Markets: function and form

Susan Thomas

28 July 2017

Recap

- Finance $\rightarrow$ smooth consumption over the life time of economic agents.
- Finance $\rightarrow$ manage future uncertainty.

- Firms as an economic organisation of people to scale production of goods and services
- Financing firms through debt and equity
- Debt as fixed promises – low risk, fixed return
- Equity for the chance of upside - high risk, high return
- Forms of firms: proprietership, partnership, limited liability
- Limited liability firms = large, dispersed shareholding
- Governance: board of directors (shareholders) who can fire management.

Financing firms

- ► The firm we set up was financed with Rs.100 of debt and Rs.100 of equity.

  The debt was in the form of 100 *bonds*. The equity was in the form of 1000 *shares*.

- ► Bonds and shares are *financial assets* or *securities*, and can be *traded*.

- ► Ownership of these assets can change identity during the life of the firm, while the obligation of the firm remains the same.

  Unlike loans and private equity holding, where the identify of the creditor or the equity shareholder cannot be readily changed.

- ► Flexibility of entry and exit of securities attract investors.

- ► Questions about these securities:

  - ► Where can a holder of these securities sell? Where can a potential buyer find them to buy?
  - ► What is the price of the firm's bond?
  - ► What is the price of the share?

Answer: **financial markets**.

Financing firms

- ► The firm we set up was financed with Rs.100 of debt and Rs.100 of equity.

  The debt was in the form of 100 *bonds*. The equity was in the form of 1000 *shares*.

- ► Bonds and shares are *financial assets* or *securities*, and can be *traded*.

- ► Ownership of these assets can change identity during the life of the firm, while the obligation of the firm remains the same.

  Unlike loans and private equity holding, where the identify of the creditor or the equity shareholder cannot be readily changed.

- ► Flexibility of entry and exit of securities attract investors.

- ► Questions about these securities:
    - ► Where can a holder of these securities sell? Where can a potential buyer find them to buy?
    - ► What is the price of the firm's bond?
    - ► What is the price of the share?

Answer: **financial markets**.

Financing firms

- ▶ The firm we set up was financed with Rs.100 of debt and Rs.100 of equity.

  The debt was in the form of 100 *bonds*. The equity was in the form of 1000 *shares*.

- ▶ Bonds and shares are *financial assets* or *securities*, and can be *traded*.

- ▶ Ownership of these assets can change identity during the life of the firm, while the obligation of the firm remains the same.

  Unlike loans and private equity holding, where the identify of the creditor or the equity shareholder cannot be readily changed.

- ▶ Flexibility of entry and exit of securities attract investors.

- ▶ Questions about these securities:
    - ▶ Where can a holder of these securities sell? Where can a potential buyer find them to buy?
    - ▶ What is the price of the firm's bond?
    - ▶ What is the price of the share?

Answer: **financial markets**.

Financial markets

What is a financial market?

Simplest: A financial market allows for the intermediation of capital between households and firms.

Such intermediation takes place at several stages in the life of a firm:

1. Fresh equity issuance: change in ownership of shares *and* change in capital.

   ▶ Initial Public Offering (IPO): change in capital, change in public disclosure about firm.
   ▶ Seasoned Equity Offering (SEO): change in capital, standard disclosure.

2. The secondary trading market: change in ownership of shares, *No* change in capital.

   2.1 Change in ownership, no material impact on management: economic agents trading on the market.
   2.2 Changes in ownership, material impact on management: Mergers, Acquisition, Takeover.

What is a financial market?

Simplest: A financial market allows for the intermediation of capital between households and firms.

Such intermediation takes place at several stages in the life of a firm:

1. Fresh equity issuance: change in ownership of shares *and* change in capital.

   - Initial Public Offering (IPO): change in capital, change in public disclosure about firm.
   - Seasoned Equity Offering (SEO): change in capital, standard disclosure.

2. The secondary trading market: change in ownership of shares, *No* change in capital.

   2.1 Change in ownership, no material impact on management: economic agents trading on the market.
   2.2 Changes in ownership, material impact on management: Mergers, Acquisition, Takeover.

What makes a market? Microstructure

Many ways to organise markets: how to choose the "best"?

Field of *market microstructure*.

