Dynamics of Exchange Rate and Stock Prices: A Study on Emerging Asian Economies

By

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Dedication

I dedicate this thesis to my father, Mr. Muzaffar Hussain, who is praise worthy for his sustenance of me on right lines because I am today, only due to his efforts for my sake.

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Abstract

The Purpose of this study is to explore the behavior of exchange rates in five Asian economies; namely Pakistan, India, Indonesia, Korea and Sri Lanka. The causality between capital and currency markets has been investigated in the first section of study. In second section, the link between exchange rate and economic variables has been scrutinized, while in the third section, forecasting performance of economic models has been compared with that of random walk and autoregressive integrated moving average model.

Using Granger Causality test and Johansen Cointegration, the causality between stock and currency markets has been explored. Link between macro economic fundamentals and exchange rates has been investigated using ordinary least square method and Johansen's cointegration, while forecasting performance of economic models has been compared with that of random walk and autoregressive integrated moving average model using one graphical and four statistical measures. These measures are Perfect Forecast Line (PFL), *Root Mean Square Error* (RMSE), Mean Absolute Error (MAE), *Median of Absolute Deviation* (MAD) and Success Ratio (SR).

Nature of short run causality between stock and currency markets has been found different in different countries. In Pakistan and Sri Lanka, causality runs from stock market to currency market while feed back relationship has been found in case of Indonesia and Korea. In India, causality running from exchange rate to stock market has been found significant. However, no long run causality between stock and currency markets has been found in sample economies. Thus these two financial markets support asset market theory in the long run. However, regression analysis proves that economic variables are not senseless, whereas Johansen cointegration technique affirm the existence of long run relationship between exchange rate and macro economic variables. Johansen's cointegration reports three cointegrating equations in Pakistan, India, Korea and Sri Lanka while two cointegration equations in case of Indonesia. Vector Error Correction Mechanism has been applied to gauge the speed of adjustment in relationship between exchange rate and macroeconomic fundamentals.

Lastly predictive capacity of economic fundamentals based models namely Purchasing Power Parity, Interest Rate Parity and Adhoc model has been compared to that of Random Walk and Autoregressive Integrated Moving Average Model. In the sample forecasting has been used for comparison. Predictive capacity has been investigated using one graphical method called Perfect Forecast Line and four statistical methods. Statistical

methods include Root Mean Square Error, Mean Absolute Error, Median of Absolute Deviation and Success Ratio. All the four measures support fundamentals based approaches in all the sample economies except Indonesia where Random Walk Model has the power to beat fundamentals' based approaches on the basis of all the four measures of statistical evaluation.

CHAPTER 1

INTRODUCTION

This study explores the interaction between currency and stock markets, macroeconomic determinants of nominal exchange rates and predictive capacity of exchange rate models is five emerging Asian economies. These are Pakistan, India, Indonesia, Korea and Sri Lanka.

1.1 Interaction between Currency and Stock Markets

Though different financial crises are associated with different factors, yet all major crises, Latin America, 1994 East Asian, 1997 Argentina, 1994 Turkey, 2001 and global financial crisis, 2000-01 and again 2007 have one common characteristic; that is simultaneous effect on prices of stocks and currencies. However, this simultaneous effect has raised a question that which one of them is the leading indicator causing the other to move. Theoretically, no consensus has yet been achieved on the nature and direction of association between stock market indices and exchange rate movements. Findings on the issue of causation are mixed. In the literature on relationship among different financial markets, there are three approaches. These are portfolio approach, traditional approach and asset approach.

According to portfolio approach, the changes in stock market lead to changes in exchange rate due to portfolio adjustment made by investors. Here the portfolio adjustment refers to the process of inflow and outflow of capital. While according to traditional approach, exchange rate causes the stock prices to move. The transmission channel of traditional approach is that exchange rate changes affect the balance sheet of firms by changing their assets and liabilities, denominated in foreign currency, thus changing the competitiveness of country and its export oriented firms in the foreign markets which is ultimately, reflected in stock market. According to asset approach, the currency price is equal to the discounted future currency prices and there may not be any link between currency market and capital market.

In the literature, findings on relationships between capital markets and currency markets lack consensus. Some researchers like (Abdalla et al. 1997) found causation running from

exchange rate changes to stock market returns while others found exactly the opposite one running from stock market returns to exchange rates. Positive association running from stock returns to exchange rates can be justified as follows. If stock returns are higher, local investors will sell their foreign assets and will buy the domestic assets. This conversion of foreign assets into domestic ones will increase the demand for local currency in the foreign exchange market by putting upward pressure on its price. Secondly, increase in stock returns increases the wealth of local investors and they also demand more money, which ultimately results in higher interest rates. If interest rate parity theory does not completely offset interest rate differential, then higher interest rate would attract capital from other countries into local stock market just as Germany attracted capital from other European countries in 1993 by increasing the interest rates.

Negative association of stock returns with exchange rates along with causation running from exchange rate to stock prices can be justified because if the home currency depreciates, the demand for exports of local firms will increase in international markets, as they become less expensive for foreign buyers. Stock markets reflect this performance through rise in their stock prices. However, weak currency may not have positive impact on exports because of the counter pricing and pre arranged international transactions. A weak or even no relationship between exchange rate and stock market can also, theoretically, be justified. According to asset market theory, the exchange rate is just the price of an asset, which is equal to the expected future exchange rates. Any factor affecting exchange rate in future will affect the currency price today. It is not necessary that the factors affecting the exchange rates and those affecting the stock returns are same. So according to this theory, there may not be any link between exchange rates and stock market indices. In addition to this, the feed back relationship may also exist, which is bi directional causality running from stock market to exchange rate (Portfolio balance approach) and from exchange rate to stock market (Traditional approach). Such dynamic interaction of stock market returns and exchange rates is the first area of interest in this research.

Using Granger Causality test and Johansen's cointegration technique, the direction of causality has been tested between stock and currency markets of sample economies.

Tests that have been applied in this research are not limited to Augmented Dickey Fuller test, Johansen's Cointegration and Granger Causality test. These have helped in understanding the behavior of stock prices and exchange rates in the sample economies of Asia. These markets include Pakistan, India, Indonesia, Sri Lanka and South Korea. The results have implications for policy makers, investors and academicians.

Asian crisis, 1997 hampered the economic growth of many developing Asian economies. Exchange rates of these countries have received less than due attention of researchers and motivates to find out what causes the exchange rate to move in these economies? As developing countries are more exposed to international disturbances, these might not exhibit stable exchange rates and therefore, their currency prices frequently deviate from parity conditions, therefore, a better understanding of their exchange rate movements is inevitable to provide greater economic stability.

1.2 Historical Overview of Sample Stock Markets

In this study, the causality between stock markets and exchange rates has been tested in five Asian economies, namely Pakistan, India, Indonesia, Korea and Sri Lanka. To calculate the stock market returns, KSE 100 index has been used in case of Pakistan, while BSE 30 index, Jakarta composite index, KOSPI composite index and Colombo all shares index have been used in case of India, Indonesia, Korea and Sri Lanka respectively.

1.2.1 Karachi Stock Exchange

Karachi stock exchange is the largest stock market in Pakistan and second oldest stock market in South Asia. It is located on Karachi stock exchange road, Karachi, Sindh province. As of December 2009, as many as 654 firms were listed in this market with total market capitalization over U.S $30 billion, both domestic as well as overseas. Karachi stock market was set up in September 1947 and was registered in March 1949. It was started with 5 companies with total paid up capital of Rs. 37 million. Trading in Karachi stock exchange started with 50 shares index, which turned into KSE 100 index in 1991. Since then, it is being used as most accepted measure of market performance. Four years later, it was felt to measure the performance of entire market and accordingly in

1995, KSE all shares index was created. In addition to KSE 100 index, KSE all shares index and KSE 30 index are also used to measure the performance of Karachi Stock exchange. It is most liquid stock market in Pakistan. KSE 100 index is market-weighted index in which companies are selected on the basis of their market capitalization. To represent the entire market, a company with highest capitalization is selected from each sector. In 2002, Business Week declared Karachi Stock Exchange as the best performing market in the world. However, in 2008, KSE 100 index started moving down. This is partly due to elections year in the country and partly due to global financial crisis.

1.2.2 Bombay Stock Exchange

Bombay stock exchange is the largest stock exchange in South Asia and the 12th largest stock exchange in the world. This market was founded in 1875 and as of August 2009, total number of listed firms were about 4,700 with total market capitalization of about $U.S 1.1 trillion. BSE 30 index is widely used index in India as well as all over the world. It is also known as BSE SENSEX index, which means Bombay Stock Exchange Sensitive Index. BSE 30 index was established in 1986 and since then it is most widely used BSE barometer. Three years later i.e. 1989, Bombay national index was formed, which was used to measure the performance of stocks listed at five major stock markets. These markets included Calcutta, Ahmedabad, Madras, Bombay and Delhi. Later in 1996, Bombay national index was renamed as Bombay 100 index and since then it is calculated on the basis of value of stocks listed over BSE only. To meet the needs of investors, Bombay Stock exchange reports different indices. BSE 200 index, BSE 500 Index, DOLLAX 200 and DOLLAX-30 are some of BSE indices. Currently, BSE has shifted all indices to free float except BSE-PSU index.

1.2.3 Jakarta Stock Exchange

Previously called Indonesian Stock Exchange, established in 1912 during the rule of Dutch government, it closed many times during World War 1 and World War 2. In 1977 Jakarta Stock Exchange reemerged and started its operations in full swing. Jakarta Composite and Jakarta Islamic Index are two widely used indicators of market performance. JII was launched in 2002. This market works under the supervision of

Capital Market Regulatory Agency, which directly reports to the Ministry of Finance. This market is divided into three main segments. These segments include regular market, cash market and negotiated market. In regular market, all the Bid and Ask orders are processed by JATS, which is automated trading system of Jakarta Stock Exchange. This system gives highest priority to highest bids, however, if two bids are of same price, then, JATS gives first priority to first coming order. In negotiated market, security prices are determined on the basis of bargaining between different players. These include exchange members, investors and Clearing and Guarantee Corporation.

1.2.4 Korea Stock Exchange

Korea Stock exchange was established in 1956 with twelve companies. As of December 31, 2007 Korea stock exchange had more than 1700 listed companies with over $1.1 trillion market capitalization. Like other capital markets, investors have to open accounts to trade in the market. Therefore, general investors trade through registered companies.

1.2.5 Colombo Stock Exchange

This is the main stock exchange in Sri Lanka and one of the modern stock exchanges in South Asia, because it provides fully automated trading system to investors. Its vision is to increase national wealth through creation and trading of securities. This stock exchange has different offices located in Kandy, Matara and Negombo. By the year 2007, Colombo Stock exchange had above 230 listed firms with total market capitalization of over $7.6 billions, which is almost 24% of total gross domestic product of Sri Lanka. Trading of equity securities dates back to late 1890s, where Colombo Brokers association started trading of private limited shares. Formally Colombo stock exchange came into existence in 1985, when this market took over from brokers association. This contains membership of 15 different financial institutions, which also act as brokers. All Shares price index (ASPI) and Malnika Price index (MPI) are most commonly used performance measures of this market.

