WEEK 1: OVERVIEW

Buy-Side: Manages financial assets for investors

- Either institutional investors ie. pension funds OR high-net-worth private clients ie. hedge funds
- *Assets under Management:* Total market value of assets that an institutional investor manages and administers for itself and customers
    - 0.5-1% can be charged as a management fee

Sell-Side: People who execute trades **on behalf of** the buy-side, matching buyers and sellers

- Charge a fee/commission per trade executed
- *Soft-Dollar Commissions:* Charge research costs for the advice provided to investors, implicitly added to the service fee
- *Prime Broker:* If only technology and operations infrastructure used to execute trades
- Includes money paid to the exchange
- Also trades with own money (*proprietary trading)* on behalf of high-net-worth individuals

Difference between Sell Side & Buy Side

Sell Side	Buy Side
• Facilitate raising capital, incl. debt and equity • Market and sell securities • Create liquidity for listed securities	• Asset Management, Hedge Funds, Private Equity, Venture Capital • Manage client's money • Make investment decisions • Perform financial modelling

Why is Buy Side adopting Sell Side tech?

1. Existing (legacy) systems cannot handle asset class
2. Operational risks due to inadequate controls
3. Focus on core competencies, uneconomical for small buy-side firms to create in-house tech
4. Existing systems adapted from sell-side anyway
5. Need to be compatible to receive sell-side data and research
6. IoT: Easier to utilize web-hosted sell-side solutions
7. Sell-side is providing tech as part of a total package of fund services, ER and tech solutions

Advantages of Using Spreadsheets:

1. Cheaper and convenient
2. Easy to perform calculations, edit data, run "what-if" tests
3. Easy to train staff

Disadvantages:

1. Less time to focus on planning and executing trading strategies
2. Unable to scale up and handle more complex
3. Human error from data entry
4. High exposure to security risk

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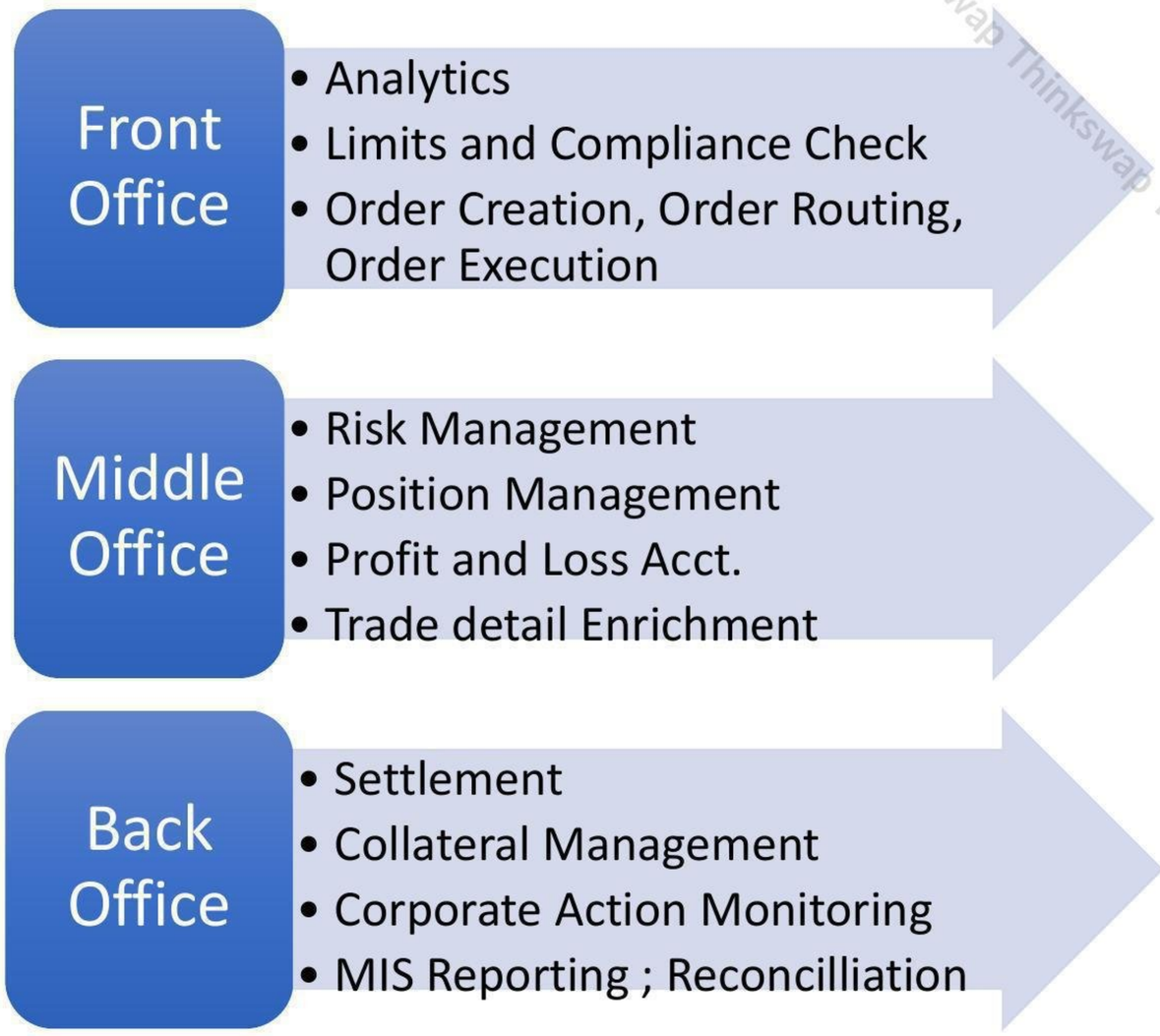
5. Discrepancies btwn spreadsheets
6. Difficult to hand over to someone else

Front, Middle, Back Offices



Technology in Financial Exchanges

- Financial Exchanges
  - Achieve **price transparency**
  - Information Technology helps in achieving that
  - Clearing and Settlement
- OTC VS Financial Exchanges
- Technology in Exchanges
  - Pre-Trade Analytics
  - Order management systems (OMS)
  - Networks
  - Settlement Systems
  - Risk Management Systems
  - Technology to Support Retail Trader

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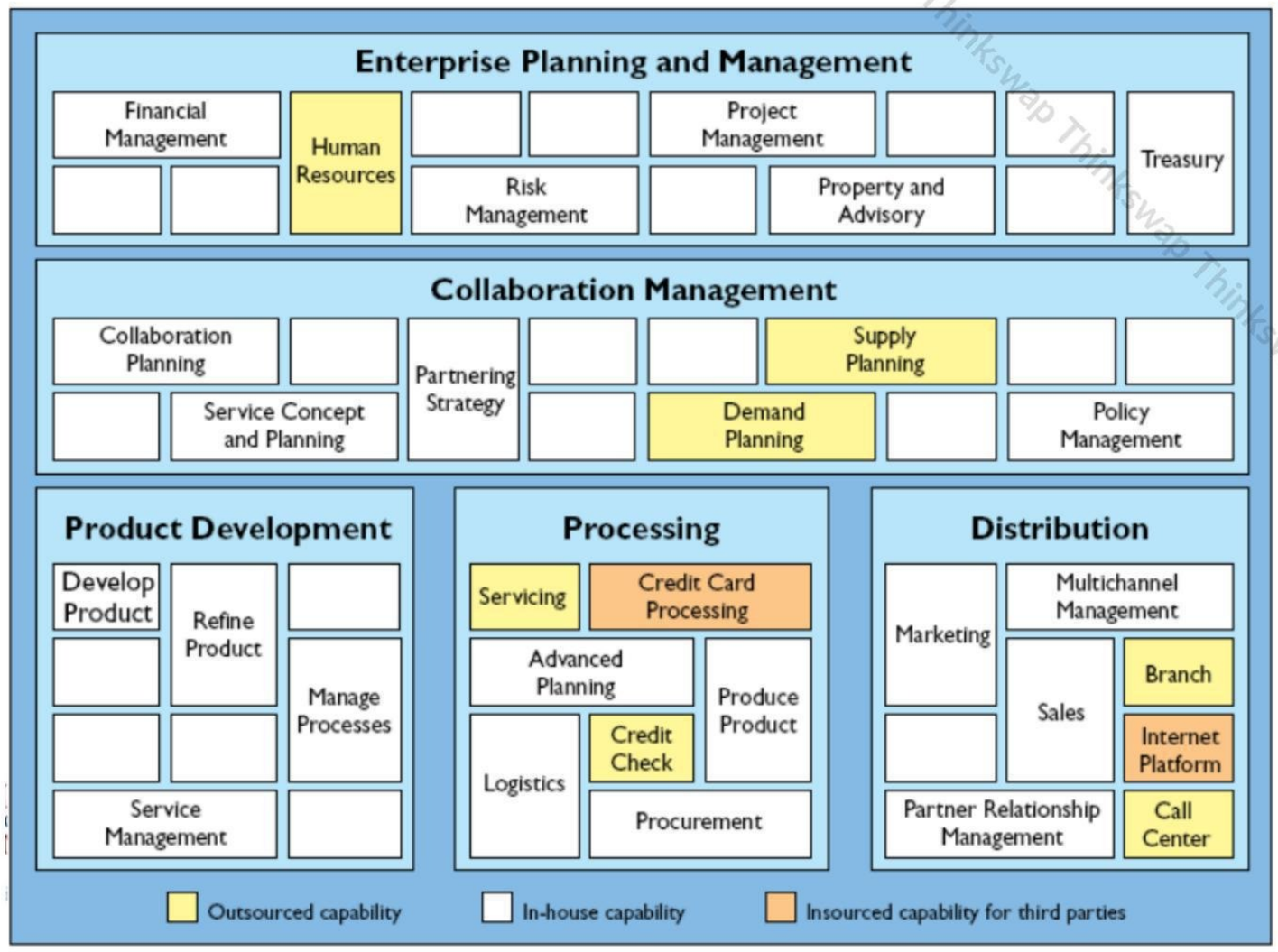
WEEK 2: IMPACT OF IT ON THE FINANCIAL SECTOR

MACRO ISSUES OF TECHNOLOGY IN THE FINANCIAL SECTOR



Disruption: physical ← → Information

Banks has restrictions on modes of activity (eg. cannot invest in properties)

- Over the years MAS has reduced monitoring on the types of companies that banks can acquire
    - Banks may not be ready for the wave of "disruption"

Disaggregation of Value Chain in Banking

- Pressure induced changes in value chains
    - Cost Considerations
    - Consumer experience
    - Agility – react to market changes
    - Improve efficiency
    - Manage complexity in banking services

- Credit Bureau Singapore

Credit Checks → Huge hurdle for developing countries

- Lack of information

Changes in Value Chain

- Decomposition of value chain into specialized entities
- Breaking down traditional process/roles into new fully functional units
- IT as enabler: Liken to business process reengineering

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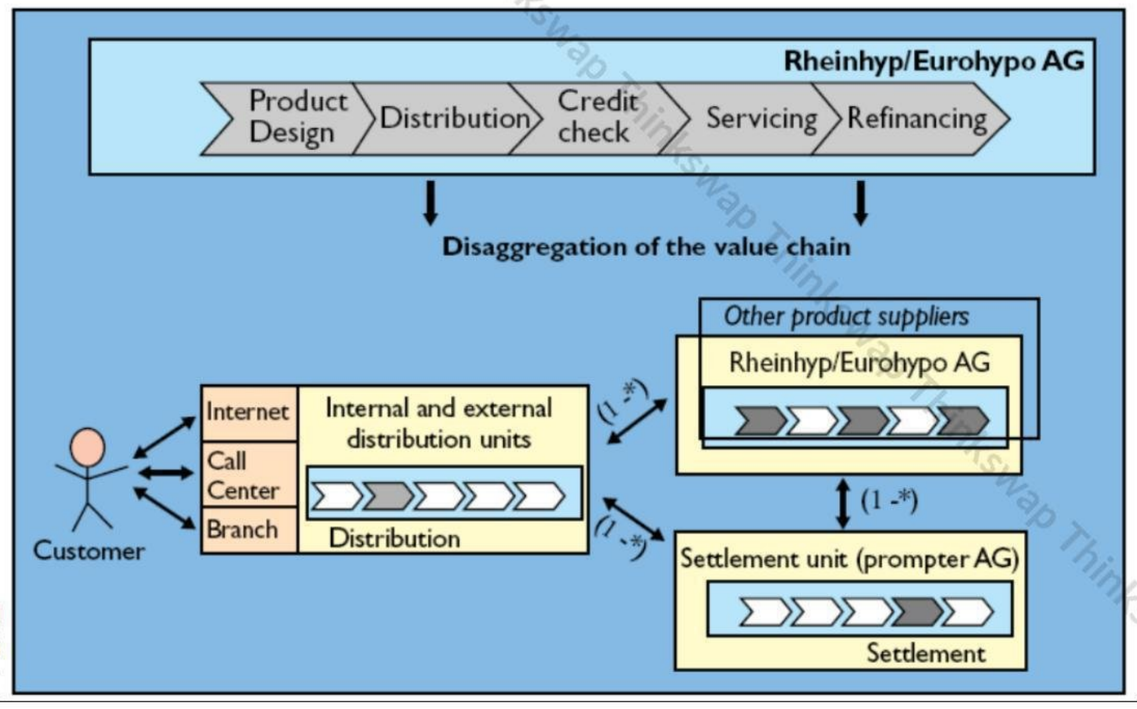
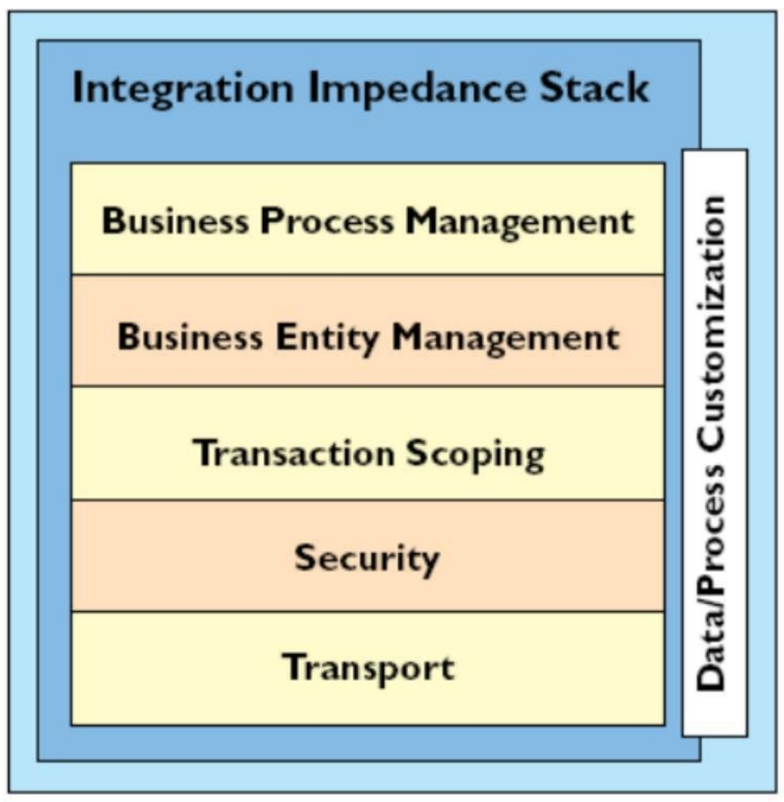
Disaggregation



A division or breaking up into constituent parts, particularly the analytic disassembly of categories which have been aggregated or lumped together.

- Eg. Banks play the role of marketing (consumer's reputation on the company)
- Sustainability in the long run?
    - Controls have to be in place

IT and Business Considerations for Value Chain Disaggregation



- Security and Transport are controls
- BPM/BEM/TS more of business considerations and activities
- Core Business?

Shared Services

- Offshoring V Outsourcing
- Centralize administrative functions into regional/global centers
- Streamline transaction processing and offer potential for value-add services
- Finance shared services best implemented after instance consolidation to single system
- HR shared services can be challenging on a global basis due to regional differences
- Singapore Context

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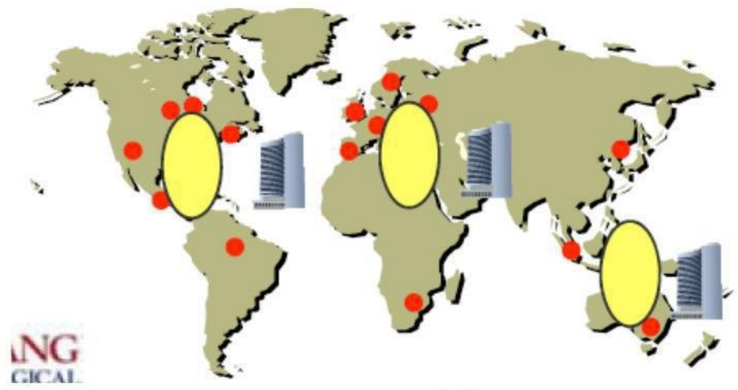
- Financial Institutions that move their operations to Singapore: eg. Barclays, Citibank, Credit Suisse, BoAML
- Economic Impact: Engines of Growth
- A Global City: Staffing of these operations? Labour market constraints and issues

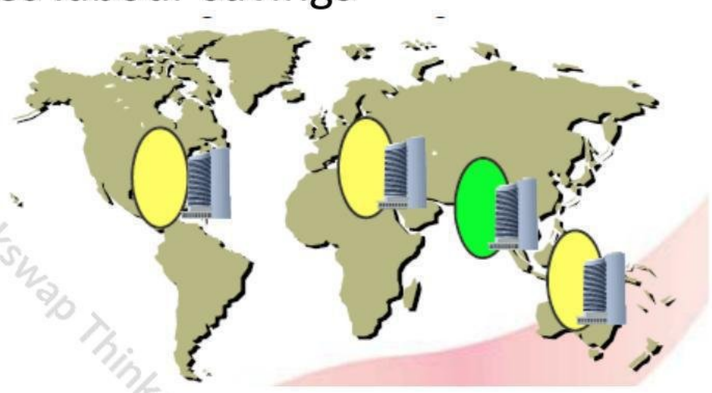
- Role of Technology in Shared Services
  - Technology as an enabler for economies of scale
  - Telecommunication advancement
  - Types of comm:
    - Phone Calls (VOIP)
    - Video Conferencing
    - Email

- Center Deployment Models
  - Single Regional Center:
    - Common "entry point" into shared services
    - Most transaction processing centralized
    - Most value-added functions in-country

  - Multiple Regional Centres (most common)
    - Replicates success of initial SSC in other regions



  - Global/Regional or Global Center (s):
    - **Have to make thing entirely **informational**
    - Most mature
    - Moves value-added activities to SSCs
    - Leverages labour savings



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Benefits of Shared Services

- Cost Savings
  - Typically 25%-35% reduction (finance operations)
  - Reduced compliance and audit costs
- Visibility and transparency
  - Systems consolidation
  - Reduced transaction processing times
- Improved Governance
  - Comprehensive documentation
  - Clear process owners
- Transformation of Administrative Functions
  - More focus on value-added activities
  - From transaction processing to strategic advisor

Challenges of Shared Services

- **Political**: Internal politics, no clear sponsor, history of autonomy among businesses
- **Skills & Culture**: Administrative staff mindset, no track record in major change programs, cost of staff reduction, erosion of culture structures
- **Systems**: Many disparate systems, consolidation challenging, no one wants to give up "their" system

Main Considerations of Shared Services

- Offer significant cost savings for admin functions, especially finance
- Potential intangible benefits exist in improved governance and better visibility of financial information
- However, political and cultural challenges can be significant – executive sponsorship is key
- Business Process Outsourcing is a potential alternative to realise many of the benefits when shared services is challenging

Sending Help:

Financial Leverage: Debt/Equity Ratio
Debt cost is fixed, make more money during good times. Equity is high, so shareholders want more dividends, cost goes up. Cost of Capital goes up.
Therefore, financial leverage is good when times are good.
Operation Leverage: Fixed Cost / Variable Cost OR Fixed Cost/Total Cost

- Times are good, fixed cost good to be incurred as it does not change
- Times are bad, fixed costs still have to be incurred

Therefore, operational leverage being high is good when times are good

This is an important consideration for IT Outsourcing in terms of costs

IT Outsourcing (Financial Services)

- IT outsourcing means getting a service provider to do any one or more of the following tasks
  - Systems Development

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- Data Centre Operations
- IT Infrastructure management
- Data Preparation, Disaster Recovery etc.

- IT outsourcing is part of current strategy to be focused on core competence and business to be competitive – not just an IT issue

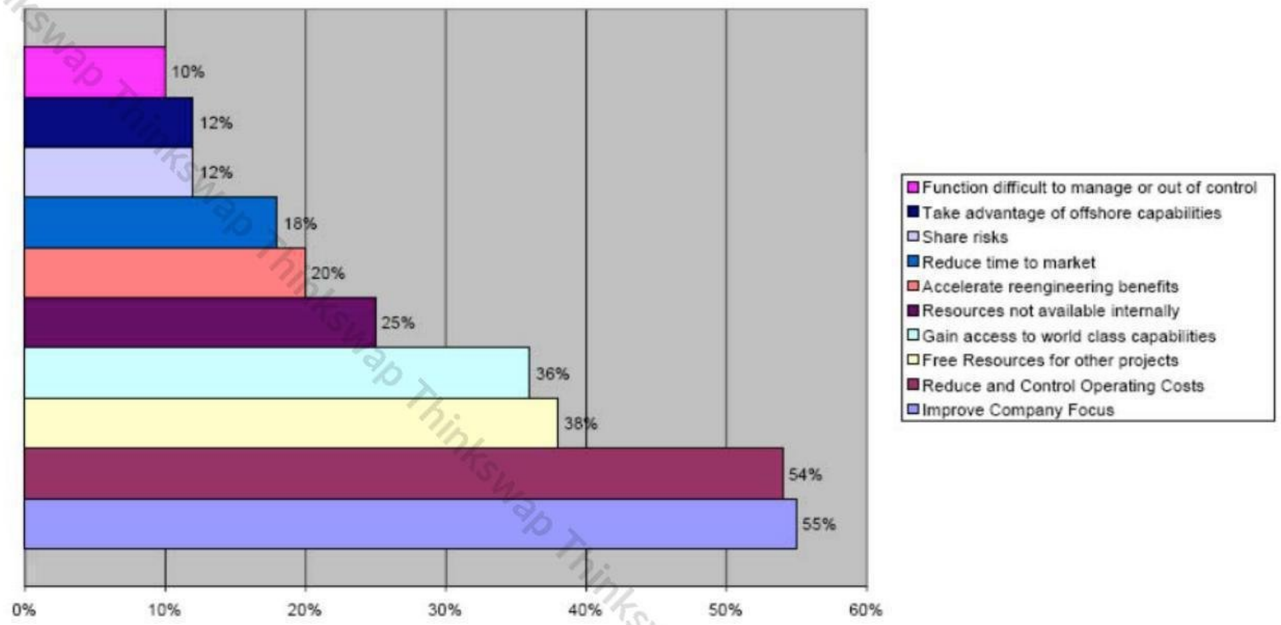
Pros of IT Outsourcing

- Focus on core competence
- Fixed Cost VS Variable Cost
- Access to state-of-the-art technology
- Access to required IT capabilities
- Faster implementation
- Freeing capital funds for core business
- Lower operating costs
- Potentially higher quality solutions
- Flexibility
- Better overall IT management

Cons of IT Outsourcing

- Loss of Control
- Cost Savings may not materialize – costs can go up
- Less flexibility
- "Being held hostage by contractor"
    - Verizon (was Bell-Atlantic) and AT&T
        - Contracted AT&T for telecom services, upgrading costs a lot
        - Infrastructure used only for call centers, and had lock-in cost
    - **Bad for items that have **no residual value**, and have assets **unique** to that relationship
        - Operating leverage risk
        - Doesn't matter if it is contracting/contracted party
- High costs of switching
- Sub-contracting issue
- Significant impact on IT staff's development and career – loss of opportunity to develop in-house IT competence which may have economic and strategic potential

Common Reasons for Outsourcing in Financial Sector (BASEL Committee)



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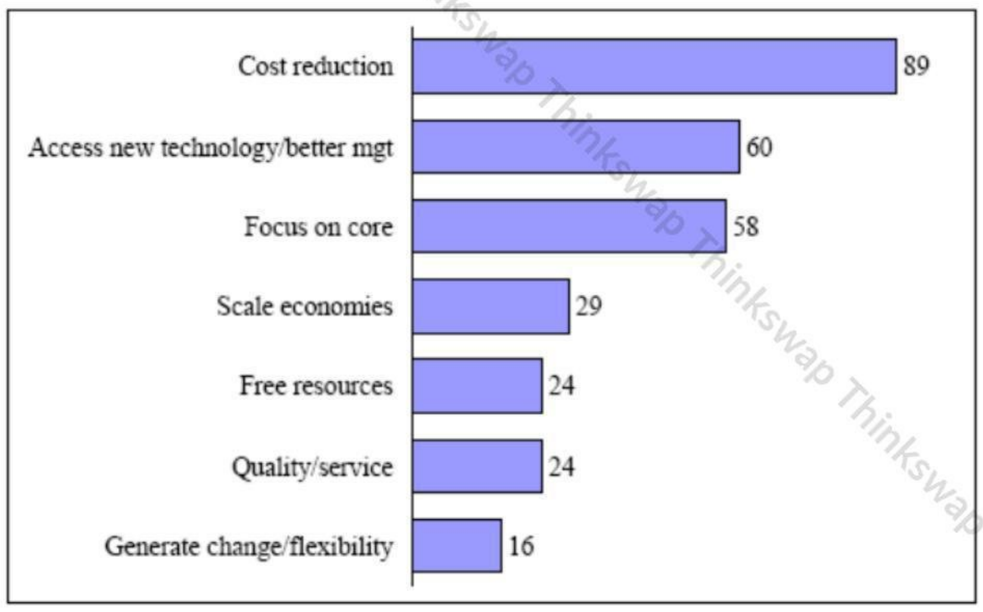
EU Perspective



Services Commonly Outsourced

- Typically back office operations
- Check clearing
- Payment processing (eg. credit cards)
- Opening of accounts
- Telemarketing (sourcing for new clients)
- Collection
- Development of software applications

Risk of Outsourcing in Financial Services

Strategic Risk	The risk that failed business decisions, or lack thereof, may pose to a company
Reputation Risk	Risk of loss resulting from damages to a firm's reputation, in lost revenue; increased operating, capital or regulatory costs; or destruction of shareholder value, consequent to an adverse or potentially criminal event even if the company is not found guilty.
Compliance Risk	Exposure to legal penalties, financial forfeiture and material loss an organization faces when it fails to act in accordance with industry laws and regulations, internal policies or prescribed best practices
Operational Risk	Risk of problems associated with operational factors in the settlement process eg. OMS
Exit Strategy Risk	
Counterparty Risk	**Counterparty risk** is the **risk** to each party of a contract that the **counterparty** will not live up to its contractual obligations. Eg. Lehman Brothers
Country Risk	
Contractual Risk	Probability of loss arising from the buyer's reneging on the **contract**, as opposed to the buyer's inability to pay. Probability of loss arising from failure in **contract** performance. Vendors have the highest **risk** in fixed price **contracts** and least in the cost type **contracts**.

