CHAPTER III

EVALUATION OF VARIOUS THEORETICAL CONCEPTS OF MARKET INTEGRATION AND INTER-LINKAGES BETWEEN THE FOREIGN EXCHANGE MARKET AND THE STOCK MARKET

Foreign exchange market and stock market are the most important constituents of a financial system. Foreign exchange market deal in foreign exchange and it is reflected in exchange rates, as stock market deals in shares of corporates and it is reflected by share prices.

Exchange rate is one of the important and most confusing risk elements in the stock market and there are theoretical support for the linkages between exchange market and stock market also. Since the objective of the present study is to empirically examine the validity of market integration hypothesis with reference to capital market and foreign exchange market, and interlinkages between the exchange market and the stock market, a prior understanding of the different theoretical concepts of both the markets will enable us to identify the importance of our study. Against this background, the present chapter discusses the various theoretical backgrounds of the corporate foreign exchange risk exposure and the interlinkages between foreign exchange market and stock market.

The rest of the chapter has been divided into four sections. The first section discusses the capital market and the foreign exchange market in
general. The second section gives an illustration of the theoretical concepts of the market integration. The third section explains the theoretical background of the inter-linkages between the exchange market and the stock market. The fourth section gives an account of the various methodologies which can be used to test the theoretical relationship and attempt to identify the suitable methodology to verify the hypothesis.

Section I: The Capital Market and the Foreign Exchange Market

The Capital Market

The capital market is a broad term which includes primary markets, secondary markets, term lending institutions, banks, investors and just about anybody and everybody who is engaged in providing long-term capital to the industrial sector. To McMenamin (2000) capital markets are markets for trading in long-term securities, that is those which have a maturity of at least a year, such as bonds, debentures and shares. Thus, they bring together the buyers and suppliers of long-term capital.

Encyclopedia of Banking and Finance (Woelfel, 1994) defines capital market as a financial market for long-term maturity financial assets. It can be classified as a primary market and a secondary market. A primary market deals with financial claims that are newly issued. The secondary market deals with financial claims that have been previously issued.
Primary market comprises the companies making the security issue and the public at large subscribing to them. Primary market is where a company makes its first contact with the public at large in search of capital.

Secondary market includes the buyers and sellers of shares and debentures subsequent to the original issue. Having subscribed to the shares or debentures of a company if one wishes to sell the same, it will be done in the secondary market. One could also buy the shares and debentures of a company from the secondary market. This is possible if the company is listed in the stock exchange. By their very role, stock exchanges are an important constitution of the capital market.

The Stock Exchange: A stock exchange is an organization for orderly buying and selling of listed existing securities. The organization includes an association of persons or firms to regulate and supervise all transactions, rules, regulations and standard practices to govern all market transactions, authorized stock brokers and an exchange floor or hall where stock brokers or their authorized agents meet during fixed business hours to buy and sell securities (Gupta, 1999).

A share represents the smallest recognized fraction of ownership in a publicly held business. Each such fraction of ownership is represented in the form of a certificate, known as the share certificate.

By enabling the convertibility of ownership in the product market into financial assets, namely shares, stock exchanges bring together buyers and
sellers of fractional ownership of companies, much as buyers and sellers of vegetables come together in a vegetable market. Because of these activities relating to stock exchanges, they are appropriately known as stock market or security market (Raghunathan, 2001).

The primary functions of the stock market are:

(i) To enable companies to raise essential long-term financing by issuing securities, and

(ii) To provide a market in which these securities can be valued and easily traded.

The stock markets are mainly involved in attracting new investible resources into the corporate sector and their allocation among alternative uses and users. How fast the corporate industrial sector grows depends upon the inflow of resources into it, apart from its own internal savings. New issues may take the form of equity shares, preference shares or debentures. The firms raising funds may be new companies or existing companies planning expansion. The new companies need not always be entirely new enterprises. They may be private firms already in business, but 'going public' to expand their capital base. 'Going public' means becoming public limited companies to be entitled to raise funds from the general public in the open market.

The main function of the secondary market is to provide liquidity to securities. Liquidities of an asset mean its easy convertibility into cash at short notice and with minimal loss of capital value. This liquidity is provided
by a continuous market for securities, i.e., a market where a security can be bought or sold at any time during business hours at small transaction cost and at comparatively small variations from the last quoted price. The function of providing liquidity to old stocks is important both for attracting new finance and for providing liquidity to the existing stocks. It encourages prospective investors to invest in securities, old or new, because they know that any time they want to get out of them into cash, for which they can go to the market and sell them off. Thus, the secondary market provides an opportunity to all concerned to invest in securities whenever they like. This opens a way for continuous inflow of funds into the market (Gupta, 1999).

The Foreign Exchange Market

According to Moles et al. (2002) exchange rate is the price at which one currency is traded with another. It is the price of the unit of one currency in terms of another. The foreign exchange market refers to the organizational setting within which individuals, business, governments, and banks buy and sell foreign currencies and other debt instruments (Carbaugh, 2001). The foreign exchange market is the largest and most liquid market in the world. The estimated world-wide amount of foreign exchange transactions is around $1.5 trillion a day. It has been estimated that the world’s most active exchange rates can change up to 18,000 times during a single day.

Unlike stock or commodity exchanges, the foreign exchange market is not an organized structure. It has no centralized meeting place and no formal
requirements for participation. Nor is the foreign exchange market limited to any one country (Sharan, 2003). For any currency, such as the US dollar, foreign exchange market consists of all locations where dollar is exchanged for other national currencies.

A typical foreign exchange market functions at three levels:

(i) In transactions between commercial banks and their commercial customers, who are the ultimate buyers and suppliers of foreign exchange,

(ii) In the domestic inter-bank market conducted through brokers, and

(iii) In active trading in foreign exchange with overseas banks.

Exporters, importers, investors and tourists buy and sell foreign exchange from and to commercial banks rather than buying from and selling to each other. The major banks who trade foreign exchange generally do not deal directly with one another but instead use the services of foreign exchange brokers. The purpose of the broker is to permit the trading banks to maintain desired foreign exchange balance. If at a particular moment a bank does not have the proper foreign exchange balances, it can turn to broker to buy additional foreign currency or sell the surplus. Brokers thus provide a wholesale, interbank market in which trading banks can buy and sell foreign exchange. Brokers are paid a commission for their services by the selling bank.
The third tier of the foreign-exchange market consists of the transactions between the trading banks and their overseas branches or foreign correspondents. These international transactions carried out primarily by telephone and computers (Carbough, 2001).

Corporations use the foreign exchange market for a variety of purposes related to their operations. Among these are payment for imports, conversion of export receipts, hedging of receivables and payables, payment of interest on foreign currency loans, placement of surplus funds and so forth. Many companies as a matter of policy restrict their participation in the market to transactions arising out of their business of producing and selling goods and services. Others, mainly giant multinationals, utilize their considerable financial expertise to take positions purely with the intention of generating financial profits from exchange rate movements (Apte, 2002).

It is believed that the variation in exchange rate affects the firm value and the firm value is reflected in its share prices. At the same time, exchange rate is affected by the stock prices also. A booming stock market will attract foreign investment, and it will lead to the inflow of foreign exchange and the resulting rise in the value of domestic currency. The opposite also may happen in case of falling stock prices. In an open economy, the expectations of relative currency values influence the level of domestic and foreign interest rates, which in turn affect the present value of a firm’s assets. This suggests that exchange rates play a crucial role in the movement of stock prices.
In this context, the importance of an efficient market concept should be examined for understanding the integration and inter-linkages between the foreign exchange market and the stock market. The theoretical background of the market integration will be examined in the succeeding section.

