, q_3 = 1{,}100$:
$p_1 = 10 + 0.02 - 0.002 \times 900 = \$9.84; \qquad \$9.84 \times 900 \quad = \$8{,}856$
$p_2 = 9.84 + 0.02 - 0.002 \times 1{,}000 = \$9.66;\ \$9.66 \times 1{,}000 = \$9{,}660$
$p_3 = 9.66 + 0.02 - 0.002 \times 1{,}100 = \$9.46;\ \$9.46 \times 1{,}100 = \$10{,}406$
$Total\ proceeds = 8{,}856 + 9{,}660 + 10{,}406 = \$28{,}922$

Chapter 18. Clearing, Settlement, and Custody

See class PowerPoints.

Terms and Concepts

Immobilization; dematerialization; central counterparty (CCP); locked-in trades; netting (bilateral, multilateral, and with a CCP); delivery vs. payment (DvP); payment vs. payment (PvP); The US paperwork crisis; Herstatt risk; Custodians and global custodians; Depository Trust and Clearing Corporation (DTCC); National Securities Clearing Corporation (NSCC); Depository Trust Corporation; CLS Bank.

Problems and sample exam questions

Problem 18.1 In the clearing and settlement process, which of the following functions typically belong to clearing?

a. Verification of trade details.
b. Arranging for transferring payment and securities.
c. Computation of taxes owed.

d. Changing the owner of record.

Problem 18.2 In the clearing and settlement process, which of the following functions are typically part of settlement.

a. Verifying that the investment manager is authorized to trade.
b. Changing the owner of record.
c. Crediting the seller's bank account with the proceeds of the sale.
d. Transaction cost analysis for both sides of the trade.

Problem 18.3 Martin purchased 100 SPQ shares at $5 per share. They rose to $7, and then dropped to $4. At that point, Martin's broker failed, and the Securities Investor Protection Corporation (SIPC) acted on behalf of the broker's customers. SIPC will give Martin ___.

a. $500
b. $700
c. $400
d. 100 shares of SPQ

Problem 18.4 In one day, brokers Broadway and Canal executed the following trades in AMD on behalf of their customers.

Buyer	Broker	AMD (sh)	Price	Cash	Broker	Seller
Beth	Broadway	100	$70	$7,000	Canal	Sam
Boris	Canal	200	$71	$14,200	Canal	Sarah
Bai	Canal	100	$72	$7,200	Broadway	Sasha
Bettina	Broadway	300	$73	$21,900	Broadway	Susan
Brooks	Broadway	100	$74	$7,400	Canal	Simon

a. What are the total gross settlement flows (total volumes of shares and cash)?
b. What are the total flows (shares and cash) that can be netted out within brokers (that is, within Broadway and Canal)?
c. After bilateral netting, what are the flows (shares and cash) remaining between Broadway and Canal?
d. What is % reduction in settlement flows due to all netting?

Problem 18.5 In the EUR/USD market, with the exchange rate at $1.23, NatWest buys €1M from ZBank, paying $1.23M. Moments after the trade the exchange rate goes to $1.24. NatWest and ZBank are settling via CLS Bank. NatWest makes their pay-in, but ZBank does not. CLS pays NatWest ___.

a. $1.23M
b. $1.24M
c. €1M
d. €1.08M

Answers

Answer to problem 18.1 a and b

Answer to problem 18.2 b and c

Answer to problem 18.3 d (SIPC only ensures customer holdings of cash and securities; it does not compensate for losses due to changes in market values)

Answer to problem 18.4

a. 800 shares, $57,700
b. 500 shares (300 by Broadway, 200 by Canal), $36,100 ($21,900 by Broadway, $14,200 by Canal)
c. Canal owes Broadway 100 shares (100+100-100); Broadway owes Canal $7,200.
d. Shares: 800→100 is a reduction of 87.5% reduction. Cash: $57,700→$7,200 is a reduction of 87.52%.

Answer to problem 18.5 a. NatWest's pay-in is $1.23M. CLS simply refunds this.

Chapter 19. Pricing, Fees, and Rebates

Problems and sample exam questions

Problem 19.1 The PAX Exchange charges a $0.003 per share access ("taker") fee and pays a ("maker") liquidity rebate of $0.002 per share. How do these fees/rebates apply to an execution in which Tae's limit order (Sell 100 shares, limit $25.00) is lifted by Sam's order (Buy 100 shares, limit $25.00)?

