
Background on Financial Markets

Electronic finance (e-finance) is mainly concerned with the automation of traditional activities in the finance domain and their associated processes. In particular, trading has become more and more a global activity because of the recent technological developments that have facilitated the instantaneous exchange of information, securities and funds worldwide. Trading decisions have also become more complex as they involve the cooperation of different participants interacting across wide geographical boundaries and different time zones. Although traditional communication media (such as phone, email and fax) are steadily being replaced by automated systems, there are still many areas that require human intervention. The evolutions in IT middleware and integration technologies (particularly those based on the Internet) are providing endless opportunities for addressing such gaps. One of the first challenges for software architects and IT professionals is getting sufficient knowledge about existing practices, business processes systems and architectures. This section contributes to the understanding of the domain of capital markets trading by illustrating some of its associated architectures, technologies and systems.

1.1 Introduction

Financial markets have the role of facilitating the movement of funds among people and organizations. The surplus units (e.g. funds suppliers) are seeking to generate returns (profits) by supplying their funds to the deficit units (e.g. the borrowers). Financial markets have evolved in such a way that enhances efficiency with which trades may take place and maximizes the fairness of trading in order to attract investors. The evolution of financial markets is a continuous process in response to changing needs, new technologies and changes in public policies. Financial markets are constantly introducing new financial instruments with various levels of risk management that equip the market participants with more confidence and risk management to conduct trades.

Financial markets are classified into primary and secondary markets. The former is used by deficit units such as businesses, governments and households to raise funds for the expenditure of goods, services and assets. The latter is used by surplus units such as the investors to trade what has been bought in the primary market. Financial markets are also classified into money markets and capital markets. Money markets bring market participants together to trade market supported instruments offering high levels of liquidity. Australian money market participants include banks, superannuation funds, money market corporations, fund managers, building societies, credit unions, cash management trusts and companies. Money market instruments include exchange settlement account funds, treasury notes, intercompany loans, interbank loans, etc. On the other hand, capital markets have the primary responsibility for the operation of both its primary and secondary capital markets. Companies that need to raise capital by offering new stocks use the primary market. These new stocks can include initial public offerings (IPOs), right issues, placement and company options. Once those newly issued stocks are sold in the primary market, they can continue to be traded through the secondary market, called the stock exchange market. Capital market participants include traders (e.g. investors), intermediaries (e.g. brokers), statutory authorities (e.g. securities

commissions) and third parties such as commercial information vendors (e.g. Bloomberg or Reuters).

The market structure is determined by the trading rules and trading systems used by that market. These rules and systems determine who can trade, what to trade, when, where and how they can trade. They also determine rules governing market information dissemination to traders and other market participants (Harris 2006). Understanding market regulations, mainly trading rules and systems, is crucial for conducting trades. Normally, trading strategies that are applied to one marketplace are not applicable to most other markets that have different regulations and structure. Such differences are motivated by different understanding and research outcome on how to facilitate fairness and efficiency of a marketplace.

Markets are characterized by six crucial elements: technology, regulation, information, participants, instruments and trading protocol. There are four characteristics to achieve market fairness and efficiency. These characteristics are liquidity, transparency, volatility, and transactions costs. Market organizers have the role of achieving the best combination of the six factors in such a way that satisfies required levels of a fair and efficient market. In the remainder of this section, we illustrate key elements in markets microstructures (trading instruments, types of trading orders, and types of markets microstructures) followed by an overview of information systems that participate in the trading cycle...

1.2 Capital markets trading instruments

Capital markets have evolved by introducing a number of trading instruments that diversify investment opportunities and attractiveness. These instruments can accommodate different trading styles for investors. They range from trading physical stocks (i.e. shares) to contracts on the willingness to trade stocks on a future date at a price determined today.

Equity market

The equity market, commonly known as sharemarket, plays the role of both primary and secondary capital markets. It is the place where financial assets are bought and sold. These assets can be the new stocks issued at the primary market or existing stocks that are currently traded at the secondary market. Secondary market transactions do not directly affect the cash flow of the corporation whose shares are being traded. The cash flow of that corporation is directly affected when it issues new stocks at the primary market. However; it has already been suggested that the existence of a well-developed secondary market is of a great significance to a corporation that may be seeking to raise capital in the primary market. The existence of an active, liquid, well-organized market in existing shares adds to the attractiveness of acquiring new shares once advertised in the market. Fig. 1 summarizes the flow of capital and ownership rights of stocks in secondary capital markets in Australia while showing the participants role in that process.