Structure includes:

- ► Products: what is available to buy and sell.
- ► Participants: who can buy and sell.
- ► Trading, Clearing, Settlement: recording who bought, who sold, making sure that everyone gets what they are due and pay what they owe
  $\rightarrow$ how to make it work!
- ► Laws and regulation: binding the action of all participants, and the promises in all products.

Design principle: select the form that best delivers on function.

Functions vs. forms of a financial market

- ▶ Robert C. Merton: "the functional perspective" to decide the form, rather than focussing on just the form.

- ▶ In history, multiple institutions have delivered financial functions:
  banks, insurance companies, exchanges, securities firms, mutual funds, hedge funds and others.

- ▶ The *objective* of good market design should be to optimise delivering the functions of the market, rather than focus on the functioning of institutions.

- ▶ Institutions are transient, functions are permanent.

Question: what are the functions?

Functions vs. forms of a financial market

- ▶ Robert C. Merton: "the functional perspective" to decide the form, rather than focussing on just the form.
- ▶ In history, multiple institutions have delivered financial functions:
  banks, insurance companies, exchanges, securities firms, mutual funds, hedge funds and others.
- ▶ The *objective* of good market design should be to optimise delivering the functions of the market, rather than focus on the functioning of institutions.
- ▶ Institutions are transient, functions are permanent.

Question: what are the functions?

Functions of financial market

- *Price discovery*: what is the *price* of a financial asset?
- *Liquidity provision*: Enable the transfer of ownership from one economic agent to another efficiently (low cost, high utility).
- *Risk management*: Measure *unanticipated* changes in future consumption and earnings, and manage the gap between the two continuously.

Functions of financial market

- *Price discovery*: what is the *price* of a financial asset?
- *Liquidity provision*: Enable the transfer of ownership from one economic agent to another efficiently (low cost, high utility).
- *Risk management*: Measure *unanticipated* changes in future consumption and earnings, and manage the gap between the two continuously.

Functions of financial market

- *Price discovery*: what is the *price* of a financial asset?
- *Liquidity provision*: Enable the transfer of ownership from one economic agent to another efficiently (low cost, high utility).
- *Risk management*: Measure *unanticipated* changes in future consumption and earnings, and manage the gap between the two continuously.

Introducing market structures (form)

Some jargon

- **Trade**: A transaction that has been executed – denoted by an asset identity, quantity (q), price (p).
- **Order**: A transaction that is waiting to be executed – includes Buy/Sell designation.
    - *Limit order*: price set by the investor.
    - *Market order*: price set by the market.
- **Limit Order Book**: (LOB) the set of all buy-sell limit orders.
- **Market by price**: (MBP) limit orders sorted by price.

Some jargon

- **Trade**: A transaction that has been executed – denoted by an asset identity, quantity (q), price (p).
- **Order**: A transaction that is waiting to be executed – includes Buy/Sell designation.
  - *Limit order*: price set by the investor.
  - *Market order*: price set by the market.
- **Limit Order Book**: (LOB) the set of all buy-sell limit orders.
- **Market by price**: (MBP) limit orders sorted by price.

Some jargon

- **Trade**: A transaction that has been executed – denoted by an asset identity, quantity (q), price (p).
- **Order**: A transaction that is waiting to be executed – includes Buy/Sell designation.
  - *Limit order*: price set by the investor.
  - *Market order*: price set by the market.
- **Limit Order Book**: (LOB) the set of all buy-sell limit orders.
- **Market by price**: (MBP) limit orders sorted by price.

Some jargon

- **Trade**: A transaction that has been executed – denoted by an asset identity, quantity (q), price (p).
- **Order**: A transaction that is waiting to be executed – includes Buy/Sell designation.
  - *Limit order*: price set by the investor.
  - *Market order*: price set by the market.
- **Limit Order Book**: (LOB) the set of all buy-sell limit orders.
- **Market by price**: (MBP) limit orders sorted by price.

Products

- ▶ Financial vs. commodity contracts

  Examples of financial contracts: shares, bonds of a firm $\rightarrow$ promise of future cashflow.

  Examples of commodities: wheat, pork bellies, pepper $\rightarrow$ promise of commodity or the ability to trade the commodity.