1.3 Determinants of Nominal Exchange Rates of Emerging Asian Economies

What causes the exchange rate to move is a far from settled issue in international finance and is the second area of interest in this study. Exchange rate stability may not be

achieved by efficient regulation of stock market if no causality runs from stock market to exchange rate.. This creates strong need for formal investigation of what causes exchange rate to move? Different theories propose different variables as explanatory variables for determination of exchange rate. For example, monetary model says that it is relative money supply, which causes the exchange rates to move. Monetary model incorporates purchasing power parity theory, which says that it is inflation differential between two countries, which determines the level of exchange rate. Absorption approach argues that when a country produces more than what it absorbs, then there will be trade surplus and currency will appreciate and vice versa. Using quarterly data from 1984 to 2008, the contribution of different macroeconomic variables in exchange rate determination of five selected economies of Asia has been investigated. These economies are Pakistan, India, Indonesia, Korea and Sri Lanka. Different studies have used different variables and have presented different relationships. This wide variety of estimates is not surprising because empirically, the modeling of exchange rate behavior is very difficult. Such sharp variance in results can partly be attributed to methodology used in the study and partly to the choice of variables and the period of study.

Currency behavior may wrongly be attributed to stock market behavior because justification of causation running from currency behavior to stock returns is based on somewhat naive assumptions. For example, if weak exchange rate is assumed to increase the stock return in capital markets, it has been assumed that listed companies have significant export sales and capital markets efficiently reflect this increased performance through higher stock prices. No empirical evidence of this causality running from exchange rate to stock market in the long run may be partly due to lack of export oriented firms and partly due to inefficiency of capital markets. Many researchers have attempted to beat naïve random walk model in forecasting accuracy, but have almost failed and this remains as elusive as it was. However, failure of economic models in forecasting exchange rate is not proof that economic fundamentals are soundless rather it may be due to technical methodologies required for modeling exchange rate behavior. For example, in the presence of outliers, economic fundamentals fail to explain exchange rate behavior.

Similarly, existence of non-linearities contaminates the results of ordinary least square method or other linear techniques.

1.4 Historical Overview of International Financial Systems

International financial systems are set of agreed principles, rules, conventions and financial institutions, which facilitate international trade, multilateral investment transactions and reallocations of capital among different countries. Before coinage, precious metals such as gold and silver were used to act as medium of exchange and thus played the role of money. These metals were termed as bullion. Egypt and Mesopotamia were two states, which practiced bullion before coinage. However at times, money played very limited role in the economic processes of human life. Until 19th century, the world economies were not integrated. America, Europe, China and India were separate economies and practicing separate monetary systems. However, with the advent of European colonization of North and Latin Americas, especially with the establishment of Spanish empire, European economies got integrated with American economies. Then with the start of European colonization of Asian countries, European currencies especially, British Pound got popularity in Asian economies. However, before 1870, there were regional monetary systems. From 1870 to 1914, Gold standard acted as international financial system. In this system, price of every currency was fixed in terms of gold and exchange rate between two countries was determined on the basis of how much gold a particular currency could purchase? Currency price determined under this standard was termed as mint parity price. The years between World War I and World War II are known as period of de globalization as in these years, the international trade as well as capital mobility had shrunk in comparison with the years before World War I. In this period, countries had abandoned Gold Standard. The period from 1914 to 1944 is called as Intermittent Period. By the end of World War I, United States rejected the requests of countries for cancellation of war debts as a result of which, United Kingdom had become heavily indebted to United States. This heavy debt on United Kingdom made it possible for United States to displace her as economic giant. But then in 1928, Great Depression started showing its effects on United States' economy. It culminated in 1930, when more than 1300 U.S banks collapsed just in one year. After World War II, as many

as 44 nations gathered in Bretton Woods in an international conference. John Maynard Keynes led the British delegate in this meeting. As a result of this meeting, International Monetary Fund (IMF) and World Bank were created. A new exchange rate system, called Bretton Woods System was established. In this system, price of every currency was fixed with United States Dollar, which in turn was linked with gold. Initial price of Dollar was set equivalent to 1/35 ounces of gold. In this system, 1% fluctuation was allowed above and below initial set rates. As a result of this system, United States Dollar had become international currency. Its demand was much higher than its supply as it was being used for international purchases. This put upward pressure on the price of Dollar, which led to huge trade deficits in United States. Due to this threat to United States' economy, American President Nixon abolished Bretton Woods system in 1971. This is known as Nixon shock in economic literature. After abolishment of this system, the world major economies had adopted floating exchange rate system in which market forces based on demand and supply determined the price of currency. However, European countries made Snake arrangement. In Snake arrangement, currency prices of participating countries were linked with Deutsche Mark. So Germany was playing leading role. Snake arrangement ended in 1979 and European Monetary System came in practice among participating European economies. Under this system, currency price of participating economies was linked with European Currency Unit, which was currency of weighted basket of participating currencies. Later in 1992, the economic objectives of Germany were different from those of other participating economies. With the fall of Berlin wall and reunification of East and West Germany, the country had a challenge to curtail price level. While other European economies were facing recession, Germany increased interest rate, which resulted in capital inflow from those of other participating economies. Then in 1999, Euro came as international currency in these economies. Two years later in 2001, Euro completely replaced the domestic currencies of participating economies.

1.5 Exchange Rate Systems of Sample Economies

1.5.1 Pakistan

Pakistan Rupee is the currency of Pakistan. The Rupee is derived from Sanskrit word rupa, which means silver. State Bank of Pakistan, central bank controls the issuance of Rupee. When Pakistan got independence from British rule in 1947, Pakistan Rupee came into circulation. In the first year of its independence, Pakistan used Indian coins and notes. In 1948, Pakistan issued its own notes and coins. Like Indian Rupee, Pakistan Rupee was also divided into sixteen annas. Thirteen years later in 1962, Pakistan Rupee was divided into hundred paisas. As far as history of exchange rate of Pakistan is concerned, it remained pegged to United States Dollar until 1982. In this era, General Zia ul Haq, the President of Pakistan abolished pegging of Pakistan Rupee with U.S Dollar and introduced managed exchange rate system. Managed exchange rate system has characteristics of both fixed as well as floating exchange rate systems. Under this system, market forces determine the level of currency price but central banks do intervene. Such interventions can be direct and indirect. Buying and selling of foreign currency by central banks, directly from foreign exchange market, is called direct intervention. This may be sterilized as well as non-sterilized intervention. In sterilized intervention, central banks keep control of money supply, which is not the case with non-sterilized intervention. The abolishment of pegged exchange rate in favor of managed float by General Zia ul Haq is regarded as the best decision as it helped in preserving the export competitiveness of Pakistan. Consequently, Pak Rupee devalued by more than 38% from 1982 to 1987. Depreciation of Pakistan Rupee against United States Dollar continued till arrival of twentieth century when Pakistan experienced large current account surpluses, which put upward pressure on the price of Pak Rupee. However, to keep export competitiveness, State Bank of Pakistan purchased Dollar from forex and lowered interest rates. The disastrous year for exchange rate of Pakistan is the year 2008. From December 2007 to August 2008, Pak Rupee lost its value against Dollar by more than 23%. The reasons of this depreciation were political uncertainty, terrorists' activities and increased trade as well as current account deficit.

1.5.2 India

Indian Rupee is the official currency of India. Reserve Bank of India acts as central bank and controls the issuance of Indian Rupee. India got independence from British rule in 1947. Although India is one of the earliest issuers of coin (almost 600 B.C), however, it is believed that Indian Rupee introduced by Sher Shah Suri (1486-1545). That Rupee was equivalent to 40 pieces of copper. In 1898, Indian government officially joined Gold Standard and pegged its currency with British Pound. Initial exchange rate of Indian Rupee was set as 15 Rupees equal to one British pound. Although British government was replacing local currencies of their colonies with British Pound but no such decision was made in British India. In 1927, pegged exchange rate of India was reset to 13.5 Rupees equal to one British Pound. This pegged exchange rate system was practiced until 1966, when pegging was changed from British Pound to United States Dollar. In this year, Indian Rupee was devalued and its value was set equal to 7.5 Rupees per U.S Dollar. This pegging lasted until 1971, when that time American President abolished Bretton Wood system. Reserve Bank of India has issued polymer money in 2009. Initially, one hundred crore notes were issued. These polymer notes had expected life of more than 5 years, which is 4 times of traditional paper notes. Although exchange rate system of India is market-determined system in which market forces of demand and supply determine the price of currency yet, Reserve Bank of India makes frequent transactions in foreign exchange market to stabilize the exchange rate against U.S Dollar. Therefore, it is de facto controlled exchange rate system. Such a system is also called as dirty or managed float. However, other exchange rates have comparatively larger volatilities and look more like a floating exchange rate system. In addition to this direct intervention by the Reserve Bank of India, the central bank had also imposed different kinds of capital controls to manage exchange rate.

1.5.3 Indonesia

Bank of Indonesia acts as central bank, which controls the issuance and supply of Indonesian Rupiah, which is official currency of Indonesia. One Rupiah is divided into 100 sens but due to higher inflations, all the coins and notes denominated in sen have

now become obsolete. Although legal tender is one Rupiah but it is now worthless and is not in circulation. The currency in circulation starts from Rupiah 25 to Rupiah 100,000. Over its history, Rupiah has faced high inflation due to which it continuously depreciated against other currencies. Efforts were put to strengthen it but of little avail. From 1946 to 1950, Indonesian Rupiah had no International recognition and its price was determined in Black market. At the time of independence in 1949, exchange of Indonesian Rupiah was set 3.8 Rupiah to one U.S Dollar. In late 1960s and early 1970s, Indonesia was hit by severe inflation. Prices were increasing at a rate of above 600% and demonetizations of Indonesian Rupee had started. The official exchange rate was set 0.25 Indonesian Rupiah equivalent to one U.S Dollar, which was artificial and could not sustain and multiple exchange rate systems put in place for time being. In 1965 President Suharto took executive control of Indonesia. Suharto made many economic reforms, which targeted acquiring foreign exchange reserves by government and stability plan of 1966 helped a lot in strengthening the economic conditions and boosting exports of Indonesia. However, Indonesia adopted fixed exchange rate system from 1971 to 1978. The exchange rate was fixed 415 Rupiah equal to 1 $ U.S. This rate was fixed with the help of government intervention in the currency market. In 1978, due to fall in oil prices in international market and decline in government reserves, Indonesian Rupiah was devalued by 33% and exchange rate moved to 625 Indonesian Rupiah equal to 1 $ U.S. Due to these factors, government abandoned fixed exchange rate system and adopted floating exchange rate system in 1978, which remained in operation till arrival of Asian Financial crisis in 1997. Now Indonesian Rupiah is a freely convertible currency but investors still find it risky to hold.

1.5.4 Korea

Economy of South Korea is fourth largest in Asia and fifteenth largest in the world. Its economy relies heavily on international trade. South Korea is the 11th largest exporter in the world. Korean Won is official currency of South Korea. Won was first introduced in 1902 and remained in practice till the invasion of Japan on Korea. Won was replaced with Japanese yen at par in 1910 when Korea lost its sovereignty. In 1945, after World War II, Won again replaced Japanese yen at par but due to division of Korea into North

Korea and South Korea, Won was divided into two currencies. Northern Won for North Korea and Southern Won for South Korea. Initially, government of Korea adopted pegged exchange rate system. They fixed the price of Won with that of United States Dollar. The initial set exchange rate was 1$=15 Won. Then due to Korean War, Won followed much devaluation. From 1945 to 1951, Won changed from Won 15= $ 1 to 6000 Won= $ 1. Two years later in 1953, Hwan replaced South Korean Won at rate of 100 Won= 1 Hwan. In 1962, Won was reintroduced and rate was fixed 1 Won=10 Hwan. Both currencies remained in use till 1975, when all coins of Hwan were withdrawn and Won achieved the position of being the sole legal tender of South Korea. Bank of Korea is the central bank of Korea, which is responsible for issuance of currency and control of money supply. This bank was established in 1952 when it assumed the functions of Bank of Joseon. Currently, Korean Won is on float, whose price is determined by market forces of demand and supply.