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Access Risk	One or more actions or permissions that, when available to a single user (or single role, profile, or HR Object), creates the potential for fraud or unintentional errors
Concentration Risk	Level of **risk** in a bank's portfolio arising from **concentration** to a single counterparty, sector or country. The **risk** arises from the observation that more concentrated portfolios are less diverse and therefore the returns on the underlying assets are more correlated.
Systemic Risk	Risk that failure of 1 participant to meet obligations when due causes other participants to meet their obligations (Domino effect, Disruption of a large number of payments may lead to broader effects on economic activity)

- Domino effect
- Disruption of a large number of payments may lead to broader effects on economic activity

Shared Services VS Business Process Outsourcing

Decision Criteria	Description	Shared Services	BPO
Time to benefit	Significant cost savings <18 months		✓
Degree of customization	Significant customization required	✓	
Brand strength	Potential "logo" client		✓
Scope of processes covered	Broad scope of admin. processes		✓
Economies of scale	Cost savings through consolidating ops.	✓	
Labor arbitrage	Not prepared to use low-cost locations	✓	
Political and cultural barriers	Limited experience of change management		✓
Confidence in BPO providers	Uncertain BPO offerings are proven	✓	
Security and control	Concerns that BPO may weaken controls	✓	

THE OPERATIONAL ASPECTS OF TECHNOLOGY IN THE FINANCIAL SECTOR

Around 70% of trades are now handled by robots

Types of Algorithms:

- Opportunistic
  - Arbitrage, high-speed
- **Execution**
  - Minimum amount of cost, not value-adding by making decisions

Robo-Trading/Algorithm Trading

- Placing a buy/sell order of a defined quantity into a quantitative model that automatically generates the timing of orders and the size of orders based on goals specified by the parameters and constraints of the algorithm
- Eg "Sell 100,000 XYZ, Buy 120,000 ABC when price XYZ/ABC > 2

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- Rule-based Trading
- Made possible by technological advancements and infrastructure established from the 90s onwards
- FIX Protocol

Benefits

- Effectively facilitates size/timing of orders based on trading parameters (e.g. split up large market order flow into smaller ones and time them so as to not move the market
- Reduce the amount of time of trading
  - Reduce opportunity cost which is a function of time
- Stealth – mask true trading directions, reduce volatility, stabilizing effect on the market
- Actively seek out trading opportunities (eg. arbitrage between derivatives and underlying assets)
- Reduce transaction costs

Internet Banking

- Types of banks:
  - Pure web banks
  - Bricks & Clicks
- Very high failure rate of pure web banks
- Operational Cost of Running a Bank

Landsbankinn – Services are entirely online (no physical bank)

- Purely internet presence – savings
- Therefore up the rates given to depositors (high deposit rate)
- Flushed with capital (high resources)
- Credit checks were a challenge
- Must be reputable, to make depositors more confident
  - Partnering with reputable banks
  - Deposits from the government
- Badly hit during the 08 financial crisis

Success in Internet Banking

- Transactional Banking
  - Can be supplemented by technology eg. credit rating or scores
  - Eg. Personal line of credit, credit cards, car loans
- Relationship Banking
  - Idiosyncrasies in the credit review process
  - ACTUAL physical presence is required, challenge for online banks
  - Large loans eg. SME banking, agriculture loans, housing mortgage
- Underlying business model of the bank dictates extent of which web banking is implemented
- Role of Government Insurance (FDIC, SDIC)
- The need to Attract Deposits (Asset Mgt VS. Liability Mgt)

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- Internet Banking increases the reach of the banks to potentially large numbers of consumers without the overhead costs
- Eg. INGDIRECT
  - Deposit/Withdraw money into a bank that does not have a physical branch
  - Open an account without F2F interaction

Risk Management: Principles of E-Banking:

Board and Management Oversight

- Effective management oversight of E-Banking Activities
- Establishment of a comprehensive security control process
- Comprehensive due diligence and management oversight process for outsourcing relationships and other 3rd party dependencies

Security Controls

- **Authentication** of E-banking customers
- Non-Repudiation and Accountability for E-Banking transactions
- Appropriate measures to ensure segregation of duties
- Proper authorization controls within e-banking systems, databases and applications
- Data Integrity of e-banking transactions, records and information
- Establishment of clear audit trails for e-banking transactions
- Confidentiality of key bank information

Legal and Reputation Risk management

- Appropriate disclosures for e-banking services
- Privacy of customer information
- Capacity, business continuity and contingency planning to ensure availability of e-banking systems and services
- Incident response planning

More than **50%** of trades do not take place on the exchange

- **NYSE ~20% / NASDAQ ~20% / BATS ~20%**
- Other smaller trading companies, that are not required by law to post the price
- Two-Tiered Prices → Price shown may not be the real price (market fragmentation)
- Largely a problem in the US, less so in SG

Tax fees has dropped by 70-80%, and it has become less profitable

How stock exchanges make money?

- Listing fees, Market Data, Spread/bid, Fees taxation, Trading Software, Membership fees, Web-Hosting/Tech Service provision to companies/System implementation as a potential revenue source

Pull Location Service (Physical Space) is now a factor

(1) Co-Location Services (new revenue stream)

- Attracts HFT (60 m/s) → Bottleneck is no longer the engine itself

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(2) Falling Market Share – Therefore the need to defend their market share

- Market is quite fragmented
- They need liquidity to defend their market position
  - Transaction costs will be very high

(3) Market Data

- Data needs to come in to get feedback
- Competitive advantage
- Selling licenses to companies

Role of a "Referee" VS Trade Suspension

- Referee places buyers where there are fewer to avoid volatility in prices
- Trade Suspension: Trade completely suspended and restart of the market is needed

WEEK 3 & 4: IT IN THE TRADE CYCLE (I) & (II)

PRE-TRADE:

Trader researches and chooses a security to buy or sell

1. Researching a security to trade
2. Running analytics
3. Analyze various scenarios
4. Checking business rules

Price Discovery

- Regulation ensures that information of securities trading executed in exchanges should be made public

Types of Markets

- **Order Driven Market – Eg. NYSE/SGX and Large Markets**
  - Buyers/Sellers orders are displayed on the market
    - Seller: Ask price + Buyer: Bid Price
    - Market Price is the average price of transactions in the market
  - Increased transparency but **no guarantee of sale**
    - Prices could change between time order is placed and time of execution
  - Need to have **a lot of liquidity** in order to adopt this for the market to operate **smoothly**

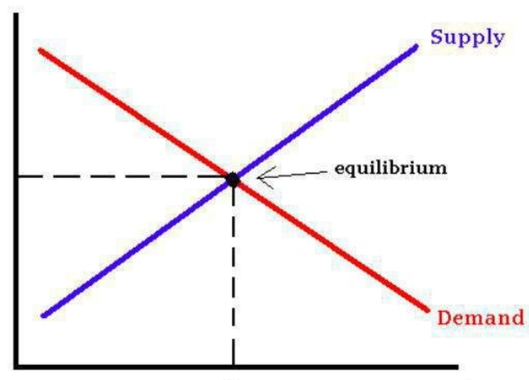
BUYER:

Quantity	Price
300	2010
200	2009
100	2009

(SPREAD IS USUALLY SMALL)

SELLER:

Price	Qty
2014	2000



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2013	**500**
2012	**40**

Order Driven Market			
Buy Orders		Sell Orders	
Shares	Price	Shares	Price
134,084	42.64	59,100	42.65
477,634	42.63	184,969	42.66
387,190	42.62	195,682	42.67
190,780	42.61	372,964	42.68
250,441	42.60	300,630	42.69
252,286	42.59	162,506	42.70
526 Buy Orders		445 Sell Orders	

SGX – Pre-Trade Opening is completely computerised
2 minutes before market opening, not allowed to withdraw orders
NYSE – Not fully automated, can add in sell orders (if they have inventory) to prop up the price of the market (stability measure)

Blue-chip companies, or "blue-chips" are the mature companies in the stock market that represent the stalwarts of industry—safe, stable, profitable, and long-lasting companies that represent relatively safe, low volatility investments.

- **Quote-Driven Market – Eg. LSE, NASDAQ**
  - Prices are determined by dealers bid/offer quotes
  - **Dealers** holds inventory – Makes money from spread
    - Marketmaker/specialist for a security is someone who is always available to either buy/sell that security at a publicly quoted bid/ask price
    - Market maker which makes the spread
  - Liquidity guaranteed by dealers, lower transparency
  - Non-Negotiable Price
  - One individual **holds inventory,** and transacts with individuals
  - Larger spread cost, so less efficient
  - Uncertainty in liquidity

Order-driven market	Quote-driven market
• An order-driven market is one in which all of the orders of both buyers and sellers are displayed • More efficient	• A quote-driven market only displays the bid and ask offers of designated market makers, dealers or specialists • Good if spread (diff between selling price and buy price) is very small

Price Orders

- Market Order: Selling security immediately at best available price
- Limit Order: Placing a max/min price threshold on the trade

Limits and Compliance Checks

- Built-in pre-trade analytics to ensure compliance

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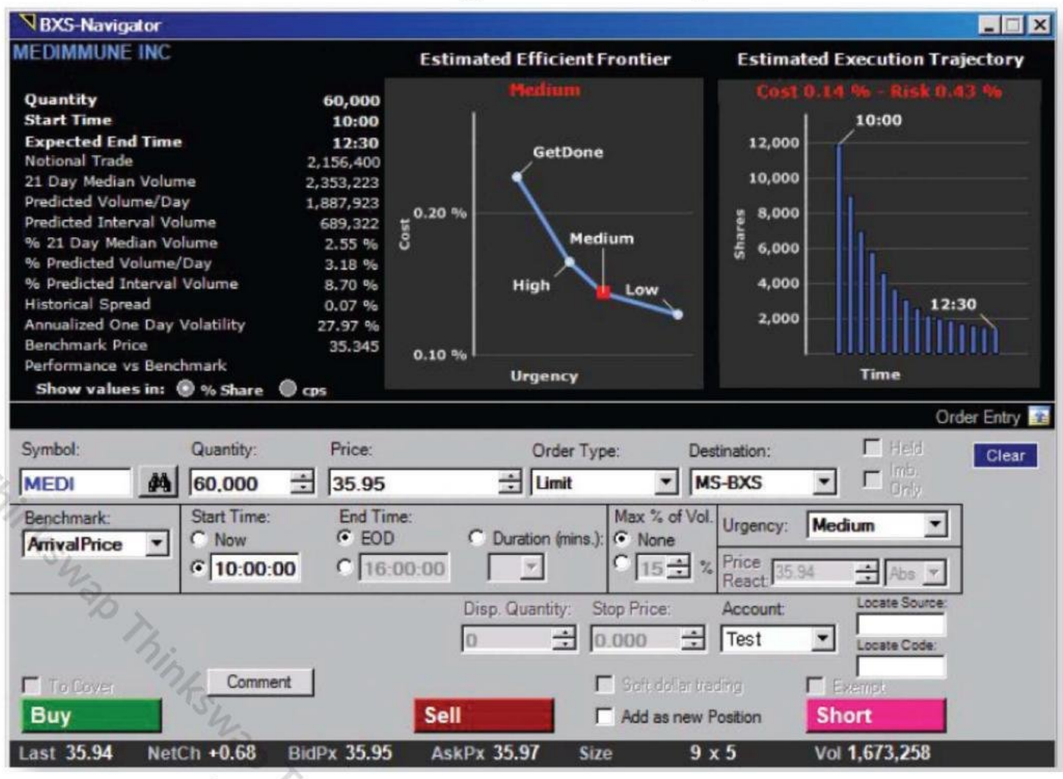
- Credit risk compliance (credit limit for clients/dealer to ensure their interests)
- Market risk compliance (limit on volume for a single equity) – moral hazard
  - Moral Hazard is when a person is insured against risk, making them immune to risky situations
- Trading restrictions
  - Restrict specific equity eg. sin stocks – tobacco, casinos
  - Restrictions on the kinds of securities that some clients want to hold (risk-averse, personal beliefs)
  - Eg. 08 Crisis: Islamic Banking Portfolios were doing well, as they are not allowed to invest in banking under law
- Regulatory Compliance
  - Preventing trades that are non-compliant eg. wash sale
    - Tax deduction purposes (30 days)

Pre-Trade Analytics

- Portfolio Analysis
  - Optimising dollar value of a portfolio while keeping risk exposure at a minimum threshold
- Best Execution/Transaction Cost Analysis – Used by sell-side
  - Best price, fastest execution speed and lowest transaction cost for a trade
  - TCA: (all about minimizing implementation shortfall)
    - **Have DMA to all major electronic marketplaces so traders have real-time quotes and superior connectivity**
    - Explicit costs: Brokerage fees, exchange fees, taxes
    - Implicit costs: Loss of price advantage due to timing and market impact
    - Implementation shortfall: difference between price of the security when order was given and cost (price) of it for the buyer (seller)
    - Strategies to spread out trade over time to minimise market impact
- Integration of Pre-Trade and Trading Technologies



*Benchmark → Algorithm to use (execution used in this case)

ArrivalPrice → Used for small trade volumes, tells the system to achieve price of execution as close as possible to the initial price that it was first placed

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The only way is probably to trade more now, and less later – not ideal for large trades that causes it to push the market

Urgency: Medium trade cost, if high 0.25%

Volume-Weighted Average Price (VWAP) – weighted average price by volume during the period, involving releasing the order slowly into the market such that it follows the surges and lulls in trading, minimises market impact

TRADE:

Order is created and routed to an exchange or such a marketplace where it can find the best counterparty

Order Routing & Execution

- Trading instructions sent from buyer/seller/ buy-side institutions to broker
- Broker creates the order and sends it to:
  - Exchange
  - Electronic Communication Networks
  - Over the Counter – large trades or involve specific assets OR when regular structures fail
  - Internalize (purchased by broker/dealer)

Order Creation

- Trade Ticket:
  - Security Identifier eg. GOOG, C
  - Buy/Sell Flag
  - Type of order
  - Quantity to be traded
  - Trade Date
  - Marketplace to trade/best execution venue

Order Management Systems

- Take in real-time data feeds from the marketplace
  (1) Consolidates and cleans trade, before sending them to the exchange
- Orders can be routed to "any" marketplace of which the broker is a member

Symbol	MSFT	Volume	56,071,087
Last	26.23	High	26.49
Change	-0.25	Low	25.70

Inside 1 Shares 100

Shares	MPID	Bid
100	arcx	26.23
9192	NSDQ	26.22
6600	cinn	26.22
400	FLOW	26.22
1000	iseg	26.20
400	W	26.19
100	FBRC	26.18
1000	NITE	26.15
100	GSCO	26.11
300	MSCO	26.07
100	MADF	26.00
1000	UBSS	25.95
100	HDSN	25.94
100	SBSH	25.85
5000	TMBR	25.83
(66 more)		

Inside 1 Shares 2667

Shares	MPID	Ask
2667	NSDQ	26.23
8400	cinn	26.24
4200	arcx	26.24
101	UBSS	26.27
100	FLOW	26.28
100	HDSN	26.34
800	W	26.35
300	MSCO	26.36
100	GSCO	26.37
100	FBCO	26.49
700	iseg	26.50
100	HILL	26.50
100	MADF	26.50
100	SBSH	26.51
100	RBCM	26.67
(67 more)		

MPID: Marketplace ID – handle different venues with 1 screen

- Efficiency of the system is measured by:
  (1) Execution Price: How close is it from the benchmark national best bid/offer?
  (2) Price Improvements: How much better does it beat the NBBO?
  (3) Execution Speed – Time that elapsed between time broker receiving order to the time the order is executed

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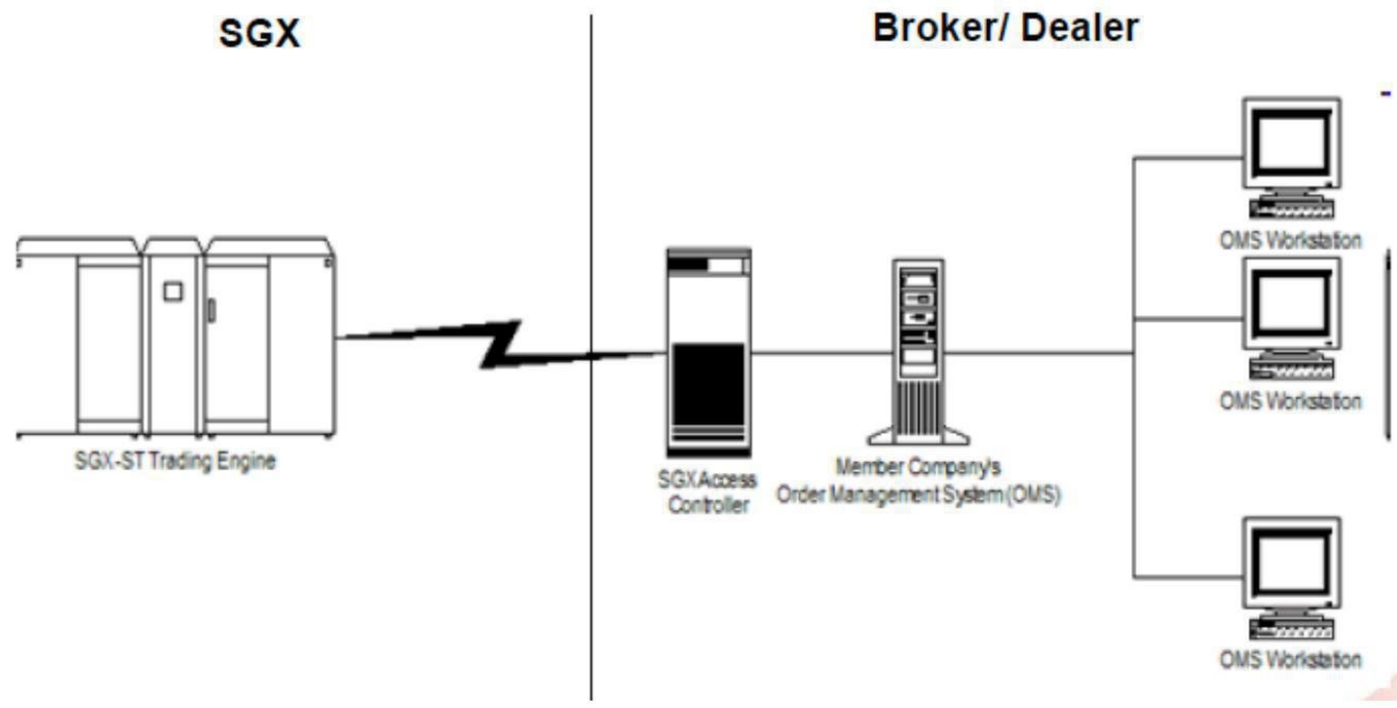
(4) Effective Spread – Distance from the midpoint of the market at the time when your order is entered to the execution price you receive

NBBO (National Best Bid/Offer) – consolidated quote from the highest bid and the lowest offer prices of a security across all exchange and marketmakers

- Mix of in-house developments and some off the shelf eg. Sungard Brass OMS
- Shift towards the DMA market due to buy-side demand
- Built-In algorithm trading

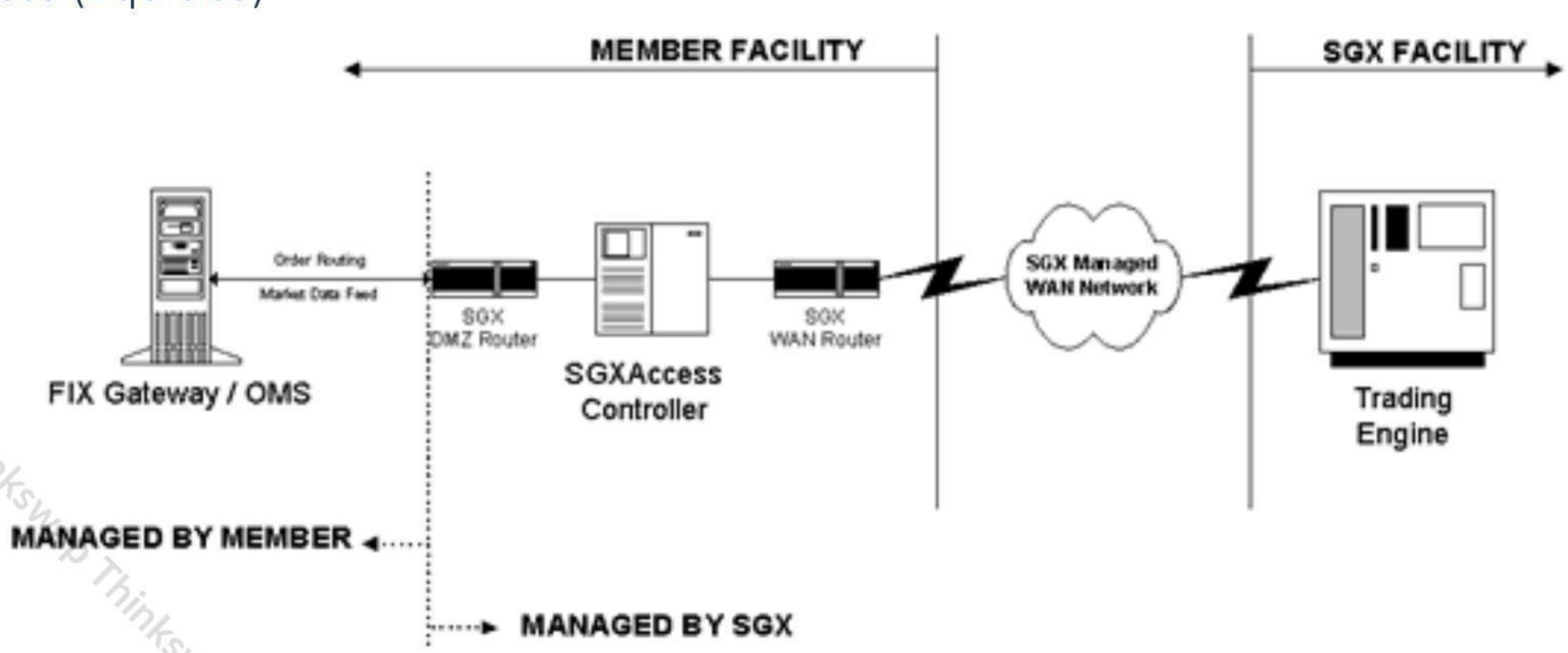
Direct market access refers to access to the electronic facilities and order books of financial market exchanges that facilitate daily securities transactions.

Trading Technology (SGX Access)



- Controller – Circuit Breaker (insulate disruptive orders to avoid rogue activities)
  - Tend to have very liberal limits

SGX Access (Equities)



MEMBER FACILITY – Can be a 3rd party facility but has to be under Member's jurisdiction and within Singapore

FIX Gateway / OMS – May be hosted locally or remotely

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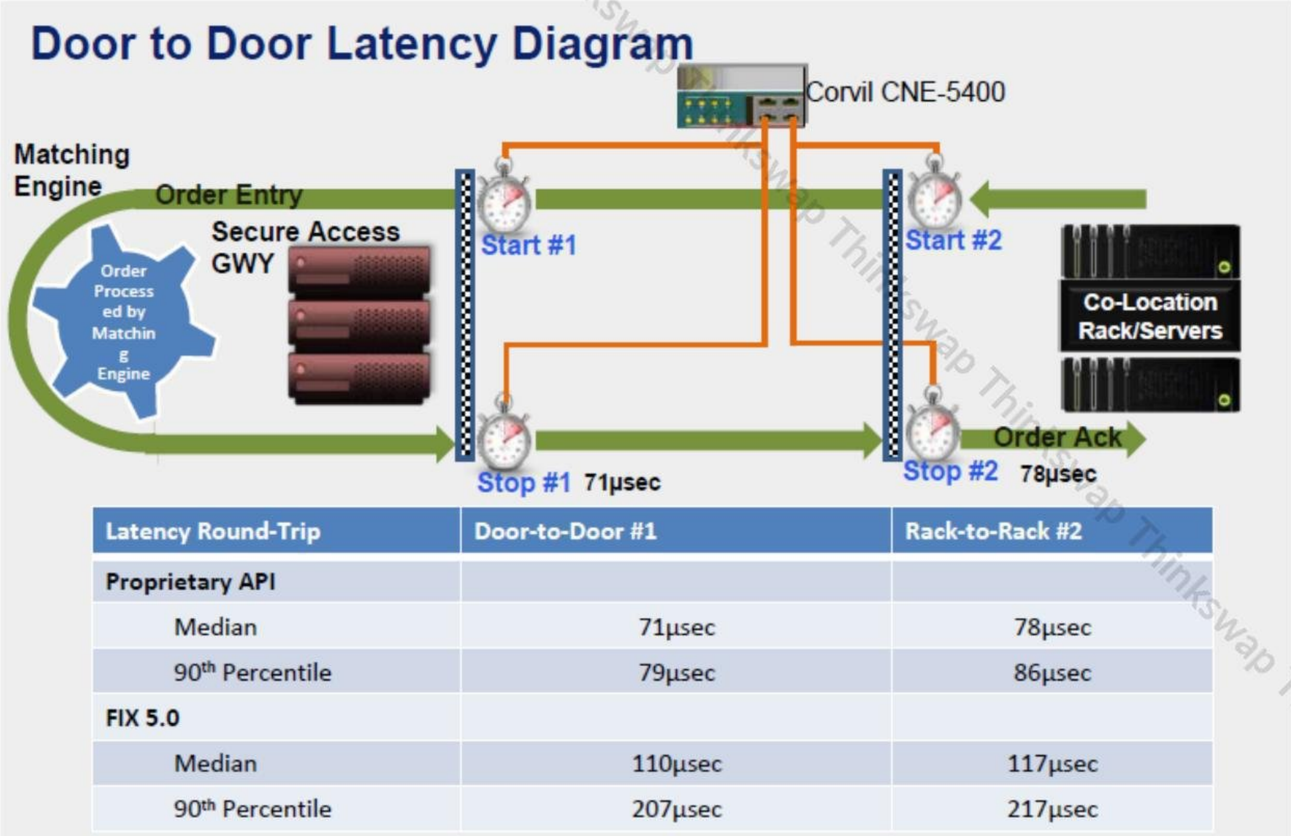
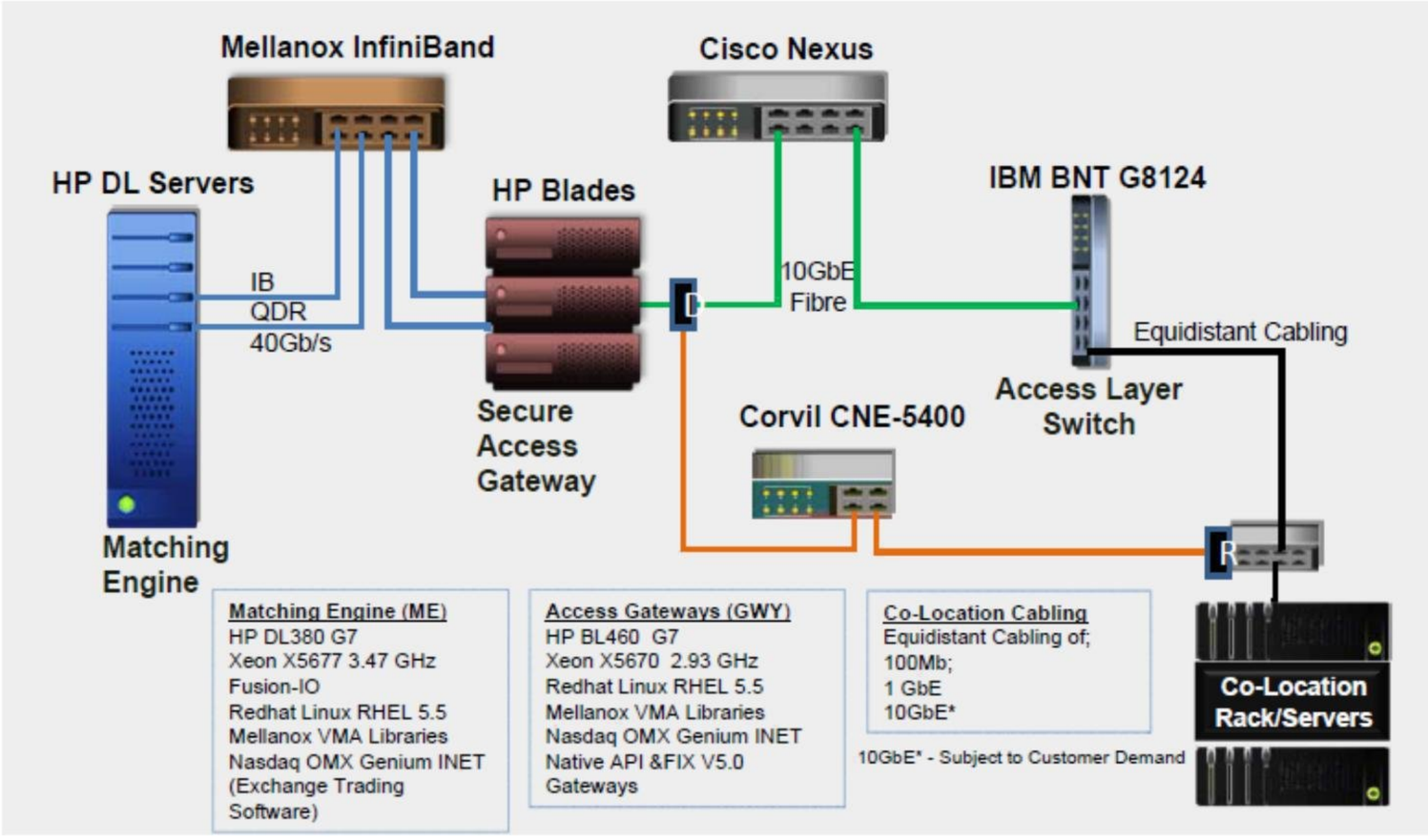
Connections (SGX Reach)