Section II: Market Integration - Concepts

The precondition for market integration is the existence of an efficient or least segmented market. Therefore, it is vital to understand the concept of market efficiency.

Market Efficiency

The three different concepts of market efficiency are:

(i) Allocative efficiency,
(ii) Operational efficiency, and
(iii) Informational efficiency.

The role of market in a competitive economy is to allocate scarce resources between competing ends in a way that leads to the scarce resources being used most productively. This means that the highest bidder for the resources gets to use them. When this occurs markets are said to be allocatively efficient.

A market is said to be operationally efficient when the transaction costs of operating in the market are determined competitively. In other words, the market operates in a competitive environment with market-makers and brokers
earning normal profits on their activities. A strict definition of operational efficiency implies that the transaction costs of making a market are zero.

A market is said to be informationally efficient if the current market prices ‘instantaneously and fully reflects all relevant available information’ (Black, 1992).

A financial market is said to be efficient, if current prices of the market reflect all available relevant information. A stock market is efficient when security prices reflect all available public information about the economy, financial markets, and the specific company involved. The implication is that market prices of individual securities adjust very rapidly to new information. As a result, security prices are said to fluctuate randomly about their “intrinsic” value. The more market participants and the more rapid the release of information, the more efficient a market should be (Van Horne and Wanchowics Jr, 2001).

As stock market, foreign currencies are heavily influenced by expectations regarding future price movements. Besides, any new pertinent information alter traders views regarding future course of prices, and is immediately reflected in the current prices.

A market is said to be efficient if the current prices fully and instantaneously reflects all available information. If market is efficient, the current price would immediately “jump”, in view of the changes in
expectations as new information arrives; if it did not, excess profit opportunities would arise.

Even though, the current fundamentals may be quite sluggish and insensitive to current events, expectations about future values of the fundamentals can be very sensitive to current information. In general, the efficient markets approach assumes rational expectations.

Fama (1972), a pioneer in efficient market research has described three levels to market efficiency. They are:

- **Weak - form efficiency**: current prices fully reflect the historical sequence of prices. In short, knowing past price patterns will not help to improve forecast of future prices.

- **Semi strong - form efficiency**: Current prices fully reflect all publically available information, including such things as annual reports and news items.

- **Strong - form efficiency**: Current prices fully reflect all information, both public and private i.e. information known only to insiders.

**Market Efficiency in Stock Market**

Most financial economists would agree that it is desirable to see that capital is channeled to the place where it will do the most good. That is, a reasonable goal of government policy is to encourage the establishment of allocationally efficient markets, in which the firms with the most promising investment opportunities have access to the needed funds. However, in order
for markets to be allocationally efficient, they need to be both internally and externally efficient. In an externally efficient market, information is quickly and widely disseminated, thereby allowing each security’s price to adjust rapidly in an unbiased manner to new information so that it reflects investment value. In comparison, an internally efficient market is one in which brokers and dealers compete fairly so that cost of transacting is low and the speed of transacting is high.

In this context, Fama’s formulation of the efficient market model will make it clearer. Fama presented a general notation describing how investors generate price expectations for securities. That is:

$$E = \left( \frac{P_{j,t+1}}{\Phi_t} \right) = \left[ 1 + E \left( \frac{r_{j,t+1}}{\Phi_t} \right) \right] P_{jt}$$

Where:

- $E$ = expected value operators,
- $P_{j,t+1}$ = price of security $j$ at time $t+1$,
- $r_{j,t+1}$ = return on security $j$ during period $t+1$, and
- $F_t$ = the set of information available to investors at time $t$.

Here $E = \left( \frac{P_{j,t+1}}{\Phi_t} \right)$ denotes the expected end of period price on security $j$, given the information available at the beginning of the period. Continuing, the term $1 + E \left( \frac{r_{j,t+1}}{\Phi_t} \right)$ denotes the expected return over the forth coming time period on securities having the same amount of risk as security $j$, given
the information available at the beginning of the period. Lastly, \( P_{j,t} \) shows the price of security \( j \) at the beginning of the period. Thus, it states that the expected price for any security at the end of the period \( (t+1) \) is based on the security's expected normal rate of return during that period. In turn, the expected rate of return is determined by the information set available at the start of the period \( F_t \) (Sharp et al, 2001).

**Market Efficiency in Foreign Exchange Market**

The concept of market efficiency in foreign exchange market is similar to that of the stock market. In the foreign exchange market, even though the current fundamentals may be quite sluggish and insensitive to current events, expectations about future value of the fundamentals can be very sensitive to current information. Consequently any new information may lead to a 'jump response' in current exchange rate and, as expectation are altered; the exchange rate can fluctuate rather widely in the short-run.

Under the efficient market expectation are formed 'rationally,' i.e., traders know the 'true' model and base their expectations of future exchange rates on such a model. In general, the efficient markets approach assumes rational expectations. If the forward rate is a guess about next period's spot rate based on all information currently available, changes in the forward rate caused by new information should be correlated with changes in the spot rate, which also depends upon expectations of future course of fundamentals.
If foreign exchange market is theoretically efficient, the following conditions will be met:

(a) **Purchasing power parity**: Spot exchange rates will adjust to reflect differences in inflation between the two currencies. If these were not true, the effective price of goods would vary between the two countries with different rates of inflation and trade flows would occur. The trade flows should, in turn, put the required pressure on the exchange rates.

(b) **Fischer effect**: Real interest rates will be the same in all currencies. Real rates are what is left after inflation is subtracted from the nominal rates. Therefore, differences in nominal rates between currencies reflect differences in inflation, assuming no or equal default and maturity risk premiums.

(c) **International Fischer effect**: Spot exchange rates adjust to reflect differences in nominal interest rates. In other words, one cannot earn higher returns by investing in high-interest-rate currencies; the currency one bought will devalue enough to offset the higher interest.
Interest arbitrage: The premium or discount of the forward price relative to the spot is equal to the interest differential between currencies. If this were not true, traders would arbitrage between the spot and forward markets by buying a currency spot, investing for a period of time, and selling forward.

The above conditions are most likely to be found where exchange rate floats freely without government intervention and where money markets and foreign exchange markets are well developed and widely accessible.

In the present study, the concept of market efficiency is most important, since the study examines the integration between the foreign exchange market and the stock market. There are sufficient theories in support of the interrelationship between these two markets i.e., the impact of foreign exchange market on the stock market and the influence of stock market on the foreign exchange market. If these markets are efficient information about the one market must disseminate to the other market. That is, if the foreign exchange market and the stock market are efficient, then these two markets should be integrated.

On the other hand, if markets are inefficient, information regarding one market will not disseminate to the other market. Among such markets, market integration is not possible. Under the absence of market integration, arbitragers can make use of the imperfections in the market and can make
huge profit. This will adversely affect the interests of small investors and institutions. Thus an understanding of the idea of market integration is of prime importance.

Market Integration

Integration is a process by which markets become open and unified, so that participants in one market have an unimpeded access to other markets. Integrated financial markets would imply that, in the absence of administrative and informational barriers, risk adjusted returns on assets of the same tenor in each segment of the market should be comparable to one another. Return differentials across markets could cause arbitrage shifts in portfolio of investors, ultimately bringing about an overall equity of returns across markets.

There have been several reasons that the need for well developed, efficient and integrated financial market is being increasingly stressed in modern literature on economics and finance. In finance theory, this refers to market condition that reduces arbitrage opportunities and also helps investors to diversify their portfolio across different markets, and hence reduce risk exposures. An economist considers one such development as facilitators of savings, investment and consequent economic growth.