Problem 19.2 (Continuation) For each execution, the ZAP Exchange *charges* a per share maker fee of $0.0029, and *rebates* $0.0018 to the active (marketable) order. On PAX, the bid is $25.00 for 10,000 shares, and the book at ZAP is empty. Vanessa enters an order on ZAP to sell 100 shares, limit 25.00. How do ZAP's fees/rebates apply if Sam's buy order is directed to ZAP instead of PAX?

Problem 19.3 DirectBook advertises a liquidity rebate of $0.0025 per share and an access fee of $0.0030 per share. The top of the bid book is a limit order to buy at $10.10 (Beth's); the top of the offer book is a limit order to sell at $10.20 (Sam's). If Charlie submits an order to sell limit $10.10, what are the total fees/rebates; who pays/receives them? *Assume all orders are for 100 shares.*

Problem 19.4 DirectBook advertises a liquidity rebate of $0.0025 per share and an access fee of $0.0030 per share. The market in XYZ is $10.10 bid; offered at $10.20. Briefly explain what this means to someone who's sending in a limit order to sell 100 shares limit $10.20.

Problem 19.5 A comment letter received by the SEC reads, "… I also encourage the Commission to give careful consideration to the issue of payment for order flow, which, in the opinion of many, can only be considered commercial bribery." What is payment for order flow, and why does the letter writer draw the comparison?

Problem 19.6 The PX exchange uses maker/taker pricing: orders that add liquidity receive a rebate of $0.001 per share; orders that take liquidity pay $0.002 per share. Sam just entered an order to buy 100 shares limit $20. This order goes into the book. Shortly thereafter Mona enters an order to sell 100 shares, limit $19. Sam's and Mona's orders are matched, and a trade occurs. In this situation, which of the following is correct?

a. Sam pays $0.20; Mona receives $0.10
b. Sam receives $0.20; Mona pays $0.10
c. Sam receives $0.10; Mona pays $0.20
d. Sam pays $0.10; Mona receives $0.20
e. Sam and Mona each receive $0.20
f. Sam and Mona each pay $0.10

Answers

Answer to problem 19.1 Tae receives the rebate, $100 \times 0.002 = \$0.20$, which brings the amount she receives from the sale to $2,500.20. Sam pays the access fee, bringing his net payment to $2,500.30. PAX keeps the $0.10.

Answer to problem 19.2 Since Vanessa's order is the first in an empty book, she's at the front of ZAP's offer queue. Sam's order executes against Vanessa's. Vanessa pays maker fee, so the net amount she receives from the sale is $\$2{,}500 - 0.29 = 2{,}499.71$; Sam pays $\$2{,}500 - 0.18 = 2{,}499.82$. ZAP keeps $0.11.

Answer to problem 19.3 The resting bid is Beth's (the maker). She receives a rebate of $0.25.; The taker is Charlie; he pays $0.30.

> Note: The *maker* is the *passive* side of the trade, the *resting* limit order, the bid that is hit or the offer that is lifted. The taker is the person who is actively executing against the maker ("taking liquidity").

Answer to problem 19.4 The order is at the offer, so it might not execute, but if it does, they will receive (in addition to the $10.20 per share) a liquidity rebate of 0.0025 per share (an extra $0.25)

Answer to problem 19.5 Payment for order flow is money paid by a dealer or market center to a broker to encourage the broker to send retail customer orders. Since the broker is supposed to be the agent for the customer, this gives the broker an incentive to act in a way that might not be in the customer's interest.

Answer to problem 19.6 c. Sam receives $0.10; Mona pays $0.20

Chapter 20. Reg NMS

NOTE: Also see Ch. 5 Multiple Markets. In 2024 Fall, this was covered on the midterm, not the final.

Terms and concepts

Fragmentation and consolidation; market competition vs order competition; interests of short-term traders vs. long-term investors; alternative trading systems (ATSs)
types and purposes of linkage systems (market data/information, access, routing); direct (market) access; the Consolidated Trade System; the Consolidated Quote System; the National Best Bid and Offer (NBBO); trade-through; trade-through prevention provisions of Reg NMS.

Problems and sample exam questions

Problem 20.1 An intermarket sweep order ____

a. Allows a trader to get the best prices on her executions, even if they are at multiple market centers.
b. Prevents trade-throughs of protected quotes that are better than the limit price of the sweep order.
c. Allows the trader to assume responsibility for avoiding trade-throughs.
d. Notifies the receiving markets that they are not responsible for checking protected quotes prior to execution.