- ▶ Spot vs. forward contracts derivatives

  Examples of spot: shares and bonds issued by a firm, foreign exchange, commodities, mutual fund units.

  Examples of futures: futures and options on the spot.

- ▶ Standardised vs. individual

  Examples of standardised contracts: anything that is traded on an exchange.

  Examples of individualised contracts: anything that is traded on an OTC market.

Products

- ▶ Financial vs. commodity contracts

  Examples of financial contracts: shares, bonds of a firm $\rightarrow$ promise of future cashflow.

  Examples of commodities: wheat, pork bellies, pepper $\rightarrow$ promise of commodity or the ability to trade the commodity.

- ▶ Spot vs. forward contracts derivatives

  Examples of spot: shares and bonds issued by a firm, foreign exchange, commodities, mutual fund units.

  Examples of futures: futures and options on the spot.

- ▶ Standardised vs. individual

  Examples of standardised contracts: anything that is traded on an exchange.

  Examples of individualised contracts: anything that is traded on an OTC market.

Products

- Financial vs. commodity contracts

  Examples of financial contracts: shares, bonds of a firm $\rightarrow$ promise of future cashflow.

  Examples of commodities: wheat, pork bellies, pepper $\rightarrow$ promise of commodity or the ability to trade the commodity.

- Spot vs. forward contracts derivatives

  Examples of spot: shares and bonds issued by a firm, foreign exchange, commodities, mutual fund units.

  Examples of futures: futures and options on the spot.

- Standardised vs. individual

  Examples of standardised contracts: anything that is traded on an exchange.

  Examples of individualised contracts: anything that is traded on an OTC market.

Market participants

- By function:
    1. **Investors:** transactions done for investment.
    2. **Speculators:** transactions done in reaction to information.
    3. **Hedgers:** transactions done to protect against changes in information.
    4. **Arbitrageurs:** transactions done in response to price deviations from *fair value*.

- By form:
    1. End customers (individuals, banks, financial institutions like mutual funds, insurance companies) and
    2. Intermediaries (brokers, dealers who trade in OTC markets, market makers, market specialists).

    In terms of controlling information access,

    customers $<$ brokers $<$ dealers who trade in OTC markets $<$ market specialists

Alternative market structures

- The first broad categorisation of markets: **exchange** and **over-the-counter** (OTC).
    - Exchange: buyers and sellers in one place.
    - OTC: buyer and seller meet directly.
- Examples of existing financial markets:
    - Centralised trading with open outcry in a pit. (Old BSE, Chicago futures markets.)
    - Centralised trading with market makers. (Old NYSE)
    - Centralised trading with limit order markets. (NSE, BSE)
    - Centralised trading with an auction. (Indian GOI bond markets)
    - Over-the-counter (OTC) markets. (Foreign exchange, real estate).

Information from markets

- The standard trade information set that comes out of a market:
  - Open price
  - High price
  - Low price
  - Close price
  - Bid-ask spread at close
  - Traded volumes
  - Number of trades
  - Returns adjusted for corporate action
- Recently, similar information for orders captured intra–day.

Market function #1: Price discovery

Discovering asset prices

- **The wisdom of crowds**

  Aggregation of information by crowds often get to better decisions than made by any single member. (*The wisdom of crowds: Why the many are smarter than the few, and how collective wisdom shapes business, economies, societies and nations*, James Surowiecki, 2004.)

- Caveats:
  - The "wise" crowd has to have (a) diversity of opinion, (b) independence and (c) decentralisation – local knowledge.
  - Lastly, the aggregation needs to be unbiased.

- Market price: reduced form outcome of the optimisation activities of a large number of rational investors.

- Sound market prices depend upon the market simultaneously enabling diversity, independence and decentralisation of participant opinion, in one place.

- Also see, *Proof that properly anticipated prices fluctuate randomly*, Paul Samuelson, Industrial Management Review, 41-49, 1965.

Discovering asset prices

- **The wisdom of crowds**

  Aggregation of information by crowds often get to better decisions than made by any single member. (*The wisdom of crowds: Why the many are smarter than the few, and how collective wisdom shapes business, economies, societies and nations*, James Surowiecki, 2004.)