Moreover, under such development, as impulses in one market get reflected quickly in other markets, transmission mechanism of monetary policy becomes smooth and speedy and thus policy intervention becomes
more effective in bringing fruits in desired direction within specified time horizon. The development of deep and integrated financial market, therefore, has been emphasized by monetary policy makers in modern days (Nath and Samantha, 2003).

According to Litzenberger and Ramaswamy (1982) it is an empirical question whether principal economic indicators, including the exchange rate, are significant explanatory factors of stock market returns. If economic variables are significantly and consistently priced in stock market returns, they should be cointegrated.

There are different ways of defining ‘financial market integration’ in the literature. To achieve financial market integration in the broader sense, it will suffice if all the conditions for the undisrupted execution of financial market transactions and for the functioning of market are fulfilled. This definition includes all institutional factors such as the regulations of the domestic financial sectors, the existence of capital controls, accounting regulations or tax systems, and legal restrictions. However, uniform standards and the absence of artificial barriers alone are not enough to guarantee actual integration. Even in the largely liberalized environment, country specific risks and other factors can cause a lasting segmentation of financial markets (Herrmann and Jochem, 2003).

A more precise definition of financial market integration should therefore include not only the necessary conditions but also the sufficient
conditions. Financial market integration in the narrower sense consequently implies not just the possibility of cross-border transactions but also requires investors to be willing to enter into such transactions. In this context Scitovsky's (1969), definition on market integration is worth mentioning. According to him “the perfect integration of asset market means...that the assets must be transferable and the portfolio preferences of individual asset holds are regionally unbiased.” Hence, integration can be defined as a situation where investors earned the same risk adjusted expected return on similar financial instruments in different markets.

Thus, it can be concluded that against the above background if the stock market and the foreign exchange market are integrated separately, there could be an interrelationship between these two markets. The theoretical background of the interaction between the foreign exchange market and the stock market are discussed in the next section.

Section III: Inter-linkages between the Foreign Exchange Market and the Stock Market

Foreign exchange markets and stock markets play a crucial role in influencing the development of a country’s economy. The relationships between stock prices and exchange rates have frequently been utilized in predicting the future trends for each other by fundamentalist investors.

The possible inter-linkages between stock prices and exchange rates are suggested by several arguments. Important among them are those identified in
'goods market approaches' (Dornbusch and Fischer, 1980) explaining the possible impact of exchange rate on stock prices and the 'portfolio balance approaches' (Branson et al, 1977) for justifying impact in reverse direction. The theoretical support for the impact of exchange rate on stock prices is very strong, especially from the point of exchange rate risk, rather than the effect of stock prices on the foreign exchange rates. The theoretical ideas of the impact of exchange rates on stock prices and then the impact of stock prices on exchange rates are discussed separately below.

The Impact of Exchange Rate on Stock Prices

The impact of exchange rates on stock prices can be explained particularly with the help of 'goods market approaches'. The 'goods market approaches' show that as many companies borrow in foreign exchange for their operations, a change in exchange rate affects the cost of funds and value of earnings of many firms. This in turn affect the competitiveness of a firm and its share prices – a depreciation of local currency makes exporting goods more attractive to foreigners, resultant increase of foreign demand for goods raises the revenue of the firms, the value of the firms appreciates and thus share prices increase. On the other hand, an appreciation of local currency makes exporting goods less attractive to foreigners, as a result, decrease in demand for goods reduces the revenue of the firms, the value of the firms depreciates and thus share prices decrease. The sensitivity of an exporting firm to a change in exchange rate is just opposite to that of an importing firm.
Therefore, on aggregate basis, the effect of exchange rate fluctuations on stock market seems to depend on both the importance of a country’s international trader in its economy and the degree of the trade imbalances.

The theoretical background of the impact of foreign exchange rate on stock prices and through which the firms can be discussed in detail by taking into account the different types of foreign exchange risk exposures to the firms. Therefore, various types of exposures and techniques to manage exposures will be discussed further. Before that it is vital to have a brief understanding of the various types of risks that the firms are facing in general.

Types of Risk

The value of firm’s assets, liabilities and operating income changes continuously in response to changes in a number of economic and financial variables such as exchange rates, interest rates, inflation rates, relative prices and so forth. These uncertainties are called macroeconomic environmental risks. In addition, uncertainties related to its operating business such as interruptions in raw material supplies, labour problems, success or failure of a new product or technology and so forth have an impact on the firms’ performance. These uncertainties are grouped as core business risks.

When the core business risks are specific to a firm, macro economic uncertainties are general, i.e. they affect all firms in the economy (Jeff, 1989). However, the extent and nature of impact of macroeconomic risks, especially exchange rates depend upon the nature of a firm’s business. For instance,
fluctuations in exchange rate will affect net importers and net exporters quite differently. When the value of domestic currency increases in relation to the foreign currency the exporters cannot export more, but for the importers it is possible to import cheaply. At the same time when the value decreases import will become dearer and the exporters are in advantage.

Corporations take risk management very seriously. Recent surveys find that risk management is ranked by financial executives as one of their most important objectives. Given its real world prominence, one might guess that the topic of risk management would command a great deal of attention from researchers in finance, and that practitioners would therefore have a well developed body of wisdom from which to draw in formulating hedging strategies (Froot et al, 1993).

According to modern portfolio theories, there are mainly two types of risks. They are: (i) Systematic risk or Non diversifiable risk, and (ii) Unsystematic risk.

Systematic risk refers to that portion of total variability in return caused by factors affecting the prices of all securities. Economic, political and social changes are sources of systematic risk. Their effect is evident on the prices of nearly all individual common stocks and or all individual bonds together in the same manner.

Unsystematic risk is unique to a firm or industry. Such factors as management capacity, consumer preferences, labour strikes and the like cause
unsystematic variability of returns. Firms with high systematic risk tend to be those whose sales, profit and stock prices follow the level of economic activity and the level of securities market closely.

Yadav et al (2000) argue that international business operations have all those risks that domestic operations have. But, international operations encounter several other risks. These risks can be broadly classified into three categories, namely, political (country) risk, interest risk and exchange rate risk.

Political risk comes from the uncertainties about the stability of government policies, ideological orientations of ruling parties and general likes and dislikes in the host country for foreign investments. Political instability can create lose of confidence among the investment community, and they in turn may withdraw their fund from the host country. This may create violent fluctuations in the stock market.

Interest rate risk is the outcome of variations in interest rates in domestic as well as foreign financial markets. An unfavourable movement of the interest rate can cause loss either in absolute terms or in terms of the opportunity forgone (Barry and Story, 1990).

Share values can be affected by the fluctuations in the general level of interest rates. The general level of interest rates fluctuates with the business cycle, and the share value fluctuates inversely with interest rates. The fluctuation of bond values as interest rates change is known as interest rate
risk. Whereas, exchange rate risk results from the volatility of exchange rates i.e. the greater the volatility, the greater is the risk. If left uncovered, this risk may result in huge losses to a business.

Among these risks, exchange rate risk deserves a special treatment, since different studies show different results on the relation between exchange rate and the firm value. This inconclusive evidence is counter intuitive. Not only that a recent survey study conducted by Yadav et al. (2000) among the corporate managers of Indian companies shows that majority of them (82 per cent) are facing foreign exchange risk.

Before going into a detailed examination of exchange rate risk, it is essential to understand the capital asset pricing theories. Capital market theory deals with how capital asset prices are determined in the market place. The prices of a capital market reflect the expected return and risk associated with that asset. Under equilibrium conditions there are two major asset pricing models. They are (a) the capital asset pricing model (CAPM), and (b) the arbitrage pricing theory (APT) models.