1.5.5 Sri Lanka

Sri Lankan Rupee is the official currency of Sri Lanka. It is divided into 100 cents and its issuance and supply is controlled by the central bank of Sri Lanka. Before 1825, Ceylonese RixDollar used to be the official currency of Sri Lanka. However in 1825, Ceylonese RixDollar was replaced by British Pound at the rate of 13.5 RixDollar =1 British pound and Silver coins of British Pound were made legal tender. In 1928, treasury currency denominated in British pound was issued. In 1871, British pound was replaced with Indian Rupee at exchange rate of one Indian Rupee equivalent to 2.3 schillings. In 1895, government of Sri Lanka issued its first paper currency in the form of Rs. 5 note, which was followed by issuance of Rs. 50, Rs. 500 and Rs. 1000 denomination notes. In 1952, Central bank of Ceylone assumed the responsibility of issuing and controlling currency. From 1970 to 1978, dual exchange rate system was in practice in Sri Lanka. Under this system, official rate was available for import of food, drugs and other indispensable items while other imports used to be made at higher exchange rate. Similarly proceeds from export of tea, coconut, rubber and some other items used to be converted into home currency at official rate while all other exports were given the benefit of higher exchange rate. This dual exchange rate system was abolished in 1978

and since then Sri Lankan Rupee has been allowed to float freely. However, this shift of exchange rate system from dual to floating one, the price of Sri Lankan Rupee went down by almost 50% just in one year.

1.6 Comparative Performance 0f Exchange Rate Models

Do economic fundamentals based models of exchange rates are strong enough to beat simple and naïve autoregressive random walk model or not? A bulk of empirical research demonstrates that volatile movements in nominal exchange rates are apparently unexplained by macroeconomic variables alone. Models based on macroeconomic fundamentals, have almost failed to forecast exchange rate and now researchers are moving towards random walk models. "Whether fundamentalists or chartist can better explain exchange rate movement" is a question, which is still unanswered in the literature of international finance. In this study, *in the sample forecasting* performance of four different models has been compared to that of traditional benchmark random walk model (RWM) of exchange rate. These models consist of three economic models; namely purchasing power parity (PPP), interest rate parity (IRP) and adhoc model and one additional model i.e. autoregressive integrated moving average (ARIMA) model. The predictive capacity of economic and autoregressive models has been compared using *in the sample forecasts*. This is consistent with methodology used by Meese and Rogoff (1988). They used actual values of independent variables instead of using forecasted values to make forecasts. Fundamentalists posit exchange rate as a function of macroeconomic variables and thus use different linear equations to forecast it, while technicians or chartists speculate it as a function of its own lagged values and thus completely ignore the role of independent variables. Exchange rate models proposed over last three decades have provided contradicting and unreliable results when applied on data sets of different time periods and have proved unstable when compared to random walk and autoregressive models. These economic or structural models are characterized by instable parameters and poor forecasting performance (Najand and Bond, 2000). One possible reason of failure of structural models in explaining exchange rate movement is our limited understanding of variables causing it to move. An attempt has been made in this study to compare the forecasting performance of three models based on economic

theories and two models based on random walk behavior of exchange rate. Three economic models include Purchasing Power Parity, Interest Rate Parity and adhoc model. Two chartists' models are simple random walk model used by Meese and Rogoff (1983), who documented that no economic model outperforms naïve random walk model of exchange rate, and auto regressive integrated moving average model. Quarterly bilateral exchange rates of sample economies against U.S Dollar have been used for period 1984 to 2008.

There are different approaches to forecast exchange rates and these approaches extremely differ from each other. At one extreme, there are very complex techniques consisting of hundreds of equations while at the other extreme, only good imagination can create accurate exchange rate forecasts. Structural models are based on economic theories, while random walk and ARIMA totally ignore them and forecast exchange rate on the basis of its own lagged values. In linear regression equation, the coefficients of independent variables are estimated and then by plugging the values of independent variables, the value of dependent variables is calculated. If values of all independent variables are known, it is called unconditional forecasting while if forecasting of dependent variable is dependent upon some forecasted value of independent variable, it is called conditional forecasting. ARIMA has become a popular forecasting technique, which completely ignores the role of independent variables and thus contradicts all underlying economic theories except those, which assume repeated patterns in the movement of exchange rate.

1.7 Objectives of the Study

The objectives of this study are: -

1. To determine the nature of causality between stock and currency markets of emerging Asian economies.
2. To find out the common determinants of nominal exchange rates of sample economies.
3. To determine the predictive capacity of different exchange rate models based on economic fundamentals and their comparison with chartism based models.

1.8 Significance of the Study

Whether one realizes or not, the fluctuations in exchange rate affect the life of every person. Exchange rate movements influence directly or indirectly many decisions of the firms, operating in domestic as well as international environment. Therefore, survival in international market with out studying the movement of exchange rate is hardly possible. The significance of this study can therefore be discussed at following levels.

1.8.1 Firm Level Significance

Exchange rate movements influence the life of firms, as all major decisions of firms operating in international environment are dependent upon exchange rate movements. This study facilitates firms in making following decisions.

1.8.1.1 Hedging Decision

Firms make hedging decisions on frequent basis. Managers are to choose whether or not to hedge their long and short exposures in foreign currencies? Hedging decisions are based on expectations about future exchange rate. This study finds out the determinants of exchange rate movements, which can be used to forecast exchange rate and thus it helps managers in deciding whether to hedge their receivables or payables in a particular currency or not.

1.8.1.2 Target Market Decision

Firms target international markets for purchasing raw materials as well as selling finished goods. However, the issue is where to sell and where from to purchase? Keeping other things constant, raw materials will be purchased from a country whose currency is expected to depreciate against home currency and exports are made to a country whose currency is expected to appreciate against home currency. Therefore, forecasting exchange rate of trading partners helps firms in selection of markets for import of raw material as well as export of finished goods. This study compares the forecasting performance of different exchange rate models and thus helps firms in selection of better forecasting techniques and ultimately in making target market decisions.

1.8.1.3 Financing Decision or Borrowing Decision

Ideally, firms borrow from a country, which exhibits low interest rate and whose currency is expected to depreciate over time. So managers face a problem about how to forecast exchange rate and decide about optimal financing location. This study explores the relationship between exchange rate and different explanatory variables and thus helps them in prediction of exchange rates and exploration of optimal place for borrowing/financing.

1.8.1.4 Capital Budgeting Decision

For capital budgeting purpose, the future cash flows are discounted to present value. Exchange rate directly affects firms' cash flows. When measured in local currency, a foreign profitable project may result in negative NPV due to exchange rate fluctuations. Talking about cash flows from perspective of parent company, capital budgeting decision can be made when all cash flows are measured in home currency. So all the interim and terminal cash flows of a project are converted into parent currency at future exchange rate instead of at current rates, therefore, forecasting exchange rate is inevitable in making capital budgeting decision.

1.8.1.5 Earnings Assessment

At the end of the year, all accounts of subsidiaries are to be consolidated into parent currency. For assessing earnings of parent company, assessment of earnings of subsidiaries and future exchange rate are required because these assessed earnings of subsidiaries are converted into parent currency at future exchange rates. This study helps in forecasting exchange rate on the basis of which managers can convert earnings of subsidiaries and project earnings into parent currency.

1.8.2 Country Level Significance

At macro level, this study helps in

1.8.2.1 Exchange Rate Stability

By analyzing the factors determining exchange rate, this study helps policy makers to stabilize the exchange rate. This stability of exchange rate reduces the transaction exposure of firms and they may conduct international business without spending huge

money on hedging their exposures. Exchange rate stability can be achieved only after making thorough investigation into its behavior and determination of factors causing it to change. This study accomplishes this objective by testing exchange rate as a function of economic fundamentals as well as its own lagged values.

1.8.2.2 Predictability of Currency Market

If the behavior of one market, say foreign exchange market, is predictable from the behavior of other market, say capital market, then the vulnerability of emerging economies towards international economic indicators increases. For example, if financial markets are integrated and share of the foreign investors in stock market of the country is significant and stock returns reduce, foreign investors will start converting their assets back into their home currencies. This will increase the demand of foreign currency and will exert downward pressure on the price of local currency. The causality between stock market and exchange returns will thus help in predicting the behavior of one market due to changes in other market.

1.8.2 3 Currency Crises be avoided through Efficient Regulation of Capital Markets

If significant causation runs from capital market to currency market then currency rates can be stabilized through proper regulations of capital markets. In other words, if stock markets crash leads to currency crash then currency crash could be avoided through taking corrective and timely measures in capital market. This research will enable to determine and control the degree to which currency market crash could be avoided through effective measures in capital markets. However, this objective can be achieved if causality running from capital market to currency market is found in sample economies.

1.8.2.4 Arbitrage Opportunities

In simple words, capitalizing on price discrepancy is called arbitrage. There are three major types of arbitrage. These are locational, triangular and covered interest arbitrage. Buying currency from a location, where it is priced low and selling it simultaneously at another location, where it is priced high is called locational arbitrage. Arbitrageurs make round trip transactions until market forces realign this discrepancy. When cross rate

between two foreign currencies in not fair, then there is opportunity for triangular arbitrage. Fair cross rate is calculated by the following formula

$$Value\ of\ \ Currency\ A\ in\ units\ of\ \ Currency\ B = \frac{Value\ of\ \ A\ in\ Local\ Currency}{Value\ of\ \ B\ in\ Local\ Currency}$$

For example, if spot rate between Pak Rs./$ U.S is 60 and Pak Rs./Euro is 100 then no arbitrage cross rate will be

$$\$\,U.S \diagup Euro = \frac{100}{60} = 1.667$$

If market rate differs from 1.667 and there are no transaction costs, then there is opportunity for triangular arbitrage.

If Interest rate parity theory does not hold, then there is opportunity for covered interest arbitrage. Through this research, possibility of covered interest arbitrage will be explored. This task will be accomplished by examining the predictive capacity of interest rate parity theory.

1.8.2.5 Stability of Price level

When exchange rate depreciates, the import prices go up as more units of local currency are surrendered to purchase one unit of foreign currency. For example, weakening of Pak Rupee against U.S Dollar raises the petroleum prices and ultimately, this increases the prices of other goods in local country. Therefore, better understanding of exchange rate behavior will help regulators to curtail inflation in the country.

1.8.2.6 Improvement in Balance of Payment Account

Exchange rate directly affects balance of payment account. Appreciation of local currency causes imports to increase leading to current account deficit and depreciation of local currency causes exports to increase leading to current account improvement. A vigorous examination of exchange rate will, therefore, be helpful in improving the balance of payment account as well.

1.8.2.7 Forecasting Performance of Exchange rate Approaches

In addition to exploring the causality between stock markets and foreign exchange market, this study compares the forecasting performance of various exchange rate

models. These include economic as well as random walk models. This study compares their predictive capacity against adhoc model.

This research is unique in its nature because, firstly, it explains the dynamic interaction between stock and currency markets both in the short as well as in the long run. Secondly, it finds out the common factors of determination of nominal exchange rates of sample economies. Thirdly, in comparing forecasting performance of economic and autoregressive exchange rate models, it uses graphical as well as statistical approach. Fourthly, the scope of this study is not limited to one country only. It encompasses five sample economies namely Pakistan, India, Indonesia, Korea and Sri Lanka. Fifthly, it compares the predictive capacity of economic models against not only widely used random walk model but also against autoregressive integrated moving average model.