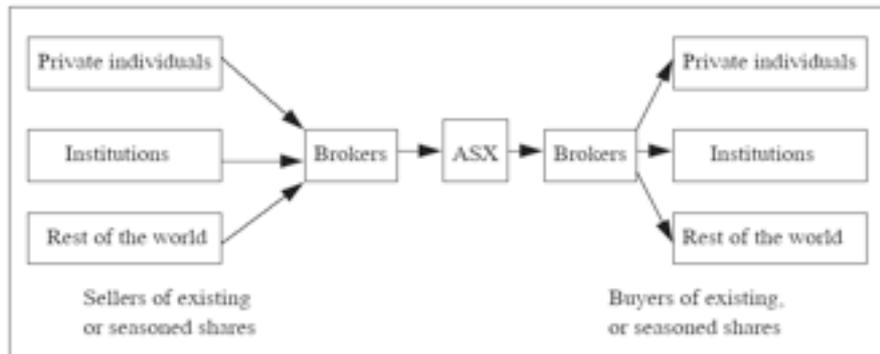


Fig. 1: Roles of secondary capital market participants and the flow of funds in Australia

Derivatives market

The derivatives market provides instruments that focus on risk management (interest rate, foreign exchange and price risks). These instruments such as options and futures have their value derived from the underlying security in the equity market or the value of a specified index for the index based derivatives.

The unit of derivative trading is a contract. Once the contract is written, it can be traded at the derivatives market at a price that depends on the underlying stock price movement or the underlying index value. Each contract is a variant of an obligation or no obligation to trade (sell/buy) the underlying stocks at a predetermined price before a predetermined date or at predetermined date at some cost or no cost. Derivatives investors should be obligated to pay or receive margins during the life of the contract on timely bases. Organized derivatives can also be based on an equity market index (index derivatives) that gives the investor exposure to a certain market index. The advantage here is the exposure to a broad range of securities comprising an index rather than being limited to one particular company. Index derivative are normally cash settled.

1.3 Types of orders

There are a number of standardized orders that can be used by investors to inform their brokers about the order specification and/or by traders or brokers to inform the market about the intension to sell (ask order) or buy (bid order). Some markets may not support certain types of orders. In this case, brokers may offer services to their clients. Brokers may support a more complicated order specification service. In both cases, the broker service would imply the execution of the order as soon as all its requirements and conditions set by the trader are satisfied. Harris (Harris 2003) has presented a number of common orders' types some of which are:

- Market order is an instruction to trade at the current available best price. This type of order is traded immediately but the trading price is not fixed before trading.
- Limit order is an instruction to trade at a specified price or better. The price of bid limit order is normally equal or less than the current best bid price, while the price of ask limit order is normally equal or greater that the current best ask price. This order is only trader when the market price moves towards it.
- Any order can carry additional information such as validity, expiration, etc. Some of the validity and expiry instructions are: open-order, day-order, good-this-week, good-this-month, good-until, immediate-or-cancel, fill-or-kill, good-after, market-on-open, market-on-

close. Quantity instructions may also be included such as all-or-nothing or minimum-or-none orders. Other instructions may also be attached such as hidden-volume (undisclosed) order and substitution orders.

1.4 Classifications of Marketplaces

There exist two main types of trading sessions: continuous and call. Continuous session allows brokers and traders to place orders at any time during the trading session and the exchange executes trades as soon as a bid/ask match occurs. On the contrary, in call session, brokers and traders can also place orders at any time during the session until the market is called. A classification of market microstructures (Harris 2006) shows the following types of markets:

- Quote-driven dealer markets: in this market type, the dealers participate in each trade by quoting the bid and ask prices once requested by brokers or traders. Traders request quote and negotiate with a number of the security's dealers and normally select the dealer with the best quote that suites their order. If the submitted order is not matched immediately, then it is processed according to the type of that order and its routing instructions, for instance, it may be cancelled or awaiting as an outstanding order. Matching outstanding orders can occur through a negotiation process in which the dealer moves his offered price to match that outstanding orders and/or the trader updates his order price to match the dealer price. NASDAQ, London stock exchange (LSE) and Reuters200 foreign exchange trading system are examples in which quote-driven market is the dominant structure organized by a dealer association and an exchange.
- Order driven (auction) market: include oral auction (open outcry), single-priced auction, continuous rule-based two-sided auction and crossing networks. In this type of markets, trader orders for any particular security are centralized in a single orderbook where buyers are seeking the lowest price and sellers are seeking the highest price. An order-driven market uses order precedence rules to match buyer to sellers and trade pricing rules to price the resulting trades. The primary order precedence rule at all markets is the order price where the higher bids and the lower asks have higher priorities for matching. Other precedence rules vary for different markets and used when a number of orders have the same price. These rules include placement time where the earlier submitted orders have a higher priority, order size where smaller/larger order volume has higher priority, public order precedence where public traders have higher priority than floor traders and display precedence where disclosed orders have higher priority than undisclosed orders. Continuous auction markets, which maintain a real-time outstanding orderbook for all securities, are used in most stock exchanges such as ASX continuous trading session.
- Brokered market: in such markets, brokers take the role of the exchange order matching under certain circumstances which is normally called crossing. Brokers' role is to search for a counterparty trader(s) for a trading request. This is normally occurs for very large trading orders which is called block orders. In dealer market, the dealer sometimes refuses to conduct risky trades due to expected abnormal price movement or in illiquid securities. In auction markets, block orders could have an impact on the market price especially if that security is illiquid that may cause the market price to move away from the quoted price before matching that block order. The ASX allows brokers under some conditions to arrange trades for block orders through in-market and off-market crossing trading rules.
- Hybrid markets: combine characteristics of the previous three market types may be presented. Normally, the market structure features of one market type are the dominant while some other features from other markets types are embedded. The NYSE, which is

classified as an order-driven market, requires the specialist dealers to offer liquidity if no one else does that. The NASDAQ, which is classified as a quote driven dealer market, requires its dealers to display or execute the limit order.

1.5 Information systems for securities trading

This section describes the information flow across the securities trading process. It also illustrates the different categories of information systems that can be utilized across such a process.

Securities trading information flow

Market information includes real-time trading data and events such as orders, trades, quotes, indexes and announcements. It also includes historic information such as past trading data and companies' periodic reports. Additional statistical data and analytics may also be available; however, participants such as brokers can generate their own analytics based on raw historic market data. As mentioned earlier, market information dissemination is very crucial to the fairness and efficiency of a capital market and hence contributes to its attractiveness to traders and encourages companies to be listed on the market.

Fig. 2 illustrates the overall information flow across the trading processes for an order-driven market structure which is derived from the way the Australian Stock Exchange (ASX) (www.asx.com.au) operates. It comes in the shape of a continuous cycle in which we identify five phases: pre-trade analytics, trading, post-trade analytics, settlement and registry. In the following is a description of each trading phase.