(a) Capital Asset Pricing Model (CAPM)

Capital Asset Pricing Model (CAPM) is a widely used theoretical description of the way in which investment assets are priced. The theory reveals that more the systematic risk, greater the expected return (Strong, 2001). The model contains a risk-free rate of interest (Rf). What counts is the return earned above the risk free rate, called the excess return. The excess

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returns on a particular stock are directly related to the beta of the stock and the expected excess return on the market in the next period (Sharpe, 1970).

The mathematical specification of Capital Asset Pricing Model is as follows:

\[ E(R_i) = \text{Riskless rate} + \text{Risk Premium} \]
\[ = R_f + \beta_i \left[ E(R_m) - R_f \right] \]

where

\[ E(R_i) = \text{expected return on security 'i'}, \]
\[ R_f = \text{risk free rate of interest}, \]
\[ \beta_i = \text{beta of security, and} \]
\[ E(R_m) = \text{expected return on the market}. \]

The traditional Capital Asset Pricing Model mentioned above tells us that exchange rate being a firm specific and hence unsystematic which can be diversifiable. However, international Capital Asset Pricing Model says that expected excess returns of risky assets are linear function of not only their beta’s but also with exchange rate factor. In other words international capital asset pricing model confirms that in a multi-national case return on securities is highly influenced by the exchange rate factor. Thus it shows that security returns are affected by the exchange rate fluctuations. The extended model can be shown as:
where
\[ R_{t,t} = \lambda_0 + \lambda_m \beta_{m} + \lambda_e \beta_{e} + \mu_t \]

- \( R_{t,t} \) = stock return on firm ‘I’,
- \( \beta_m \) = market beta, and
- \( \beta_e \) = exchange rate beta.

The Capital Asset Pricing Model is limited by many factors. First of all it consists of a number of assumptions. It is also necessary to specify a concept like “the market portfolio”, but constructing such a basket is challenging. Finance theory requires that all assets be included in the market portfolio, including non financial assets such as real estate, gold and so forth. It cannot be done conveniently and some proxy is used. Therefore, beta calculated via the Capital Asset Pricing Model will be inconsistent if the market portfolio is incomplete.

(b) Arbitrage Pricing Theory (APT)

Due to the drawbacks of Capital Asset Pricing Model an alternative model of asset pricing was developed by Ross (1976). He proposed a more complex model centered around Arbitrage Pricing Theory (APT). The key point behind the Arbitrage Pricing Theory is the seemingly logical statement that the market return is determined by a number of distinct factors. Roll and Ross (1980) states that Arbitrage Pricing Theory assumes that a security’s long-run return is directly related to its sensitivities to unanticipated changes in four economic variables – (1) inflation (2) industrial production (3) risk
premium, and (4) the slope of the return structure of interest rates. Assets, even if they have the same Capital Asset Pricing Model beta, will have different patterns of sensitivities to these systematic factors. The distinct factors which are influencing the market return include exchange rate factor also. Thus, like Capital Asset Pricing Model in an international context here also security returns are influenced by the exchange rate factor.

The general representation of Arbitrage Pricing Theory model can be shown as,

\[ R_A = E\left( R_A \right) + b_{1A} F_1 + b_{2A} F_2 + b_{3A} F_3 + b_{4A} F_4 \]

where

- \( R_A \) = actual return on security A,
- \( E\left( R_A \right) \) = expected return on security A,
- \( b_{iA} \) = sensitivity of security A to factor i such as exchange rate, and
- \( F_i \) = unanticipated changes in factor i.

The risk premium on a particular security is determined by the security sensitivity to each number of a set of macroeconomic factors including the exchange rate and with each factor associated with its own premium. The specification of exchange rate factor is highly relevant, since the Arbitrage Pricing Theory requires the specification of macroeconomic factors (Sharpe et al, 2001). In the international context, among the macro economic factors
exchange rate deserves special treatment. This is because here security returns are highly influenced by the exchange rate factor. Thus, Arbitrage Pricing Theory also confirms the exchange rate risk in the stock market.

Hence, the international asset pricing theories specify the relevance of exchange rate risk to the security returns. When exchange rate fluctuates security returns and by which stock market prices also varies. Thus, in this context it is pertinent to examine different exchange rate risk exposures.

Exchange Rate Risk

Since the advent of floating exchange rates in 1973, firms around the world have become acutely aware of the fact that fluctuations in exchange rates expose their revenues, costs, operating cash flows and hence their market value or share prices to substantial fluctuations. Firms which have cross-border transactions – exports and imports of goods and services, foreign borrowing and lending, foreign portfolio and direct investment and so on are directly exposed. Not only that, even purely domestic firms which have absolutely no cross-border transactions are also exposed because their customers, suppliers and competitors are exposed (Apte, 2002).

Foreign exchange risk arises out of the fluctuations in the value of assets, liabilities, income or expenditure when unanticipated changes in exchange rate occur. An open foreign exchange position implies a foreign exchange risk. When a firm owns an uncovered claim in foreign currency it is
said to be ‘long’ and when it has an uncovered liability in foreign currency, it is said to be ‘short’ (Machiraju, 2002).

Bishop and Dixon (1992) defined corporate foreign exchange exposure as the possibility of a change in shareholder wealth arising from a movement in the foreign exchange rate. The functioning of exchange rate exposure will make clear how the share prices are influenced by the exchange rate movements. The three basic types of corporate foreign exchange rate exposures are: (i) Transaction, (ii) Economic, and (iii) Translation.

(i) **Transactions Exposure**

Firm value can be affected by transactions exposure. In brief, transactions exposure refers to a potential gain or loss arising from business transactions that are planned, are currently in progress or have already been completed. However, the actual gains and losses are based on current foreign exchange transactions.

Transaction exposure involves the gain or loss that occurs when settling a specific foreign transaction. The transaction might be the purchase or sale of a product, the lending or borrowing of funds, or some other transactions involving the acquisition of assets or the liabilities denominated in a foreign currency. While any transaction will do, the term “transaction exposure” is usually employed in connection with foreign trade, i.e. specific imports or exports on open account credit (Van Horne and Wachowicz Jr, 2001).
In other words an unanticipated change in the exchange rate has an impact — favorable or adverse — on its cash flow. Such exposures are known as transaction exposure. It is a measure of the sensitivity of the home currency value of assets and liabilities which are denominated in foreign currency, to unanticipated changes in exchange rates, when the assets or liabilities are liquidated.

Situations in which transactions exposure arise are (Rajwade, 2000):

(a) When a currency is converted in order to make or receive payment for goods and services — import payables or export receivables denominated in a foreign currency.

(b) When a currency is converted to repay a loan or make an interest payment, or receive a repayment or an interest payment.

(c) When a currency is converted to make a dividend payment, royalty payment and so forth.

(d) Publication of a price list for goods which guarantees the price for several months, and the amount of goods to be sold is uncertain.

(e) Submission of bids or tenders in a foreign currency. A contingent exposure is created, dependent whether or not the contract is won.

(f) Funds held in foreign currencies as margin for commodity future contracts.

These transactions exposure can be measured with an analysis of the balance sheet. Here only completed deals represented by an asset or a liability
are included. In order to identify foreign – currency – denominated accounts, it is necessary to specify the home or country currency, which is usually the primary shareholders currency (Jones and Jones, 1987).

Because of the above mentioned facts, transactions exposure may reduce profit or create loss to a business firm. This in turn will get reflected in its shares in the form of falling prices. Since this is detrimental as far as a firm is concerned, transactions exposure must be managed effectively. The management of this exposure also has its own impacts on the stock prices, which will be discussed after explaining the rest of the risk exposures.