Chapter 2

Review of Literature

2.1 Review of Literature on Interaction between Capital and Currency Markets

In literature, Frank and Young (1972) were the first, who examined the association of stock prices with exchange rates. On the basis of empirical analysis of six different exchange rates, they concluded that no relationship existed between stock returns and exchange rates. Thus they supported asset approach and negated both traditional as well as portfolio approach.

The speed, with which the financial institutions are getting inter-connected with each other, has led to higher share of foreign investments in domestic markets. Thus one of the implications of globalization is that the share of foreign investors has significantly increased in the domestic markets. This higher share has increased the degree of vulnerability as sudden capital outflow from domestic market causes home currency to move down. Gazioglu (2000) writes that globalization has created problems of international debt and balance of payments for many developing economies like Malaysia, Indonesia and Turkey. He argues that reason behind this threat is globalization.

Gormus (2001) find mix results about relationship of stock returns and currency exchange rate. He proved that currency crisis was not the leading indicator of stock market crisis and that contemporaneous relationship existed between stock returns and currency rates.

Foreigners invest in international stocks and enjoy the benefits of international diversification. In literature, this is possible only if stock markets are negatively related to each other. Exchange rate may offset this gain on international investment. Theoretically, if exchange rate risk is hedged successfully through pegging or joining same currency zone like Euro zone, then, international stock markets may provide opportunity for international diversification. But this is possible only if these markets are negatively correlated. Aggarwal (1981) studied the relationship between stock price indices and Dollar exchange rates over a period of 1974 to 1978 and showed through simple regression that stock indices and price of Dollar have positive correlation and found this relationship more stronger in short run than in the long run. He studied that variations in

exchange rates change the balance sheet of multinational firms by converting their assets and liabilities denominated in foreign currency, which induces the value of their equity to change in proportion to change in exchange rates. Thus he supported the traditional approach.

In developed economies many researchers have documented no relationship between stock market indices and exchange rates, thus supporting the asset approach. Ratner (1993) employed cointegration technique to determine the nature of relationship between U.S stock prices and U.S Dollar exchange rate. He documented that these two financial markets were not related because he could not reject the null hypothesis of no cointegration. So he too supported asset approach. Ajayi and Mougoue (1996) also conducted research on relationship between financial markets in developed economies. They studied capital and currency markets in seven advanced economies. These included Canada, France, Italy, Germany, Netherlands and Japan. They applied error correction mechanism and documented bi directional relationship between these two markets, thus supported the feed back relationship, both over the short as well as over the long run. Nieh and Lee (2001) supported asset market approach of relationship between stock market and exchange rates. They conducted research in G-7 countries and employed two cointegration techniques viz Engle-Granger and Johansen's cointegrations. They did not find any significant relationship between two financial markets over the long run; however, they found ambiguous and significant short run relationship in these economies. Solnik (1987) explored the impact of several variables like interest rate and inflation on stock indices. Using monthly data of Japan, United Kingdom, Germany, Canada, Switzerland and Belgium, he found that currency depreciation had positive but insignificant effect on the U.S stock market indices. Ong (1999) employed non-linear least square method and examined the association between exchange rate and U.S stock market indices. He suggested a very weak association between exchange rates and U.S stock market indices. He concluded that decrease in value of currency led to rise in stock market returns and vice versa.

Amare and Mohsin (2000) employed the cointegration technique and tested the long run relationship of stock indices with changes in exchange rates in nine Asian markets.

Analyzing monthly data, they found that from 1980 to 1998, stock prices of only Singapore and Philippine were positively related to exchange rates.

Allsopp Louise (2003) highlighted one common feature of currency crisis i.e. calm before storm. He found that all major currency crises were characterized by calm foreign exchange market before flurry activities started leading to strong speculative attacks on currency. He discussed three models of currency crises namely first generation models, which were built on framework of economic variables, the second generation models included speculative attacks on currency while third and new generation models considered the role of moral hazard in lending, leading to crisis through creating runs on banks.

Kashefi (2006) found that since inception of Euro as common currency by EEC in 1999, MNCs enjoyed the benefit of complete elimination of exchange rate risk but the markets were positively correlated thus international diversification was no more possible.

Nshom (2007) explored the association of exchange rate and stock returns by applying linear regression on 18 performing stocks of London Stock Exchange. He showed that significant exposure of stock returns existed to movements in exchange rates for the samples companies included in FTSE 100 index. He further found that particular currencies might pose more risks to certain companies than they did with others. By applying the lagged values tests, he found that significant stock mispricing existed and stock prices were positively related to last day prices

Feridun (2007) made an attempt to identify the major determinants of currency crisis in Turkey. Analyzing Turkish data from 1980 to 2006, Feridun found that indicators of traditional currency crises had failed to provide satisfactory explanation of currency crisis in Turkey. His results had significant deviations from the traditional literature of international finance. He found that it was financial liberalization of Turkey, which had led to financial crisis. He justified that globalization made the countries vulnerable to factor changes in the globe.

Dornsbusch (1975) suggested that relationship between stock markets and exchange rates could be explained on the basis of capital mobility. He argued that reduction in stock price caused exchange rates to move down. Transmission mechanism is reduction in

wealth of local investors, whose demand for money decrease. Decrease in demand of money, in turn, decreases the price of money i.e. interest rates. This reduction in interest rate leads to capital outflow. When foreign investors take capital out of country, it puts negative pressure on the price of local currency in foreign exchange market and currency depreciates. Two years later, same findings were documented by Boyer (1977).

Convergence of exchange rates is pre requisite for formation of big economic unions like European Union. Becker and Stephen (2009) used common factor approach to measure the convergence of exchange rate over time in European Monetary Union over monthly data of 1970 to 2001. They used U.S $ as reference currency. Their analysis period covered different stages. It ranged from breakdown of Bretton Woods System in 1971 to formation of EMS in 1979 and then to 1992 crisis, which led to breakdown of EMS and fixed conversion of national currency against Euro in 1999. Complete convergence of two series means that they move exactly together. If X and Y series are non stationary then convergence may be defined with the notion of cointegration. But this definition is useful only when series are non-stationary. They concluded that no complete convergence existed over analysis period for 12 member countries either for nominal or real exchange rate.

In this study, causality between stock markets and exchange rates has been tested and possibility of existence of such causality has empirically been investigated. Cointegration has been used to test whether stock returns and exchange rates move together over time or not. If exchange rates and stock returns are cointegrated in sample economies, they move together over the long run other wise not.

Bask (2009) presented an asset-pricing model to determine the exchange rate between two countries and concluded that both technical and fundamental analysis were used in currency trade, therefore current exchange rate was affected by both past (Chartism) as well as expected exchange rate.

Rossi (2006) revealed that random walk models better explained the exchange rate volatility instead of macroeconomic fundamentals. The proportion of exchange rate variation, which can be explained by existing economic models, is insignificant. What needs to be done is regular updating of these economic models and inclusion of new

explanatory variables. Therefore, economic models cannot be generalized for all periods. What is the best set of explanatory variables depends upon sample period. Rossi focused on issue of model selection between economic and random walk models of exchange rate.

Ding (2009) inspected the impact of order size on exchange rate spread. He analyzed two types of spreads. One spread was the inter dealer and second was customer spread. He concluded that order size was negatively related to spread in the customer transactions while insignificantly related to spread in inter dealer market. Models that focus on processing costs propagate negative relationship of order size with spread while models, which focus inventory holding risk propagate positive relationship between order size and spread. Ding found insignificant contribution of processing cost or inventory holding risk and concluded that it was strategic trading, which caused the spread to be different. Obviously, strategic trading would prioritize customer market over inter dealer market.

Granger Causality has been extensively used in literature to determine the causality between stock market and exchange rates of different economies. Unfortunately, results were mixed and time variant and nothing could be said with certainty about relationship of stock market and exchange rates. Hatemi and Irandoust (2002) tested causality between Swedish Krona and stock market returns using vector auto regression (VAR) approach and concluded that granger causality ran from stock prices to effective exchange rate. The findings about time varying parameters and even time varying set of explanatory variables in developed and emerging economies create need to study this phenomenon of dynamic relationship between stock markets and exchange rates in sample economies over analysis period. Before further investigation of exchange rate behavior, study of causality between exchange rate and stock market returns is of utmost importance.

2.2 Review of Literature on Exchange Rates Approaches

As we are in search of what causes exchange rates to move in sample Asian economies? Therefore, discussion on exchange rate theories and models can be a good beginning point of exploring relevant variables. This discussion on exchange rate models helps us to identify relevant explanatory variables, which have potential effect on exchange rate

movements. The existence of non-traded goods logically describes the deviations from purchasing power parity. Purchasing power parity theory holds well in the long run but in the short run, naïve random walk has outperformed economic models. However, this does not prove that economic fundamentals are senseless. Searching for better economic models is still challenging. As in this study, exchange rate is regressed on economic fundamentals proposed by different theories; therefore, exploration of these fundamentals is started from discussion on balance of payments approach.

2.2 1 Balance of Payments Approach

The BOP approach posits various kinds of explanations about exchange rate behaviors and the emphasis of these explanations has changed from time to time along with changes in the scene of international finance. Before 1960 this approach completely ignored the role of interest rate in determination of exchange rate. The reason was very limited capital movement across the countries due to non-convertibility of currencies under strict government regulations. Thus the focus of researchers was just on current account balance and they completely ignored the role of capital and financial account balance in the determination of exchange rate.

BOP is an account, which records all transactions taking place between a country and rest of the world during a given period of time. All inflows are recorded as credits while all outflows are recorded as debits. A balance of payment account is neither income statement nor balance sheet of a country, but it is cash balance of a country relative to rest of the world. Balance of payments usually consists of three components. First component is current account, which records imports and exports of goods and services, factor income and unilateral transfers. Second component is capital account, also known as financial account, which records foreign direct investment, portfolio investment and other capital transactions especially short term money market transaction and net error and omissions. Third account is official reserve account, which records net changes in the government's foreign reserves. For example, if State Bank of Pakistan sells foreign currencies, it will receive Pak Rupees in exchange. This inflow of Pak Rupee is recorded as credit to the balance of payments account. This official reserve account further consists of two main accounts with one reflecting the change in central bank's holding of foreign

assets while other reflects the change in borrowing powers of central bank from other central banks.

Models developed before 1960s totally ignored the role of capital mobility in the determination of exchange rate. Current account theory is one of them. This theory assumes that capital account and official reserves account balance is zero and thus balance of payments is equal to balance of current account. Real exchange rate, domestic income level and foreign income levels determine current account balance. Therefore,

Current Account=exports-imports

Balance of payment approach encompasses the purchasing power parity theory. Higher real exchange rate means lower inflation at home and thus higher exports with less imports and ultimately higher current account surpluses, while at lower real exchange rate, the case will be reverse. Looking this phenomenon from reverse route, positive current account balance leads to appreciation of home currency and negative current account balance leads to depreciation of home currency. For example, to purchase goods from Pakistan, foreigners need to buy Pak Rupee. With in given supply of Pak Rupee, this act of foreigners will increase demand of Pak Rupee and it will put upward pressure on its price. While to purchase goods from abroad, Pakistani residents exchange Pak Rupees for foreign currency as a result of which, its supply increases and keeping its demand constant, price moves down. It is evident from this discussion that according to the balance of payment approach, or more precisely, according to current account theory, exchange rate is determined in the flow market. This approach helps in identification of relative inflation rate as determinant of trade balance and ultimately exchange rate. Application of absorption approach and monetary approach provide further insight into mechanism of current account theory.