Latency Round-Trip	Door-to-Door #1	Rack-to-Rack #2
Proprietary API		
Median	71µsec	78µsec
90th Percentile	79µsec	86µsec
FIX 5.0		
Median	110µsec	117µsec
90th Percentile	207µsec	217µsec

- Additional Co-location services provided

Technology Architecture (SGX Reach)



Post-Trade

Obligations of each party are calculated, and the money and securities exchanged

- Process may vary depending on the trading parties involved
  (1) Broker-to-Broker Trade OR

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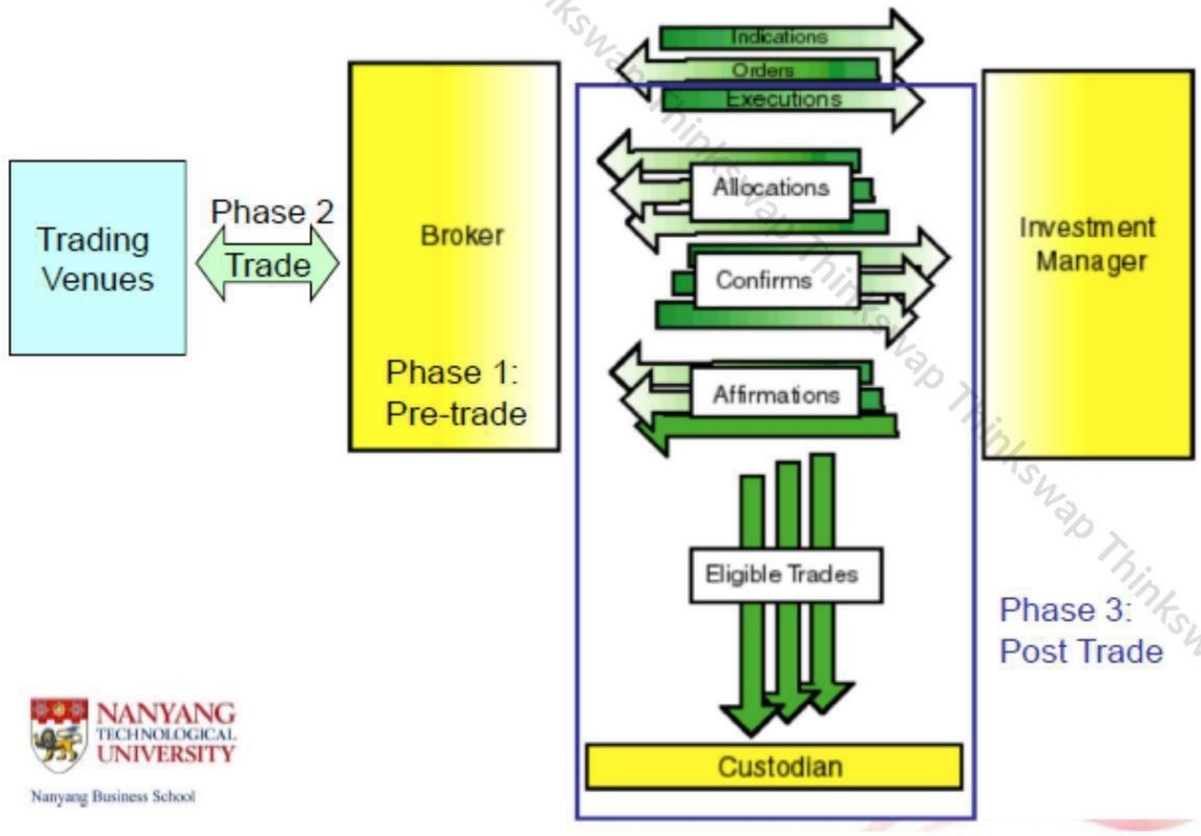
(2) Institutional Trade



- Instructions = Orders
- Indications = Market Research and Valuations (not necessarily part of the trade cycle)

Confirm/Affirm

- Broker-Dealer sends the fund manager a *notice of execution*, containing details of the trade
- Investment manager sends allocation details of client to the BD
- BD sends confirmation for each allocation
- Investment manager affirms
- After affirmation, all orders are sent to a clearing facility
- **Confirm/Affirm Technologies**
    - Outsourced by many brokers/dealers
    - OMGEO (Thomson Reuters): The leading post trade management solutions
    - Processes 1 million institutional trades/day, serving 6000 investment managers and BD
    - Confirms most trade by T+0, affirms by T+3
        - Affirmation rates: 23%, T+0, 85% T+1, 88.5% T+2

Trade Matching

- Involves matching the trade details from the buying broker and the selling broker
- Performed by clearing houses eg. SGX
- Outsourced to 3rd parties eg. Omgeo
- Successful matches are then sent to the clearinghouses for clearing

OMGEO CTM [Identifies Partners]

- Strategic platform for the central matching of cross-border and domestic transactions automating the trade confirmation process across multiple asset classes.
- Automatically sends settlement notification to custodian banks with SWIFT
- Automates confirmation and allocation post-trade

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- Exception-only trade processing
- 3% processed manually, if discrepancies found

OMGEO Alert [Provides Legal Rights]

- Industry's largest and most compliant online global database for the maintenance and communication of accounts and standing settlement instructions
- Significantly reduces trade failures by allowing investment managers, brokers/dealers and custodian banks share accurate account and SSI automatically worldwide

Allocation & Settlement

- Performed by clearinghouses eg. Depository Trust and Clearing Corp (DTCC), Central Depository (CDP)
- **Singapore: Central Depository System (CDP) - 2 Roles**
  - CCP (Central Clearing Party) - Clearing & Depository House for SGX
    - Must have
    - Equities like stocks and fixed income instruments like bonds
  - CSD (Central Securities Depository)
    - Holds securities in trust for investors
    - Needed probably only for smaller markets
      - Mitigate systemic risk
    - Replaced by custodian banks
      - Holds shares on behalf of investor

- **Depository Trust and Clearing Corp**
  - The Depository Trust & Clearing Corporation is an American post-trade financial services company providing clearing and settlement services to the financial markets

- *Novation* occurs: Replacing contract between counterparties with 2 new contracts with the clearinghouse
- Clearinghouse is the buyer for the seller and seller for the buyer

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- Absorbs counterparty risks
- Mitigates risk by restricting dealings with parties that are not creditworthy
- Clearinghouses facilitate the final settlement of trade – transferring ownership of shares electronically and allocating them to the rightful owner
- Enforces Receive-versus-payment (RVP) and Delivery-versus-payment (DVP) instructions
    - **RVP – payment by money (seller perspective)**
    - **DVP – payment immediate on delivery (buyer perspective)**
    - Any credit risk that one of the parties will default on obligations is eliminated
- Ensure payments are successful through FedWire/CHIPS between financial institutions before transfer of the securities
- From T+3 to T+1:
    - T+5 before 1995
    - T+3 since then
    - SEC target of T+1 by 2005 failed
    - Industry focus on setting up infrastructure for STP

Should clearinghouses be consolidated?

- European Clearing: Cross-border securities are inefficient, high risk, high cost with unclear governance
    - Without general consensus on clearing and settlement, cross-border securities trading in Europe will remain hampered by inefficiencies, high costs, high risks and opaque governance
    - Merger of LSE's clearing agency, the London Clearing House and Clearnet – sign of future trend to unification of clearing agencies
- YES:
    - Broker/dealer customers did not want costs from need to reconcile end-of-day balances with multiple clearinghouses – with different and incompatible rules
    - Market forces prevailing- customer sentiment
    - Reflection of US Market's Success
        - DTCC reduced 97% of total value of equity trade obligations that require final settlement
        - Clearing and Settlement in equity trade is 0.09 USD
- If commercial entity takes over all the clearing, increased bargaining power and monopolistic over time – costs will increase gradually

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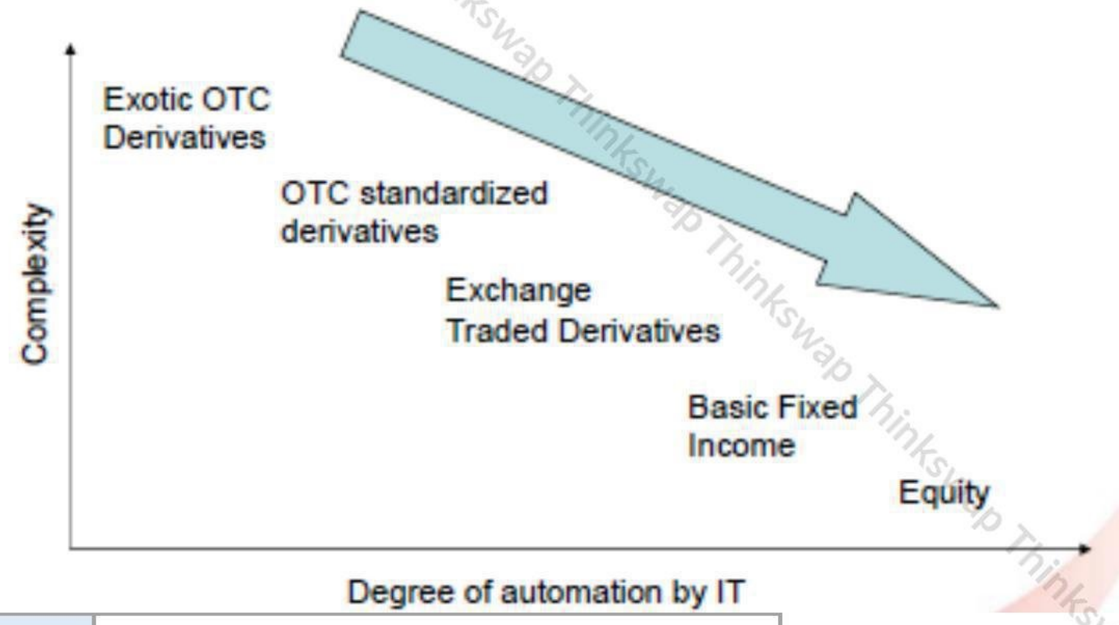
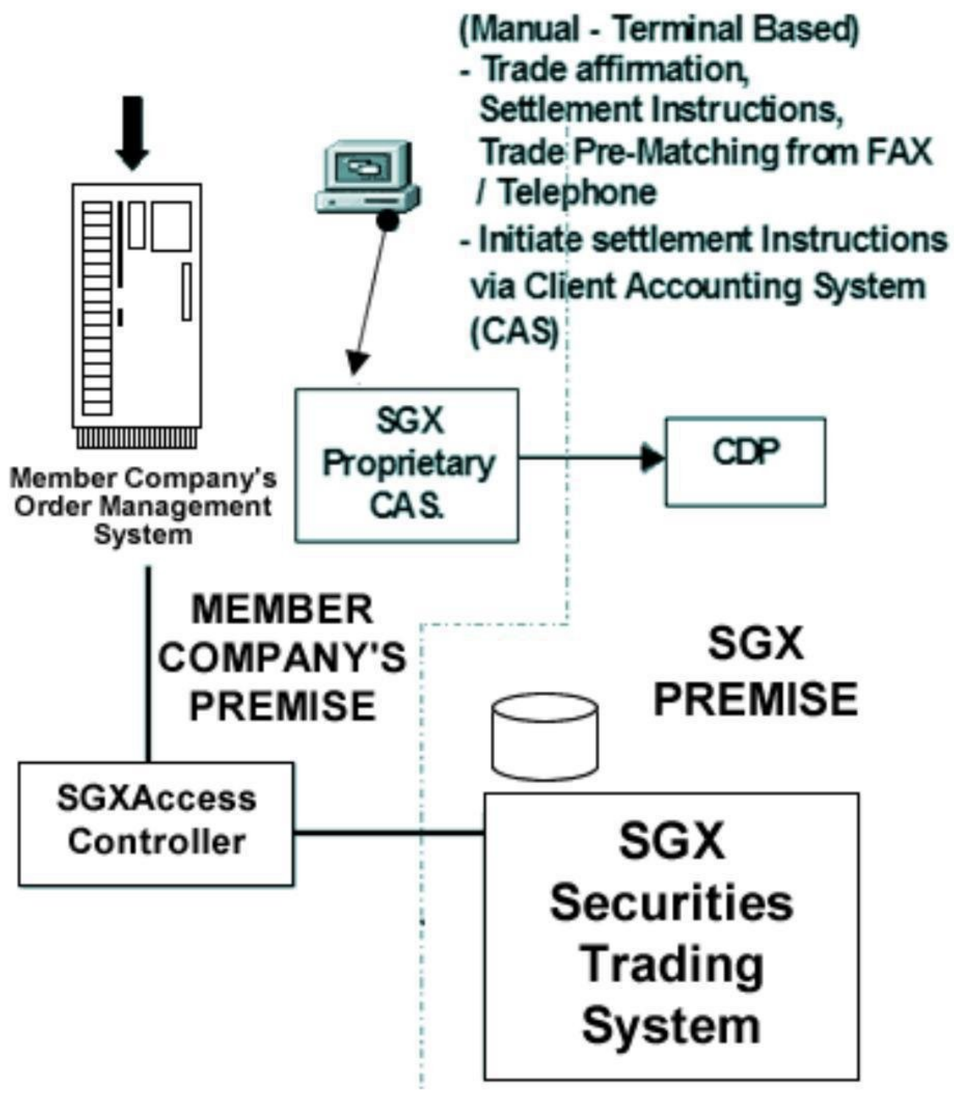
Degree of Automation by IT for Different Asset Classes



Equities	Easy to trade, can automate fully
Rare, exotic instruments	Done manually

Clearing/Settlement (SGX)



Post-Settlement (**ongoing process)

Collateral Management

- Evaluating credit risk of counterparty
- Requiring counterparty to provide collateral to engage in trades
- Granting, verifying, giving advice on collateral transactions to reduce credit risk in unsecured financial transactions

Position Management

- Snapshot of current trading position and all outstanding orders at any time
- *Position* is how much of a trading security a trader holds

Risk Management

- Market risk, credit risk, operational risk

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Profit & Loss Accounting

- Marking a position in the market
- Continually calculating profit/loss based on real-time market data

Corporate Action Monitoring

- Change that happens in a corporation that would affect stock price and dividend flow (eg. mergers/acquisitions, rights issues, stock splits, dividends)

Reconciliation

- Ensuring one "golden" copy of transaction
- Can be brought forward to earlier stages – mismatches can be identified earlier

Reporting

- Managing accounting reports
- Annual/Quarterly reports
- Performance reports to clients
- Compliance report to regulatory bodies (SEC, FDIC etc)

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WEEK 5: STRAIGHT THROUGH PROCESSING

- Initial drive for shortening settlement cycle of securities

Straight Through Processing Paradigm is a set of business processes and technologies that can be used to create an infrastructure for *automated real-time transaction processing*

- CCP benefits the most from STP
  - Has the most obligations
- STPs: Complete automation of trade-related processes in the securities industry
  - End-to-end streamlining of operations within and across firms
- Includes trade initiation, settlement, auxiliary process (risk management, accounting)
- STP replaces manual communication processes of trade transactions (reduces trade failure)
- Both internal and external parties involved in the trading process has to contribute to this

Trends that lead to STP – The demand for greater efficiency

Implications:

- Lines between SS and BS are blurring
- SS makes lower margins – have to find ways to increase their revenue or reduce costs
- Information asymmetry reduces

Exploding Trading Volumes

- **Growth in Trading**
  - Increase in securities issued (US$71 trillion in 2000 and USD$120 in 2006)
  - Increase in trade frequency (esp. bull markets) (NYSE 1 billion a day in 1997 to 3 billion in 2005)
  - **More securities are being traded more frequently**
- Increase trading volume leads to higher **settlement exposure**
  - (the risk of counterparty default the trade agreement is made and the time payment is made)
  - Credit Risk – Risk that party defaults on obligations
  - Liquidity Risk – Risk that party can only meet partial obligation
- Improving T+3 to T+1 reduces total exposure by US$250 billion

Shrinking Margins

- Increase volume but lower margins (Buy-Side VS Sell-Side)
- **Reasons behind falling margins**
  - Evolution of electronic trading, through electronic communication networks
  - Increased commoditization of financial products
  - Regulatory changes – Decimalization of stock prices in 2001 instead of $1/16. Margins declined by as much as 38%
- **Electronic Trading**

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- Posed a huge problem for broker-dealers who made commissions based on ability to match
- 1996: LSE changed from open outcry to electronic screen-based trading (The Big Bang) – significant no. of traders lose their jobs
- NYSE did the same too with a partly automated trading system (NYSE Hybrid Market on Jan 24, 2007)
  - Mostly liquid stocks
  - Total shares handled by trading floor specialists and floor brokers fell from 86% in 2006 to 18% by mid 2007
  - 30% layoff of floor traders on day before system went live
  - "Death of the floor trader" syndrome

- **Commoditization**
  - Standardization of financial products: Able to objectively and succinctly define the characteristics of the traded product
    - Easier to understand and to trade electronically
  - Move to greater standardization of products
    - Increase market participation
    - Increase liquidity → Decrease bid-ask spread → Lower Commissions for broker-dealers who charge a commission on the price that is finally agreed on
    - Eg. International Swaps and Derivatives Association working on industry standard for credit derivatives ie. Credit Default Swaps (CDS)
      - T&Cs used to be unique to each contract
- **Regulation**
  - 2000/2001: SEC mandates all stock quotes to be cents, instead of $1/16 as the min. increment
    - To make the stock prices more easily understandable
    - Movement from imperial to metric
    - Reduce bid-ask by 50% since then [because trading commissions shrinks when spread shrinks]
  - Greater transparency in different security classes eg. fixed income
    - To make the market more transparent – bonds used to be traded OTC and negotiated privately between two parties
    - Eg. bonds
    - National Association of Securities Dealers require all corporate bonds traded prices to be posted 15 min after the transaction into their online system (Trade Reporting and Compliance Engine – TRACE)
    - Increase price transparency → Decrease spread → Margins dwindle

Evolving Marketplaces

- A good marketplace should have:
  - Transparency
  - Access
  - Competition

- Regulators are forcing marketplaces to display prices
- Merger and Acquisitions consolidate the world of exchanges

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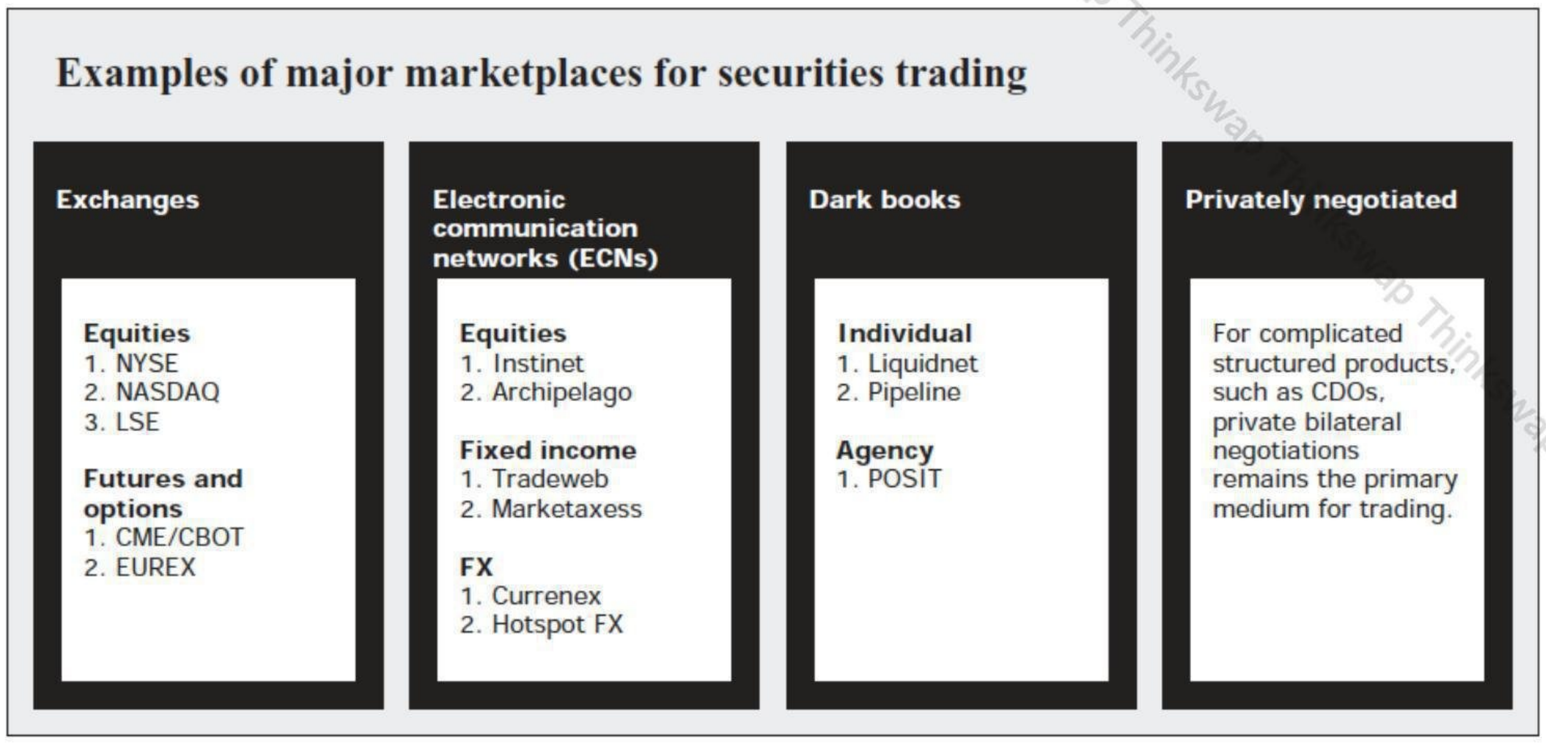
- CBOT acquired by Chicago Mercantile Exchange: 70% of electronic trading and 25% open outcry
- NYSE and NASDAQ have acquired various ECNs

- **Fragmentation** Market: Buyers need to go to different markets to determine the price of their trades
  - US Market is fairly fragmented – but there are actions taken by marketplaces to consolidate them



- Dark Pools: Prices and Orders are not made public
  - Benefits Buy-Side when it comes to placing large blocks of trade
    - But they have to visit several dark liquidity pools to find a good price for trades
  - Sell-Side benefits as they can save on exchange, ECN commissions
  - To create the **spread** again that has been reduced by technology
  - Good for buy-side that wants to anonymise clients

Shifting Trends

- Regulatory pressures to improve best execution parameters ie market impact and price
- Buy-side shifting to less menial tasks – more independent and electronically oriented, also increasing executions through FIX-based flow

Changing Revenue Models

- Two strategies in increasing profits:
  - Low-Touch Model **(HIGH VOLUME)**
    - Create and offer sophisticated electronic and algorithm trading to clients
      - Algorithms that can minimize the market impact of block trades sent by buy-side firms
    - Automation to increase speed and reduce human intervention (decrease cost per trade)
    - Sell-side is more interested in making buy-side trades more cost effective and speedy
  - High Touch Model
    - Value-Add, create structured products (financial engineering)

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- More complex structured products
- Role of financial engineers – intellectual labour intensive
- Tailor products to needs of particular clients
- Occur infrequently but carry high margins for sell-side
- Largely used for **hedging**

Transformation of the buy-side

- Change in composition of buy-side – becoming savvier and want more control over the trade
- Major player – the hedge funds US$1.2 trillion in 2005 Assets Under management (AUM)
    - High volume traders, especially in prime brokerage
- A move towards greater autonomy from the buy-side – want better control over trade execution
- Multiple dealer-brokers for research and execution of the trade
- Buy-Side now has better access through liquidity tools than before (DMA tools)
    - Demanding that broker-dealers unbundle the research fees from commission fees so that institutional investors can better gauge the value-added quality of the research
- Buy-Side under pressure from clients to give a unified multi-asset portfolio management offering – Unified Managed Accounts