Problem 20.2 For stock *XYZ* markets AX and BX are the only two market centers bidding. Their bid books look like this:

Price	AX		BX	
$10.10	100 sh	*Hidden*		
$10.09	200	Visible	100 sh	Visible
$10.08			300	Visible
$10.07	300	Visible	500	Visible

a. What is the National Best Bid?
b. Market BX receives an order to sell 400 shares limit 10.08 (not marked "sweep"). It executes 100 shares at 10.09 and 300 more shares at 10.08. Does this constitute a trade-through from the perspective of Reg NMS? Explain.
c. Suppose the seller divides her orders:
Sell 200 shares limit 10.08 (marked sweep) to AX
Sell 200 shares limit 10.08 (marked sweep) to BX.
Is this consistent with the Reg NMS trade-through policy? Explain. What executions will result?

Problem 20.3 The bid sides of the books at three market centers are as follows. There are no hidden orders.

Price	Exchange A shares	Exchange B shares	Exchange C shares
50.49	300	200	
50.48	100	800	
50.47	100	300	400
50.46		900	600
50.45	2,000	2,000	2,000

a. For each exchange, what are the protected bids (prices and quantities)?

b. A trader wants to sell 1,000 shares limit 50.45 using ISOs (intermarket sweep orders). What is the minimum quantity that must be submitted to *A*? to *B*? to *C*?

c. A trader wants to sell 6,000 shares limit 10.48 using ISOs. What is the minimum quantity that must be submitted to *A*? to *B*? to *C*?

d. If the trader submits sell 2,000 shares limit 10.45 to each exchange using ISOs, are there any trade-throughs of displayed bids that aren't protected.

Problem 20.4 The bid sides of the books at three market centers are:

	Exchange A		Exchange B		Exchange C	
Price	Shares (Displayed)	Shares (Hidden)	Shares (Displayed)	Shares (Hidden)	Shares (Displayed)	Shares (Hidden)
10.49	100	900	800	2,000		
10.48	300	100	200	200		
10.47	400		500		200	400
10.46			700		1,000	
10.45	800		200		2,000	

a. For each exchange, what are the protected bids (prices and quantities)?

b. A trader simultaneously sends the following sell orders, all with limit prices of 10.46, all marked ISO: sell 800 to A, sell 2,000 to B, sell 500 to C. What executions occur?

Answers

Answer to problem 20.1 c and d.

Answer to problem 20.2

a. 10.09

b. This is a trade-through. AX is posting a visible quantity of 200 shares; BX trades at an inferior price without executing AX's shares.

c. At AX, 100 sh trade at 10.10; 100 sh trade at 10.09. At BX, 100 sh trade at 10.09, and 100 more trade at 10.08. Although AX still has 100 shares left at 10.09, this does not constitute a trade-through because the trader's order was sufficient to execute all of AX's protected quantity. AX's hidden quantities are not protected.

Answer to problem 20.3

a. *A*'s protected bid is 300 sh @ 50.49; *B*'s is 200 sh @ 50.49; *C*'s is 400 @ 50.47. It is not necessary for a protected quote to match the market-wide best bid or offer.

b. The limit price of 50.45 is below all of the protected bids, so the trader must send 300 to *A*, 200 to *B*, and 400 to *C*.

c. Only *A*'s and *B*'s protected bids are better than the limit price, so the trader must send at least 300 to *A* and 200 to *B*. There is no need to send anything to *C*.

d. On exchanges *A* and *C*, the final executions will occur at 50.45. But *B* will still have 200 shares left at 50.46 (a better price).

Answer to problem 20.4

a. Only the top of the visible book is protected. A's protected quote is 10.49 bid for 100; B's is 10.49 bid for 800; C's is 10.47 bid for 200.

b. On exchange A, 800 shares @ 10.49; on B, ***2,000*** shares @ 10.49; on C, 500 shares @ 10.47. Based on what was displayed, the trader would have expected that the orders would take out all of the displayed interest on A and B above 10.46. In fact, due to the hidden executions, everything executed at each markets best bid. In retrospect, the executions on exchange C could have been filled at better prices on the other exchanges.

In this situation you might wonder why all 500 shares get sold on market C at 10.47? Wouldn't the only protected orders be the 200 visible orders? And if that is the case then the ISO wouldn't require the remaining 300 shares to be sold from the hidden quantity at 10.47?

And wouldn't it be the case that all orders that are priced better than the ISO order must be executed in a market before they can move to the next market?