2.2.1.1 Absorption Approach to the Current Account Theory

Absorption approach studies the response of consumption on domestic goods due to change in domestic output. Current account reflects the difference between what a particular country produces and what it consumes or absorbs. Equation of total output can be written as

$$Y = C + I + G + NX \text{ ----------(2.1)}$$

Where C is consumption, I is investment, G is government expenditure and NX is net exports. The sum of first three terms is called absorption. Now if sum of C, I and G exceeds Y, it means that country is absorbing more than what it is producing so it will import more and if Y exceeds sum of C, I and G, it means that a particular country is producing more than what it is absorbing and thus exporting more to rest of the world. By applying absorption approach to current account theory, we can easily study the impact of currency depreciation on trade balance. For example, if economy is working below full employment level, the currency depreciation will lead to more output and more exports but if economy is already working at full employment level, then currency depreciation will just be putting inflationary pressure. When we subtract consumption (C) from output (Y), it is called savings. Treating NX as current account balance, equation 2.1 can be rewritten as under

$$CA = S - I - G \text{ ----------(2.2)}$$

This equation tells us that in order to reduce current account deficit or to improve current account balance, savings should increase for a given level of investment and government expenditures and investments should fall for a given level of savings in the economy. Application of absorption approach makes us understand the mechanism of current account theory. Persistency in current account surpluses of Japan can be explained by this theory because savings rate of Japanese is very high.

2.2.1.2 Monetary Approach to Current Account Theory

In Balance of payments approach and absorption approach to current account theory, the role of capital account is totally ignored. In a current diversified and interconnected financial world, it would be very naïve assumption that capital mobility does not have any impact on exchange rate determination. If official reserve component is small we can say that capital account provides the other side of the current account. A current account surplus means that the country is either increasing its foreign assets or decreasing its foreign debts and a current account deficit means that a country is either increasing its borrowings or selling its foreign assets. The monetary approach to current theory incorporates capital mobility (financial flows) into consideration and argues that any disequilibrium in exchange rate is monetary phenomenon.

As capital account takes financial transactions into account, therefore, any discrepancy is settled through flow of capital. For example, if interest rates in domestic country rise relative to interest rates in foreign county, the demand for local financial assets will increase in international financial markets. Foreigners will purchase local currency as a result of which its demand would increase. With given supply, when demand for local currency increases, it would put upward pressure on its price and vice versa. So monetary approach guided to another variable called interest rate differential, which determines the capital flows in a country and ultimately the exchange rate.

There are some limitations of current account theory. For example there is a possibility that in the short run, current account deficit may not deteriorate exchange rate. For example, when capital mobility is taken into consideration, willingness of foreigners to finance current account deficit will produce current account surplus and will not allow the exchange rate to depreciate. Nevertheless, in the long run, balance of payments approach seems to offer more accurate prediction. In the long run, foreigners will not be willing to finance current account deficit forever and capital outflow will occur in the form of interest payments and other profits.

2.2.2 Asset Approach

Balance of payments approach worked well till 1970 but with the increase in capital mobility across countries, this theory started losing its value in 1970s. Economists started thinking currency prices to be determined just as prices of other assets are determined. As prices of other speculative assets are determined on the basis of their future expectations similarly exchange rate is determined on the basis of its future expectations. Therefore, previous or current trade flows do not determine the value of exchange rate. By applying monetary theory to asset approach, it can be argued that current exchange rate depends upon future information. As interest rate changes predict changes in future exchange rates, therefore, the current exchange rate changes depend upon expected changes in future exchange rate. Quantity theory of money and purchasing power parity theory are the basis of monetary approach. Monetary model can be written as under:-

$$M_S.V = PY$$

$$\frac{M_{Sd}.V_d}{Y_d} = P_d$$

$$\frac{M_{Sf}.V_f}{Y_f} = P_f$$

$$\frac{P_d}{P_f} = S_t = \frac{\frac{M_{Sd}.V_d}{Y_d}}{\frac{M_{Sf}.V_f}{Y_f}}$$

$$\frac{M_{Sd}.V_d}{Y_d} * \frac{Y_f}{M_{Sf}.V_f}$$

$$S_t = (\frac{V_d}{V_f}) * (\frac{Y_f}{Y_d}) * (\frac{M_{Sd}}{M_{Sf}}) \text{ ----------(2.3)}$$

Where

M_{Sf} and M_{sd} are foreign and domestic money supply

V_d and V_f are domestic and foreign money velocities

Y_d and Y_f are domestic and foreign output levels

P_d and P_f are domestic and foreign price level and

S_t is spot exchange rate, measured in the form of direct quotation

The relevant information upon which exchange rate is to base is relative output level and relative money supply. Monetary approach assumes fully flexible prices, which adjust due to changes in money supply. This approach encompasses both, quantity theory of money as well as purchasing power parity theory. Although the balance of payments also encompasses purchasing power parity theory in it yet it argues that change in the price level is a monetary phenomena and is the reaction of changes in money supply. One

implication of this theory is that the increased domestic money supply increases the value of S_t and thus depreciates domestic currency but if central banks increase interest rate, then the depreciation might not occur. There are many reasons to start discussion of exchange rate from monetary approach. It is the first simple theory, which explains balance of payments and exchange rates. Secondly, it is used as best benchmark, when explaining exchange rate behavior with other structural models. Different propositions can be established through this theory. For example, assume that real income and output are fixed and there is change in money supply. If domestic money supply increases with higher percentage, keeping prices constant, this will increase spending of economic agents. This increased spending will put upward pressure on demand of foreign goods as well and ultimately local currency will depreciate and foreign currency will appreciate.

2.2.3 Mundell-Fleming Model of Fixed Prices

Unlike monetary model, the Mundell-Fleming model assumes that the prices are fixed and determined exogenously. This model offers different propositions. It proposes that increase in money supply will lead to increase in income, decrease in the interest rate (provided there is no perfect capital mobility), depreciation in exchange rate and improvement in current account (Flemming 1962, Mundell 1962). Apparently, the impact of money supply increase is same as that in monetary approach, however, in Mundell-Fleming model, the increase in money supply does not lead to change in price level. Furthermore, exchange rate depreciation is not in proportion to change in money supply as it works under monetary approach. Interpretation of fiscal expansion in this model is as under.

It argues that increase in government expenditures leads to increase in interest rates, given immobility of capital, appreciation of domestic currency and finally the deterioration of trade balance.

This model is different from monetary model of exchange rate on various grounds. Firstly, in monetary model, the aggregate supply curve remains vertical at all price levels and the prices move in reaction to changes in money supply while in Mundell-Fleming model, the prices do not play any role in the domestic economy. Secondly, income plays totally different role in monetary and Mundell-Fleming model. In monetary model

(Frankel 1976), the income acts as exogenous variable and its role is limited to determining the level of real balances. The only role played by income in monetary model can be explained as under. At a given level of money supply, the nominal income level should be constant and if real income increases, the prices decrease, which have positive impact on local currency. In monetary model, consumption does not depend upon income level, rather it depends upon interest rate. However, in Mundell-Fleming model, income plays central role. Its first role is that increase in income increases demand for money as it does in monetary model; secondly it increases consumption and ultimately deteriorates the current account balance due to propensity to import.

2.2.4 DornBusch (1976) Model of Sticky Prices (Overshooting Model)

Monetary model seems failed in explaining the movement of exchange rate not only because it is based on the assumptions of purchasing power parity but also because the exchange rate fluctuations are so big that seem never be explained by relative money supply only. Furthermore, Mundell Fleming assumed constant prices; therefore, its prediction is limited to shorter horizon only. It is evident that exchange rate fluctuation cannot be explained by simple relative money supply and relative income. These fluctuations are far more violent than these could ever be described by only national income or money supply. Although monetary model is used as vast benchmark for comparing forecast performance, however, it seems rare that exchange rate movements are determined by relative money supply. To make forecasts for longer time, the Dornbusch (1976) model needs to be taken into consideration, which assumes sticky prices and explains large fluctuations in exchange rates.

Significant contribution of this model in the economics of exchange rate is that it explains many anomalies appearing in exchange rate behavior. For example, home country may have relative higher inflation rate but its currency could be at premium, thus violating purchasing power parity theory. Such anomalies are explained by overshooting model of Dornbusch. According to loanable fund theory, money demand should be equal to money supply at equilibrium. Therefore, if money supply increases in a country, some subsequent events should take place to increase the demand for money to bring the market back to equilibrium level. Assuming that people hold money either for conducting

transactions or for holding interest-bearing bonds, money demand can be represented as function of income and interest rate. Numerically it can be expressed as under:-

$$M_d = \alpha_0 . Y_t + \beta_1 . Int_t \text{ ----------(2.4)}$$

Where M_d is demand for money, Y_t is income level and Int_t is interest rate. Theoretically, first coefficient alpha should exhibit positive sign as when income rises like demand of goods, the demand for money also rises. However, second coefficient beta has negative expected sign because demand for money is negatively related to interest rate. Dornbusch argues that when money supply increases in short run, the income and price levels do not react quickly; therefore, interest rate must fall to bring money demand equal to money supply. This argument can be substantiated by the fact that financial markets react to exogenous shocks more quickly than goods market. Thus due to sticky nature of price level, interest rate brings money market back to equilibrium where demand for money is again equal to supply of money. The effect of this decreased interest rate will be observed in foreign exchange market by interest rate parity theory

$$\frac{i_h - i_f}{1 + i_f} = \frac{F_t - S_t}{S_t} \text{ ----------(2.5)}$$

If domestic interest rate falls, the right hand side of above equation should also fall. If Domestic money supply increases, its long-term effect on price levels will be positive. This high-expected price level will weaken spot rate over time. This expectation will cause current forward price to weaken also. When forward price falls, to maintain interest rate parity, spot price will fall relatively more than forward price. Subsequently, when inflation rises over time, the value of real balances will decrease and interest rate will rise and spot rate will adjust itself to maintain equilibrium. Thus spot rate will overshoot its long-term value. With this fact, Dornbusch captured short run overshooting of exchange rate in his model.

2.2.5 Portfolio Balance Approach

Portfolio Balance model was put by Branson and Halttunen (1979), Branson (1983) and Frankel (1983). Portfolio balance theory is said to be an extension of monetary model, which introduces foreign currency and foreign bonds as potential substitutes for domestic money and domestic bonds. Monetary model says that money demand and supply at home determines the exchange rate. If interest rate parity theory holds, then portfolio balance theory reduces to what we call monetary model of exchange rate. Proponents of this theory contend that foreign currency as well as foreign bonds, are not potential substitutes of local currency or local bonds in the short run, therefore, exchange rates are partly determined by money supply difference and partly by other assets. This theory also considers the impact of exchange rate on the wealth of agents. This theory has following assumptions:-

1. Agents use their wealth to hold domestic money, foreign money, domestics bonds and foreign bonds. Agents in local country can hold foreign currency as well as foreign bonds while residents of foreign country can hold domestic currency as well as domestic bonds. According to this approach, exchange rate seems to be a function of domestic currency, foreign currency, domestic bonds and foreign bonds.

$$E.R_t = f(M_d, M_f, B_d, B_f) \text{ ----------(2.6)}$$

Where

M_d is domestic money supply

M_f is foreign money supply

B_d is domestic bond

B_S is foreign bonds

2. Foreign monetary authorities do not change foreign interest rate so it is assumed to be held constant.
3. Home country acts as price taker, while foreign country acts as market maker in international financial markets.