Globalisation

- Liquidity is very global, exchange has to make sure that cost to participants are minimised to attract business, drive down compliance funds
- First Trans-Atlantic merger of Euronext and NYSE in 2006-2007
- Hostile takeover of LSE by NASDAQ (failed in 2007)
- Strategic alliance between Tokyo Stock Exchange with NYSE
- NYSE looking at buying a stake in National Stock Exchange of India and even in China
- Move towards reducing global market fragmentation: A consolidated liquid pool

Regulatory Pressures

- To protect interest of investors, ensuring a fair, transparent and efficient market

Sarbanes-Oxley (Sarbox) Act of 2000

- Collapse of **Enron** and the subsequent disclosure of accounting fraud, need to return investor confidence in the stock market
- **Detailed audit trails** to be kept when reporting financial accounts, including documentation of internal IT controls
- **CFO** of each firm to sign final report on compliance to act
- Flight of IPOs to London and HK due to stringent demands

- SOX, Reg NMS (United States), MiFID (Euro)
- Reg NMS
    - Deadline: Fall 2007
    - Promote market transparency, use of electronic trading to access markets

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- Implicit guarantee that investors get best available price from brokers and dealers
  - Upgrade IT infrastructure to accommodate automated quotation and electronic execution
- Electronic display of prices from different markets by brokers/dealers

Straight Through Processing

Four Pillars:

- Seamless communication between parties
- Significant real-time processing, less batch processing
- Electronic, not physical processing
- Concurrent, not sequential, exchange of information

Performance Metrics for STP

- Connectivity: Between systems, both within firms and between firms involved in the trade execution and post-trade processing
- Speed: Achieve T+1 Settlement Time
- Accuracy: Ensure integrity of financial data
- Standardization: For industry participants to effectively and seamlessly exchange transaction-related information
- Scalability: Ability to scale up for new markets
- Reliability: Fault resistance, redundancy built into it
- Security: Large quantum of monetary assets transacted
- Extendibility: Flexible enough to accommodate new products

The Trade Lifecycle: Business activities associated with a trader/investor buying and selling a security

Benefits of Implementing STP

Instant Transfer: With connection, shorter trading time T+5 heading to T+1, speed up overall economy
Automation: Avoid human error and enables accurate data, efficient process of transaction without time consuming paperwork
Risk Control: Reduce liquidity risk, intraday settlement risk by real time basis, seamless transaction
Standardization: Standardized communication and connection allows cost efficiency and higher productivity

Challenges Faced by the STP

Technical	Non-Technical
- Standards: SWIFT: post-trade processing and FIX: pre-trade and trade activities of brokers and managers. Two sets of competing protocol FIX and SWIFT are not yet compatible	- **Intertia** in the industry - Different types of firms (Segmentation) places different emphasis on what needs to be improved

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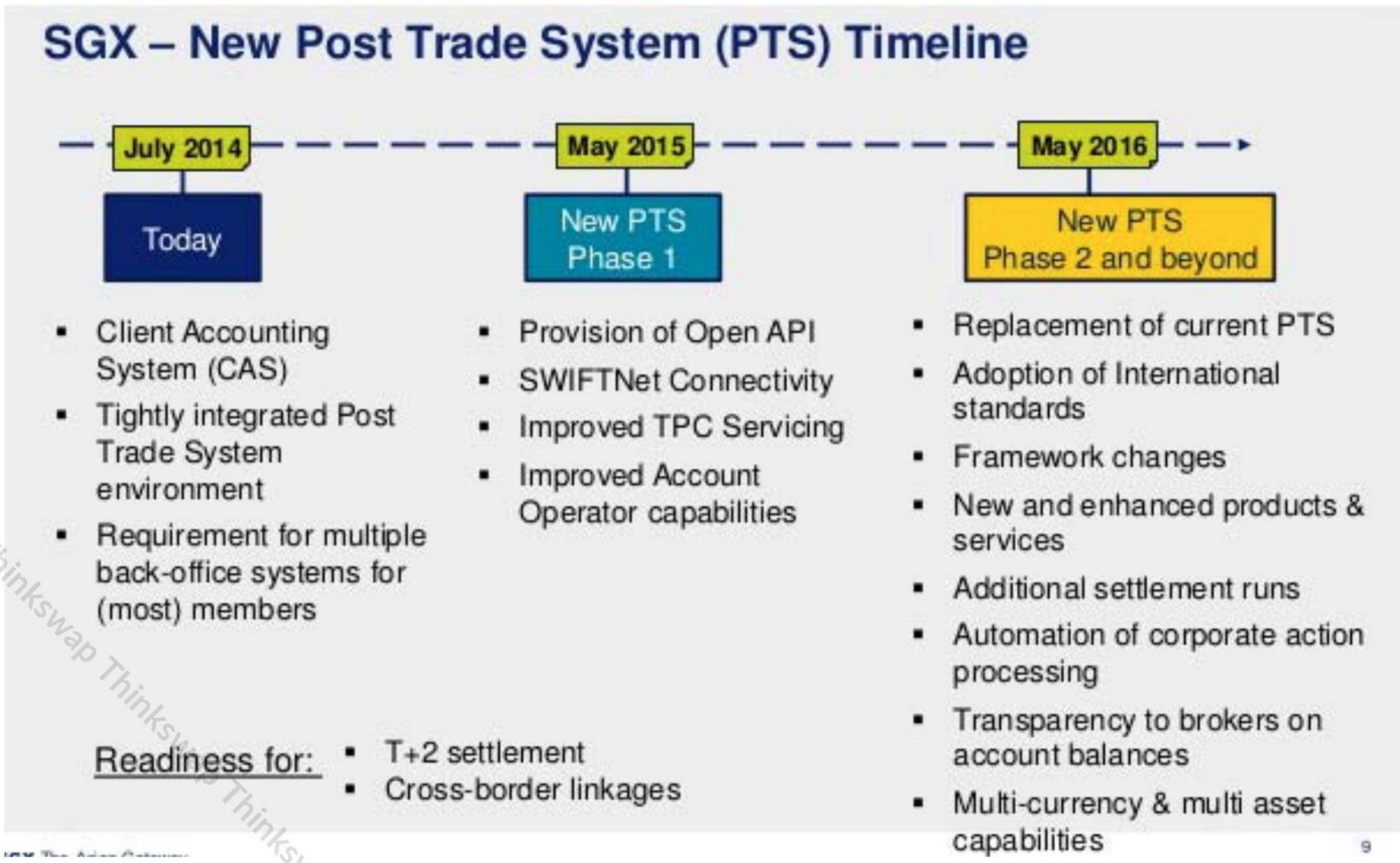
- Network Connectivity by routing, format mapping and protocol conversion - Tools: Vendor-created automated tools not designed to work easily with other applications – automation, reconcilement, delivery instruction - Vendor Support: Incompatible supports in areas such as new security issues, customer interactivity, vendor support applications, vendor storage/retrieval - Effort to move to T+1, fundamental changes in their primary system, real time processes for many activities	- Knowledge Base: Each firm has different capabilities (different approaches) - Expensive for many firms to upgrade to T+1 - Implementing STP will be a significant expense to many firms that have fallen behind their peers in automation and process optimization

CHANGES TO THE POST-TRADE (S'PORE AND ASEAN)



ASEAN TRADING LINK

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ASEAN Vertical Clearing and Settlement Structure for Equity Securities

	Indonesia	Malaysia	Philippines	Singapore	Thailand	Vietnam (HNX)	Vietnam (HOSE)
Trading	Indonesia Stock Exchange (IDX)	Bursa Malaysia (BM)	Philippine Stock Exchange (PSE)	Singapore Exchange (SGX)	Stock Exchange of Thailand (SET)	Hanoi Stock Exchange (HNX)	Ho Chi Minh Stock Exchange (HOSE)
Matching	Kustodian Sentral Efek Indonesia (KSEI)	Bursa Malaysia Securities Clearing (BMSC)	Philippine Depository & Trust Corporation (PDTC)	Central Depository (CDP)	Thailand Clearing House(TCH)	Vietnam Securities Depository (VSD)	Vietnam Securities Depository (VSD)
Clearing	Kliring Penjaminan Efek Indonesia (KPEI)		Securities Clearing Corporation of the Philippines (SCCP)				
Securities Settlement	Kustodian Sentral Efek Indonesia (KSEI)	Bursa Malaysia Depository (BMD)	Philippine Depository & Trust Corporation (PDTC)				
Cash Settlement	Approved Commercial Banks	Bank Negara Malaysia (BNM)	Approved Commercial Banks	Approved Commercial Banks	Approved Commercial Banks	Bank for Investment & Development of Vietnam (BIDV)	Bank for Investment & Development of Vietnam (BIDV)

- Trade Cycle still largely ran by each nation

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WEEK 6 &7: E-MONEY AND FINANCIAL NETWORKS I

Characteristics of Money

- Portable
- Low Holding Cost / Low Cost
- Quantifiable/Measurable – no ambiguity
- Denominated
- Secure → Hyperinflation
- Fiat Currency

Financial Networks

- **Consumer Based Networks:** E-Money and E-Payments
- **Wholesale Payment Networks:** NSS, RTGS, Hybrid Settlement Systems, CLS Bank
- **Trading Networks:** ECN, Crossing Networks, Darkpools

E-Money

- Electric money products are intended to be used as general, multipurpose means of payment compared to single-purpose pre-paid card products
- Needs to be distinguished from so-called access products, which typically allow consumers to use electronic means of communication to access conventional payment services
- Bearer of the token has ownership of the money
- General multipurpose VS single purpose
- Card-based products VS network/software-based products
- HK was the first country to have a successful E-Money system – common in smaller cities

Success Factors in Payment System

- Two-sided market externality problem (users VS producers)
- Security (confidence in using)
- Compatibility (backward compatible)
    - Tamper Resistance – (1) Encryption and (2) Physical VS Logical Control
    - VISA: Chip, barcode, CVV, pin, paywave, face of card
        - Ensure that while growing the network, size of the network is not reduced – retain market share
    - Challenges with being backward compatible – when fixing bugs, need to retain elements of the old system
- Seigniorage – who should bear the costs
    - Minimise costs to maintain the payment network (if by customer, not very successful)

Electronic Payments

- Mainly through the Internet/mobile phones
- Mobile phones: two business models are in use – paying from a prepaid balance or paying layer along with the mobile phone bill
- More rapid growth than e-money (esp. via internet)

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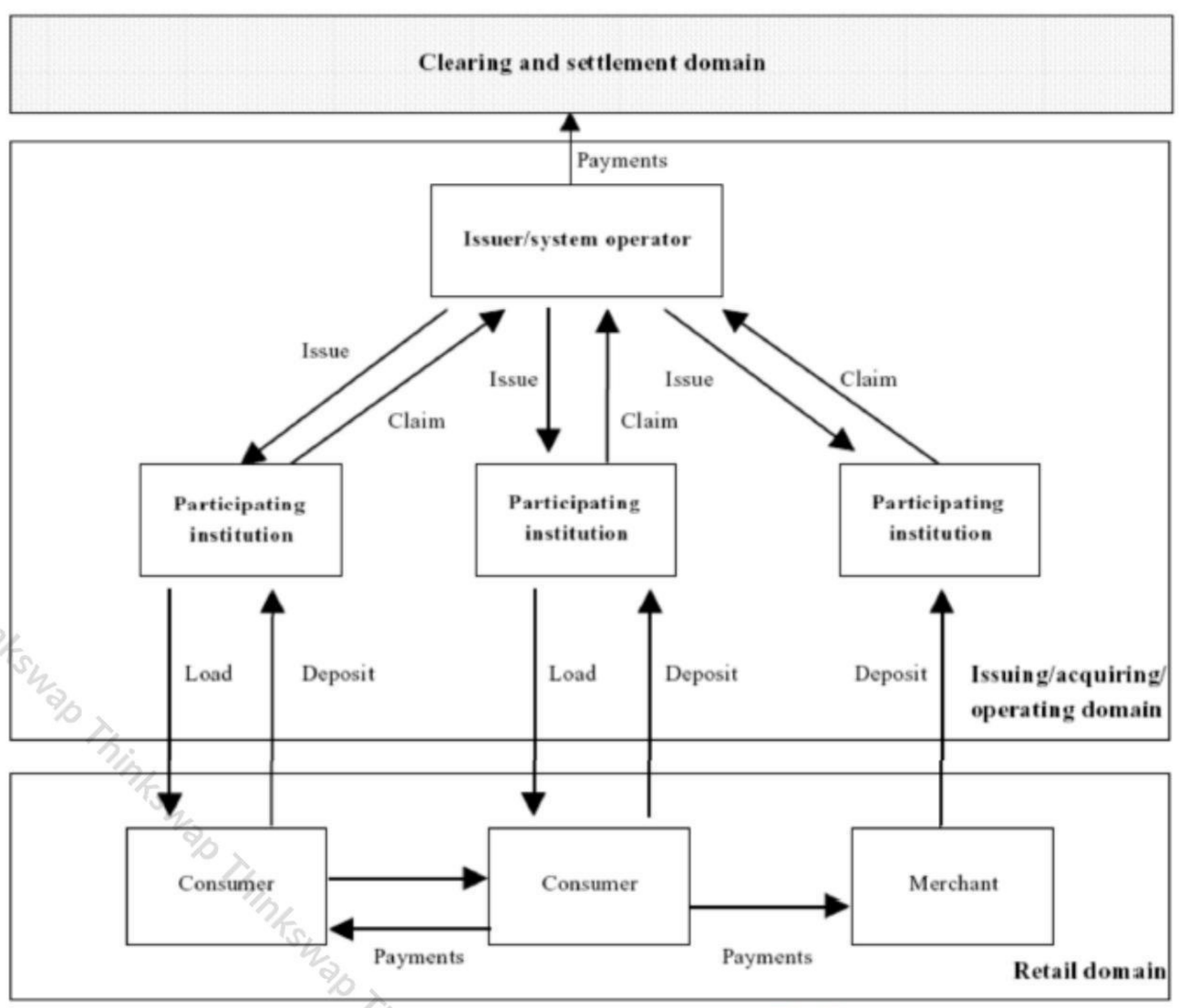
- B2B, B2C and P2P payments
  - B2B and B2C eg. Online Credit Card Payment, inter-bank transfer, wire transfer etc.
  - P2P – Yahoo! PayDirect, EBay PayPal, Citibank c2it

Issues to Consider about E-Money and Electronic Payments

- Monetary Policy and Seigniorage
- General Legal Issues
  - Supervision of issuer, oversight of payment systems, effect of issuance of e-money on consumer and data protection
  - In several countries, legislation exists which provides legal context for internet and mobile payments. Nations where legal aspects have not caught up with the developments
- Security
  - Fraud Risk
    - Duplication of devices
    - Alteration or duplication of data or software
    - Alteration of messages
    - Theft
    - Repudiation of transactions
  - Malfunctions
    - Balance cost with robustness of device
- Issuer Details
  - EU regulatory framework allows only deposit-taking institutions and authorised electronic money institutions to issue e-money



^ Missing: Third party vendor that supports the infrastructure

- Wirecard, SG: Banks (code-sharing)
- US and Europe: predominantly 3rd party vendors

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- P2P: ie. PayPal/Tencent/Alibaba

Risk Management: Prevention Measures

- Tamper-Resistance of Devices (physical control)
  - Security-Related Processing is performed inside a physically secured module (smart card chip)
  - Sophisticated features include both logical and physical protection
- Cryptography (logical control)
  - Logical protection of electronic money systems by ensuring the confidentiality, authenticity and integrity
- Online Authorization
  - What you know, who you are, what you have
  - Login ID, Password, Biometrics, MAC Addresses, secret questions, two factor authentication, virtual credit card numbers
- Procedural and Administrative Controls
  - Card manufacture, cryptographic key management
  - Separated geographically and administratively

Risk Management: Detection Measures

- Transaction traceability and monitoring
  - Balance between cost to run the system and risk management
- Interaction with a central system
- Limits on transferability
- Statistical analysis
  - Detect unusual volumes of payments that could be indicative of fraud

Risk Management: Containment Measures

- **Time and Value Limits on Devices**
  - Value limits is to contain the magnitude of losses from successful fraud attempts
  - Cloning a large number of devices is required for attackers to make the effort financially worthwhile
  - Expiration dates on devices contain the extent of any fraud
- **Registration of devices**
  - Facilitate investigation of any attempted fraudulent activity
- **Hot lists and disabling of devices**
  - Records of the serial numbers of suspect devices maintained by a central system operator
  - Disabling of devices can include multiple attempts to enter a PIN or multiple failed transactions
- **System Suspension**
  - Implement facilities to rapidly change the cryptographic keys or algorithms used if a wide-ranging fraud is detected

Risk Management: Organizational

- **Manufacturing of devices**

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- Manufacturing, initialisation and personalization are strictly controlled and carried out by different organizations
- Separation of staff within organization for different responsibility
- **ATM Machines – NCR**

- **Security Evaluation**: To be performed by independent 3rd party (ext. audit)
- Background checks for merchants and staff involved
- Monitorin g of financial institutions, due diligence programs

Financial Networks

- Banks Switch to Gross Method (RTGS – Real-Time Gross Settlement)
  - SG: MEPS+ (MAS Electronic Payment System)
    - Instantaneous Transfer of $ - initiate the transfer
    - **Cannot be challenged or reversed**
  - **"Run on the bank" –** when a large number of people withdraw from the bank, as they believe that it will cease operation in the near future
- Net Settlement Herstatt Risk – 1974 - Risk associated with **cash-cash settlements**
  - Settlement risk associated with currency

Depends on a wide array of networks

- Electric power utilities network
- Communication lines (eg. phone, wire transfer etc.)
- Payment & Settlement networks/systems (credit card payment network)
- Trading networks

Historical Financial Networks: Physical Delivery to Virtual Delivery

- 1838 onwards – Samuel Morse applied for various patents of technologies that eventually led to the telegraph
- Technologies patented included automation in routing of telegrams
- After a series of market upheavals, 6 organizations throughout US were formed – Western Union one of them
- Price of transmitting a 10-word message for 160km is $2.50 – unaffordable

Telegram

- 57% of the initial users of telegrams were related to financial markets
- Timely information key in financial trading
- Opportunities of arbitrage across different exchanges
- Railroad, and telegram boom in the 1800s help funded growth, aided financial trading

Settlement & Payment Networks

Upgrading a Financial Network

- Concurrent usage and upgrading
- Backwards compatibility and installed base:
  - Compatibility VS Tech. Improvements
- Balance between disruption and upgrades
- Relying on existing externalities for compatibility
  - Europay and MC; Plus and Visa; Discover and AMEX

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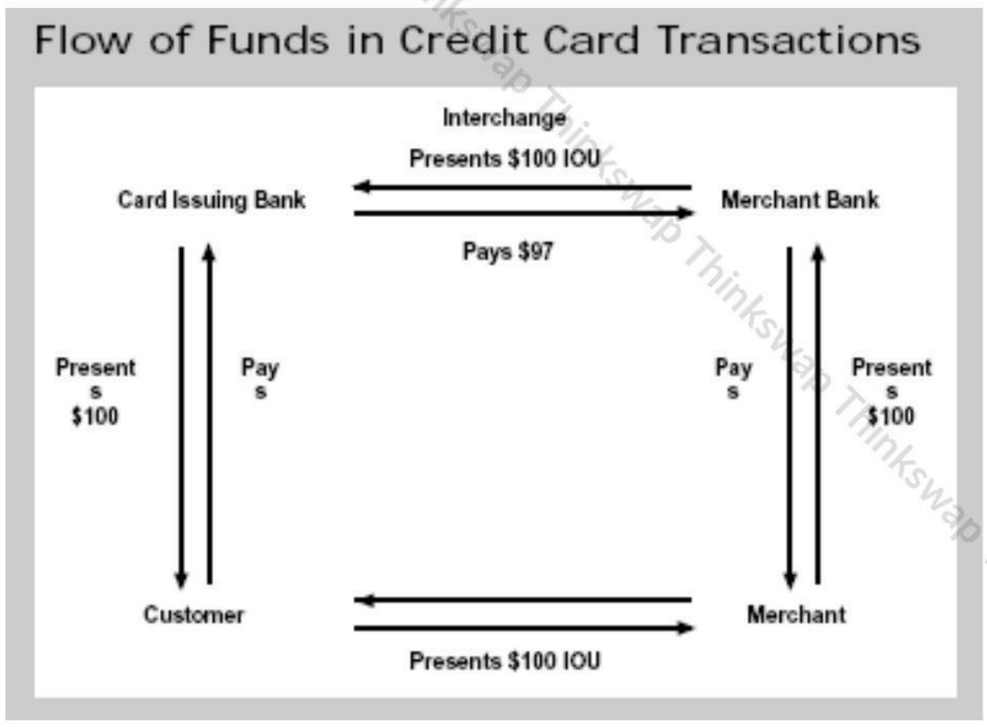
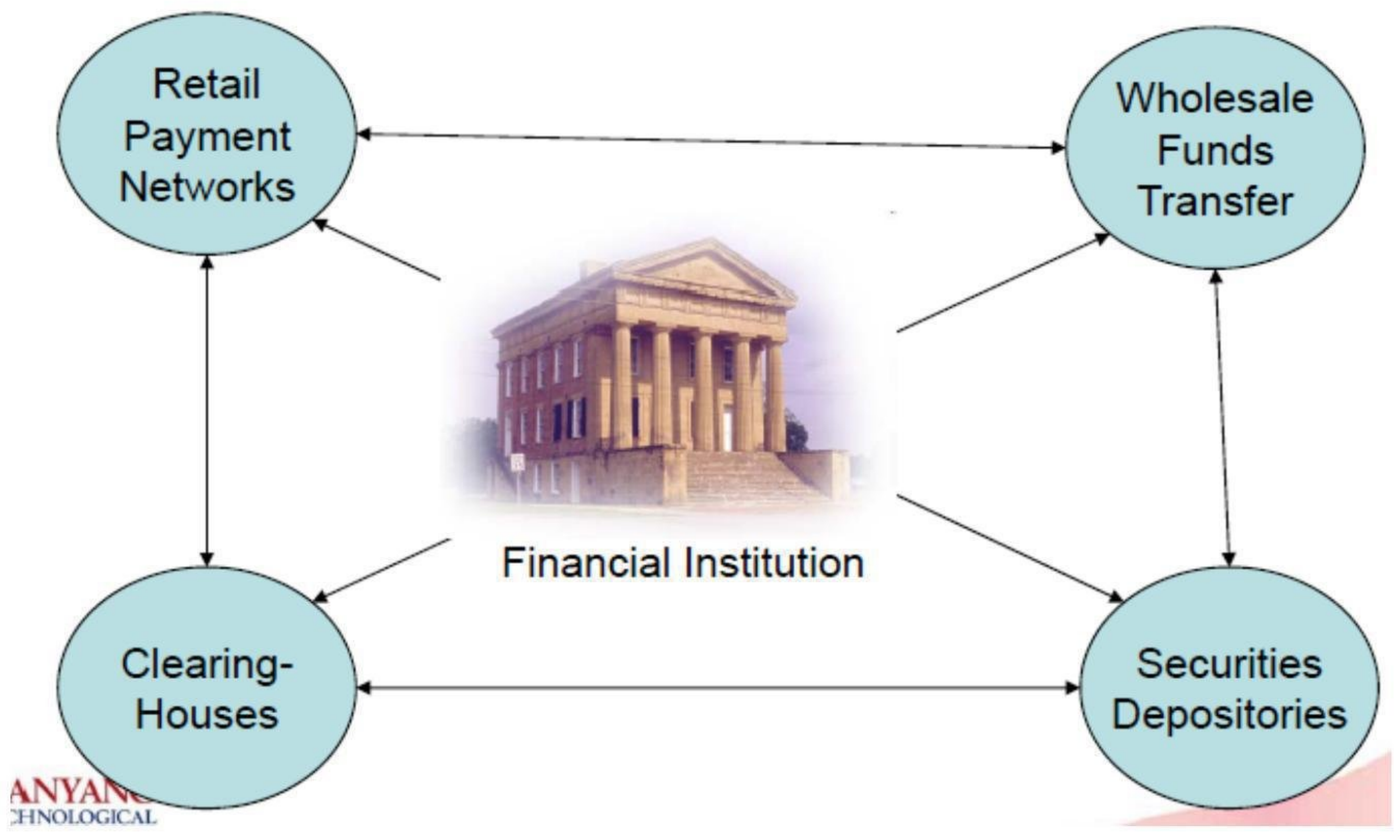
Illustration of a Financial Transaction



Payment & Settlement Systems / Network Landscape



Types of Payments & Settlement System

- Funds Settlement System:
  - Wholesale funds transfer service (Fedwire), CHIP
  - ACH, Check
  - Credit Card, ATM, POS
- FX Settlement Systems
  - Funds Transfer Service (Fedwire), CHIPS
  - CLS Bank (Continuous Linked Settlement)
    - Supports 17 currencies worldwide
- Securities Settlement Systems
  - DTCC (DTC & NSCC)
  - Securities Transfer Service (Fedwire)

Payment Systems (Wholesale)

- Large-Value Funds Transfer System
  - Provides for transfer of large-value payments
  - Primarily used by financial institutions

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- Transfers are typically more time-critical
- Operates as a clearinghouse
- System often run by central bank

- Central Bank: Banker for the banks

***Real Time Gross Settlement (RTGS) – mainly high risk settlements

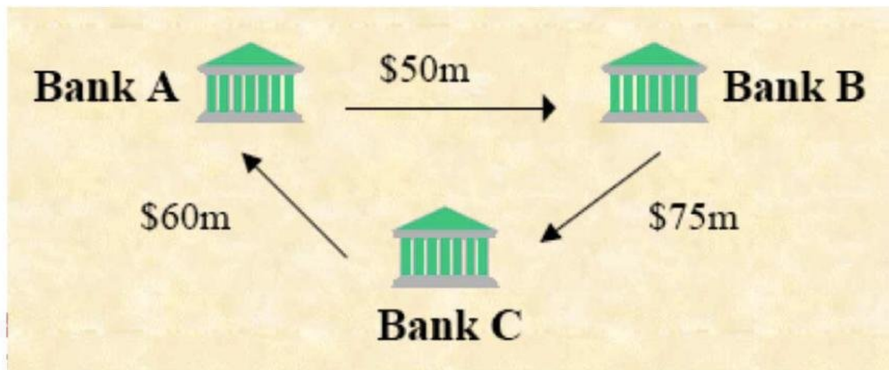
- Real Time: Not subjected to waiting
  - Processing and final settlement occurs on a continuous basis throughout the processing day
  - Gross Settlement: No **netting** of positions (netting is done at the end of the day)
    - Each payment is processed individually
  - Payments are final and irrevocable
    - Unconditional, not subject to reversals
  - Eg. US: FedWire and CHIPs, Britain: Clearing House Automated Payments System