The answers to these questions arise in the distinction between routing and execution. The trade-through rule only dictates what quantities must be routed (sent) to a market. The executions those orders actually receive depends on the state of the order books at those markets. Sweep orders are sent simultaneously, not sequentially. Each receiving market handles its own portion of the ISO independently of what other markets are doing.

Relative to what is on the books at A and B, the entire execution of 500 shares at 10.47 at C could be judged a trade-through. That is, both A and B are holding buy orders at prices better than 10.47. But these orders aren't protected unless they're visible and at the top of the book. C will execute the incoming 500 share sell order instantly: once C's front end sees that the order is marked "ISO", C is relieved of the responsibility of checking other markets protect bids.

Chapter 21. HFT (Placeholder)

Chapter 22. Cryptocurrency Markets

See class PowerPoints (Cryptocurrencies.pptx; cryptoMarkets.pptx; Front-running and sandwiching)

Terms and Concepts

Centralized vs Decentralized Exchanges (CEXs vs DEXs); v2 Automated Market Makers (AMMs); fiat currency; blockchain (distributed; immutable; transparent); mempool; sandwich attack; gas fee. Proof of work (PoW); Proof of Stake (PoS); Bitcoin futures contracts; Bitcoin ETFs.

Problems and sample exam questions

Problem 22.1 Like the limit order books found in equities markets, the centralized cryptocurrency exchanges generally ____ (Mark all that are true.)

a. Pay rebates for executed limit orders
b. Charge fees for taking liquidity
c. Allow customers to hit displayed bids and lift displayed asks.
d. Customer balances of cryptocurrencies are held in a central depository

Problem 22.2 Automated market makers in decentralized cryptocurrency exchanges ____.

a. Are generally held responsible for maintaining a fair and orderly market.
b. Are paid by the issuer of the cryptocurrency.
c. Have conditions under which they can trigger a market-wide trading halt
d. Are constructed up so that the price rises as a buyer increases the size of their purchase.

Problem 22.3 With the price of ETH at $1,250, the liquidity pool for an automated market maker holds 1,000 ETH and $1.25M. After an outside customer buys 10 ETH, the pool will hold ___.

a. $1.237500M
b. $1.262263M
c. $1.262500M
d. $1.256250M

Problem 22.4 With the price of ETH at $1,250, the liquidity pool for an automated market maker holds 1,000 ETH and $1.25M. In a transaction with this pool, a buyer of 10 ETH will pay an average price of ____ $ per ETH

a. 806.45
b. 1,237.62
c. 1,275.51
d. 1,262.63

Problem 22.5 With the price of ETH at $1,250, the liquidity pool for an automated market maker holds 1,000 ETH and $1.25M. In a transaction with this pool, a seller of 10 ETH will receive an average price of ____ $ per ETH

a. 806.45
b. 1,237.62
c. 1,275.51
d. 1,262.63

Problem 22.6 With the price of ETH at $1,250, the liquidity pool for an automated market maker holds 10,000 ETH and $12.5M. In a transaction with this pool, a seller of 10 ETH will receive an average price of ____ $ per ETH

a. 1,248.75
b. 1,237.62
c. 1,251.25
d. 1,262.63

Answers

Answer to problem 22.1

b, c. ("b" is part of their usual fee structure; "c" is a basic functionality of any limit order book. They also charge for executed limit orders (no rebates); customer balances are held in an account at the exchange.

Answer to problem 22.2

d. This is a basic property of the AMM.

Answer to problem 22.3

b. The constant product rule asserts that the product of the pool's holdings before the trade is equal to the product of the pool's holdings after the trade:

$$\underbrace{1.25M \times 1000}_{Before} = \underbrace{Y(1000 - 10)}_{After}$$

Where Y represents the $ holdings of the pool. (The ETH holdings of the pool drop by 10 ETH due to the customer's purchase.) Solving, $Y = 1.25M \times \frac{1000}{990} = 1.26263M$

Answer to problem 22.4

d. Using the constant product rule:

$$\underbrace{1.25M \times 1000}_{Before} = \underbrace{(1.25M + P)(1000 - 10)}_{After}$$

Where P is the total $ payment to the pool. Solving for P (in $M) gives

$$\frac{1250}{990} - 1.25 = P \; or \; P = \$0.0126263M \; for \; 10 \; ETH, or \; \$1262.63 \; per \; ETH$$

Answer to problem 22.5

b. Using the constant product rule:

$$\underbrace{1.25M \times 1000}_{Before} = \underbrace{(1.25M - P)(1000 + 10)}_{After}$$

Where P is the total $ amount paid by the pool. Note that a sale by a customer increases the pool's holdings of ETH. Solving for P (in $M) gives

$$1.25 - \frac{1250}{1010} = P \; or \; P = \$0.0123762M \; for \; 10 \; ETH, or \; \$1237.62 \; per \; ETH$$

In comparing the two price changes in this problem and the last, the purchase of 10 ETH drives the price up by $12.62; while the sale of 10 ETH drives the price down by $12.38.