- Caveats:
  - The "wise" crowd has to have (a) diversity of opinion, (b) independence and (c) decentralisation – local knowledge.
  - Lastly, the aggregation needs to be unbiased.

- Market price: reduced form outcome of the optimisation activities of a large number of rational investors.

- Sound market prices depend upon the market simultaneously enabling diversity, independence and decentralisation of participant opinion, in one place.

- Also see, *Proof that properly anticipated prices fluctuate randomly*, Paul Samuelson, Industrial Management Review, 41-49, 1965.

Discovering asset prices

- **The wisdom of crowds**

  Aggregation of information by crowds often get to better decisions than made by any single member. (*The wisdom of crowds: Why the many are smarter than the few, and how collective wisdom shapes business, economies, societies and nations*, James Surowiecki, 2004.)

- Caveats:
  - The "wise" crowd has to have (a) diversity of opinion, (b) independence and (c) decentralisation – local knowledge.
  - Lastly, the aggregation needs to be unbiased.

- Market price: reduced form outcome of the optimisation activities of a large number of rational investors.

- Sound market prices depend upon the market simultaneously enabling diversity, independence and decentralisation of participant opinion, in one place.

- Also see, *Proof that properly anticipated prices fluctuate randomly*, Paul Samuelson, Industrial Management Review, 41-49, 1965.

Features of market prices observed empirically

- ▶ When orders are placed, investors can observe a *potential* price.
- ▶ When a trade takes place, investors observe the *market* price.
- ▶ Standard observations:
    - ▶ Prices are *noisy* (high fluctuations) when markets start or close.
    - ▶ Prices have least noise around lunch time.

    This generates a "U-shaped" curve in the time series graph of price variance during the day.

- ▶ Market designs use auctions to manage uncertainty by pooling orders to buy and sell over a short period to determine a price.

    Examples:
    - ▶ NYSE and NSE calculate open price using auctions.
    - ▶ NYSE closing price out of the the auction market.
    - ▶ NSE closing prices are the weighted average of the last half hour of trades.
    - ▶ BSE closing prices are the weighted average of the last 30 trades in the day.

Asset pricing models for a benchmark price

- ▶ Inputs to asset pricing models:
  Get better measures systematic risk and the risk-free rate.
- ▶ Some approaches to asset pricing models:
  Asset Pricing Theories (Capital Asset Pricing Model -
  CAPM, Arbitrage Pricing Theory - **APT**, Stochastic
  Discount Factor models - **SDF**), Efficient market
  hypothesis (**EMH**), Microstructure studies.

Some features of a rational market price

Micro-economic models of asset pricing + empirical analysis show that there are two types of economic risks - **systematic risk** and **unsystematic risk**.

Rational prices have the following features:

1. Investors are paid **only** for holding systematic risk.

2. The returns to holding systematic risk is a weighted fraction of investing in risk-free bonds and a system wide **risk premium** which is constant.

Some features of a rational market price

Micro-economic models of asset pricing + empirical analysis show that there are two types of economic risks - **systematic risk** and **unsystematic risk**.

Rational prices have the following features:

1. Investors are paid **only** for holding systematic risk.
2. The returns to holding systematic risk is a weighted fraction of investing in risk-free bonds and a system wide **risk premium** which is constant.

Some features of a rational market price

Micro-economic models of asset pricing + empirical analysis show that there are two types of economic risks - **systematic risk** and **unsystematic risk**.

Rational prices have the following features:

1. Investors are paid **only** for holding systematic risk.

2. The returns to holding systematic risk is a weighted fraction of investing in risk-free bonds and a system wide **risk premium** which is constant.

Liquidity provision

Defining liquidity

- In a liquid market, economic agents will be able to
  1. Buy or sell an unlimited amount of the security,
  2. with immediacy,
  3. at a price close to the price that they last observed.
- In such a market, economic agents can transfer their wealth from one asset form to another with certainty.

Defining liquidity

- In a liquid market, economic agents will be able to
  1. Buy or sell an unlimited amount of the security,
  2. with immediacy,
  3. at a price close to the price that they last observed.
- In such a market, economic agents can transfer their wealth from one asset form to another with certainty.