FedWire

- Started in 1913 by connecting 12 Federal Reserve Banks, RS Board and US Treasury
- Allows netting of positions instead of paying for physical delivery of cash/gold to counterparties
- Eliminate the interest lost due to wait for physical delivery
- Important participant in providing interbank payment services + safekeeping and transfer services for US gov and agency securities
- One of two primary RTGS for interbank payment, or large-value, domestic, funds transfer payment orders between banks in US

***Multilateral Net Settlement Systems (eg. GIRO/Nets/Visa/Mastercard)

- Banks continually send payment instructions to system; system continually "nets" participant's position
- Netting: Offset participants obligations such that single net position
  - Bank A owes $10m, Bank B owes $5m, Bank C owes $15m



- Settlement occurs at 1 or more pre-specified times in the day, usually at the end of the processing cycle
- Participants with net debit positions make payment;
- Requires **less funding for netting**
  - Funding level required for gross is **very high**
  - VS netting: large sums compensated by smaller sums
- System makes payments to participants with net credit positions
- Finality achieved upon completion of settlement

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- Eg: Old CHIPS

***Hybrid Settlement Systems (eg FAST)

- Combines features of RTGS and Net Settlement Systems
  - For example, a hybrid settlement system may net participants' positions (thereby achieving liquidity savings)
  - Providing for settlement throughout the processing day such that intraday finality is achieved (limits payment system risk)
- Eg: New CHIPS

Clearing House Interbank Payment System (CHIPS) and other Systems

- CHIPS is the other Hybrid/RTGS System within US
- Privately owned by consortium of FI
- Payments transferred over CHIPS are often related to international interbank transactions, including the dollar payments from foreign current transactions
- Payment order processing follows the predefined rules and operating procedures of large value payment systems
- Large value payment system operating procedures include identification, reconciliation and confirmation procedures

Payment Systems (Retail)

- Small-Dollar payments made in G&S Market
  - Cash (anti-counterfeiting devices, distribution networks, high-speed sorter processors)
  - Checks (clearinghouses; eg. Federal Reserve)
  - Credit Cards (operators/processors; eg. Visa)
  - EFT (ACH Operators: eg. Federal Reserve, NYACH)
  - Debit Cards, E-Money (Smart Cards, Digital Cash, Electronic Bill Payment)
- National Settlement Services (NSS)
  - Participants in private clearing arrangements to settle their net obligations with same-day finality with participant's reserve or clearing account balances at Federal Reserve Banks
  - Participants include check clearinghouse associations, automated clearinghouse networks, credit card processors and ATM networks

Settlement System (Risk)

- Risk that completion of individual transfers does not take place as expected
  - From: Credit Risk, Liquidity Risk, Operational Risk, Systematic Risk
- Push to RTGS instead of net settlement systems

Types of Risk:

- Credit Risk: Risk that a party to a trade does not meet an obligation when due or at any time thereafter
- Liquidity Risk: Risk that party to a trade will not settle obligations for full value when due, but at some unspecified time thereafter

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    - Counterparty meanwhile have other obligations to complete and may not to cover shortfall
- Operational Risk
- Systemic Risk

Society for Worldwide Interbank Financial Telecommunication (SWIFT)

- Does not carry your money!! Just the secured communication network
- International financial messaging network
- Transmit payment instructions for both domestic and international financial transaction
- SWIFT operates as a messaging system, transmitting instructions to move funds
- **Only handled for public networks, and at the very last part during settlement**
- Still needs the domestic systems discussed before to accomplish the actual funds movement
    - OCBC – SWIFT Code: OCBCSGSG
    - Citibank Singapore – SWIFT

Funds Transfer Operations (Wire Room Security Measures)

- Hardware & Software components to control access and support effective monitoring
- Strong user authentication
- Support user entitlement (information access and function controls) administration
- Presence of audit trails in sufficient detail to support the analysis or investigation of specific transactions
- Enable funds transfer activity logs
- Designate independent staff members to monitor operations, applications support, system administrator and security administrators' activities
- Information security program include access, authentication and transmission controls surrounding wire room activities and all terminal connections
- Presence of strong physical controls (sabotage)
    - Secured room (ID passes, Pin, Logbook)
    - Fire and flood management
- Encrypting data during transmission

WEEK 8: TRADING SIMULATION

Trading Simulation

- Buy-Side → Buying **below** market average
- Sell-Side → Selling **above** market average
- Prop-Trader → Starts with zero position, but given funds to trade, do not have overnight position as there is risk, ends with zero position
    - Performance solely based on P/L

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        - Realised
        - Unrealised – Shares x Last Price
- Placing Limit Orders
    - Buy on left, sell on right (cancel by pressing x)
- Market VOL
- VWAP – Volume Weighted Average Price
    - Multiple, sum altogether and divide by total
    - (100 x $10, 200 x $11, 400 x $12)/700
- TWAP

- The **opening price** is the **price** at which a security first trades upon the **opening** of an exchange on a trading day;
- The closing price is the price of a security at the end of the day's business in a financial market.

WEEK 9: FINANCIAL NETWORKS II

Difference between ECN and Crossing Networks
- ECNs do not have the right to list and typically only allow for secondary offerings, not so much IPOs
- ECNs are more transparent than crossing networks
- If you are trading at once, you will use a transparent network, but if you are trading over a long period of time, one may not want to reveal to the market that you are driving prices

Alternative Trading System (ATS):

- Non-exchange electronic trading system that automatically matches and sells orders at specific prices
    - Trading without the need for regular exchanges
    - Permits matching of bid/ask quotes
- Matches buyers and sellers to find counterparties for transactions
- Transactions occur along electronic, automated means

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- Discloses limited information about its operations and trades
- Increases liquidity and competition
- **Gets a 3rd party clearing house eg. DTCC**
    - Buy-Side used to not be able to bypass the sell-side
        - Technical reason (Skills needed to trade)
            - Overcome with algorithms and availability of sell-side software
        - Clearing Fund – Accessibility (Financial Reason)
- Reasons for Rise:
    - Technological advancements
        - Emerging communication networks
    - Growing need for block trades
        - Algorithmic trading strategises and diminishing order sizes
    - Attractive fee structures, price improvements and faster processing speeds
    - 18% of all stock trading was in ATS
    - 2009 - no. of dark pools rose to 32, 10 trillion traded there every year
        - More than NYSE, NASDAQ

Electronic Communication Networks (ECN)

- Offers real-time price discovery, enabling buyers and sellers to transact inexpensively with a minimum of intermediation
- "Integral to the modern securities market"
- Can actually execute large orders effectively through rapid-fire small, block trades + offer anonymity
- Different ECNs target different clientele with different strategies
- Alternative Trading Systems registered and regulated by SEC
- Potentially eliminate involvement of trader (sell-side)
- **Each ECN has its own liquidity pool**
- Orders come in to the ECN, immediately matched against trader's initial parameters within the ECN

How to subsidise the market?

- Those making market orders are more "desperate", therefore, subsidise the liquidity providers (free transactions; paid to trade)
- Eg. BATS did not have the backing of financial institutions and had to seed the network themselves

Types of ECN: Market Structure

- **Continuous Limit Order Book**: Order book displays orders and ranks them by price, then by time
    - **Greatest Transparency**; **Most exchanges determine prices this way**
    - Demand & Supply Curve
    - Typically used by large ECNs where orders flow in consistently
- **Single Price Auction:** Participants submit bids and offers over a period of time
    - Systems execute all trades and at the same time, with a same price to max. trading volume
    - Issues in price determination; to batch orders for different periods

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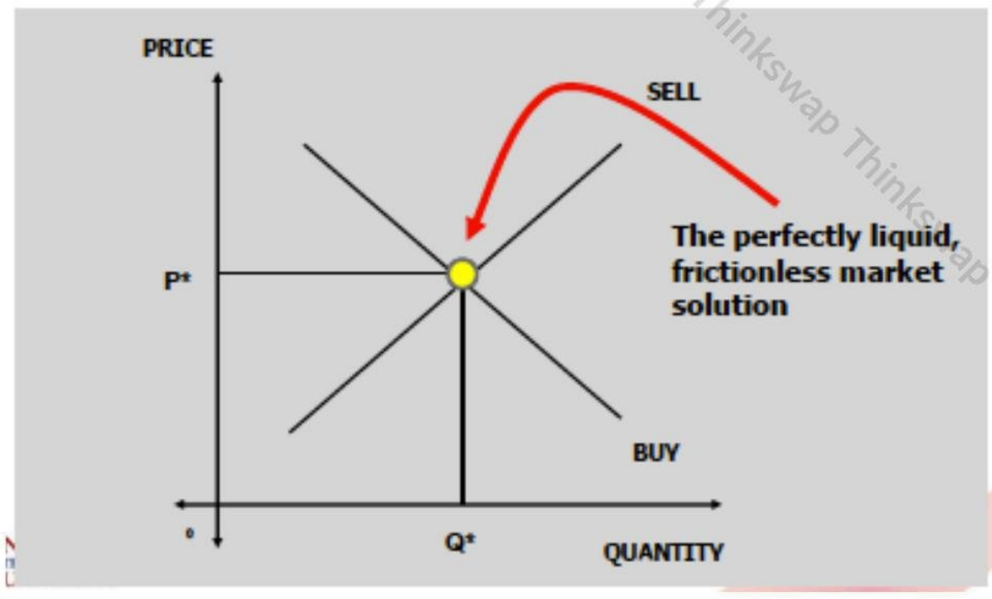
- **Passive pricing:** Refer to other systems/exchanges for trading prices, no price discovery
    - Very rare and the most opaque
    - Do not have the necessary qty to form a demand and supply curve

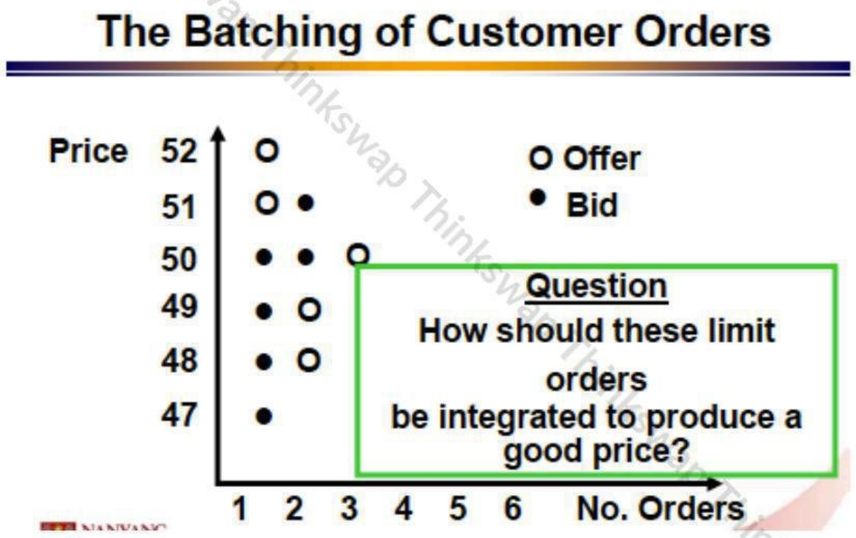


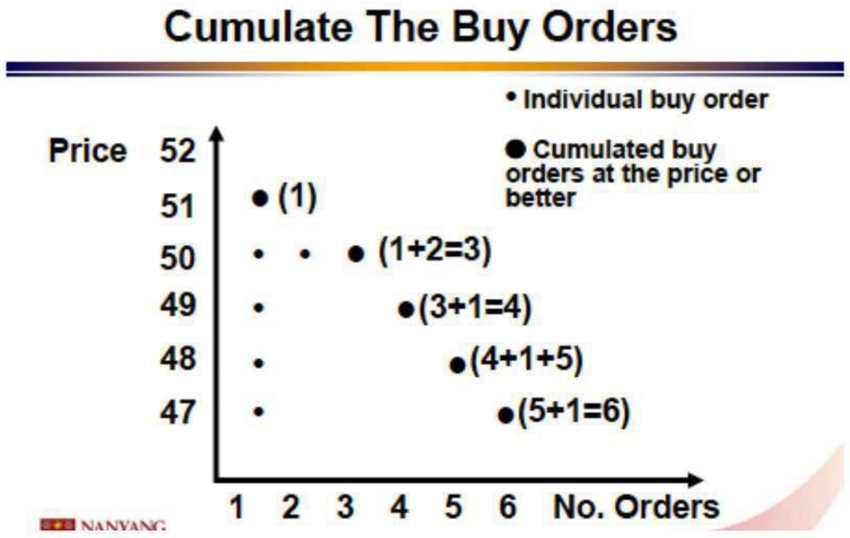
Big problem: Enabling buyers and sellers, large and small to find each other across places and time

- In order driven market, limit order book brings buyer & seller together
- Dealer intermediation: Dealer provision of immediacy brings buyer and seller together
    - Dealer helps to mitigate gap between buy & sell
    - The longer the time, the larger the spread (3-5%) to insulate the dealer's risk
- A Call Auction: A meeting point in time can bring multiple buyers & sellers together
    - Only for ECNs with high variation (1 hour); for counters of relatively lower trade levels
        - Allows all buyers & sellers to come in
        - Match cumulated buy & sell orders

Electronic Call Auction

- Orders that could otherwise be matched and executed are held for a big, multilateral clearing
- Clearings held at pre-determined points in time
- All crossing orders are executed at a single price
    - buy orders at that price and **higher** execute
    - sell orders at that price and lower execute





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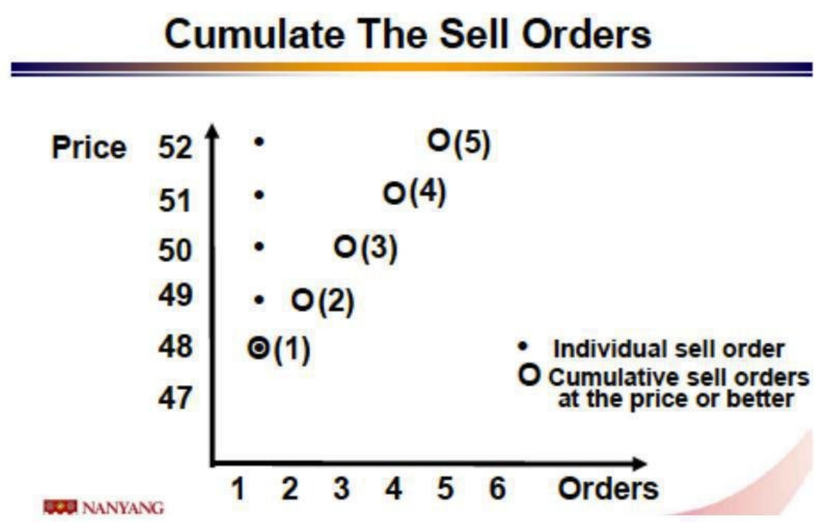

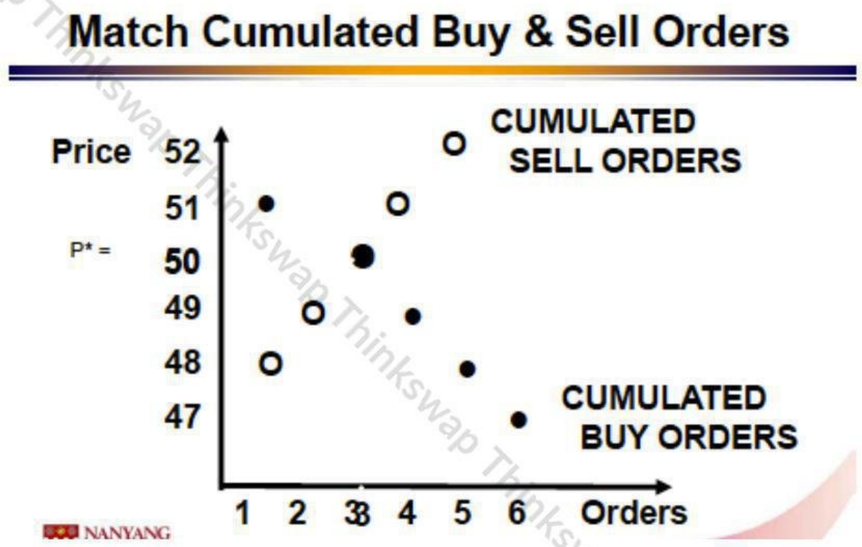

When Calls Are Used: Market Openings, Market Closings (MOC & LOC Orders), NASDAQ's Crosses (Open and Close), Intra Day (At predetermined time, to reopen the market after a trading hault

Smaller ECNs began to merge in the 200s

ECN Trading

- ECNs have lower liquidity than major exchanges like NYSE, NASDAQ
- If order is not executed, may be routed to a competing ECN (sporadic nature of liquidity
- Permits direct connection to trading venues and utilise smart-routing concepts to fulfil order specifications w DMA tools

Information Transferred on ECN

- Security identification
- Buy/sell order
- Trade price
- Trade date
- Order instruction (eg. market, limit, fill/kill)
- Broker identification
- Details of buyers/sellers hidden

ECN Order Types – Not seen in exchanges due to higher p(execution)

- Committed Order Flow: Orders submitted into ATS and available for immediate execution (liquidity providers)
- Uncommitted order flow: Orders available for execution, **but require confirmation first**
    - **Buy more than what is being prescribed at first** – and will be asked if they want to proceed with the trade
    - Probability of success is NOT very high
- Pass-through order flow: orders on their way to another execution venue ie. exchange/ECN, may pass through ATS first to cross // or IOC (immediate or cancel) to "ping" for liquidity, without leaving in the order in the system for any length of time
    - Various market orders that fund the revenue of the ECN
- Negotiated order flow: more human interaction, and indications provide information that a counterparty is available in the ATS
    - Room to negotiate before executing the trade (relatively rare)

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Advantage of ECNs

- Match buyers/sellers directly
- **Allows buy-side traders to access multiple execution venues and liquidity pools w/o broker's trading desk → increase efficiency of the market (reduces info asymmetry)**
- Facilitate hedge funds – most aggressive users of ECN
- Anonymity in trading (At times)
- **Execution price is low**
    - Funds are from provision of DMA software to the buy-side

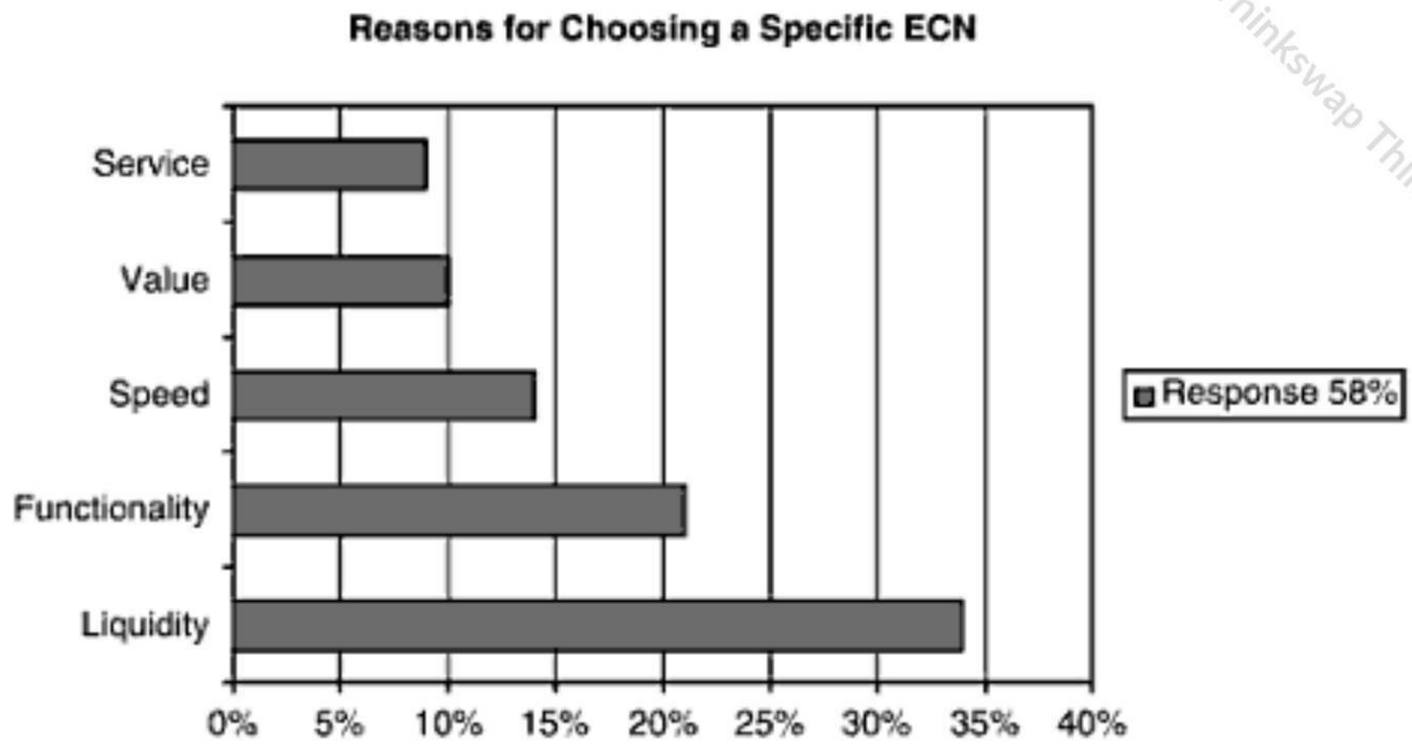

Exhibit 7.5 *Source: LLC Institutional Equity Trading in America*, TABB Group, April 2004.

ECN Revenue Model

- Commission: low ($0.005 per share), sometimes "free"
- Other fees
    - Use of DMA software
    - Inactivity fee/min. trading volume
    - Interest spreads
- Use by:
    - Day Traders (high vol. trades)
    - Tech traders
    - Scalpers (low slippage required)

Implications of ECN

- Algorithm Trading and FIX Protocol
- Broker has to differentiate services – disruption for major players by offering brokerage services
- ECNs cause liquidity fragmentation in equities
- Consolidation of ECNs
    - NYSE & NASDAQ purchases
    - NYSE Acra – Formerly AcraEx originally created by archipelago
    - INET – Bought over NASDAQ from Instinet
    - BRUT – Sungard (Sold to NASDAQ)
    - SuperMOntage – NASDAQ propriety ECN

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- Cost for brokerages to provide tech to support ECN, ranging from 15-50 mill

Crossing Networks allow one to access liquidity from other sources that may not be readily available in an active market

- Matches block (large) trades anonymously
- Limited or no trade information
- System mat hes and determines transacted price based on variety of parameters. No negotiation
- Prevents information leakage
- Eg. Credit Suisse (Crossfinder), Instinet (Instinet Crossing)...

Crossing Network (Scheduled) • Larger blocks effectively executed with low market impact • Orders in the system anonymous to participants • Unmatched orders can be cancelled
Crossing Network (Continuous) • Provides access to liquidity and negotiations throughout the day • Provides more information, prone to information leakage
Crossing Networks (Darkbox) • Hide liquidity in the darkbox, providing price improvements to both sides without broadcasting information

Crossfinder

- System crosses orders on a continuous basis at prices at or better than NBBO (national best bid/offer)
- Approx. 122 million shares/day
- Institutional, retail and liquidity partners
- Types of orders: market and limit orders eligible for execution at/within the NBBO
- Time of crossing: Continuous crossing during market hours
- Fee structure: rates are negotiated on an individual basis

Sniping Algorithms to front-run the Market

  - Send in a small order to sell
  - If successful, send a higher amount
  - Then send a large amount to sell
- Common Trait: Do not specify how the price is being determined
- Can have strong claims and misrepresentation
  - Value proposition: Secrecy
  - Can you be exposed by audits?

POSIT

- Match equity orders with complete confidentiality, access to diverse liquidity pools, zero market impact and the cost savings of midpoint pricing
- Currently, 700+ clients participate, comprised primarily of institutions, broker-dealers and hedge funds
- POSIT MatchTM has 13 cross times a day

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- POSIT NowSM offers continuous, anonymous crossing throughout the trading day
- Commission on a per share basis

Participants of a Crossing Network

- Some crossing networks do not allow sell-side broker-dealers to join

Potential Problems

- Strong claims and potential misrepresentation by providers
    - Pipeline Trading Scandal 2011: False claims of confidentiality
    - Barclays Dark Pool Scandal 2014-2015: HFT vs Non-HFT. Claims that it is HFT free, but invited HFTs

Changes in Order Flow Patterns

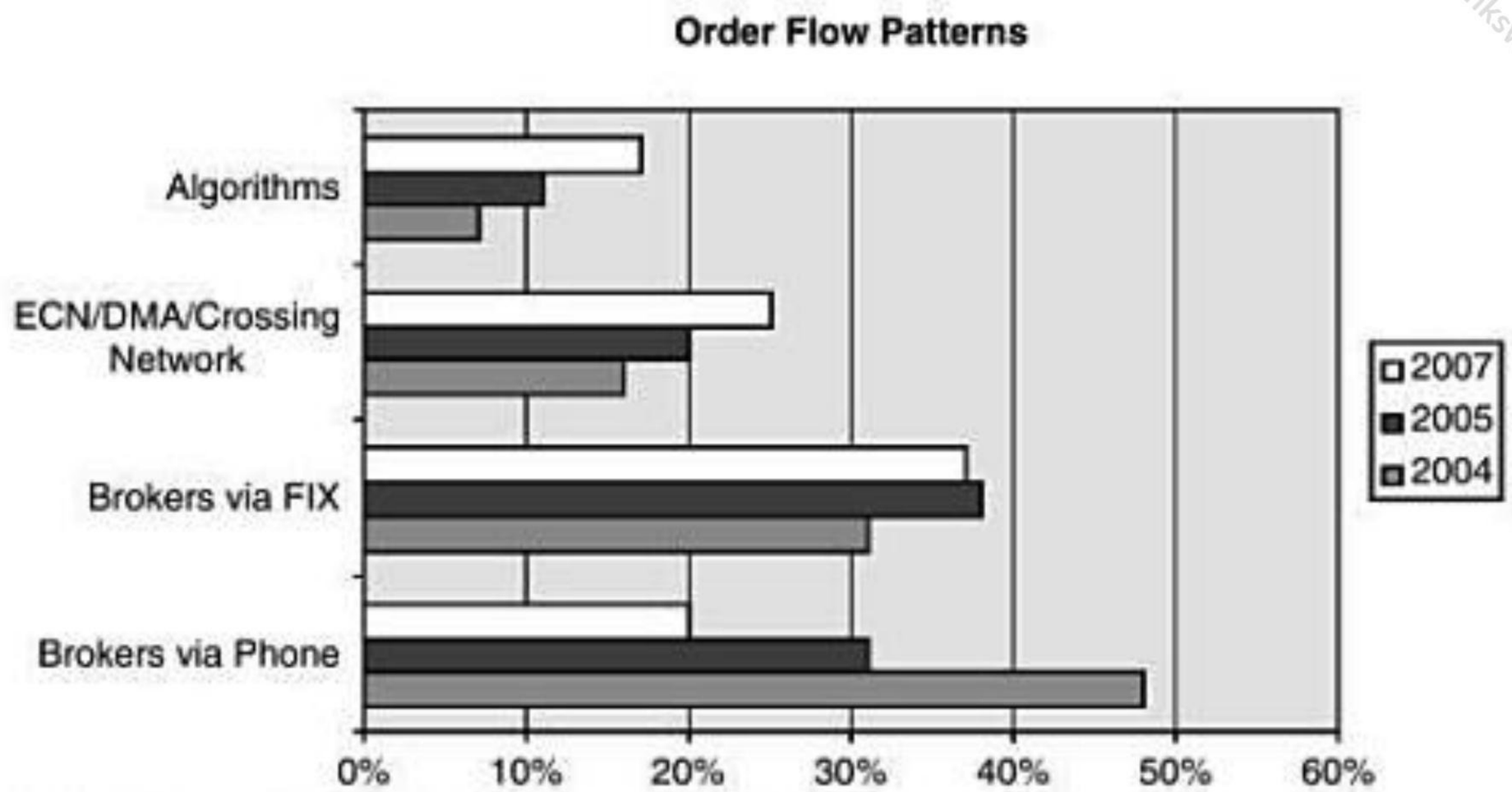

Exhibit 7.6 *Source:* TABB Group, June 2005.