Answer to problem 22.6

a. Using the constant product rule:

$$\underbrace{12.5M \times 10{,}000}_{Before} = \underbrace{(12.5M - P)(10{,}000 + 10)}_{After}$$

where P is the total \$ amount paid by the pool. Solving for P (in \$M) gives

$$12.5 - \frac{125{,}000}{10{,}010} = P \; or \; P = \$0.0124875M \; for \; 10 \; ETH, or \; \$1248.75 \; per \; ETH$$

The only difference between this problem and the last is the size of the pool. With a larger pool, there is less price impact. Here, the price only moves down by $\$1{,}250 - \$1{,}248.75 = \$1.25$.

Chapter 23. RIT Exercises

Problems and sample exam questions

Problem 23.1 In the RIT PDJ exercise, your competition comes from: (Mark each alternative true/false.)

a. Your classmates who are trading the same ticker symbol.
b. Automated traders trading in the same direction as the news.
c. Automated traders acting as uninformed traders.
d. Anyone who is using a limit order.

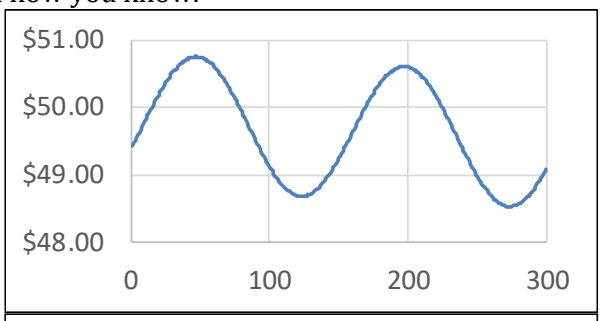
Problem 23.2 *New 2025F* In the RIT ALGO1 exercise, we usually submit paired buy and sell orders. Market orders are preferred to limit orders in this exercise because _____. *There may be multiple correct answers.*

a. A limit order might not execute, leaving a long or short position that would expose the trader to risk.
b. Market orders can be timed to guarantee a profit.
c. A limit order might be executed by another trader who is acting as your competitor.
d. We want to trade with speed and certainty. Arbitrage opportunities can disappear suddenly.

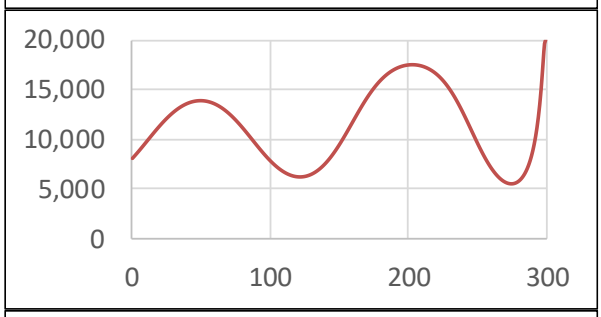
Problem 23.3

In a play of the H3 exercise, the price of SAC stock over 300 seconds of play is graphed in the first panel below. There are three possible hedging strategies (A, B, and C); the number of shares held is plotted against time. Two of these cannot possibly be correct. Which ones are they? Explain how you know.