Full information on liquidity

▶ The most complete description of liquidity would involve
  ▶ at what price can the security be bought or sold for a given quantity, at a given time?
  ▶ how does this price change if the desired quantity changes?
  ▶ how does this price change if the transaction is to be done at a different time?
  ▶ resilience: how soon after a trade does the market liquidity revert to the original level?
▶ Kyle (1985): one of the first papers that links market microstructure and liquidity.

Full information on liquidity

- ▶ The most complete description of liquidity would involve
  - ▶ at what price can the security be bought or sold for a given quantity, at a given time?
  - ▶ how does this price change if the desired quantity changes?
  - ▶ how does this price change if the transaction is to be done at a different time?
  - ▶ resilience: how soon after a trade does the market liquidity revert to the original level?
- ▶ Kyle (1985): one of the first papers that links market microstructure and liquidity.

Measures of liquidity

- ▶ Traditional measures of liquidity only captured the volume of transactions: **daily volumes traded**, **number of transactions**, **turnover rate**.

  These can be measured at the level of an individual stock, or at the level of the market.

- ▶ The next set of measures reflected the **depth** of the market, being the quantity of shares available to be sold (or bought) in the market.

- ▶ Most recent innovation: **bid–ask spread**: the difference between the best price to sell and buy ($P_a - P_b$).

Measures of liquidity

- Traditional measures of liquidity only captured the volume of transactions: **daily volumes traded**, **number of transactions**, **turnover rate**.
  These can be measured at the level of an individual stock, or at the level of the market.

- The next set of measures reflected the **depth** of the market, being the quantity of shares available to be sold (or bought) in the market.

- Most recent innovation: **bid–ask spread**: the difference between the best price to sell and buy ($P_a - P_b$).

Measures of liquidity

- Traditional measures of liquidity only captured the volume of transactions: **daily volumes traded**, **number of transactions**, **turnover rate**.
  These can be measured at the level of an individual stock, or at the level of the market.

- The next set of measures reflected the **depth** of the market, being the quantity of shares available to be sold (or bought) in the market.

- Most recent innovation: **bid–ask spread**: the difference between the best price to sell and buy ($P_a - P_b$).

Measures of liquidity

- ▶ Traditional measures of liquidity only captured the volume of transactions: **daily volumes traded**, **number of transactions**, **turnover rate**.
  These can be measured at the level of an individual stock, or at the level of the market.

- ▶ The next set of measures reflected the **depth** of the market, being the quantity of shares available to be sold (or bought) in the market.

- ▶ Most recent innovation: **bid–ask spread**: the difference between the best price to sell and buy ($P_a - P_b$).

Measures of liquidity, contd.

- Variant on spread: **impact cost**.
- Improvement: calculated for a transaction size q:

$$
\begin{aligned}
IC(q) &= \frac{P(q) - P_{opt}(q)}{P_{opt}(q)} \\
P_{opt}(q) &= \frac{1}{2}P_a + P_b
\end{aligned}
$$

- **Intuition**: If we were to buy and immediately sell a stock, the cost that we incur in this roundtrip transaction is twice the impact cost.
  It is the most direct cost of transacting on a market.
- Highly liquid stocks will have a low impact cost.

Measures of liquidity, contd.

- ► Variant on spread: **impact cost**.
- ► Improvement: calculated for a transaction size q:

$$
\begin{aligned}
IC(q) &= \frac{P(q) - P_{opt}(q)}{P_{opt}(q)} \\
P_{opt}(q) &= \frac{1}{2}P_a + P_b
\end{aligned}
$$

- ► **Intuition**: If we were to buy and immediately sell a stock, the cost that we incur in this roundtrip transaction is twice the impact cost.
  It is the most direct cost of transacting on a market.
- ► Highly liquid stocks will have a low impact cost.

Measures of liquidity, contd.

- Variant on spread: **impact cost**.
- Improvement: calculated for a transaction size q:

$$\begin{aligned} IC(q) &= \frac{P(q) - P_{opt}(q)}{P_{opt}(q)} \\ P_{opt}(q) &= \frac{1}{2}P_a + P_b \end{aligned}$$

- **Intuition**: If we were to buy and immediately sell a stock, the cost that we incur in this roundtrip transaction is twice the impact cost.
  It is the most direct cost of transacting on a market.
- Highly liquid stocks will have a low impact cost.