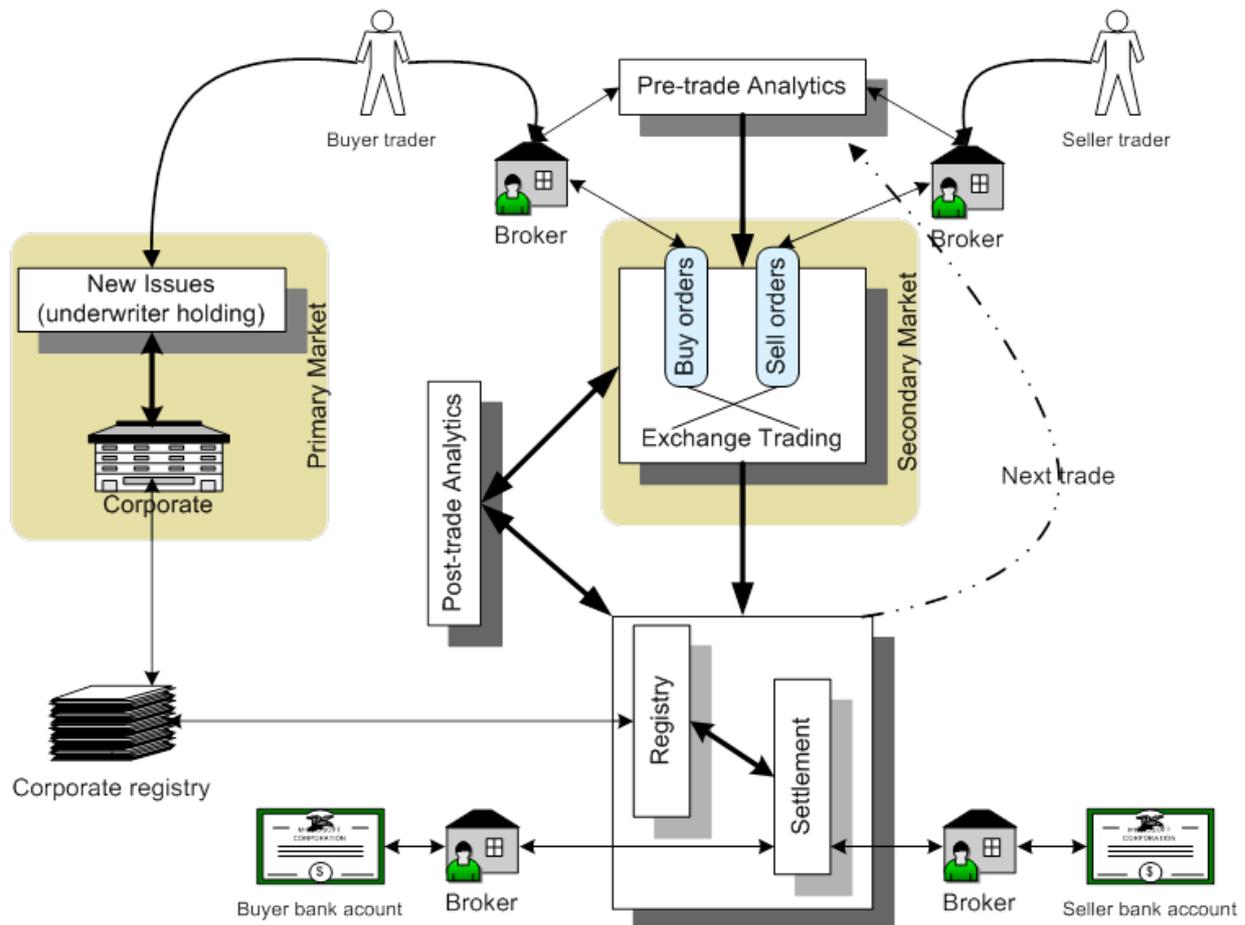


Fig. 2. Flow of trading information within the trading cycle

Pre-trade analytics phase

The trading cycle starts with a pre-trading analytics phase that is normally conducted by the brokerage firms. In this phase, analysts use real-time information (trades, orders, volume, etc.) and correlate it with company announcements and historic information (including periodic company reports) to predict price movement with a degree of certainty. Consequently, the purpose of this phase is to support buy or sell decisions in order to gain capital profit or prevent losing capital respectively. Most brokers provide the outcome of their analysis as services to their clients (investors) and extra fees normally apply. Investors can seek historic information, delayed real-time market information and announcements from the capital market web site or from third party such as commercial information vendors e.g. Bloomberg (Bloomberg.com) and Reuters (www.reuters.com). These services are offered free or for some fee that depends on the level of detail and real-time accuracy.

Trading phase

The trading phase basically implements a market structure as discussed in the previous section. Buyers and sellers both signal their intentions in the form of orders (different types of orders were also discussed earlier) and different markets have different methods for determining trades depending on the order type, the market structure and the degree of the trade process automation. At the heart of the trading system is the trading engine (TE).

Post-trade analytics phase

A capital market attracts investors by maximizing the fairness and efficiency of trading. Post-trade analytics focuses on detecting illegal trading behaviour based on the available real-time and historic market information. Post-trade analysis can also use this information for other purposes such as analysing past and current market behaviour and trading patterns and predicting future behaviour, etc.

A capital market surveillance department is an example of a place for conducting post-trade analytics. The major responsibility of a surveillance department is to detect illegal trading incidents and to generate real-time alerts for such incidents. A surveillance department must have real-time access to every piece of market information across all stages in the trading process such as order and trading data, settlement and registry databases, possibly brokerage firms' databases and investors' holdings and personal data. Due to information privacy measures that are enforced, surveillance departments may not be able to access some of this information. Instead, they are partially coping by implementing intelligent and smart techniques to detect illegal trading behaviour. Because of heuristic nature of these techniques, surveillance is in constant need for improvements.

Settlement and registry phases

Settlement and registry is a transactional-based process for transferring securities from seller's profile to buyer's profile and transferring money from buyer's account to seller's account. The transfer of both securities and money is simultaneous and irrevocable once the settlement process is started. The registry phase completes the settlement process by modifying the ownership of shares in the company's registry from the seller to buyer. It is possible that a number of brokers are involved in one single trade, this happens when, for example, in equity market one large bid order is matched with a number of smaller ask orders. The settlement process is complicated since it involves transferring money and ownership of securities between the different parties involved.