4. Theory of rational expectations holds, according to which, market can rationally forecast exchange rate reflected in current forward prices. So current forward price is used as good predictor of future spot rate. This assumption is also known as market based forecasting.
5. Foreign currency and foreign bonds are substitutes for their local counterparts, but not in the short run. Therefore, exchange rate is determined partly by relative money supply and money demand and partly by other assets such foreign bonds.

According to this theory, relationship between interest rate and exchange rate is ambiguous. Conditions of money market equilibrium and bond market equilibrium give opposite possible signs. Impact of increase in interest rate on bond market is discussed as under:-

If domestic interest rates increase, demand for local bonds will go up. If their supply is fixed, the only way to bring higher demand back to original demand level is through income effect. When demand for local bonds increases, agents want to hold local assets as a result of which local currency appreciates. This appreciation reduces the home currency value of foreign bonds. Through this income effect, the excess demand created in local market is eliminated.

The above discussion provides hint for positive coefficient between interest rate and exchange rate. However, increase in interest rate reduces the demand for money and assuming constant supply, some thing must happen to equate money demand and money supply to bring equilibrium in money market. This reduction in demand will be fulfilled only by increased local currency value of foreign bonds. This increased value is possible by depreciation of home currency relative to foreign currency. In this interpretation, increase in interest rate has negative impact upon exchange rate.

2.2.6 Model of Rational Expectations and Exchange Rate

Before discussing the model of rational expectations, it is important to explain the differences between subjective expectations, mathematical or conditional expectations and rational expectations. Expected value of a variable is calculated by multiplying all outcomes with their probabilities of occurrence. Conditional expected value of a variable is its value dependent or conditioned upon some set of past information. What kind of

past information is used depends upon circumstances but all the relevant information is included in a set to determine future value of a variable. This information set, which is used to determine the future value of a variable, is different from individual to individual. One agent gives more weight to one kind of information than others do, and vice versa. Agents make forecast about future on the basis of their beliefs, knowledge, experience and other circumstances. This expectation of investors is called subjective expectations as it varies from one individual to other. It is subjective in a sense because, it lies in the mind of individual and it is not necessary that it is in accordance with objective data. When it comes to future, if subjective values of all or at least significant numbers of individuals are similar to conditional expected values, then these individuals are said to be having rational expectations. As long as these subjective expectations match with conditional expected values, these are rational expectations, irrespective of how they are calculated. Their calculations may be irrational or somewhat based on astrology, chartism or something else. Mathematically, this concept of rational expectations can be written as

$$E(S_{t+1}) = F_t \text{ ----------(2.7)}$$

Where S_{t+1} is expected spot price, which is equal to forward price in current period (F_t). In the literature of hedging the above equation is also known as market based model of forecasting exchange rate. Now if subjective value of a variable is depending upon information contained in its past value, then market is said to be having weak rational expectations. This weak rational expectation is given by

$$E(S_{t+1}) = f(S_t, S_{t-1}, S_{t-2}, S_{t-3}.....) \text{ ----------(2.8)}$$

In this equation, the expected spot rate at time t+1 is not conditioned on all information available to public at time t. therefore, it can not be fully rational. A fully rational expectation reflects all the available information instead of just lagged information of variable being forecasted.

In nutshell this model assumes that forward market is perfect and difference between current spot price and forward price is not enough to provide arbitrage opportunities to arbitrageurs. Although speculator can think of profit even at rationally expected price but this profit is equal to risk premium.

2.2.7 The News Model of Exchange Rate Volatility

Model of rational expectations has focused on relationship of expected spot price at time t+1 and current forward price at time t. The focus of News model is based on the factors, which arrive in market during this gap between time t and time t+1. These are the news regarding any factor relevant to exchange rate determinations. Examples are monetary arrangements and news regarding trade balance and monetary policy adopted by central banks. Proponents of rational expectations theory argue that current forward price is good predictor of future spot price. Specifically, they say that future period spot rate is equal to current period forward rate, current period risk premium and random error term. This error term is center of discussion of The News model of exchange rate. As these error terms arise because of effect of all omitted variables, these can also be said to be mistakes made by market players. The intensity of the news on exchange rate depends upon the difference between the extent these were estimated and the actual facts when they come to public.

Statistically, this model can be expressed as under

$$S_t = \alpha_0 . Z_t \text{ ----------(2.9)}$$

Where Z_t is set of fundamentals determining the exchange rate and S_t is current exchange rate.

If theory of rational expectations holds then we can write expected spot rate as

$$E_{t-1}.(S_t) = \alpha_0 . E_{t-1}.(Z_t) \textbf{ ---------(2.10)}$$

This equation represents spot exchange rate expected at time t-1 as a function of a set of fundamentals, expected at time t-1. By subtracting equation 2.10 from equation 2.9 and taking coefficient as common, we get

$$S_t - E_{t-1}.(S_t) = \alpha_0 . (Z_t - E_{t-1}.(Z_t)) \text{ ----------(2.11)}$$

In equation 2.11, left hand side tells us the difference between current spot exchange rate and spot rate expected one period before. This is forecasting error made by agents, while right hand side tells us information about actual fundamentals and expected fundamentals. The right hand side of above equation is components of news or surprise regarding fundamental variables. Equation 2.11 says that news is that component of

information about fundamental variables, which is not foreseen at the time of forecasting. Equation 2.11 can be rewritten as

$$S_t = E_{t-1}.(S_t) + \alpha_0.(Z_t - E_{t-1}.(Z_t)) \text{----------(2.12)}$$

Here the first component on right hand side of above equation, according to rational expectations theory, is equal to forward price at time t-1 minus the risk premium, so it can also be written in following form

$$S_t = F_{t-1} + \rho_{t-1} + \alpha_0.(Z_t - E_{t-1}.(Z_t)) \text{----------(2.13)}$$

Researchers have extensively used this equation for testing purpose. The News model seems hardly a model rather it is a methodology to model.

There is another aspect of exchange rate determination. This is related to political economy, according to which the structure of democratic institutions affects the exchange rate movements and exchange rate policies are designed keeping in view the political costs of losing elections. Impact of democratic institutions on exchange rate behavior can be described under two approaches. First approach is called political budget cycle. According to this approach, ruling party attempts to manipulate exchange rate to enhance its reelection chances. Second approach is comparatively more empirical. According to this approach, the significant devaluations are delayed until after elections. Exchange rate devaluations are recognized as politically very sensitive events because they not only put immense impact on chance of reelection but also increase the political costs of losing elections. Cooper (1971) pointed out that currency devaluations in developing countries have forced many finance ministers to leave their offices and in some cases have led to the fall of governments. The intensity of these political costs affects the timings of currency devaluations. Therefore, political parties in power are expected to postpone necessary currency devaluations until national elections are held. Cruzado plan (1986) in Brazil, Mexican Peso crises (1994) and the Primavera plan (1989) in Argentina are the real episodes, which support this proposition of postponement of currency devaluations. These political manipulations make it difficult to predict exchange rate behavior. Financial liberalizations increase the economic costs of such political manipulation, because when investors expect such manipulations, they start moving capital out of country. Developing economies are known for more manipulation of exchange rate as

well as other economic indicators. This manipulation may be direct as well as indirect. The indirect intervention is captured through adhoc model of exchange rate, which uses different variables to estimate movement of exchange rate.

In Cruzado plan, current account deficits were very high and the market players started expecting devaluation of Brazilian Real but keeping in view the political costs of such devaluations, government kept on pegging exchange rate. Continuing their traditions, Brazilian government kept these corrections on hold (Cordoso 1991). Public does not like higher inflation rate in the country, as it erodes the worth of their savings (Stein and Streb, 1998). Politicians know it well and intentionally manipulate foreign exchange market to show exchange rate stability as an indicator of their competency. They convey this competency to public by controlling or avoiding higher inflations in periods near elections. They do this to enhance their chance of reelection. Stein and Streb (2004) studied 26 South American economies and showed that average rate of currency depreciation is two percent higher in months following the elections. This finding again supports the idea of political budget cycle. The same was shown by Meon (2004). He argued that individuals indirectly assessed the competency of ruling party by knowing how party managed exchange rate; therefore, ruling parties avoided depreciations in periods near elections. Stein (2005) studied 15 Caribbean and South American economies over a period of 1960 to 1994 and presented similar findings of political budget cycle. Governments can postpone inflation in various ways. One way is to take debt and use it for subsidies in various sectors of economy. This will reduce current inflation rate at the cost of higher inflation in coming periods. Government can increase the demand of non-tradable through government expenditure and thus appreciate local currency in periods before elections. Bonomo and Terra (2005) stressed on how governments appreciate real exchange rate through increased government spending by targeting the demand of non-tradable. Furthermore, politicians cannot tolerate the cost of election defeat and postpone the necessary large devaluations until after election. In literature, large devaluation means devaluation of at least 15 percent (Edwards 1994). Edwards conducted this study on democracies and dictatorships of developing countries and found that in democratic governments, politicians devalued exchange rate right after they got into office while this

was not the case with dictatorships. Then possibility of giving up pegged exchange rate system should be higher right after elections in countries practicing pegged exchange rate system. Gavin and Preotorri (1997) conducted a study on Latin American countries over a period of 1968 to 1995 and concluded that probability of a government of giving up pegged exchange rate system was highest right after the national election was held. Frieden (2001) conducted a study on sample averages of 26 South American countries and found that the probability of large exchange rate devaluations was 3.1 times more after national elections. They defined large devaluation as 25%. However, focus of this study is not on the postponement of devaluations during election years rather it is on exploring the economic factors, which cause the exchange rates to move.

2.3 Review of Literature on Forecasting Performance of Exchange Rate Models

Literature on exchange rate forecasting is divided into two schools; the fundamentalists and the chartists. Many researchers have documented that macroeconomic variables alone are unable to predict exchange rate movements. For example Meese and Rogoff (1988) constructed forecasts on the basis of actual values instead of forecasted values of independent variables and concluded with the failure of economic fundamentals to explain exchange rate behavior. Since the collapse of Bretton Wood system in 1971, a hot debate is raging on forecasting exchange rate, but much needs to be done as literature has mixed results. Musa (1979) concluded that random walk model performed better than economic models in forecasting exchange rate. His findings were supported by seminal work of Meese and Rogoff (1983), who documented that no exchange rate model performed better than random walk model. Although sometimes, *in the sample forecasting* reported better results but *out of sample forecasting* performance of random walk model was better than that of structural models. By constructing rolling forecasts, they argued that predictive capacity of random walk models was significantly higher than that of economic models. However, many researchers have documented that better forecasting is not a justified criterion for selection of exchange rate models (Hendry, 1986 and Pagan, 1987). Some researchers argue that forecasting performance of economic models can be improved by assuming parameter instability. Wright (2003) argued that economic models' forecasts might produce promising results when compared

to results of random walk model, but simultaneously many researchers had used time varying parameters in their research and concluded that random walk outperformed economic models even when parameters were allowed to change. Wolff (1988) reached some sort of similar conclusions and documented that structural models, even in the presence of time varying coefficients did not have the power to beat naïve random walk model. However, it could be argued that limitations of economic models of exchange rate forecasting, was not that the variables used were irrelevant rather it might be due to non-linear relationship between exchange rate and explanatory variables. Hsieh (1989), Baille and Mcmahon (1989) and Hong and Lee (2003) investigated exchange rate behavior using non linear techniques and documented that exchange rate was non linearly dependent upon macro economic variables instead of linear relationship. However, this conjecture of non-linear dependence of exchange rate too has failed to achieve significant empirical support as many researchers have not only tried to explain exchange rate behavior with the help of non-linear techniques, but have also concluded that predictive capacity of economic models was still less than that of simple autoregressive models, which completely ignored the economic theories. For example, Diebold and Nasan (1990) and Meese and Rogoff (1990) employed non parametric techniques like kernel regression and compared different structural models against random walk model and documented that non parametric models were not able to defeat random walk model in the field of exchange rate forecasting. Meese and Rogoff (1991) incorporated non-linearity into their econometric modeling of exchange rate behavior and concluded that such inclusion did not improve the forecasting capacity of economic models. Engel and Hamilton (1990) and Engel (1994) compared performance of Markov- Switching model against random walk and concluded that random walk model had the power to beat the structural models of exchange rate forecasting.