Ownership of Content in Network

- Who owns the market data?
    - Quotes, last done prices
    - Historically – those who produces it owns it
    - 1975, SEC
        - Promotes public access to market information, "requested" national exchanges to "eliminate rules that restricted assess"
        - "Reasonable fees" is acceptable
- Historically, not valuable, as law states that market data must be provided at a reasonable cost

Sources of Revenue for Exchanges: Market Data Revenue, Trading Volume, Market Capitalization, Market data revenue/trading volume

- Larger market, less earnings per exchange

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Technology Supporting Trading Networks

Direct Market Access (DMA) Tools

- (1) **Provide Trading Capabilities through algorithms**
    - Buy-Side's desire to have more control over the execution of trades (commissions are far lower – 1c a share, while program trades cost two cents and block trades 4-5c)
        - Autonomous role in deciding on investment strategy, matching buyers and sellers directly
- (2) **Access to the venue, as clearing activities are also supported**
    - **On top of technological capabilities, also has collaterals/clearing funds attached to it – funds are shared amongst all software users into the markets directly**
- Technology used to by-pass sell-side and trade directly at ECNs
    - **Direct Market Access (DMA) tools allow buy-side clients to directly access electronic exchanges, liquidity pools, ECNs without having to go through the broker's trading desk**
- Different face of OMS
- Integral part of trading technology that facilitates profileration of ECNs
    - Aggregation tech.
    - Help route orders to ECNs
    - Use in fragmented markets
    - Analyses orders, polls market, locate most efficient venue
    - Low cost to use these technologies
- 2004: 33% of buy-side equity routed via DMA as of 2004 (38% by 2008)
- Hedge funds use DMA aggressively; over 30% of buy orders are routed through DMAs
- Lava Trading; Rediplus; PASSPORT
- For a broker-dealer, costs associated with building DMA trading capabilities are around 15 million.

Advantages of DMA Tools

- Often facilitate STP, DMA tools can integrate with other clearing, settlement systems
- Order captured in the beginning, data for downstream post-trade activities – reduces error
- Maximising access to liquidity
- Faster trade execution (operationally)
    - Speed of execution and potential for better pricing for investors that may not have been provided
- Tools enable buy-side to bypass sell-side
    - Reduce transaction costs
    - Increase control
- May improve liquidity with the use of crossing networks or accessing to different liquidity pools
    - Ability to supply wide range of order entry functionality allowing for stealthier trading of large blocks
    - Access to multiple products and markets

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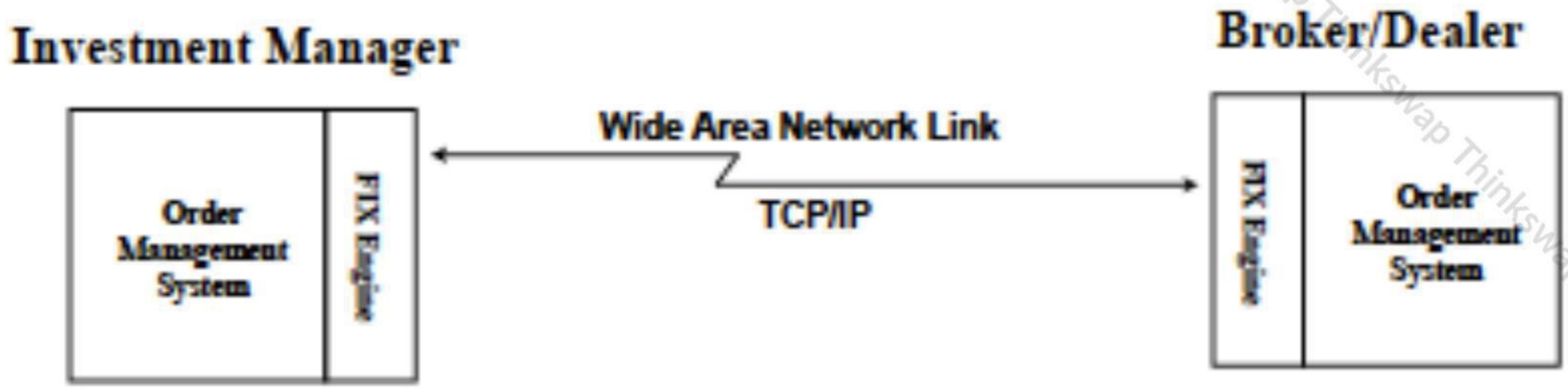
FIX Protocol

- For Trade Cycle/Pre-Trade: Predominantly due to legacy protocol that standardises the way trades are encrypted
- Messaging standard developed specifically for the real-time electronic exchange of securities transactions
- Public domain specification owned and maintained by FIX Protocol Ltd
- "TCIP/IP" for Financial Trading Networks
- First developed by Salomon Brothers (!992) to facilitate trading between Fidelity Investments



FIX Messages

- Groups of Fields strung together to describe a business action

FIX and Security

- **Public Networks used today, private only when order is sent from OMS (security for execution server)**
- **Private Networks**
  - Network is secure
  - Common approach
  - Normal on hub and spoke networks eg. SWIFTNet, RITD, Bloomberg
  - VPN: Eg. TNS, Radianz
- Combination
  - Use encryption over a connection to a private network
- **<u>FIX does not mandate security, but can be used securely</u>**
- Number of approaches
- Generally, any weakness are around poor implementation, not core technology
  - DES Key may be a weakness but takes so long to crack that info is of little value

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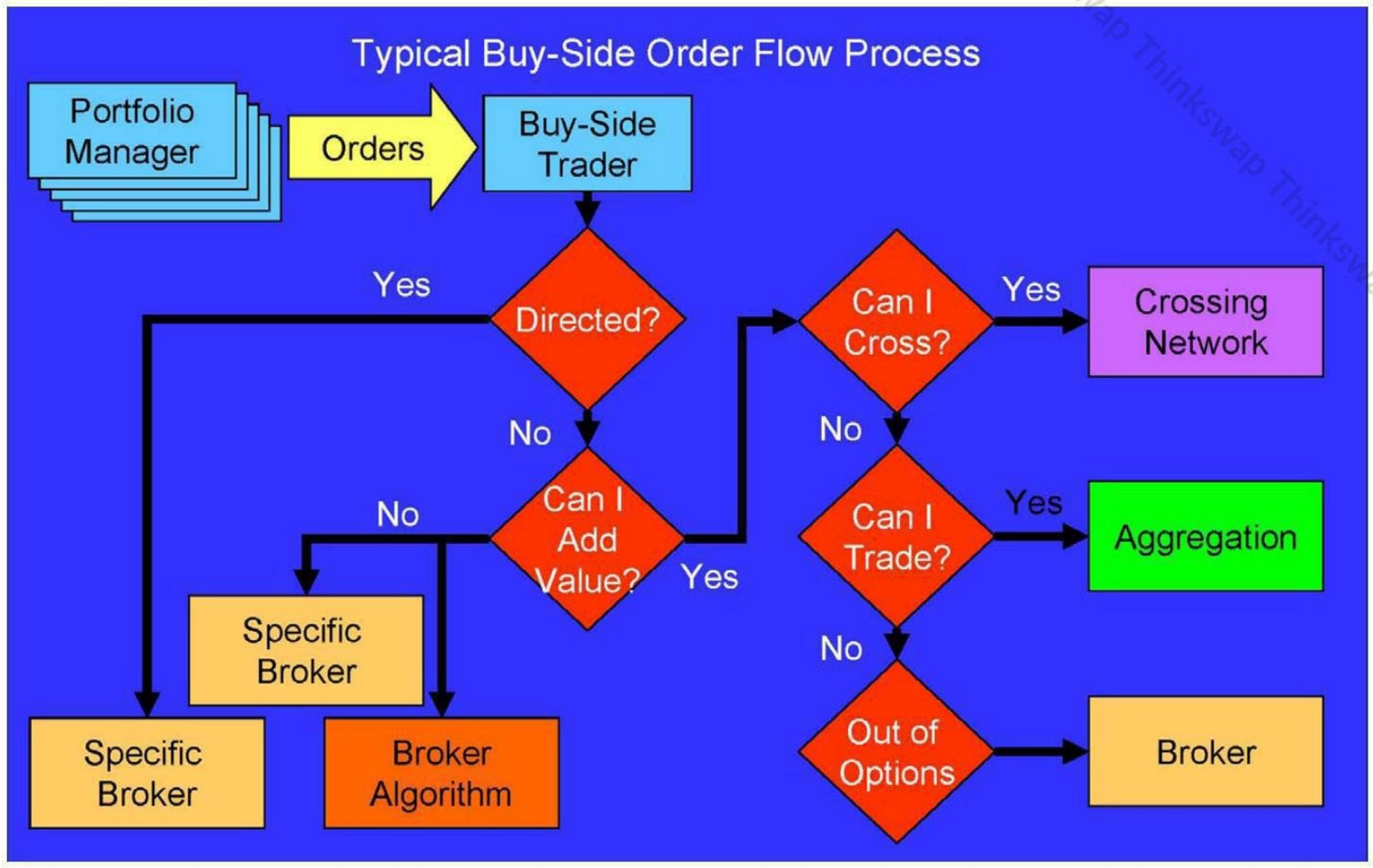
Week 11: Algorithm Trading (I)

Algorithm Trading

- Placing a buy/sell order of a defined quantity into a quantitative model that automatically generates the timing of orders/size of orders based on goals specified by the parameters and constraints of the algorithm
- All algorithm strategies have an objective

Buy-Side Order Flow



TYPES OF ALGORITHMS

1. Trading Algorithm (ie. Prop. Trader) → Not covered
2. Execution Algorithm (Broker – Buying or Selling) – 7-8 major ways, can mix & modify
    a. Market Impact (most common)
    b. Price Based (more common)
    c. Liquidity Based (most complicated, less common)
3. Implementation Shortfall – How well will the algorithm work?
    a. Measured both on brokers & algorithms – to measure their performance

Program Trading

- Equity securities that encompass a wide range of portfolio-trading strategy involving the purchase or sale of a basket of at least 15 stocks valued at $1 million or more
    - 11.6% of total trades in NYSE are program trades in 1995
    - 22% of all trades in 2000 and 50.6% of all trades in 2004
- Highly correlated with algorithm trading (most algorithm trading are executing program trades)

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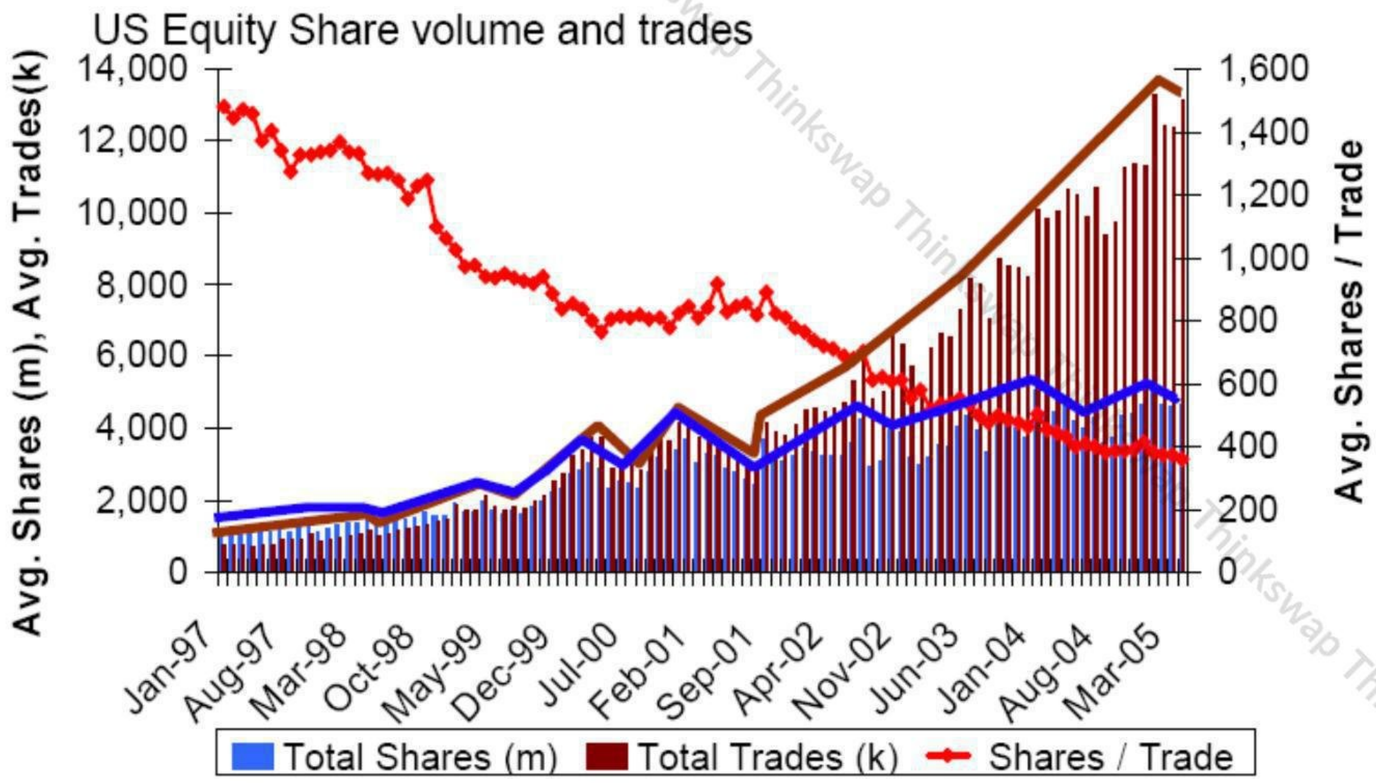
Market Impact



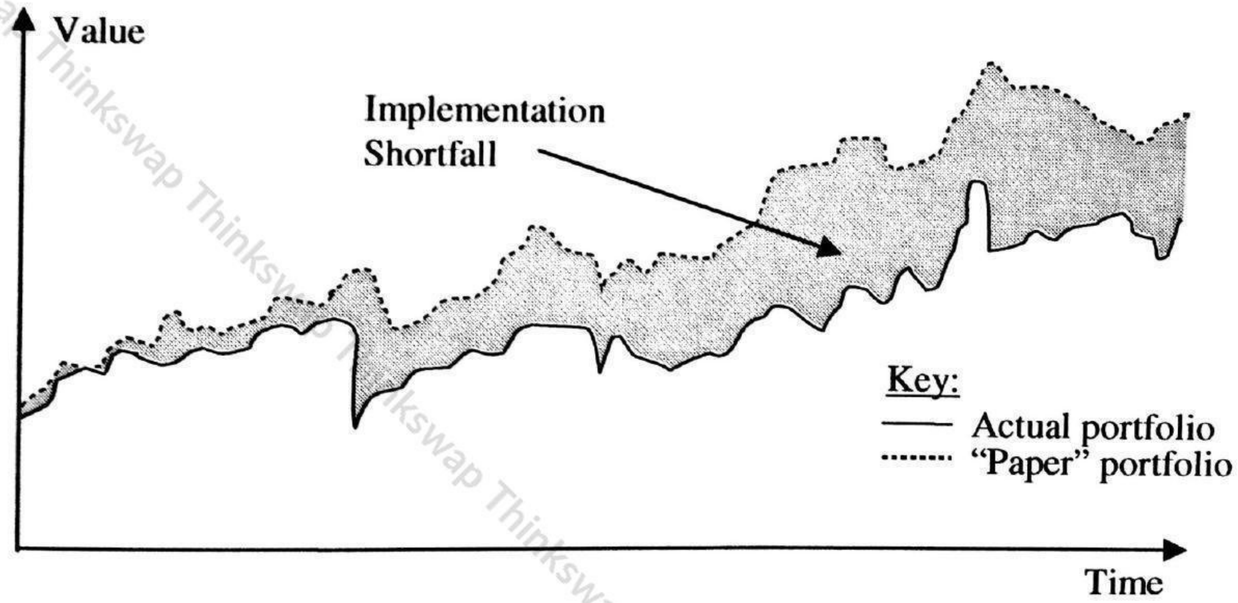
- No longer relying on humans to execute the trade
- Orders of smaller qty over time

Development of Algorithm Trading

- Trading has changed with the decriminalization of (2001) instead of $0.0625 price increments
  - Reduced trading margins by 84%
  - Lower margins → Traders are less willing to use their capital to provide market liquidity → Fragmentation of market liquidity
  - Increased focus on efficiency
- Securities Traded Now:
  - Mainly highly liquid large cap stocks
  - Future: Small cap stocks, commodities derivatives, forex
  - Remote future: Fixed income instruments (due to lower liquidity)
- FIX Protocol – Original Standard for ECN
  - Involved: Sell-side brokerage firms/mutual funds, pension funds, hedge funds & private investment firms
- Built into DMA Tools and OMS

Algorithm Strategies

- Transaction Cost – Cost paid by buyers, not received by sellers
- Paper Portfolio – Theoretical portfolio VS Actual portfolio – the difference is the transaction cost!
- In 2000, total transaction costs amount to $120 billion 1% of total trade costs



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Breaking down the Components

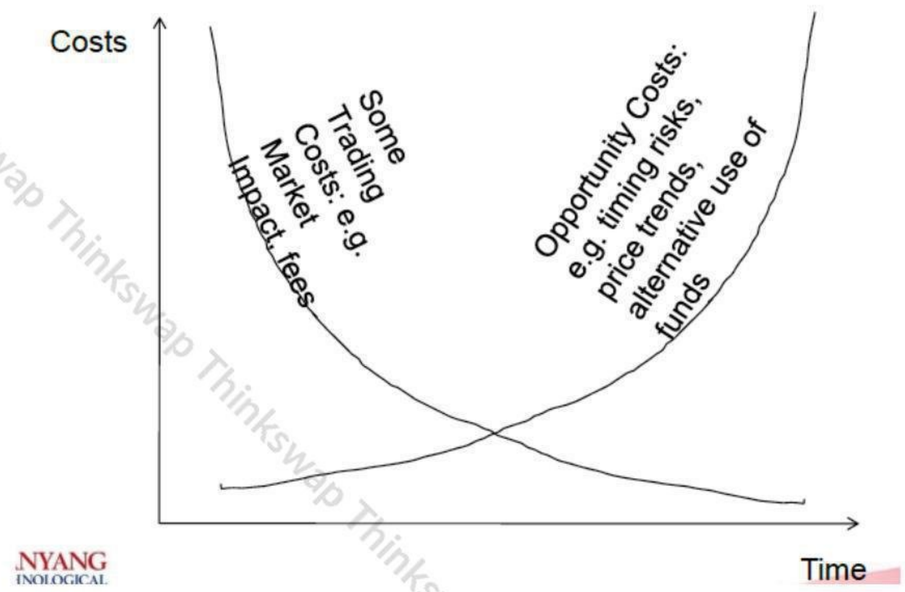
Cost type		Classification				Focus for:	
		Explicit	*Implicit*	*Fixed*	*Variable*	*Algorithms*	*Execution Tactics*
Investment	Taxes	✓			✓		
	Delay Cost	✓ [5]			✓		
Trading	Commission	✓		✓			
	Fees	✓		✓		○	○
	Spreads		✓ [6]		✓		●
	Market Impact		✓		✓	●	○
	Price Trend		✓		✓	●	
	Timing Risk		✓		✓	●	○
	Opportunity Cost		✓		✓	○	

● often ○ sometimes

- Transaction costs are estimated by quantifying each of these costs - granular
- Delay Cost ie. Buy-Side sitting on it, and communicated to the Sell-Side later
- **Largest components of transaction cost – most algorithms will try to balance the cost and focus on these**
    - Market Impact
        - Large market impact if you trade a lot within a time period
    - Price Trend
        - Price trending upwards/downwards – slope of the line
    - Timing Risk
        - Volatility within the market – the variation – the amplitude of the line
        - Measured with general volatility in prices
- Opportunity Cost – Exists only if you fail to execute!
    - Responsibility of sell-side
    - Only liquidity cost will suffer – only trades in low liquidity environment so chances of not executing is higher
- Spread
    - Cost for execution tactics, which are mini-algorithms

Trading Costs & Opportunity Costs

- Trade-off between trading costs and opportunity costs
- Implementation shortfall is the sum of both costs
- Fees will go down when you wait it out – **ATS as a liquidity provider, therefore there are no fees**
- **Finding an equilibrium point that both will achieve**



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Implementation Shortfall

- Difference in return between a theoretical portfolio and the implemented portfolio
  - Paper portfolio: Ideal situation – all securities at benchmark prices with no transaction costs/slippage/opportunity cost
  - Actual portfolio: Transacted in real market prices with inefficiencies factored into it

IS = Profit (or losses) from Ideal – Profit (or losses) from Actual = Benchmark Volume (Difference between benchmark and current price) – Actual Volume (Difference between actual and current price +/- Txn. costs)

- Difference between Benchmark and Current Price could be either CP-BMP or BMP-CP depending on if it is a buy/sell
- Difference between actual (AP) and current price (CP) is either CP-AP or AP-CP depending on whether it is a buy/sell
- Buy Order: Add txn cost to AP
- Sell Order: Subtract txn cost from AP
- No specific sign convention for IS
  - Just assume that positive shortfall is detrimental
    - Actual profit < ideal profit OR actual loss > ideal loss

BUY!!: V(BM) (P(current)-P(benchmark) -V(actual)(P(current) – P(actual))
SELL!!: V(BM) (P(benchmark – P(current) – V(actual)(P(actual) – P(current))

Steps for Computing Implementation Shortfall

1. Determine benchmark price(s) and benchmark volume – BM based on algorithm used
2. Determine executive price, transaction cost and executed volume
3. Compute the paper portfolio profits/losses based on benchmark prices
4. Compute actual portfolio profit/losses based on the actual price considering transaction cost
5. Difference between paper portfolio and actual portfolio is the implementation shortfall

Example

- You intend to place a buy order of 700 XYZ shares. Order was placed on Day 0 after the market close at $100.
- Your sell-side broker bought the shares over 3 days in this fashion. Day 1: 300 @ $101; Day 2: 200 @ $101.75; Day 3: 100 @ $102.50. Your broker charge a commission of $0.03 per share purchased.
- Compute the implementation shortfall

Day	Price of Close	Trade Price	Number of Shares
0	$100.00	$100.00	0
1	$102.00	$101.00	300
2	$102.50	$101.75	200
3	$102.75	$102.50	100

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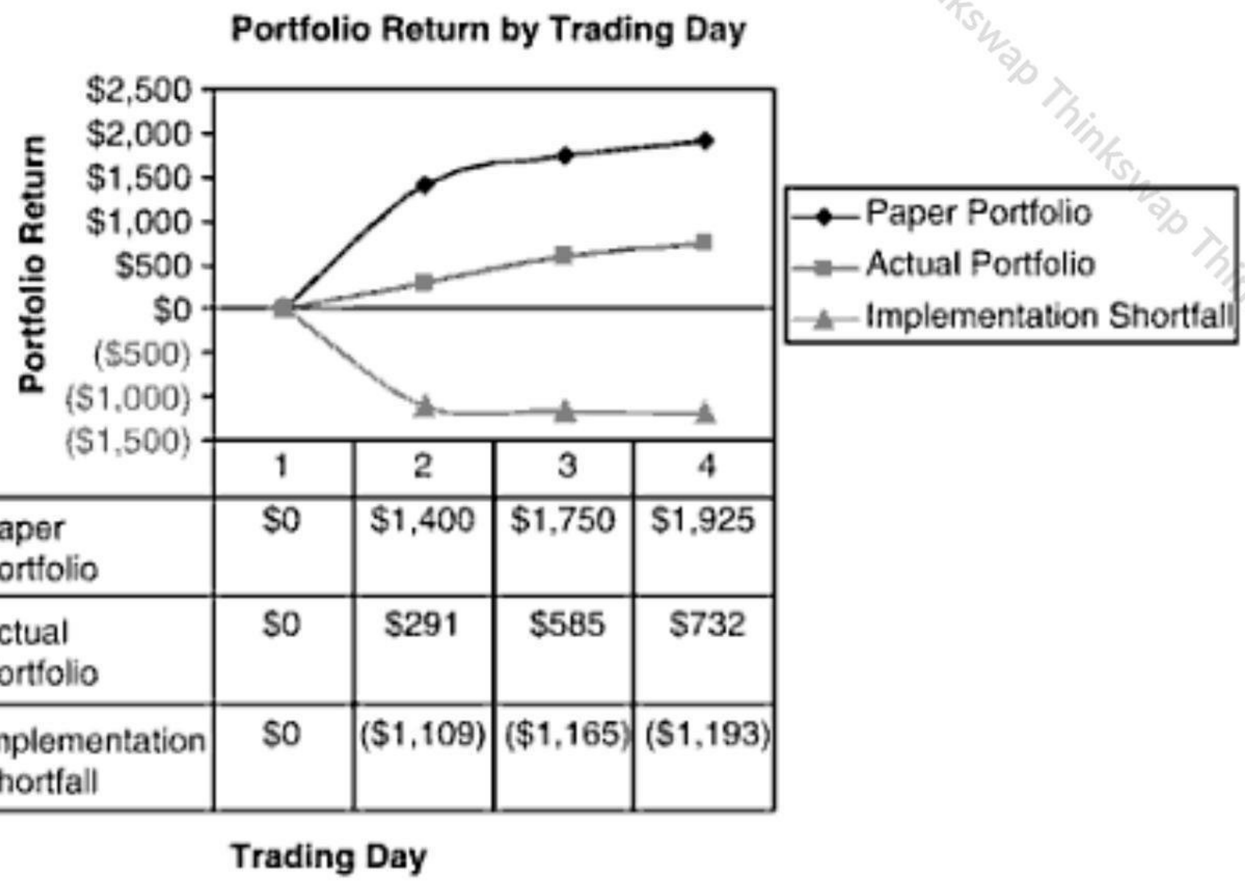
Day 1:
700 (102-100) – 300 (102-101.03)=1109
Day 2:
700(102.5-100)-[300(102.5-101.03)+200(102.5-101.78)] = 1165
Day 3:
700(102.75-100)- [300(102.75-101.03)+200(102.75-101.78)+100(102.75-102.53)]=1193