(ii) Economic Exposure

Economic exposure of exchange rate on firm’s share value is a measure of the reduction in cash flow and value that a business may experience as a result of a real adjustment in the foreign exchange rate. Cash flow and value depend on profitability, while profitability depends on price and volumes and particularly on the competition position of the business. If another firm can sell same product in same market for considerably less money, then the existing business could be in trouble. A real change in a currency exchange rate may enable a competitor to do so.

The exchange rate as a price becomes relevant when the extent of import and export activities in most markets, and the increasing degree of globalization of business operations is considered. If the competitors are in
another country, a move in the exchange rate may make a real and permanent change in its cost structure compared with the existing firms (Madura, 1989).

There are mainly two approaches to access the economic exposure. One is simulation or scenario approach. Under this profit and loss statement of the firm is considered. Here different exchange rate scenarios are analyzed and the behaviour of prices, quantities and costs are specified. This is based on considerations of competitive behaviour and the response of the various cost components to domestic and foreign inflation and changes in exchange rate. The firm needs to know the structure of its output markets, demand elasticities and competitive reactions, as well as detailed information of its cost structure and the response of the various cost components to changes in exchange rate and other macroeconomic shocks. Because of the simultaneous changes in different variables, precise identification of the impact of each becomes difficult.

The other approach to access economic exposure is the regression approach. Under this approach the sensitivity of the firm's cash flows to exchange rate is analyzed. Through regression approach the exposure of several factors can be identified simultaneously. Here several exchange rates, home and foreign interest rates, prices of key commodities like oil, to which a firm's cash flow is exposed, may be included. The impact of all these risk factors can be estimated analyzing the historical data.
The economic exposure is important in the present study because when exchange rate changes the competitors of the domestic firms may be in advantage. That is the competitors can sell the good in the market at a lower rate. This may lead to the reduction in profit or create loss to the domestic firms. This low profit or loss may be reflected in the share market in the form of low prices. Thus, it is necessary to manage the economic exposure.

(iii) Translation Exposure

Translation exposure of exchange rate on firm’s share prices arises mainly from the changes in the value in home currency of overseas assets and liabilities from one balance sheet date to the next. It also relates to the consolidations of the years profits and the effect on earnings per share when some of the profits relate to an overseas subsidiary (Watson et al, 2002).

The value in the reporting currency of the group is measured by using the rate of exchange at the balance sheet date. Therefore, even if the net worth of the subsidiary remained unchanged between balance sheet dates when denominated in the currency of the subsidiary, there would be a translation gain or loss in the reporting currency of the consolidated accounts. This is based on the movement of exchange rates between the two balance sheet dates (Shapiro, 1988).

Translation exposure has its effect on the profit and loss account also. It can be explained with an example: A Japan based company has a subsidiary located in the USA. Here the year’s profits denominated in United States
dollar will have to be included in yen in the consolidated accounts. This consolidation will happen even though the profit is retained in the subsidiary.

Thus, because of the above discussed reasons, price of the shares of a firm suffering from translation exposure may go down. This exposure also can be reduced by using the various hedging tools.

The above mentioned facts make it clear that all the three exposures may reduce profit or create loss to a business firm. This in turn will get reflected in shares in the form of falling prices. Since this is detrimental as far as a firm is concerned, all these exposures must be managed effectively. The management of exposures has its own impact on the share prices. Therefore a brief understanding of different hedging tools to manage exposures will make the picture clearer.

Management of Exposures

There are different types of hedging strategies to avoid or to minimize exchange rate risk exposures and ultimately by which to reduce the impact of exchange rate movement on the company's share prices. When different hedging techniques are adopted the negative impact of exchange rate movement on firm and industry portfolios will be the minimum. The important hedging tools to manage all the three exposures are mentioned below*

The transactions exposure is managed mainly through without financial market contracts and with financial market contracts. Transaction exposure

*Details of different hedging tools are given in Appendix 3.1.
arises mainly from operations and financial activities are managed without financial market contracts (Rodriguez, 1984). The important hedging tools to manage exposure from operations are:

(i) Risk shifting,

(ii) Leading and Lagging, and

(iii) Netting and Reinvoicing.

The exposure arising from financial activities can be minimized by using the following hedging methods. They are:

(i) Parallel loans,

(ii) Credit Swaps, and

(iii) Currency Swaps

The important transactions exposure management technique by using financial market contracts are:

(i) Forward contracts,

(ii) Hedging with the money market,

(iii) Currency Options, and

(iv) Currency Futures.

The choice of the above hedging methods depends on the nature of the exposure, the decision maker's risk preference, market forecasts, and the access available to the various markets (Howcraft and Storey, 1990).

In the case of economic exposure, it is difficult to manage risk by using financial market hedges. It is managed mainly by choice of markets, sourcing,
locations of production etc (Logue, 1995). The important ways to reduce economic exposures are:

(i) Reduce bad effects of exchange rate changes by shifting into products which are fewer price sensitive.

(ii) Decision regarding the source of inputs. If the input markets are global in scope, such as crude petroleum and petroleum products, sourcing decisions are relatively less important.

(iii) Shifting the location of production to countries whose currencies have depreciated in real terms can reduce the adverse of exchange rate changes.

As far as the translations exposure is concerned, the risk can be minimized mainly by adopting the following methods:

(i) Borrowing local currency and shifting the proceeds to another currency, leading or lagging receivables or payables, and changing the currency of purchase or sales transactions, and

(ii) Using profit or loss from foreign exchange contracts to offset a gain or loss on transaction.

All the three exposure management strategies and hedging tools mentioned above are adopted according to the circumstances, situations, and the nature of the companies. Therefore, discussion on the impact of a particular hedging technique on the stock market is futile. However, firms must adopt the proper hedging tools which the situations demand i.e., the
nature of the company's activities, and the general political and economic environment. When these hedging tools are adopted, the chances for loss to the company out of the exchange rate fluctuations may be the minimum. Hence, the effective hedging of the exchange rate risk exposures will leave the share prices of the corporates more or less intact by the fluctuations in the exchange rates. Therefore, in general, it can be concluded that above mentioned hedging tools will have their impact on the stock market.

All the three different exchange rate exposures and their hedging strategies show one side of the problem i.e. how share prices are influenced by the exchange rate movements. The theoretical base of the impact of stock price movements on the exchange rate is explained further.

The Impact of Stock Prices on Exchange Rate

The theoretical background of the impact of stock prices on the exchange rate can be explained mainly by the portfolio balance approach. This model is mainly attributed to Branson et al (1977). Authors like Dornbush (1976), and Frankel and Rodriguez (1975) have also contributed to this model.

The 'portfolio balance approach' recognise first that asset choice must be modeled as a portfolio diversification problem, that is, given total wealth, investors divide it between various assets – domestic and foreign money, domestic and foreign securities – based on their expected returns and, second, that assets denominated in different currencies are not perfect substitutes.
The portfolio balance approach takes a short-term view of exchange rates and broadens the focus from the demand and supply conditions for other financial assets as well. The asset market approach assumes that domestic and foreign bond are not perfect substitutes. Firms and individuals balance their portfolios among domestic money, domestic bonds, and foreign-currency bonds, and they modify their portfolios as conditions change. It is the process of equilibrating the total demand for, and supply of, financial assets in each country that determines the exchange rate.

Each individual and firm chooses a portfolio to suit its needs, based on a variety of considerations: the holder’s wealth and tastes, the level of domestic and foreign interest rates, expectations of future inflation, and so on. Any significant change in the underlying factors will cause the holders to adjust their portfolio and seek a new equilibrium. These actions to balance portfolios will influence exchange rates.