LOB example: Reliance, NSE

Liquidity of Reliance

- **Turnover**: Rs.108.06 million
- **Turnover ratio**: $0.008 \times$ (at 9:23 am)
- **Bid–ask spread**: Rs.0.45 (= 0.0536% or 5.36 bps of the mid-quote price of Rs.839.225)
- **Impact cost**:
  - $q(=$ INR 10,000), IC_{buy} = 0.0268% or 2.68 bps, IC_{sell} = 0.0268% or 2.68 bps.
  - $q(=$ INR 100,000), IC_{buy} = 0.0380% or 3.80 bps, IC_{sell} = 0.0268% or 2.68 bps.

Liquidity of Infosys Technologies

Question: What is the liquidity of Rs.1crore of Infy?

Quote As on Oct 01, 2012 09:28:21 IST   All prices in ₹

Infosys Limited   Get Derivatives Quote | Option Chain

Series: **EQ** |

Symbol: **INFY** ISIN: **INE009A01021**   **Market Tracker**

2,583.10 ▲ 48.15 1.90%	Pr. Close 2,534.95	Open 2,551.30	High 2,592.30	Low 2,549.00	Close -

Trade Snapshot	Company Information	Peer Comparison	Historical Data

Print

VWAP	2,573.37
Face Value	5.00
Traded Volume (shares)	85,315
Traded Value (lacs)	2,195.47
Free Float Market Cap(Crs)	1,13,865.81
52 week high	2,994.00 (22-FEB-12)
52 week low	2,101.25 (26-JUL-12)
Adjusted 52 week high	-
Adjusted 52 week low	-
Lower Price Band	No Price Band
Upper Price Band	No Price Band
Note:	

	Order Book	Intra-day Chart	Stock V/s Index Chart	Quarterly Charts

Buy Qty.	Buy Price	Sell Price	Sell Qty.
90	2,583.10	2,583.45	710
6	2,583.00	2,583.60	19
10	2,582.50	2,583.95	20
1	2,582.05	2,584.00	10
5	2,582.00	2,584.20	125
71,510	Total Quantity		67,597

Security-wise Delivery Position (28SEP2012)

Value at Risk (VaR in %)

✔ - VWAP is Volume Weighted Average Price.
✔ - % change is calculated with respect to open price on ex-date for Bonus, Rights & Face Value Split.
✔ - Free Float Market Capitalisation (FFM) is updated at the end of business hours.

Liquidity of Infy

- **Turnover**: Rs.219.5 million
- **Turnover ratio**: 0.019 $\times$ (at 9:23 am)
- **Bid–ask spread**: Rs.0.35 (= 0.0135% or 1.35 bps of the mid-quote price of Rs.2583.28)
- **Impact cost**:
    - $q(=$ INR 10,000), IC_{buy} = 0.0068% or 0.68 bps, IC_{sell} = 0.0068% or 0.68 bps.
    - $q(=$ INR 100,000), IC_{buy} = 0.0068% or 0.68 bps, IC_{sell} = 0.0068% or 0.68 bps.

Measures of liquidity, contd.

- ▶ The graph of IC(q) against *q* is called the *liquidity supply schedule* (LSS).
- ▶ The LSS is different
  - ▶ For the buy and the sell transactions.
  - ▶ At different times of the day.
  - ▶ For different days of the week.

An example of the LSS: Infy at 12 noon, 8th June, 2012

Order size (in '000 shares)
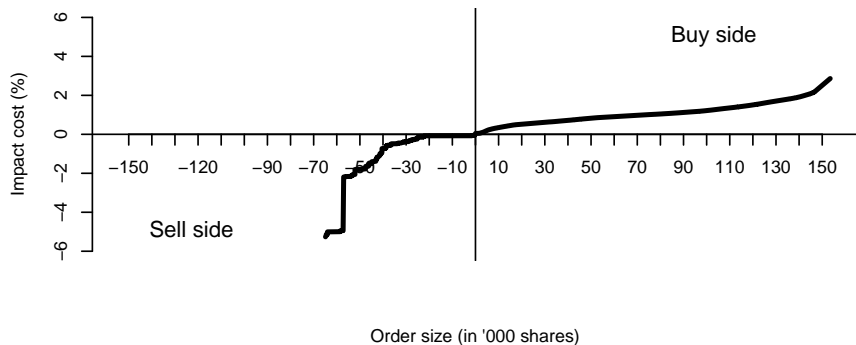
Uses of the LSS

- ▶ We will know more exactly the amount of money to be paid (or received) if we buy (or sell) a security: less price uncertainty.