	1	2	3	4
Paper Portfolio	$0	$1,400	$1,750	$1,925
Actual Portfolio	$0	$291	$585	$732
Implementation Shortfall	$0	($1,109)	($1,165)	($1,193)

- Commission should be part of the actual price
- Buying – actual price goes up, and Selling – actual price goes down

Types of Algorithm Trading Strategies

Volume-Weighted Average Price (VWAP) – most common, commonly used with other algorithm

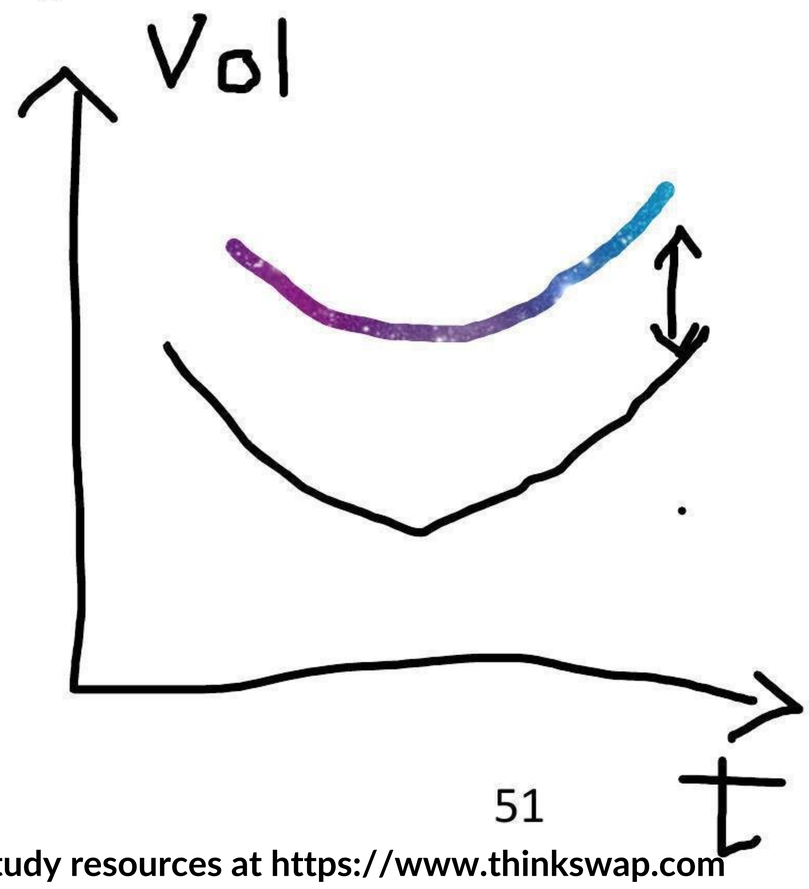
- With or without algorithm trading
- 2 meanings: Price, and Algorithm

10	100
10.10	200
10.20	300

  - TWAP is 10+10.1+10.2/3
  - VWAP is (100x10+200x10.1+300x10.20)/600
- Attempt to achieve execution price at or better than VWAP
  - Buy orders at or lower than VWAP; sell orders at or higher than VWAP
  - Objective: To **lower market impact** of the trades

$$VWAP = \frac{\sum_{i=1}^{n} V_i * P_i}{V_{cum}}$$

for i = 1 to n



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VWAP	=	volume weighted average price
V	=	traded volume
i	=	transaction number
P	=	traded price
V_{cum}	=	cumulative traded volume

Drawbacks

- Introduces uncertainty for time dimension into the trade as one cannot control the trading volume
- Large institutional trades may not be able to complete within a single day if trade quantity > usual volume – multiple days required
- Increase trading time as opportunity costs involved
- Not appropriate for traders motivated by short-term momentum
- Not suited for trades that are a significant fraction of daily volume
- Purple line cannot be estimated with confidence

How to Achieve VWAP (Not necessarily algorithm trading) – NOT IMPORTANT -

- Guaranteed principal VWAP bid: The sale/purchase price is guaranteed by the sell-side (sell-side assumes the risk to achieve it)
- Forward VWAP cross: buyers and sellers matched electronically and agree to execute at the end of the day at a price equal to full-day VWAP
- VWAP trading:
    - Buy-side using built-in algorithms in DMA tools
    - Sell-Side acts as agent to trade (w/o assuming risk)
        - May use algorithms
    - Algorithm trading usually used in this option

Steps in VWAP Algorithm

- **Step 1: Analysis of Incoming Orders**
    - Pre-trade Analysis filters out any orders that would be more appropriately traded with other means
    - Illiquid block trades/large relative to average daily volume are diverted for manual attention
- **Step 2: Intelligent Volume Distribution**
    - Predict daily volume for the order
    - A trading distribution created to match projected volume pattern, participating more heavily during the periods of the day when volume is expected to be heaviest
- **Step 3: Work orders intelligently**
    - Ability to obtain best execution on individual trades around the expected volume distribution is the last critical element
    - Actively pursues liquidity, tapping into all available sources and trading most heavily when markets are most liquid
    - Predicted daily volume
        - If one can get best price for volume traded proportional to predicted volume, one achieves VWAP

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Compute the Implementation Shortfall for the Following VWAP Algorithm

Time	Cumulated Volume for day	VWAP (for the hour)	Qty. Sold	Price Sold
1	10,000	$ 7.00	1,000	$ 6.90
2	20,000	$ 7.10	1,000	$ 7.00
3	30,000	$ 7.20	1,000	$ 7.20
4	40,000	$ 7.20	1,000	$ 7.10
5	50,000	$ 7.40	1,000	$ 7.30

benchmark is 10% of amount traded in 1st time period
NOT actual amount traded, but how much you should have traded

Implementation Shortfall: Sell:
T1: 1000(7-Pc)-1000(6.90-Pc) = $100 – cancels off as there is no opp cost
T2: [1000(7-Pc)+1000(7.1-Pc)]-[1000(7-Pc)-1000(6.9-Pc)] = $200
T3: $300
T4: $400
T5: $500

Case 2: If qty changes

900	N
1100	Y
1200	N
800	Y
1000	Y

***algorithm changes the V(bm)**

Time-weighted average price (TWAP)/Timing Slicing

- Allows trades to be "time sliced" over a certain period of time
- Same amount of trades regardless of market volume at any point in time → trade qty spread equally throughout time
- One of the easiest to implement
- Simple objective function
- Used when there is urgency/for illiquid stocks where volume analysis is less useful
- Use when: Time urgency; small volumes of trades
- Less as an algorithm, more as an execution tactic

Advantages and Disadvantages of TWAP

Advantages	Disadvantages

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• Not dependent on market volume → Reduce uncertainty in terms of execution time • Ending time is very clear • Potentially faster in execution • Limit price may be put as price protection	• Experience higher execution costs from greater impact on prices ie. Block trades • May not be good for hiding block trades

Question & Potential Modification

- Assuming you are to sell up to 1 million XYZ shares over the next 10 days. You have decided to use TWAP as the key strategy. XYZ is rather illiquid which makes VWAP less effective.
- Historically, the daily volume of XYZ shares ranges from 100,000 to 500,000. You will not be able to predict the volume prior to trading
- How will you modify the TWAP strategy to ensure that you are able to achieve the sale of 1 million with the less price impact?
    - Inner Cap (Percentage of Vol.)

- Modification: 1,000,000 XYZ, TWAP from Day 1 to 10, Max % of daily volume – 50%.
    - Slices the trades into multiple lots
    - Subject to cap of 50% of the total volume for the day – mitigate price impact for illiquid stocks
    - Common to see limits on participation volume together with TWAP, sometimes VWAP too.

Volume Participation/Percentage of Vol (POV)/Volume inline/%ADV

- % ADV (average daily volume) or Participation
- Places either upper limit or strict target for trade size to achieve a particular target volume
- Goes along with volume dynamically
- End time of algorithm need not be fixed; can complete as soon as market volume allows/fixed end time
- To achieve the % of volume, algorithm relies on both historical data and current volume to dynamically adjust the order sizes throughout trading horizon
- TYPE 1: Target POV
    - Start at 9am → Software only trades at 9.15am
    - Trades at 20% of volume at 9.15am
    - Continues to do so for subsequent time periods
    - Assumes autocorrelation between trade volumes across time periods
    - Is done AS YOU MOVE ALONG → Done when you cannot estimate VWAP properly (in cases of high volatility)
    - VS VWAP – computes every 15 minutes, compared to VWAP which plots the curve and estimates at each time period. – VWAP estimates the entire market beforehand. Based on amount you wish to trade, calculate how much you wish to trade at each time period
    - If this is executed properly, target POV should be very similar to VWAP

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- Seeking
  - When there is pressure to execute
  - IOC – Partial execution
- Sniper – FOK
  - When looking for opportunities to trade
  - Executed only if it can be executed in its entirety
- Algorithms have to decide where to trade in CNs, better than going in blindly and incurring a lot of signalling cost
  - Creates some sort of feedback
- Many CNs today do not let you use high frequency trading algorithms

Evolution of Execution Algorithms

- Impact Driven (MI) – ie VWAP, TWAP, % of Volume
- Cost Driven – Consider the price, on top of the volume
- Opportunistic – ie. Looking for liquidity when market is volatile

Earliest Form of Algorithms (Impact Driven)

- TWAP, VWAP, % of Volume
- Modified VWAP and POV can be regarded as **cost driven** or even **opportunistic**
  - Adaptive Shortfall
  - Price Incline
  - Liquidity Driven

TWAP – Problems

- Poor execution quality due to rigid adherence to the time schedule, especially when prices become unfavourable
  - For exchanges that show who the broker is – People know you are using TWAP – HIGH SIGNALING RISK!
- Predictable, high signalling risk – only thing other market players don't know is the size of the order

Actual Market Order for a particular day

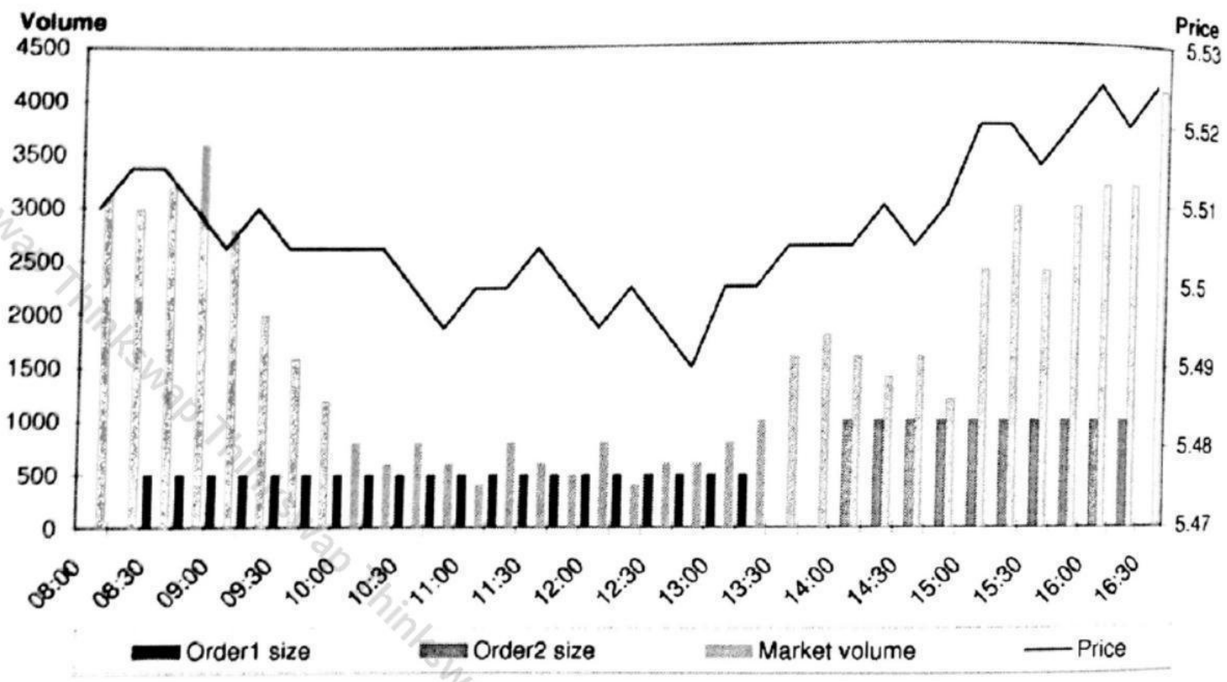

Figure 5-1 Two example TWAP orders

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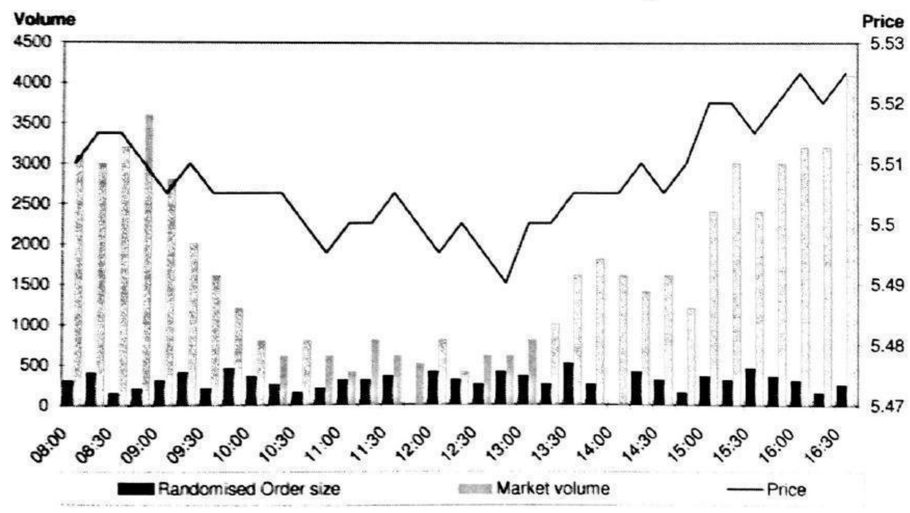
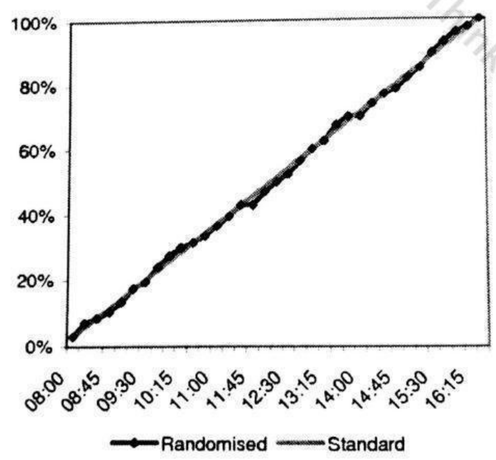
Modification 1 – Creating a "masking effect"

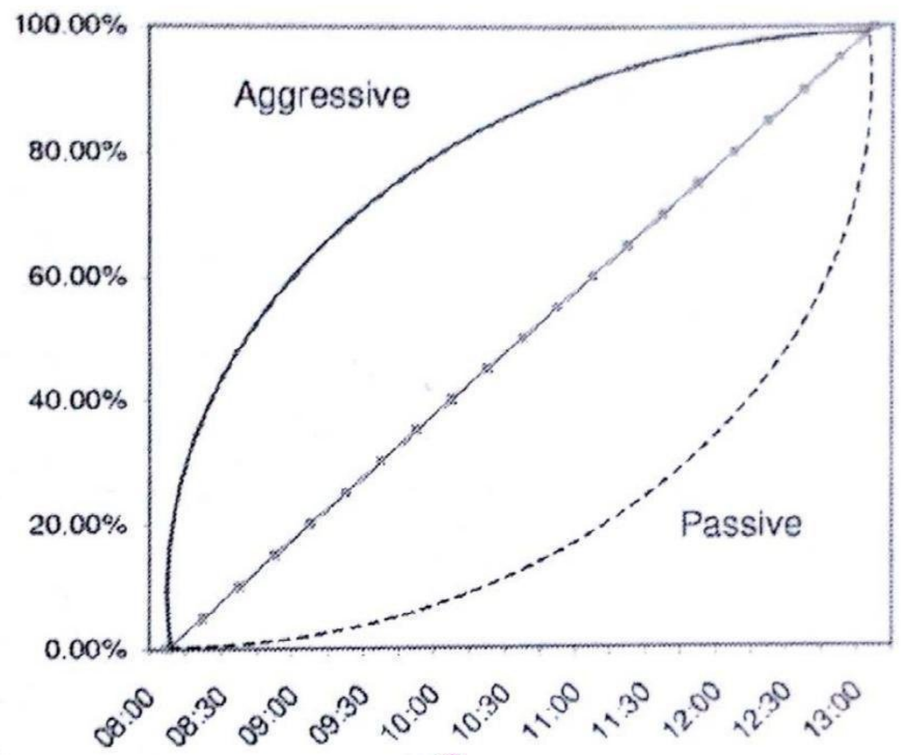
- Add a random parameter to TWAP
  - TWAP + R, where R~N(0, σ2)
  - Criteria 1: Works when you have many slices (Central Limit Theorem) – when you have many time periods
  - Criteria 2: Standard Deviation cannot be too large! Smaller, safer as it has a smaller band
  - R has to have a mean of 0, else completion time is impacted
  - Main purpose is to reduce signalling risk
  - Number of time periods must be relatively large
    - Smaller no. of time periods result in greater uncertainty of completion

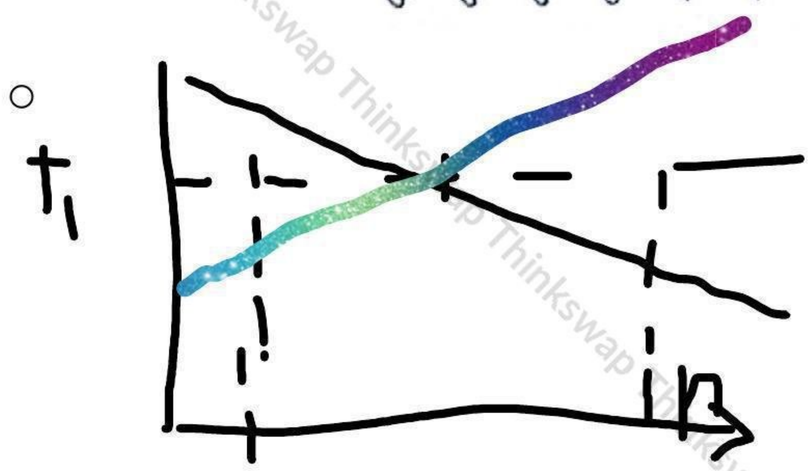




Modification 2

- Modify the quantum of trade for each time period
- Aggressive tilt – Morning Tilt
  - +3.1%, +3.0%, +2.9%, … -2.9%, -3.0%, -3.1%
  - Reduce timing risks, but potentially raise market impact
- Passive Tilt:
  - -3.1%, -3.0%, -2.9%, … +2.9%, +3.0%, +3.1%
  - Increase timing risk, potentially lower market impact



- 

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- Tilt is determined by how confident you are
  - Can add a randomised parameter

VWAP

- Orders correspond to overall turnover for the day

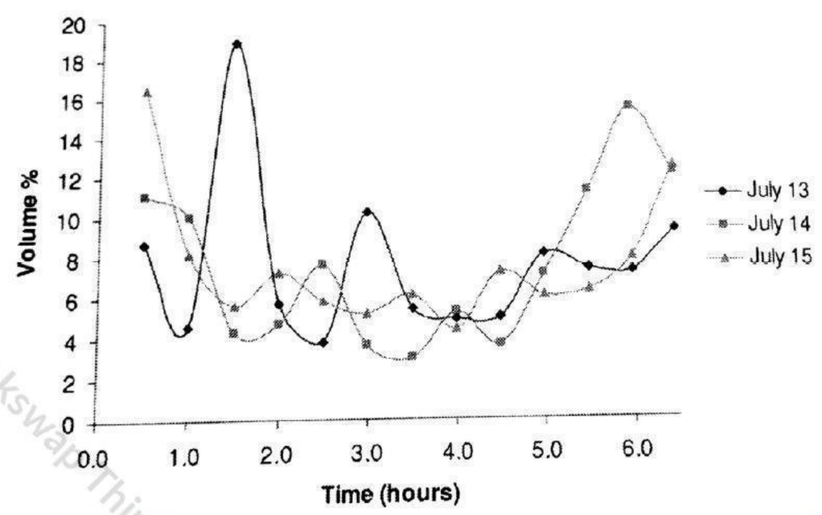
$$VWAP = \sum_j u_j \overline{p}_j$$

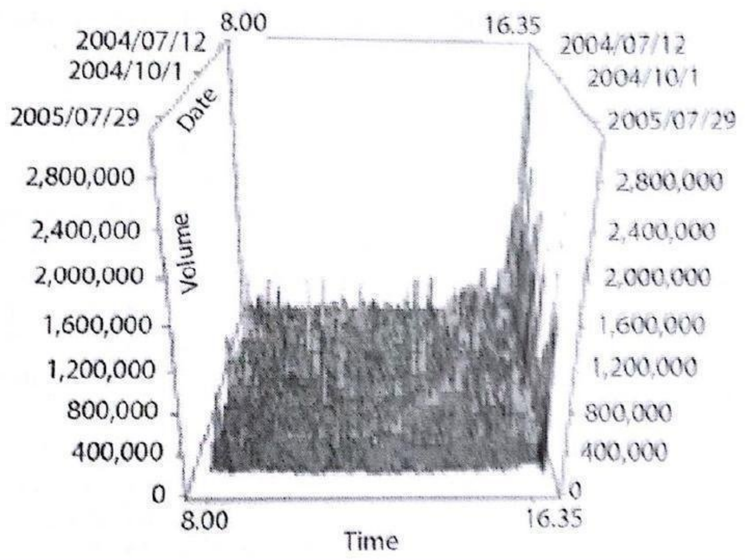
- Where uj represents the % of daily volume for time period j
- $\overline{p}_j$ represents the average price for that period
- Use historical volume profile to estimate the volume for each time period
- Apply the estimates of volume to the equation:

$$x_j = \widehat{u}_j X$$

- Where $\widehat{u}_j$ is the predicted volume percentage for time period j
- X is the total intended volume, xj is the intended volume for period j.