In addition to this, a growing stock market would attract capital inflows from foreign investors, which may cause an increase in the demand for a country’s currency. In this way local currency appreciates. The opposite would happen in case of falling stock prices where the investors would try to sell their stocks to avoid further losses and would convert their money into foreign currency to move out of the country. There would be demand for foreign currency in exchange of local currency. Because of this, rising stock prices would lead to an appreciation in local currency. In the opposite case, declining
stock prices would lead to a depreciation of local currency. Moreover, foreign investment in domestic equities could increase overtime due to benefits of international diversification that foreign investors would gain. In addition to that, movements in stock prices may influence exchange rates (and money demand) because investors’ wealth (and liquidity demand) could depend on the performance of the stock market. These all happens under the exchange rate regime that allows exchange rate to be determined by market mechanism.

The theoretical explanations discussed above reveal varied relationship between the foreign exchange market and the stock market. The goods market approaches talks about how stock market prices are influenced by the exchange rate? Different foreign exchange risk exposures such as the transactions exposure, economic exposure and translations exposures, and various hedging strategies to minimize these exposures confirm the impact of foreign exchange rate risk in the stock market. On the other hand, portfolio balance approaches demonstrates how foreign exchange rate is determined by the stock market prices? Therefore, the theoretical explanations do not rule out the integrated and inter-related nature of these two markets. Hence, there may exist four kinds of relationship between the foreign exchange rates and stock market prices. They are: (a) stock market prices influence exchange rates (b) exchange rates cause stock market prices (c) stock market prices and exchange rates are bidirectional (d) stock market prices and exchange rates are independent. Therefore, this is an empirical question to investigate all the
possible relationship between the foreign exchange market and the stock market.

Based on the above theoretical arguments, different econometric and statistical methodologies to explore the relationship between the foreign exchange market and the stock market have been discussed in the fourth section.

IV. Methodologies to Test the Linkages between Foreign Exchange Rate and Stock Prices

For the purpose of analyzing the linkages between foreign exchange rate and stock prices earlier researchers employed the following methodologies, and it is evaluated critically to identify the suitable methodology to be employed for our study. The important among them are:

(i) Linear Simple Static Regression,
(ii) Linear Simple Static Regression with heteroskedasticity,
(iii) Seemingly Unrelated Regression (SUR) model,
(iv) Generalised Autoregressive Conditional Heteroscedasticity (GARCH) Model,
(v) Granger Causality, and
(vi) Cointegration.

A) Engle-Granger methodology, and
B) Johansen’s cointegration analysis in a bivariate setting
(i) Linear Simple Static Regression

This method is attributed to Carl Friedrich Gauss, a German mathematician. The general form of the equation is:

\[ Y_i = \beta_1 + \beta_2 X_i + U_i \]

A two variable sample regression function estimated using Ordinary Least Squares method for examining the impact of exchange rate on stock prices and it is written as

\[ Y_i = \hat{\beta}_1 + \hat{\beta}_2 X_i + \hat{U}_i \]

where,

\[ Y_i \] = stock prices,  
\[ X_i \] = exchange rate,  
\[ \hat{\beta}_1 \] = estimated intercept coefficient,  
\[ \hat{\beta}_2 \] = estimated slope coefficient, and  
\[ \hat{U}_i \] = estimated residuals.

The algebraic sum of \[ \hat{U}_i \] is zero although \[ \hat{U}_i \] are scattered about the sample regression function. In the above equation value of \[ \hat{\beta}_2 \] will show the impact of exchange rate on the stock prices (Mills, 1999).

Many researchers (Jorion, 1991; Choi and Prasad, 1995; Vansconcellos and Kish, 1998; and Wetmore and Brick, 1998) have employed this method to examine the foreign exchange risk in the stock market. However, this static linear regression is a uni-directional method and it cannot be used for testing
integration and interrelationship between foreign exchange market and stock market.

(ii) **Linear Simple Static Regression with heteroskedasticity**

This method has been employed by researchers such as Choi and Prasad (1995) and Patro et al. (2002) to examine the relation between foreign exchange market and the stock market. The usual Ordinary Least Squares method does not make use of the 'information' contained in the unequal variability of the dependent variable. It assigns equal weight to each observation. But the method of Generalized Least Squares, takes such information into account explicitly and is therefore capable of producing estimates that are best, linear and unbiased (BLUE). A two variable Generalized Least Squares equation is normally written as

\[ Y^* = \beta_1^* X_{oi}^* + \beta_2^* X_i^* + U_i^* \]

Here original equation is transformed by dividing it with \( \sigma_i \), i.e.

\[ \frac{Y_i}{\sigma_i} = \beta_1 \left( \frac{X_{oi}}{\sigma_i} \right) + \beta_2 \left( \frac{X_i}{\sigma_i} \right) + \left( \frac{U_i}{\sigma_i} \right) \]

where

\( X_{oi} = 1 \) for each \( i \).

Under Generalized Least Squares method the variance of the transformed disturbance term \( U_i^* \) is now homoscedastic.

This procedure of transforming the original variables in such a way that the transformed variables satisfy the assumptions of classical model and then
applying Ordinary Least Squares method to them is known as the method of generalized least squares (GLS) method (Gujarathi, 1995).

Under the least squares it can be shown as:

$$\sum w_i \hat{u}_i^2 = \sum w_i \left( y_i - \hat{\beta}_1 - \hat{\beta}_2 \ast x_i \right)^2$$

where $w_i = \frac{1}{s_i^2}$

Here weight assigned to each observation is inversely proportional to its $s_i$.

The Generalized Least Squares method is an extension of Ordinary Least Squares method. As Ordinary Least Squares method, this test is mainly used for the risk analysis. Even though Generalized Least Squares method is superior to Ordinary Least Squares method, it is a one directional method and so it cannot be an appropriate method for testing integration and interrelationship between foreign exchange market and stock market.

(iii) The Seemingly Unrelated Regression (SUR) Model

The method of Seemingly Unrelated Regression (SUR) model has been used by Prasad and Rajan (1995), and Morely and Pentecost (1998) to study the foreign exchange risk in the stock market. The model consists of a series of endogenous variables that are considered as a group because they bear a close conceptual relationship to each other (Pindyck and Rubinfeld, 1991).
According to Zellner (1962) the Seemingly Unrelated Regression model consists of a series of equation linked because the error terms across equations are correlated.

The working of the model can be explained by using a two-equation model

\[ Y_1 = \alpha x + U_1 \]
\[ Y_2 = \beta z + U_2 \]

Here efficiency can be improved by writing the equation system as one combined equation and estimating that equation using generalized least squares estimation.

In order to write the system as one large equation 1 to N observations are assigned to the first – equation variables and observations N+1 to 2N to the second – equation variables. i.e.

\[
\begin{align*}
y & = \begin{cases} 
y_{i1} & \text{if } i = 1, \ldots, N \\
y_{i2} & \text{if } i = N+1, \ldots, 2N
\end{cases} \\
x^* & = \begin{cases} 
x_i & \text{if } i = 1, \ldots, N \\
0 & \text{otherwise}
\end{cases} \\
z^* & = \begin{cases} 
z_i & \text{if } i = 1, \ldots, N \\
z_{i2} & \text{if } i = N+1, \ldots, 2N
\end{cases} \\
u^* & = \begin{cases} 
u_{i1} & \text{if } i = 1, \ldots, N \\
u_{i2} & \text{if } i = N+1, \ldots, 2N
\end{cases}
\end{align*}
\]

Also

\[ s_1^2 = \text{Var}(U_1), \quad s_2^2 = \text{Var}(U_2), \text{ and } s_{12} = \text{Cov}(U_1, U_2) \]

The combined equation will be as

\[ y^* = \alpha x^* + \beta z^* + u^* \]

The generalized least squares procedure is applied to obtain parameter estimates for \( \alpha \) and \( \beta \).
Even though, Seemingly Unrelated Regression model has been used by many authors for exchange rate risk analysis, it cannot be used to examine the comovement and causality between the variables such as the stock prices and the exchange rates. This is a one directional analysis and interrelationship cannot be tested by this method.