However, many researchers have documented that neural network model of exchange rate forecasting beats the random walk model. But findings of majority of these NN models are on *out of sample forecasting* ability. For example, Kuan and Liu (1995) employed Neural Networks techniques on daily exchange rate changes and argued that these models reported lower *out of sample* forecasting errors when compared to

forecasting errors of random walk models. Brooks (1997) supported the findings of Kuan and Liu (1995) and found existence of relationship between monetary fundamentals and exchange rate behavior. One reason of poor performance of economic models in forecasting could be the existence of outliers in the series. Presence of outliers affects the mean and standard error of coefficients, which in turn affect t-statistics. Different financial crises have caused abrupt changes in financial assets. Like other financial assets, exchange rates are subject to big shocks. These shocks may result in poor performance of economic models. Balke and Fomby (1994) documented that presence of outliers results in misspecification and controlling outliers was inevitable to get better forecasts. Similar results were found by Van et al. (1999). They found that presence of outliers in exchange rate caused non-linearity in the series and made it difficult to investigate its behavior with the help of linear regressions.

Furthermore, significant research has been conducted on effects of outliers in the series. Most commonly reported effects are biased parameters, which harm the forecasting performance of exchange rate models (Ledolter, 1989 and Hotta, 1993)

Rossi (2006) argued that portion of exchange rate fluctuations explained by economic models was almost zero. In empirical investigation of nominal exchange rate movements, she documented that in some countries random walk models failed to explain exchange rate movement. This finding rejected the discussion that macroeconomic variables had no link with exchange rate movement. Thus, the rejection of macroeconomic models might not be due to their irrelevance with exchange rate rather due to their unstable relationship over time. This unstable relationship can be captured through rolling forecasts in which parameters are updated for every forecast. The relationship between model selection and forecasting capacity has attained attention of researchers. Clark and Mc Cracken (2005) have addressed the same issue. They documented that difference between *in the sample* predictive capacity and *out of sample* predictive capacity could be captured by the presence of parameter instability. After examining the power property of *out of sample* tests, they concluded that *out of sample* predictive capacity was less than that of *in the sample* capacity. The question, whether existing economic models of exchange rate beat random walk model or not, is unsettled but prevailing answer to this question is 'No'.

Random walk models better explain the movements in exchange rate but they ignore economic theories (Meese and Rogoff, 1983). In the literature of exchange rate forecasting, economic fundamentals based models have been compared with random walk model in various periods and various countries. However, it lacks comparison of adhoc model with single variable based economic models like purchasing power parity and interest rate parity. Secondly the existing literature lacks comparison of adhoc model with autoregressive integrated moving average model especially in developing economies. This study fills this gap by comparing predictive accuracy of adhoc model against not only widely used random walk model but also against autoregressive integrated moving average model.

Data Sources

To study interaction between currency and capital markets of sample economies, monthly data of exchange rate has been collected from International Financial Statistics, International Monetary Fund. Analysis period starts from July 1997 to October 2009. Thus total monthly observations are 148 in case of each sample country. Stock indices data has been collected from Yahoo Finance. In case of Pakistan, KSE 100 Index, for Indonesia, Jakarta Composite index, for India, BSE 30 index, for South Korea, KOSPI composite index and for Sri Lanka, Colombo All Shares Index have been used.

To study determinants of nominal exchange rate, data about economic indicators of sample economies has been obtained from International Financial Statistics, International Monetary Fund. Government bond yield has been used as measure of interest rate. For United States, two government bond yields are reported in International Financial statistics. First one is 3 years government bond yield and second one is 10 years government bond yield. In this study, 10 years government bond yield has been used as proxy for U.S interest rates. To calculate relative inflation rate, consumer price index has been used for sample countries as well as for United States. As United States acts as foreign country in all the sample countries, therefore, foreign terms of trade is same for all the sample economies, which is calculated by dividing prices of U.S exports by prices of U.S imports. Both U.S exports as well as U.S imports are FOB (Free on board). Furthermore, to calculate the proxy for trade restrictions in sample countries, both exports and imports are Free on Board.

CHAPTER 3
METHODOLOGY

3.1 Measurement of Variables

To study interaction between stock markets and exchange rates, two variables namely exchange rate and stock prices of sample economies have been used.

Exchange Rates

There are three main issues in the measurement of exchange rate.

1. The first issue is to decide whether to use real or nominal exchange rate? The difference between real and nominal exchange rate may matter in principle but from perspective of their statistical use, there is little difference between the two as both are strongly correlated. In this research, nominal exchange rates have been used.
2. Whether to use exchange rate in direct or indirect quotations is the second issue in the measurement of exchange rate. In economic sense, both are same while interpretation of exchange rate coefficient becomes opposite. However, interpretation of coefficient also depends upon how a particular explanatory variable has been measured. Reason of different interpretation is that in case of direct quotation increase in exchange rate digits is the appreciation of foreign currency and depreciation of local currency and vice versa.
3. Third issue is whether to use bilateral or weighted basket exchange rates? One approach is to use U.S Dollar as base currency as has been used in the literature extensively. Second approach is to use exchange rate as the price of weighted basket of all major currencies. In this study, bilateral exchange rates have been used, in which United States Dollar acts as foreign currency in case of each sample country.

In this study, exchange rate quotations are direct, which measure the price of foreign currency in terms of local currency. Bilateral nominal exchange rates have been used in

which U.S $ acts as foreign currency in case of each sample exchange rate. For empirical analysis, natural log of direct quotation has been used.

$$E_t = Ln(E.R_t) \text{ ---------- (3.1)}$$

Where $E.R_t$ is exchange rate at time t

Stock Prices

Using monthly data, stock prices of sample economies has been calculated as follows

$$\text{Stock Prices}_t = Ln(Indx_t) \text{ ----------(3.2)}$$

Where

$Ln(Indx_t)$ is natural log of Index at time t

As our understanding of factors causing exchange rates to move is very limited (Najand, 2000), therefore, application of structural models on determination of exchange rate consists of two steps. In the first step, related variables are identified in the second step, suitable statistical and econometrics techniques and procedures are selected

There are different theories of exchange rate determination, which consider different factors as determinants of exchange rate. Most common factors are relative inflation rate, relative interest rate, relative income level, government restrictions and market expectations. According to Edwards (1988), Lane (1999), Zakaria et al. (2007), following factors can have possible impact on the movement of exchange rates.

Relative Interest Rate (RIR)

Inflation affects exchange rate through current account, while interest rate differential affects it through capital account. Before 1970s, the role of interest rate in exchange rate determination could not attain significant attention of researchers and practitioners because of very limited capital mobility across the national boundaries. However, with the inception of monetary model of exchange rate and removal of controls on capital mobility by different countries, it has gained significant attention of researchers and practitioners. Higher real interest rate in domestic country attracts foreign investments into the country. This increases the demand of local currency in foreign exchange market and puts upward pressure on its price and vice versa. Thus theoretically, higher real interest rate has positive expected relationship with exchange rate. This variable is measured as under:-

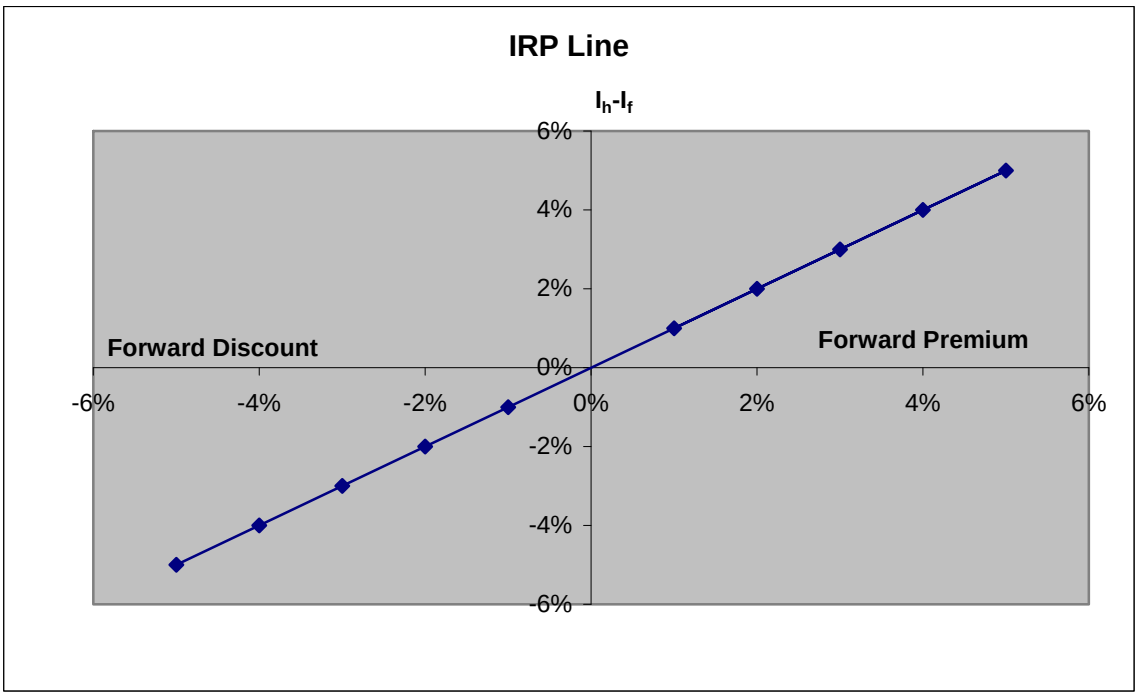
$$RIR_t = \frac{i_t^{\,f}}{i_t^{\,h}} \text{ ----------(3.3)}$$

Where RIR_t is relative interest rate, $i_t^{\,f}$ is foreign interest rate and $i_t^{\,h}$ is home interest rate.