- ▶ If the behaviour of the LSS is captured through time, fund managers can optimise on how to execute trades most efficiently: minimise trading costs.

- ▶ Portfolio managers can calculate a liquidity adjusted Value at Risk to better understand how much they will lose under a large market movement.

LSS depends upon the structure of the market.

Risk measurement and management

Risk

- Risk is *unanticipated* fluctuations in asset price.
  The measure: Volatility/variance of changes in market
  price.
- Volatility can be calculated, *given* transparent and reliable
  market price information.
- Possible values of prices can be observed *given* the
  volatility can be calculated *and assuming* a form of the
  distribution of future prices.

Empirical facts about observed price changes

▶ Prices are non-stationary – future price uncertainty is perpetually increasing.

▶ Price changes are stationary – uncertainty about the amount of change in future prices is bounded.

▶ Volatility of prices changes is not a constant: it changes from day to day, year to year.
  This phenomenon of changing volatility is called *heteroskedasticity*.

▶ When there is a shock to the prices, the variance of price changes increase and the increase is *persistent*.

▶ This implies that volatility in financial markets can be *predicted* once a change takes place.

▶ Scope for time series models to predict price change variance.

Empirical facts about observed price changes

- ▶ Prices are non-stationary – future price uncertainty is perpetually increasing.

- ▶ Price changes are stationary – uncertainty about the amount of change in future prices is bounded.

- ▶ Volatility of prices changes is not a constant: it changes from day to day, year to year.
  This phenomenon of changing volatility is called *heteroskedasticity*.

- ▶ When there is a shock to the prices, the variance of price changes increase and the increase is *persistent*.

- ▶ This implies that volatility in financial markets can be *predicted* once a change takes place.

- ▶ Scope for time series models to predict price change variance.

Empirical facts about observed price changes

- ▶ Prices are non-stationary – future price uncertainty is perpetually increasing.
- ▶ Price changes are stationary – uncertainty about the amount of change in future prices is bounded.
- ▶ Volatility of prices changes is not a constant: it changes from day to day, year to year.
  This phenomenon of changing volatility is called *heteroskedasticity*.
- ▶ When there is a shock to the prices, the variance of price changes increase and the increase is *persistent*.
- ▶ This implies that volatility in financial markets can be *predicted* once a change takes place.
- ▶ Scope for time series models to predict price change variance.

Measures of risk

- ▶ Traditional approaches where r_t is the change in price from $t - 1$ to t:
    1. Time series of r_t^2,
    2. Moving window average of r_t,
- ▶ Recent approaches using new markets and improved market information:
    1. Range calculated as (highest price - lowest price) within the day
    2. Implied volatility from options markets,
    3. Realised volatility using intra-day high-frequency data.

HW: Market outcomes, market microstructure

- ▶ Pick four major asset markets in India, and identify their market microstructure.
- ▶ Compare these four on the amount of information, access that is available on price, liquidity and risk.
- ▶ Pick a firm that you have selected for the HomeWork of the previous class, capture the various measures of liquidity covered in this session on the 2nd and 3rd of August, 2017.
- ▶ Tabulate these measures.
  (For impact cost, use two transaction sizes of Rs.20,000 and Rs.500,000 at 2pm on the two days above.)

HW: Market outcomes, market microstructure

- ▶ Pick four major asset markets in India, and identify their market microstructure.
- ▶ Compare these four on the amount of information, access that is available on price, liquidity and risk.
- ▶ Pick a firm that you have selected for the HomeWork of the previous class, capture the various measures of liquidity covered in this session on the 2nd and 3rd of August, 2017.
- ▶ Tabulate these measures.
  (For impact cost, use two transaction sizes of Rs.20,000 and Rs.500,000 at 2pm on the two days above.)