(V) Generalised Autoregressive Conditional Heteroskedasticity (GARCH) Model

The Generalised Autoregressive Conditional Heteroskedasticity model was developed independently by Bollerslev (1986) and Taylor (1986). The model allows the conditional variance to be dependent upon previous own lags, so that the conditional variance equation in the simplest case is now

$$\sigma_i^2 = \alpha + \alpha_i u_{i-1}^2 + \beta \sigma_{i-1}^2$$

This is a Generalised Autoregressive Conditional Heteroskedasticity (1,1) model. $\sigma_i^2$ is known as the conditional variance since it is a one-period ahead estimate for the variance calculated based on any past information though relevant. Using the Generalised Autoregressive Conditional Heteroskedasticity model it is possible to interpret the current fitted variance, $h_i$ as a weighted function of a long-term average value, information about volatility during the previous period ($\alpha_i u_{i-1}^2$) and the fitted variance from the model during the period ($\beta \sigma_{i-1}^2$).

The Generalised Autoregressive Conditional Heteroskedasticity (1,1) model can be extended to a Generalised Autoregressive Conditional
Heteroskedasticity (p, q) formulation, where the current conditional variance is parameterized to depend up on q lags of the squared error and p lags of the conditional variance (Bera and Higgins, 1993).

$$\sigma_i^2 = \alpha_0 + \sum_{j=1}^{q} \alpha_j u_{i-1}^2 + \sum_{j=1}^{p} \beta_j \sigma_{i-j}^2$$

But in general a Generalised Autoregressive Conditional Heteroskedasticity (1, 1) model will be sufficient to capture the volatility clustering in the data, and rarely is any higher order model estimated (Brooks, 2002).

To capture the pervasive conditional heteroskedasticity in the daily observations, the impact of exchange rate exposure on stock prices can be discussed within a Generalised Autoregressive Conditional Heteroskedasticity regression framework. The model, where the stock prices of a company or an industry index ‘i’ at time ‘t’ is a linear function of the exchange rate risk factor is described below:

$$R_{i,t} = \alpha_i + \alpha_2 F_t + \epsilon_{i,t}, \quad \epsilon_{i,t} \sim T(0, h_{i,t})$$

$$h_{i,t} = \beta_1 + \beta_2 h_{i,t-1} + \beta_3 F_t + \beta_4 \epsilon_{i,t-1}^2$$

The estimation is based on the exchange rate, $F_t$. $R_{it}$ is the stock prices of firms or industry indices. $\beta_3$ is the exchange rate coefficient in the conditional variance equation.
Some of the authors like Koch and Saporoschenko (2001), Tai (2000), Bin et. al (2003) and Bailey et. al (2003) have employed Generalised Autoregressive Conditional Heteroskedasticity model to test the foreign exchange risk in the stock market. The Generalised Autoregressive Conditional Heteroskedasticity model is mainly used to test the volatility or to forecast the volatility of variables. This methodology is not used to examine the bidirectional relationship between the variables. Since the testing of market integration between the foreign exchange market and the stock market is the aim of this study, the cointegration methodology is found to be the suitable method of analysis.

(V) Granger Causality

This method was popularized by Granger (1969), even though it was earlier suggested by Wiener (1956). Therefore, it is also known as Wiener – Granger Causality test. Researchers such as Granger, Huang and Yang (1998) Baig and Goldfajn (1999), employed this methodology for the purpose of financial research.

The Granger causality test assumes that the information relevant to prediction of the respective variables, Y and X, is contained solely in the time series data on these variables.

The method of estimation can be shown as (Gujarati, 1995)

\[ Y_t = \sum_{i=1}^{n} a_i X_{t-i} + \sum_{j=1}^{n} B_j Y_{t-j} + U_t \]
\[ X_t = \sum_{i}^{n} \alpha_i X_{t-i} + \sum_{j=1}^{m} d_j Y_{t-j} + U_{1t} \]

where it is assumed that the disturbance \( U_{1t} \) and \( U_{2t} \) are uncorrelated.

There are four cases here:

1. Unidirectional causality from \( X \) to \( Y \) i.e.
\[ \sum a_i \neq 0 \text{ and } \sum d_j = 0 \]

2. Unidirectional causality from \( Y \) to \( X \) i.e.
\[ \sum a_i = 0 \text{ and } \sum d_j \neq 0 \]

3. Feedback, or bilateral causality i.e. when the set of \( X \) and \( Y \) coefficients are statistically significant from zero in both regression.

4. No Granger-causation is suggested when the sets of \( X \) and \( Y \) coefficient are not statistically significant in both the regression.

To implement the Granger causality test, for the first equation, the null hypothesis is

\[ H_0 : \sum a_i = 0 \text{ i.e. lagged } X \text{ terms do not belong to the regression.} \]

To test this hypothesis, the F-test is used i.e.

\[ F = \frac{(RSS_R - RSS_{UR})/m}{RSS_{UR}/(n-k)} \]

Where,

\( RSS_R \) = residual sum of squares of the restricted regression equation,

\( RSS_{UR} \) = residual sum of squares of the unrestricted regression equation,
\( m = \text{number of lagged } X \text{ terms,} \)

\( k = \text{number of parameters estimated in the unrestricted regression.} \)

If computed F value exceeds the critical F value, the null hypothesis is rejected and therefore, \( X \) causes \( Y \).

The same step can be followed to test the second equation i.e. whether \( Y \) causes \( X \).

The Granger causality test is limited by its lags. It is very sensitive to the number of lags used in the analysis. It is always advisable to use more lags than fewer lags. Therefore, one has to be very careful in implementing the Granger causality test. Besides, Granger Causality test assumes that data series are stationary at first order level which is highly restrictive in its assumption. Thus, it cannot be used to test the market integration hypothesis.

Not only that Hendry and Mizon (1978) finds that finding Granger causality in an empirical model does not necessarily entails "causal links" – in the sense of genuine influences in the real world – nor does the empirical absence of Granger causality entails no link. They strongly recommend that the case for the practical importance of Granger causality needs to be evaluated.

(VI) Cointegration Technique

Cointegration means that despite being individually non-stationary, a linear combination of two or more time series data can be stationary. Cointegration of two or more time series data suggests that there is a long-run,
or equilibrium, relationship between them. The pre-condition for the test of cointegration is the existence of a stationary data series. Therefore before getting into cointegration test it is necessary to test the stationarity of the data and thus the examination of the market integration hypothesis. The common methods which are used for this purpose are:

(a) Dickey-Fuller (DF) Test

(b) Augmented Dickey-Fuller (ADF) Test, and

(c) Phillips-Perron (PP) Test.

(a) Dickey-Fuller (DF) Test

This method was first introduced by Dickey and Fuller (1979), and so it is known as Dickey-Fuller test. The regression specification for the test can be shown as

\[ Y_t = \rho \ Y_{t-1} + U_t \]

Here, if \( \rho = 1 \), the stochastic variable \( Y_t \) has a unit root. If it is so, \( Y_t \) should be differenced once, and the differenced series will be stationary. It is called integrated of order one i.e. I(1). In the same way if the original series has to be differenced twice, it is called integrated of order two i.e. I(2).