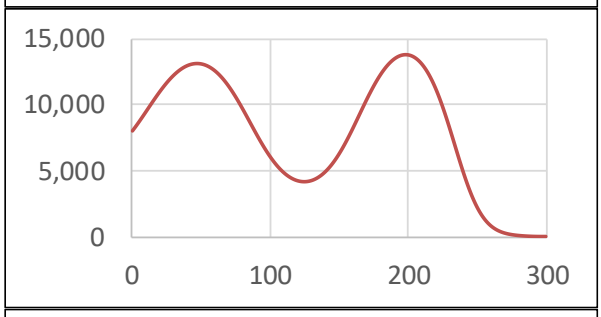
SAC price path →



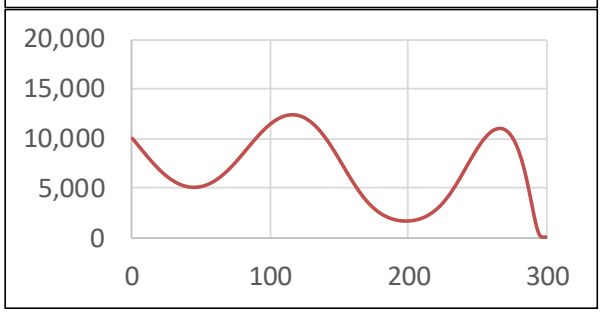
Hedging strategy A →



Hedging strategy B →

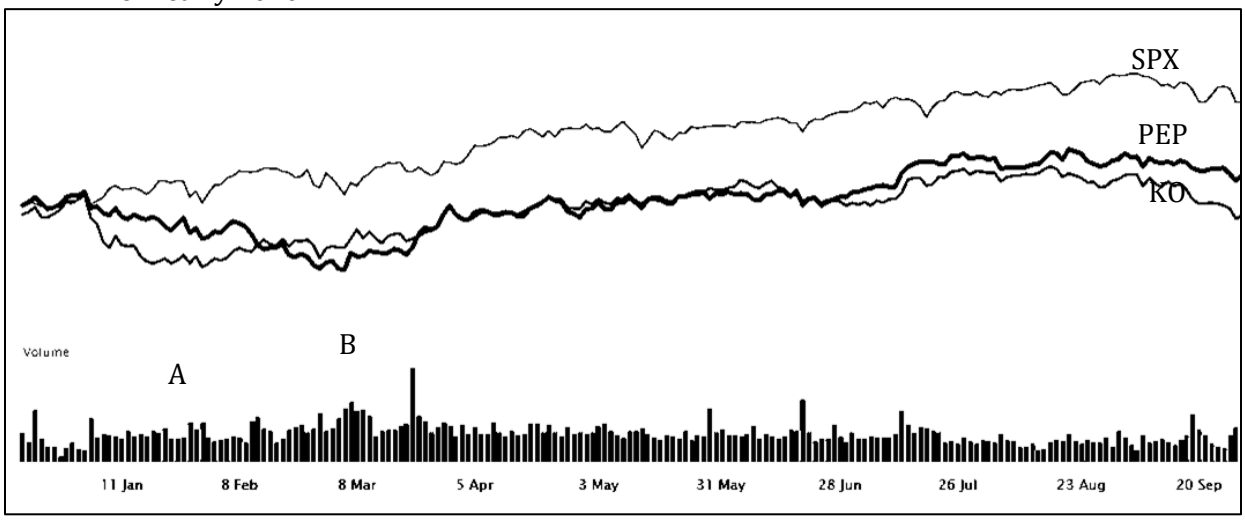


Hedging strategy C →



Problem 23.4 (RIT PAIRS Exercise)

The graph below shows a price plot of Coca Cola (KO), Pepsi (PEP) and the market (SPX) from early 2020.



Describe a pairs strategy. What should you be long and/or short On Feb 1 (roughly indicated by "A")? On Mar 8 ("B")

Answers

Answer to problem 23.1

a. True (You should be using market orders to hit slow limit orders. Your classmates are trying to do the same thing. If they trade before you do, the slow limit orders get removed, forcing you to trade at worse prices.)

b. True (for the same reason as a)

c. True (Even though their orders are not necessarily in the same direction as the news, they can still remove limit orders that you might like to hit/lift.)

d. False (Limit order traders tend to be on the wrong side of the market, buying when the news is negative and selling when the news is positive.)

Answer to problem 23.2

a and *d* are correct. *b* is not true because even with market orders, latency (delay) may cause bid and ask quotes to change in a way that our orders execute at a loss.

Answer to problem 23.3

To hedge a written call, the stock price and the stock position (number of shares) must move in the same direction at all times. This rules out C. From the SAC price path, we know that the call expires out of the money: we'd want to be holding zero shares at the end. This rules out A, which has us owning 20,000 shares. We're left with B.

Answer to problem 23.4

In a pairs trading strategy, we assume that while the prices of two stocks might diverge in the short-run, they will come back together in the long-run. The strategy is to buy the stock with the lower price and sell (or sell short) the stock with the higher price. On Feb 1, we'd buy KO and short PEP; on Mar 8, we'd short KO and go long PEP.