1.6 Categories of capital markets' information systems

We now take a close look at the different types of computer-based systems that participate in the securities trading process. These systems include those that facilitate information dissemination to market participants and contribute to market's transparency. Other systems facilitate order routing to and from the exchange and across the trading cycle. Remarkably, each phase in the trading cycle is supported by one or more computer information system. In the following classification, one system may perform tasks related to more than one category.

Information collection and distribution systems

These systems have replaced the clerks (market reporters) who used to observe and record all trading activities. Information collection includes reordering all market activities such as orders, cancellations, amendments, trades, quotes and announcements. Most exchanges provide real-time market feeds that can be accessed by outside systems.

The distribution of market information is directly related to market's transparency. Distribution can occur in real-time or delayed basis governed by market regulations and the type of requester. Most markets provide delayed quotes and companies historic information as a free service for public. Real-time services are only available registered members such as brokers and data vendors. Data vendors, such as Bloomberg and Reuters, often support query and broadcast services of its customers. Query services provide information on demand while broadcasting provides continuous streams of information as it is received from the participant exchange. Broadcast services include trade reports (ticker tape) and/or quotes (quotation feeds). Broadcasting delayed quotes service is normally available free on the watch board of the market while query services of delayed quotes are also available for free on the Web sites of markets or data vendors.

Trading engines

The trading engine (TE) is at the heart of an automated trading system. The main function of the TE is to match bid/ask orders using order precedence set by the market regulation. In an order-driven market such as the Australian Stock eXchange (ASX), the TE implements a number of bid/ask order-matching algorithms that depend on the security concerned, the current trading phase (opening, continuous, closing etc.) and the type of order. Once a security's best bid price matches its best ask, an irreversible trade is executed. In-house developed trading engines were often the choice in large markets but the tendency in recent years have been to move towards customised solutions. Nasdaq OMX (<http://www.nasdaqomx.com/>) is one of the main providers of trading engine technology with several products such as Genium INET (used in Nasdaq) and XSTREAM (used in Indonesia Stock Exchange).

Order routing systems

Order routing systems transmit orders between the appropriate market participants and systems. Traders use them to send orders to the broker or dealer. Brokers use them to transmit orders to a dealer or an exchange and to report back to the trader about the status of the order. Dealers and exchanges use them to report trades to the brokers and/or traders and to the registry and settlement systems. Order routing systems of Australian brokers such as IRESS IOS (www.iress.com.au) are conformant with IO interfaces to ASX's trading engine. American ITS (Intermarket Trading Systems) facilitate trading across different equity markets in US. Some Electronic Communication Networks in the US are participants to order routing systems.

Order presentation systems

Order presentation systems present information about orders and quotes to the market participants (e.g. brokers). In order driven markets, this information is presented on traders screen connected to the screen-based trading system. Brokerage firms support their own presentation/visualization systems that receive feeds from ORSs. For example, IRESS system has its own facility for order presentation to the brokers whereas SMARTS (to be described later) has two subsystems called SPREAD and REPLY which support orders visualization facility to market researches and surveillance personnel. Dealers markets often use messaging systems that allow participant to communication via messages.

Settlement and registry systems

Settlement and registry systems facilitate the registration of the trade volume to the buyer and transferring the trade value to the seller. We often distinguish between settlement and registry systems. Settlement is about the transfer of money in return for title and the legal title is often (not always) then held in what is known as a depository. The settlement and depository is often done in the same organization which are in general called "CSD" – central securities depository. The registry system is really a duplication of this information but is a specialized function because its role is to facilitate the communication between a company and its shareholders (such as voting, annual meetings, distributing annual reports and dividends etc) and is becoming an increasingly important role given that issues of corporate governance are becoming more prominent. In the ASX, CHES is the official settlement system and depository that acts upon receiving trades from SEATS with the cooperation of the trade participating brokers. CHES is capable of communicating with issuer sponsored registry if one of the trade counterparties is not CHES sponsored.

Surveillance systems

Market surveillance is facilitated by computer systems that try to detect illegal market behaviours that violate the market regulations. Surveillance systems should have access to every piece of real-time or historic market information. Examples of Market Surveillance systems include Nasdaq OMX's SMARTS (<http://www.nasdaqomx.com/>) and First Derivatives' Delta Stream (www.firstderivatives.com).