Under the null hypothesis that \( \rho = 1 \), the conventionally computed statistic is called as the \( \tau \) (tau) statistic, and its critical values have been tabulated by Dickey and Fuller on the basis of Monte Carlo simulations (Fuller, 1976). This tau test is known as Dickey-Fuller (DF) test.
One of the main drawbacks of Dickey-Fuller test is that the problem of serial correlation is present. It is also seen that the autoregressive or moving average errors have a sizable effect on the power of the Dickey-Fuller test.

(b) Augmented Dickey-Fuller (ADF) Test

Augmented Dickey-Fuller (ADF) test is an extension of the Dickey-Fuller test. It can be shown as

\[ Y_t = \beta_1 t + \beta_2 t + \sum_{i=1}^{m} \alpha_i Y_{t-i} + \varepsilon_t \]

Here lagged difference terms are used for the analysis. m is selected to be large enough to ensure the error \( \varepsilon_t \) as a white noise. The number of lagged difference terms is determined empirically. The null hypothesis is that \( \rho = 1 \), i.e. there exists a unit root (Dicky and Fuller, 1981). When Dickey-Fuller test discussed above is applied to this model it is called Augmented Dickey-Fuller (ADF) test.

The Augmented Dickey-Fuller test is limited by its number of lags. It reduces the power of the test to reject the null of a unit root, because the increased number of lags necessitates the estimation of additional parameters and a loss of degree of freedom.

(c) Phillips – Perron (PP) Test

The Dickey-Fuller (DF) tests assume that the errors are statistically independent and have a constant variance. Phillips (1987), Phillips and Perron (1988) generalized the Dickey-Fuller procedure that allows for fairly mild
assumption concerning the distribution of errors. The Phillips-Perron approach is to add a correction factors to the Dickey-Fuller test statistics (Patterson, 2002).

The test can be shown as follows;

\[ Y_t = a_o^* + a_o y_{t-1} + \mu_t \]

and

\[ Y_t = \tilde{a}_o + \tilde{a}_1 y_{t-1} + \tilde{a}_2 (t-T/2) + \mu_t \]

Where \( T = \) number of observations and the disturbance term \( \mu_t \) is such that \( E\mu_t = 0 \), and there is no requirement that the disturbance term is serially uncorrelated or homogeneous.

The Phillips-Perron test statistics are modifications of the Dickey-Fuller t-statistics. The critical values for the Phillips-Perron statistics are precisely those given for the Dickey-Fuller tests (Franses, 1998).

(A) Engle – Granger Methodology

Engle – Granger (1987) method which is applied when the data at hand is thought to be nonstationary and possibly cointegrated. It is a single equation technique. The estimation can be conducted as follows (Brooks, 2002):

Step 1

In a specification like

\[ Y_t = \alpha_1 + \beta X_t + U_{1t} \]
make sure that all the individual variables are I(1). Then estimate the cointegrating regression using Ordinary Least Squares method. But here it is not possible to perform any inferences on the coefficient estimates. Now test the residuals of cointegrating regression to ensure that they are I(0). If they are I(0), proceed to Step 2; if I(1) a model containing only first difference should be estimated.

Step 2

Using the step 1 residuals as one variable in the error correction model, i.e.

\[ ?Y_t = \beta_1 ?X_t + \beta_2 (\hat{U}_{t-1}) + V_t \]

where

\[ \hat{U}_{t-1} = \Delta Y_{t-1} - \Delta X_{t-1} \]

The linear combination of variables that are stationary is also known as the cointegrating vector. Now, it is valid to perform inferences in the second stage regression, i.e. concerning the parameters \( \beta_1 \) and \( \beta_2 \), since all variables in this regression are stationary.

According to critics, this methodology suffers from a number of weaknesses. Firstly, the usual finite sample problem of a lack of power in unit root and cointegration tests is applicable. Secondly, there could be a simultaneous equation bias if the causality between \( Y \) and \( X \) runs in both directions. But this single equation approach requires the researchers to
normalize one variable. Finally, it is impossible to perform any hypothesis tests about the actual cointegrating relationship estimated at Step 1. However, these problems can be removed through a different approach based on estimation of a vector Autoregression (VAR) system.

(B) Johansen's Cointegration Analysis in a Bivariate Setting

Johansen's (1988) cointegration method has been used by many researchers like Shamsuddin and Kim (2003) for testing the possible linkages between exchange rate and stock market. This test procedure has several superiority. Further, by examining the distributional properties of maximum likelihood estimates of cointegrating vector, it is observed that the maximum likelihood estimator is super-consistent, symmetrically distributed and median unbiased - asymptotically and that an optimal theory of inference applies (Cheung and Lai, 1993). Johansen's approach also provides with a very flexible format for investigating the properties of the estimates under various assumptions about the underlying data generating process (Sarker, 1993). Since Johansen's test is carried out in a vector autoregressive model of reduced form, the problem of simultaneity can be avoided.

The steps involved in this method can be used to test market integration hypothesis and inter-relationship between exchange rate and stock market price index.

Johansen (1991, 1992, 1995) suggested three steps for the analysis. Firstly, since the stationary data series are necessary, it is important to test the

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data series for unit root. If data series is stationary, as the next step cointegration should be tested. If cointegration is present Vector Error Correction Model (VECM) is the appropriate method. Otherwise, Vector Autoregression (VAR) is the method to be considered for further analysis.

From the above discussion of various methodologies, it is clear that Johansen’s cointegration method¹ is the superior method to test the market integration and interrelationship between the foreign exchange market and the stock market.

Concluding Remarks

The present chapter has discussed the various theoretical aspects of market integration and interlinkages between the foreign exchange market and the stock market. In addition to this, the chapter examined different econometric techniques employed by the earlier studies to examine the relationship between exchange rate and stock prices.

Foreign exchange risk is a pricing factor for corporates. There are theories in support for the impact of stock prices on the exchange rate also. The goods market approach, exchange rate risk exposures, and their various hedging methods revealed how stock prices or firm and industry portfolios are affected by the exchange rate movements. The influence of stock market on the exchange rate was made clear by the portfolio balance approach. With reference to market integration hypothesis, theoretical debate revealed that

¹ For detailed examination of Johansen's Methodology see Chapter Five.
depending upon the context the stock market and the foreign exchange market may be integrated. With respect to India, we hypothesis that both markets may be integrated due to the innovation and policy changes such as the convertabilities of current account through the introduction of liberalized exchange rate system, the opening up of the capital account for international investment, the advent of floating exchange rates, the development of 24-hour screen based global trading, the increased use of national currency outside the country, the innovation in internationally traded financial products, the recent spurt in the Foreign Institutional Investments (FII), and the introduction of American Depository Receipts (ADR) and Global Depositors Receipts (GDRs) after 1992. Even though some amount of research has taken place in international context, in India a few studies only have been taken place to this end. Besides, most of the international and national studies are one directional. They mainly concentrated on the examination of exchange rate risk exposure.

From the various methodologies discussed above, it is clear that methods such as ordinary least squares (OLS), generalized least squares (GLS), seemingly unrelated regression (SUR) model are mainly used for testing the exchange rate risk, and they are testing one directional relationship. While generalized autoregressive conditional heteroskedasticity (GARCH) model is mainly used for testing the volatility, granger causality test assumes that data series are stationary at first order level which is highly restrictive in its assumption. Johansen's bivariate cointegration method is found to be the
best and one of the latest model to examine the interlinkages between the stock prices and the exchange rates. This test can be used to examine the market integration and interrelationship between the exchange rate and stock prices.

The next chapter would present the economic profile of various firms, industries, and BSE sensex. This will help us to understand the nature of the firms and industries which are going to be examined in the fifth chapter.