Estimating daily volume movement





- Superimpose all distribution over a fixed time period – get a certain sense of what the shape is!
- Aggregated data might be needed for fragmented markets
- For each time period, compute the value which will minimise the sum of squares

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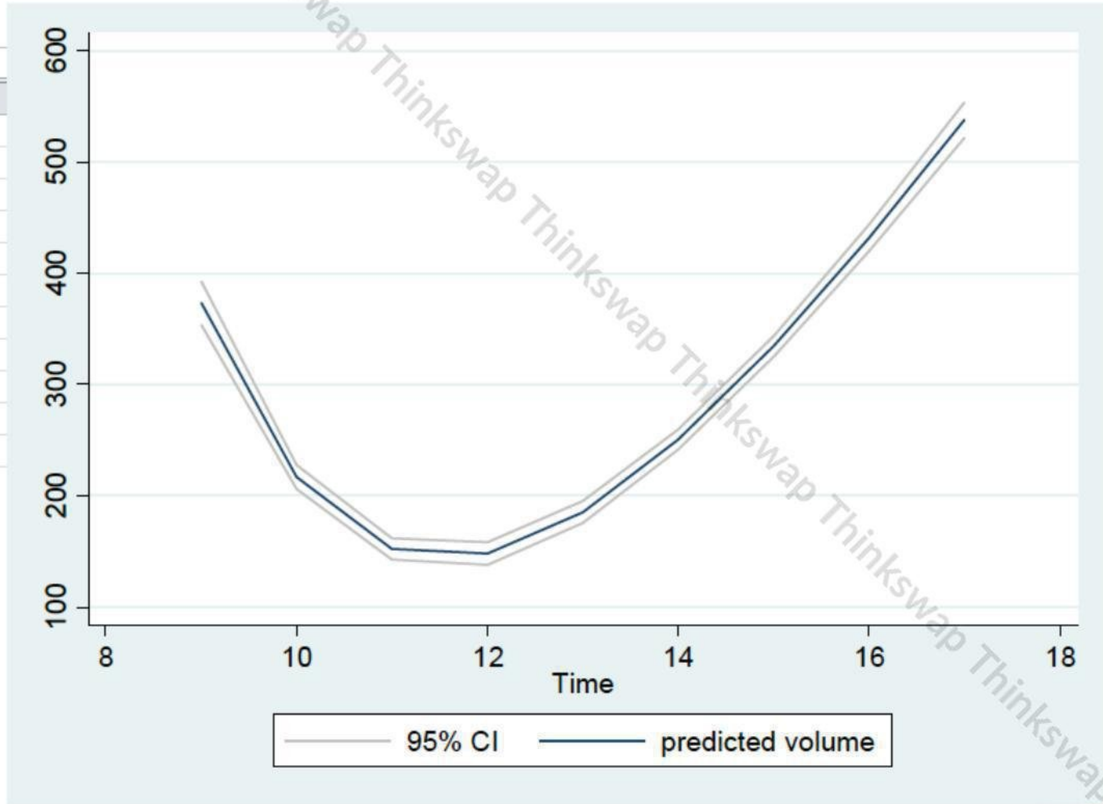
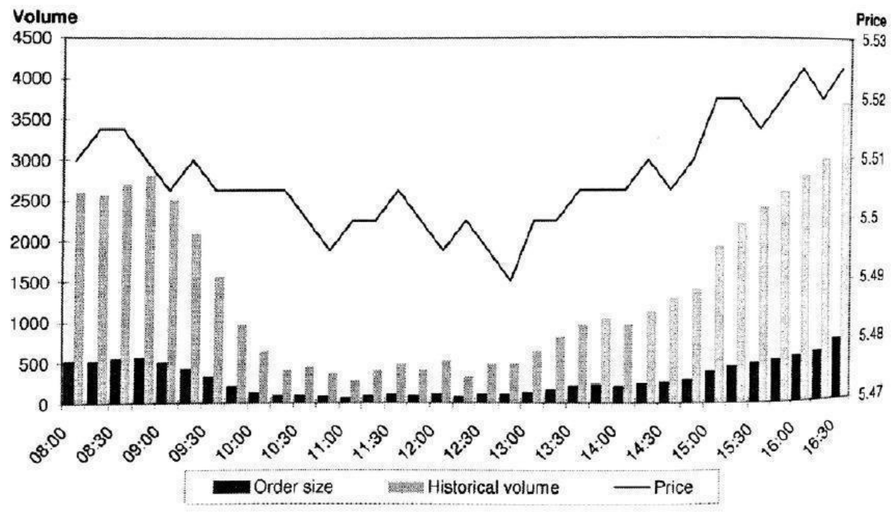
Estimating Trade Volume

	A	B	C
1	Date	Time	Volume
2	1/2/2015	9	290
3	2/2/2015	9	300
4	3/2/2015	9	344
5	4/2/2015	9	394
6	5/2/2015	9	363
7	6/2/2015	9	500
8	7/2/2015	9	362
9	8/2/2015	9	362
10	9/2/2015	9	308
11	10/2/2015	9	301
12	11/2/2015	9	382

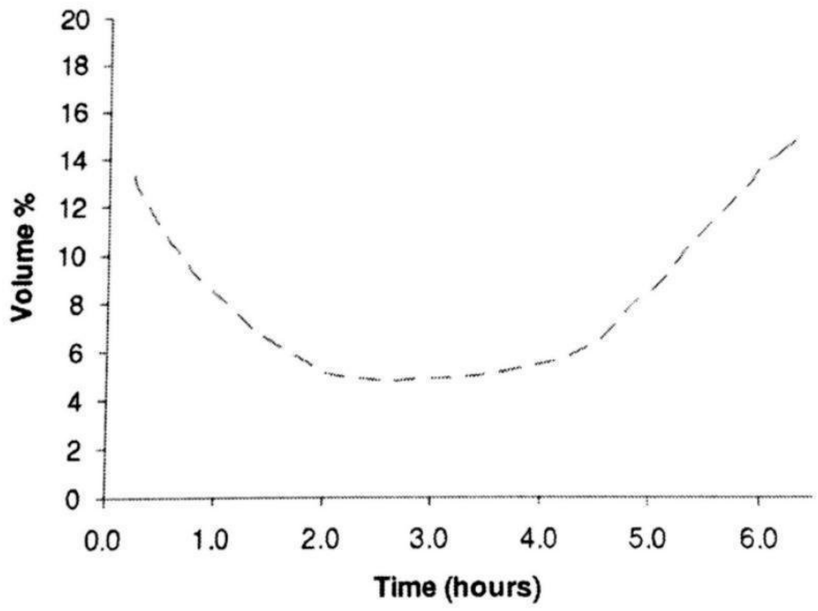


- Record the volume at every time period
- Plot the curve with a confidence interval
- If width is too large, use POV instead

Darkened line is predicted volume, lighter band is 95% confidence interval



- Smoother curve compared to a POV, and does not fall off the cliff



Use the estimates as $\widehat{u_j}$ for the relevant time period

Modification of VWAP – Tracking

- Tracking whether one is getting ahead/falling behind the schedule, with relevant remedial actions
- At the end of the time period, tracking option will:
  - Add up cumulated trades executed
  - Cumulated trades executed > cumulated ideal quantum (ahead)

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- Cumulated trades < Cumulated ideal quantum (behind)

Remedial Actions

- Ahead:
  - Surplus quantity have to be proportioned to remaining time periods (Weighted by historic volume) in the form of reduced trade quantity
    - Avoid spikes in VWAP, which causes it to not meet the VWAP criteria,
  - If original trade is buying with VWAP, this is equivalent to a sell with VWAP for the excess quantities
    - Net "buy" qty w/ "sell" qty
- Behind
  - Deficit proportioned to remaining time periods in the form of increased trade qty
  - Equivalent to putting in another VWAP order of the same direction for the remaining time period

VWAP – **Estimating** Price

$$E(VWAP) = p_0 + \Delta p \frac{(n+1)}{2}$$

$$\sigma^2(VWAP) = \frac{(n+1)}{2}\sigma_p{}^2$$

p_0 = arrival price
Δp = change in price per trade period
n = total number of trade periods
$\sigma_p{}^2$ = variance of price per trade period

Arrival price → price that algorithm first kicks in
n is number of time periods you "Slice" in your VWOP
variance -> last 30/60 days; the variance of prices

Eg. Assume a broker intend to perform a trade using VWAP algorithm at the start of the trading day when the opening price is $25.00. The number of trading periods in the VWAP algorithm is 1000 for the trade horizon and the price is assume to increase by $1.00 for the entire duration of the trade. The variance of the price is $0.009 per trading period. Compute the probability of which the VWAP price is less than $27.
Ans: P(VWAP)<$27 = 0.76

$$E(VWAP) = p_0 + \Delta p \frac{(n+1)}{2} = \$25 + \$0.001 \frac{(1000+1)}{2} = \$25.5005$$

$$\sigma^2(VWAP) = \frac{(n+1)}{2}\sigma_p^2 = \frac{(1000+1)}{2} \cdot \$0.009 = \$4.5045$$

$$\sigma(VWAP) = \sqrt{\$4.5045} = \$2.1224$$

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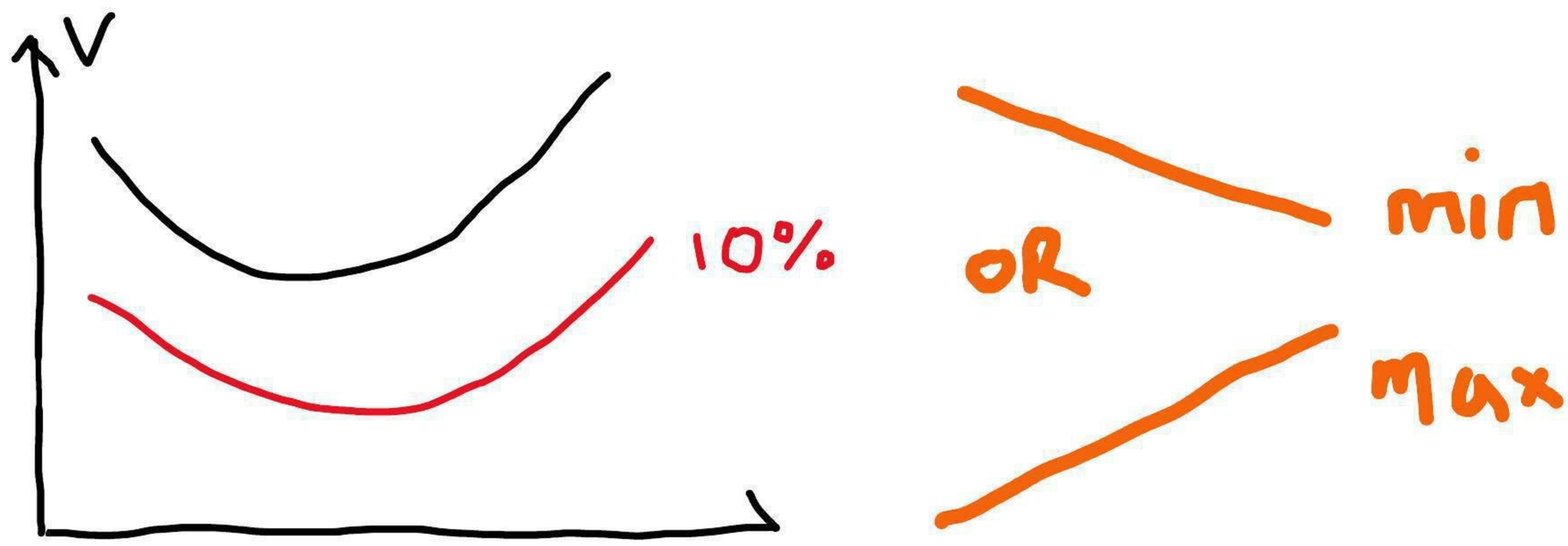
$$z = \frac{X - \bar{x}}{\sigma_x} = \frac{27 - 25.5005}{2.1224} = \frac{1.4995}{2.1224} = 0.7065$$

$$P(VWAP < 27) = P(z_i < 0.7065) = F(0.7065) = 76\%$$

t-test

VWAP Modification – TILT

- Some brokers believe they can accurately predict price movement over the day
- If price trend is significant, might motivate to modify VWAP with a tilt
- Two types:
  - Morning tilt – trade more early
    - Buying in +ve price trend
    - Selling in -ve price trend
  - Afternoon tilt – trade more in later time periods and less earlier
    - Selling in +ve price trend
    - Buying in -ve price trend
- Morning Tilt
  - Adding a line to a curve



$$w_j = \frac{u_j a_j}{\sum u_j a_j}$$

u_j = % of daily volume for time period j, (i.e. original VWAP %)
a_j = adjustment factor
w_j = percentage of trades to be executed at time period j

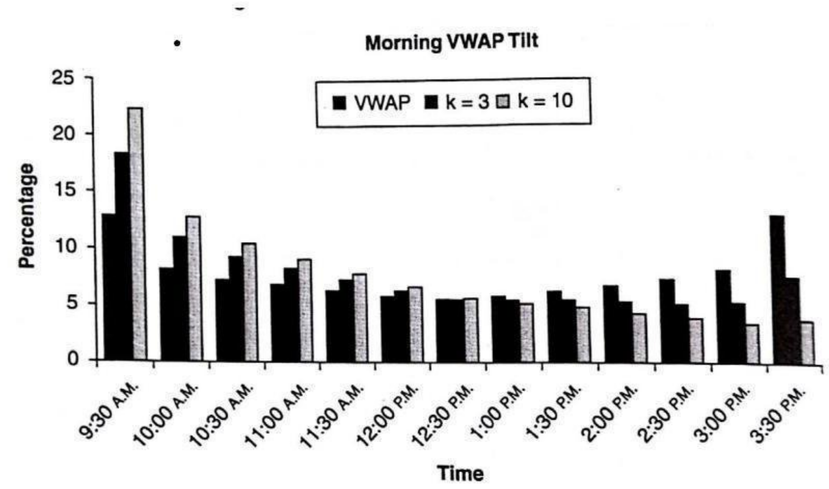
Morning Tilt

$$a_j = \frac{(p_0 + nk) - k \cdot j}{n^2 + n(2p_0 - 1)}$$

Afternoon Tilt

$$a_j = \frac{p_0 + k \cdot (j - 1)}{n^2 + n(2p_0 - 1)}$$

p_0 = Arrival price
n = number of time periods in VWAP strategy
k = intensity parameter – how confident you are in the price trend & how strong you think the trend will be



If k is large, VWAP looks more like closing
Small k, arrival price

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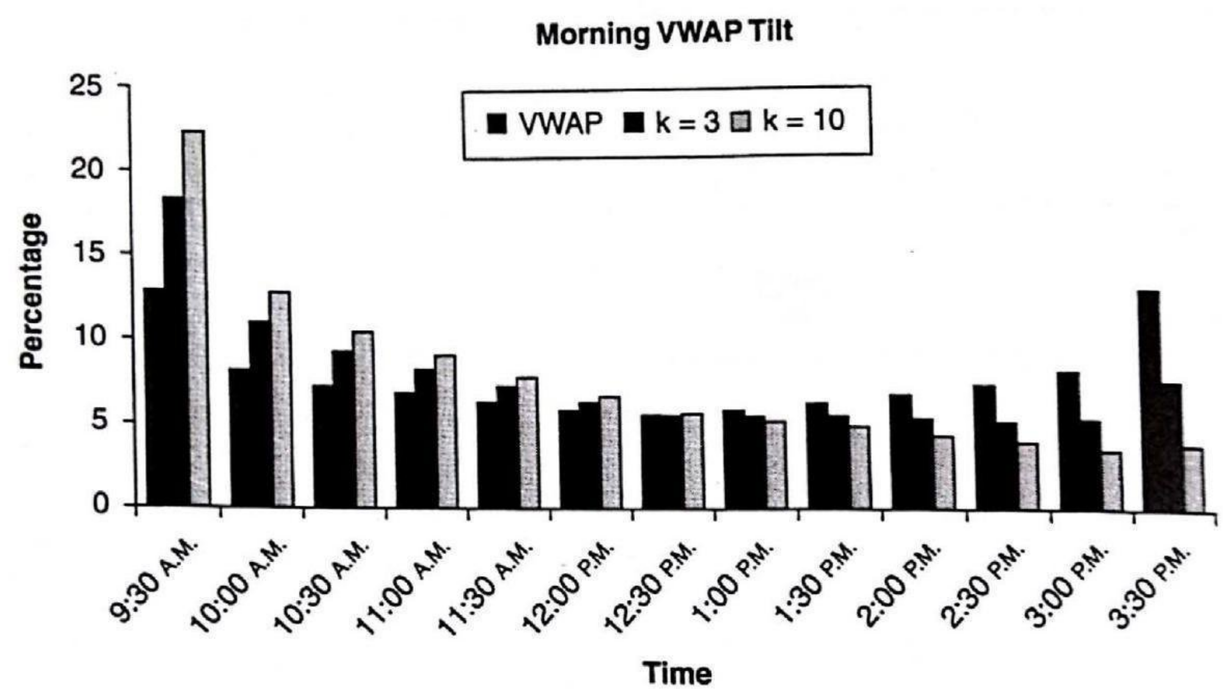
Percentage of Volume

- Determine ex-ante the % of volume one intends to target
- Time slice trade horizon to smaller time periods
- After each time period has elapse, obtain total trade volume
- Compute amount to trade for the next time:

$$- \; Quantum\ to\ trade_{t+1} = \frac{1}{1-P} * Volume\ in\ time\ t$$

- Adjustment factor (1/1-P) is significant if P is large given that one's trade will change the market volume → Encourage participation
- Only for large POVs!!



(1) The spikes shows that it is POV, smoother means its VWOP
(2) The trading stop shows that it is POV

Drawbacks

- Backward-looking: Can be mitigated if time period is made smaller
- End time unpredictable
- Multiple POVs, prices will go up, but still a better option cos no purple curve
- If several POV algos in the market competing for illiquid asset, might drive up the price
  - Common to place price limits
- Poor performance if markets experience large block trades (volume spikes), as it might be too late to execute after trades are booked

Modifications – Price Adaptation

- POV is mainly volume-driven and does not have intrinsic price dependency
- One way to introduce price dependency is to adjust participation rate based on how current market price compares to benchmark price
- When market prices vary from a particular benchmark by a level, volume of participation varies
- Analogous to combining a POV with adaptive shortfall algorithm

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Modifications – Excluding Trades

- Volume Filters:
  - Ignore specific orders that are wayyy too large
  - Excluding block trades in order books
  - Impose max. volume limits
- Price Filters:
  - Ignore trades that are out of **particular price range**
  - When price limit is set for POV algorithm to prevent error in volume signals

VWAP VS POV (Move this to the top)

- VWAP is schedule driven (forward looking), POV is dynamically driven (backward looking)
- VWAP normally has a set end time, POV can end earlier or have a set end time
- VWAP (that lasts entire trading day) generally ends on high trade volume, POV generally ends with low trading volume

Adaptive Shortfall

- Newer form of execution market impact algorithms is more dynamic
- Commonly used as an addition/modification on a VWAP/POV strategy
- Introduces price components into most market impact algorithms which are volume driven
- Adapts trading schedule based on changes to market price

AIM (Short-Term View)

- Trade more aggressively with favorable prices
- Favorable → Price below a benchmark for buys/above for sells
- AIM strategy achieves better prices than PIM, but at a higher risk

PIM (Long-Term View)

- Trade more passively (less trade) with favourable prices
- Unfavourable prices → More trade
- Relies on trend persisting
- PIM strategy quicker to cut losses short, so has lower risk, but may achieve poorer prices

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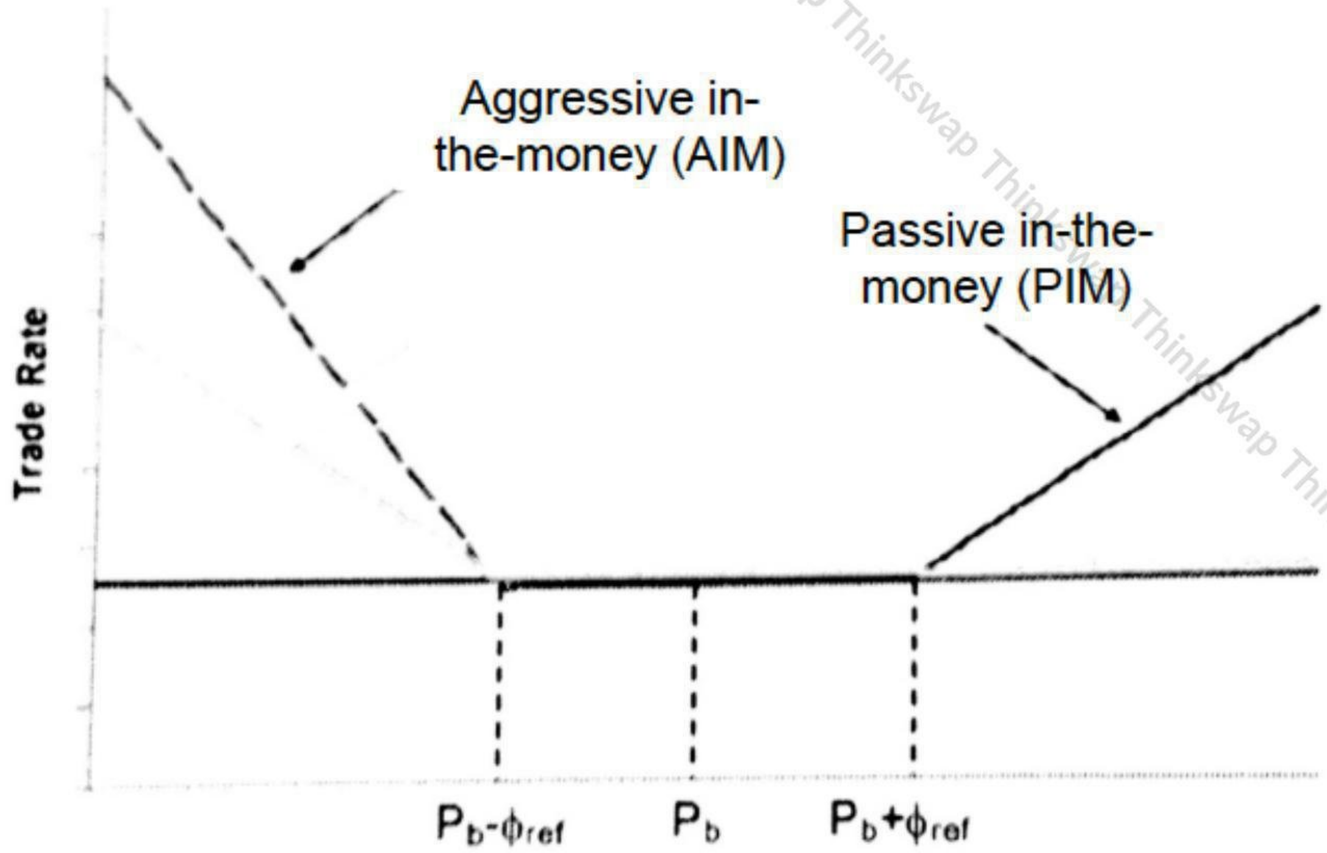

- Slope represents tilt factor (% Of increased trades for the condition)
- Slope of strategy can vary
- Sell order, AIM becomes PIM and vice versa

Price Inline

- Adapts trading to the market price in a similar way the POV algorithm works on volume
- Dynamic trading pattern, but backward looking (similar to POV)
- Benchmark price is defined and trading quantum is adjusted every trading period, j, based on difference between mid-price at the start of the trading period, and the benchmark
- Favourable price for buy => Mid-Price lower than benchmark, unfavourable otherwise
- Favourable price for sell => Mid-Price higher than benchmark, unfavourable otherwise
- Generally use "AIM" method similar to adaptive shortfall – transact more when prices are favourable
- Straightforward adjustment to the participation rate based on changes to market price
- Similar to POV, time horizon for completion is unknown (based on price movement)

$$\text{Participation rate} = u_j + k \cdot sign(X) \cdot \left(\frac{p_0 - p_j}{p_0}\right)$$

u_j = baseline proportion of trade for time period j (e.g. 0.3 of X)
k = adjustment factor, higher values more sensitive towards price changes
X = total intended volume of trade (+ for buys, - for sells)
p_0 = benchmark price (e.g. arrival price)
p_j = price at **start** of trading period j.

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Modifications and Calibration of Price Inline:

- Calibration of algorithm requires testing of different k values
- Equation is true for AIM strategy (dominant one for price inline)
- For PIM strategy (rare), replace +k with -k
- Can have asymmetric model, larger k values for favourable and smaller k for unfavourable

Liquidity Driven (Liquidity Seeking)

- High volatile situation → VWAPs and TWAPs won't work so well
- TWO PURPOSES: Execution and Verification
- Trading decisions based on available order book depth rather than best bid/ask
- Originally created to use more illiquid assets in fragmented markets
- More market depth => less spread costs for illiquid assets
- Challenges faced by algorithm
    - Fragmented markets (multiple venues)
    - Hidden/iceberg orders

Aggregation of Order Books

- Obtain order book details from different execution venues
- Rank by price, then probability
- Probability obtained from historical execution success rates, latency, past history of cancellations
- To establish choice of execution venues
- Create a predictive score, and see which one has highest probability of having hidden orders

Predicting Hidden Liquidity

- Seeking or sniping micro orders to ping the market
- Historical data to build an empirical estimation model
- Or a combination of both

Estimating Hidden Liquidity

- For example, "moments" after we observe (a), a trade of 2000 is executed
- The surplus of 500 of the executed trade and the excess of 1000 left in the order book has to come from either a new order, hidden order or iceberg order
- The smaller the time frame ("moment"), the increased in likelihood of this the order is from a hidden or iceberg source
- Obtain best quotes and quantity for the execution venue for a particular ticker for over a period of time (e.g. 10 days). The best quotes values are obtained at regular small intervals e.g. one snapshot every 250 milliseconds.
- Capture the immediate time period after the quote values are captured. Observed if there is a trade with trade quantum greater than the bid or ask quantities. Flag those instances as 1 i.e. presence of hidden liquidity.
- Do the same for different tickers and aggregate the data
- Develop an empirical model with the following logic:

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- H = f(qty. of bid & ask, ticker, exchange, …..) where you can include other factors which might influence the probability of having "hidden order" e.g. market depth, time of day etc.
- A discrete choice model may be used here
- Parameter estimates of this model are to be retained and the model is used as a predictive tool for estimating the probability of hidden liquidity in future scenarios
- Parameters found to be strong predictors
    - Market depth
    - Ticker
    - Execution venue
    - Pass success rate

Liquidity Driven Algorithm

- Market depth includes both observed and imputed market depth from estimated hidden orders
- Orders fed into the market correlated a function of the market depth

Modification of Algorithms

- Changes to input parameters derived from other estimation models
- Eg. VWAP tilt, whereby tilt parameter, k, dependent on price trend forecast from market depth

Combination of Algorithms

- Most common between price=dependent and volume-dependent algorithms
- Eg. VWAP with price inline

Execution Tactics

- Order placement/management
- Mini Algorithm – Within the 15 minute time block ONLY, does not exist for the entire duration of trade – tend to rely a lot on TWAP
- After overall algorithm for execution is determined, orders sliced and ready to be placed in the market at small time intervals
- Mainly to reduce spread costs, reduce signaling and be opportunistic

Types: Slicing, Hiding, Layering, Seeking/Sniping

- Slicing: Slice 3000 into smaller parts *this is essentially TWAP*
- Introduce a randomize component into the slicing to reduce signaling risk
- Eventual outcome = synthetic iceberg order
- Some time lag compared to a native iceberg order as iceberg orders are still in order book

• E.g. you use a VWAP strategy to trade 100,000 units of ABC over numerous 10-minute period. For a particular 10-minute period, you need to execute 3000 units.
• Using slicing, you slice 3000 into smaller parts
• Introduce a randomize component into the slicing to reduce signaling risks (as in TWAP with randomization)

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• Eventual outcome = a synthetic iceberg order
• But some time lag compare to a native iceberg order as iceberg orders are still in order book (but without time priority), so can still cross
• It is not a synthetic hidden order as time priority is not granted

- Time priority not granted

Hiding

- Choice between discretionary, iceberg and fully hidden
- Discretionary: Only for small orders as order size is fully revealed (hide by price)
  - Limit price shown slightly less favorable to market e.g. actual
  - price limit for "sell" is 101, but noted as 102 in the order book. I market order of 5000 units will 8000 will result in 4000 sold at 102. If limit order of 101 of 8000 units will result in 4000 sold at 101.
- Iceberg: Show only a % of the trades to participants (hide by volume)
  - Low percentage: Longer to complete as only visible component has price and time priority
  - High percentage: Shorter time to complete, but risk signaling
- Hidden: Lowest signaling risk; order in the books but hidden from others, subj. to execution venue permission & requirements (hide by volume)

Sells		
Price	Size	Id
101	1,000	S1
101	3,000	S2
102	**4,000**	**S3**
102	2,000	S4

(a)Discretionary

Sells		
Price	Size	Id
101	2,000	S1
101	3,000	S2
101	**1,000**	**S3**
101	*7,000*	*H1*
102	4,000	S4

(b) Iceberg

Sells		
Price	Size	Id
101	1,000	S1
101	2,000	S2
101	*4,000*	*H1*
102	1,000	S4

(c) Fully hidden

Layering

- Place orders at different tick levels
  - To maintain time priority
- Important for liquid stocks with densely populated order books
- Time priority essential to get orders done, else have to incur more aggressive prices to gain priority
- If layers, price changes
  - Will take the bottom most one and distribute to where the action is

Seeking & Sniping

- Micro Orders to detect hidden liquidity
- Can be used as orders to ping for liquidity after which will be used to impute liquidity for "higher order" liquidity seeking algorithms
- Can also seek hidden liquidity and fill order
  - Dual Objective to see liquidity and hide intentions

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Algorithm Trading (III)

Challenges Algorithm Trading Faces

- Buy-Side Complaints
- VWAP algorithms have become commoditized
- High-Grade Volatility
    - Statistical assumptions in algorithms
    - Shocks in the market cannot be modelled

Potential Criticisms of Algorithm Trading

- Crashes may occur
- But can be corrected very quickly

Algo and Equity Services

1. Algorithms will thrive in exchange-based instruments (highly traded with good flow of info, and good secondary markets)
2. Good for instruments that are volatile in prices

Algorithm and Fixed Income

Algorithms aim to MINIMISE IMPLEMENTATION SHORTFALL

(last few slides not impt)

3 questions, similar to the tutorial qns
Trade cycle, financial networks, algo trading
1 on trade cycle for sure
Current affairs, but apply something in the course to it

BUY!!: V(BM) (P(current)-P(benchmark) -V(actual)(P(current) – P(actual))
SELL!!: V(BM) (P(benchmark – P(current) – V(actual)(P(actual) – P(current)

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