However, nominal interest rate has opposite expected relationship with exchange rate. This interpretation is done in the light of arguments of interest rate parity theory. This theory says that the return on local investment should be equal to the return on hedged foreign investment. If interest rate parity holds, then currency of higher interest rates should decline to bring its return equal to that of local currency. Thus nominal interest rate is expected to have negative relationship with exchange rate. Theoretical justification of this negative relationship between interest rate and exchange rate is as follows. Interest rate parity theory assumes that real interest rate remains same in all countries. Now if real interest rates are same and nominal interest rates are different, then according to Fischer equation, this difference is due to inflation premium. Thus higher nominal interest rate means higher expected inflation. As higher inflation affects exchange rate negatively through deterioration of trade balance and reducing the competitiveness of country. Therefore, it can be argued that interest rate may be negatively related to exchange rate. Numerically, interest rate parity theory can be written as under

$$1 + i_h = \frac{1}{S} * (1 + i_f) * F \text{ ----------(3.4)}$$

Where S is spot rate, i_h is home interest rate, i_f is foreign interest rate and F is forward rate. When interest rate parity theory does not hold, there exists covered interest arbitrage. Arbitrage is the process of capitalizing on price discrepancy. Assuming no transaction cost, if quoted forward rate is different from what is determined by interest rate parity theory, then there is arbitrage opportunity either for local or foreign investors. This concept of covered interest arbitrage can be graphically explained as under



In this graph, difference between home interest rate (i_h) and foreign interest rate (i_f) has been drawn on Y-axis while forward premium/discount has been drawn on X-axis. The line, which crosses at 45^o angle, is called interest rate parity (IRP) line. All the points lying along the IRP line do not provide arbitrage opportunity because if any local investor invests abroad to capitalize on higher interest rate, he loses money due to depreciation of foreign currency against local currency. Similarly if foreign investors invest in local country, they earn comparatively low interest rate but get compensation through appreciation of local currency against their home currency. However, all the points lying below IRP line provide arbitrage opportunity to local investors to invest in foreign country and all the points lying above IRP line provide arbitrage opportunity to foreign investors to invest in local country.

The premium or discount can be determined by using following procedure. Assume

V_h = Beginning value of investment in local currency at time t

V_f = Value of investment made in foreign country at time t+1

S=Spot Exchange rate

F=Forward Exchange rate

R= Return on foreign investment

i_h= Return on local invest/ home interest rate

i_f= foreign interest rate

R=Return on foreign investment

As according to Interest rate parity theory, return on local investment should be equal to return on hedged foreign investment, therefore, we can write

$$R = i_h$$

$$R = \frac{V_f - V_h}{V_h}$$

$$V_f = \frac{1}{S}(1 + i_f) * F$$

$$F = S(1 + p)$$

$$V_f = \frac{V_h}{S}(1 + i_f) * S(1 + p)$$

$$V_f = (1 + i_f) * (1 + p)$$

$$R = \frac{V_h * (1 + i_f) * (1 + p) - V_h}{V_h}$$

$$R = (1 + i_f) * (1 + p) - 1$$

$$(1 + i_f) * (1 + p) - 1 = i_h$$

$$p = \frac{1 + i_h}{1 + i_f} - 1$$

$$F = S(1 + p)$$

$$F = S(1 + \frac{1 + i_h}{1 + i_f} - 1)$$

$$F = S(\frac{1 + i_h}{1 + i_f}) \text{----------(3.5)}$$

Equation (3.5), discussion on interest rate parity theory and IRP line reveals that a currency whose interest rate is higher relative to other currency will be on discount because higher nominal interest rate has higher expected inflation, which deteriorates the real exchange rate of a country, reduces its competitiveness in international market and ultimately affects the exchange rate negatively. So according to interest rate parity theory, nominal interest rate should have negative relationship with exchange rate as indicated by

above equation, wherein, forward price of foreign currency is directly related to home interest rate and inversely related to foreign interest rate.

Relative Inflation Level (RIL)

According to Cassel's (1916) theory of purchasing power parity, if nominal exchange rate (S_t), domestic price level and foreign price levels are given then real exchange rate of a country can be calculated as

$$RER_t = S_t(\frac{I_t^f}{I_t^h}) \text{ ----------(3.6)}$$

By taking natural log of both sides, above equation can be written as

$$Ln(RER) = Ln(S_t) + Ln(I_t^f) - Ln(I_r^h) \text{ ----------(3.7)}$$

Although Purchasing power parity has not performed well in the short run but many researchers have documented that over the long run, real exchange rates move towards one and purchasing power parity theory still holds (Bhatti, 1996).

There are two major forms of purchasing power parity theory. One is called as absolute form purchasing power parity while second one is known as relative form purchasing power parity theory. Due to real life complications of different transportation costs and different tax laws across the countries, it is very difficult for absolute form PPP theory to exist, however, relative form exists in the long run. According to relative form of purchasing power parity (PPP), prices may be different in absolute terms but rate of change in prices should be same. The rationale behind purchasing power parity is very simple. That if two products of different countries are substitutes of each other, the demand for products should change when relative inflation rate changes. For example if Pakistan and India are producing two similar goods, which can be used as substitutes for each other and inflation rate in Pakistan rises relative to that in India, prices of Pakistani goods will go up and they will become more expensive for international buyers. Due to this decreased competitiveness of Pakistani goods, demand will shift from Pakistani goods to Indian goods. This will put downward pressure on the demand of Pak Rupee and upward pressure on demand of Indian Rupee. Numerically, it can be shown as under

Assume A_h and A_f are the prices of basket of goods in home country and foreign country respectively and at the beginning of year both are same

$$A_h = A_f$$

At the end of the year, prices of these basket baskets will be

$$Ah(1 + I_h)$$
$$Af(1 + I_f)$$

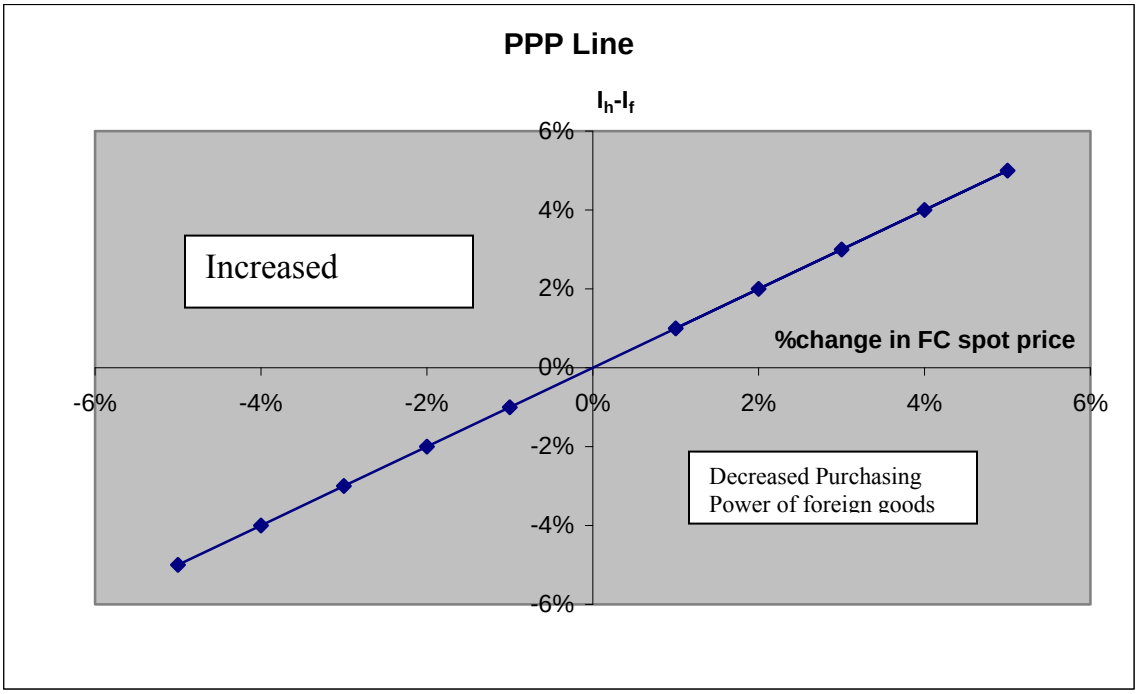
Where I_h and I_f are home and foreign price levels. These two can be equated by multiplying the foreign basket with exchange rate

$$Ah(1 + I_h) = Af(1 + I_f)$$

As A_h and A_f are equal, they cancel each other and by solving above equation for e_f, we get

$$e_f = \left[\frac{(1 + I_h)}{(1 + I_f)} - 1\right]$$
$$F = S(1 + e_f)$$
$$F = S\left[\frac{(1 + I_h)}{(1 + I_f)}\right] \text{----------(3.8)}$$

This formula indicates that as long as foreign inflation rate exceeds domestic inflation rate, foreign currency depreciates and vice versa. This relationship can also be shown with the help of purchasing power parity line



A line, which crosses at the 45^o is called as purchasing power parity line. Along this line purchasing power of both domestic and foreign goods remains same. While all the points lying below PPP line indicate the decreased purchasing power of foreign goods and all points lying above PPP line indicates the increased purchasing power parity of foreign goods. Exchange rate is negatively related to inflation level. It argues that relatively higher domestic inflation rate will lead to less demand for exports because when prices rise, goods become less competitive for foreign buyers in international markets. As demand for exports falls, demand for local currency also falls and keeping other things constant, it puts downward pressure on the price of local currency (Lane 1999). Thus theoretically, relative inflation rate is having negative relationship with currency price. It has been measured as under:-

$$RIL_t = \frac{I_t^{\,f}}{I_t^{\,h}} \text{----------(3.9)}$$

Where RIL_t is relative inflation rate, $I_t^{\,f}$ and $I_t^{\,h}$ are foreign and domestic price levels respectively. As in this study, exchange rate has been measured in the form of direct quotation, RIL should have negative coefficient. However, empirical investigation may

not support above discussed relationship if goods are not substitutes for each other. In empirical analysis, relative inflation level has been used with lag 1 as according to Dornbusch overshooting model, prices do not react quickly to change in money supply.

Terms of Trade (TOT)

Fluctuations in exchange rates are also caused by shocks in import and export price levels (Edwards 1988, Chowdhury 2000 and Zakaria et al. 2007). There are different ways to capture the impact of these shocks on exchange rate. Capturing these effects through foreign terms of trade is one of them (Zakaria et al. 2007). Foreign terms of trade is defined as under

$$TOT_t^f = \frac{X_t^f}{I_t^f} \text{ ----------(3.10)}$$

Where TOT_t^f, X_t^f and I_t^f are foreign terms of trade, foreign export and import levels respectively. Whether terms of trade affects exchange rate positively or negatively, depends upon whether income effect overcomes substitution effect or substitution effect overcomes income effect. According to income effect, when export level of foreign country increases, its income level rises and it affects foreign currency negatively. This is equivalent to appreciation of domestic currency. According to the substitution effect, when there is increase in the price of foreign exportable, it shifts production resources away from non-tradable to tradable ultimately raising the price level of non-tradable. When price of tradable falls relative to non-tradable, terms of trade improve and foreign currency appreciates. This is equivalent to depreciation of local currency of sample economies in this study. Therefore, relationship of terms of trade with exchange rate is theoretically, vague and is subject to empirical analysis. However, some researchers have documented positive relationship between terms of trade and exchange rate (Edwards 1988).

Trade Restrictions (TR)

This variable is measured as opposite of trade openness or trade intensity (Zakaria et al. 2007). As trade openness is measured by dividing the sum of exports and imports by gross domestic product of a country, therefore, trade restriction is measured by the reciprocal of trade openness ratio. These trade restrictions are tariff on imports, export

taxes and import quotas etc. These reduce the trade openness of a country. This variable of trade restrictions is constructed as follows

$$TR_t = \frac{No\min al\, GDP_t}{(\mathrm{Im}\, ports + Exports)_t} \text{----------(3.11)}$$

Where TR_t is trade restrictions

These restrictions imposed by government may take different forms and have different impacts on exchange rates. For example, consider the case of import taxes. The imposition of import taxes raises the price of imports for local buyers and shifts the demand away from imports. Resultant improvement in trade balance puts upward pressure on the price of local currency. If restrictions work in this fashion, then they should have positive relationship with local currency. However, if trade restrictions are imposed through export taxes, they reduce exports and resultant decrease in trade balance puts negative pressure on the price of local currency, which ultimately depreciates relative to foreign currency. In this way, trade restrictions have negative coefficient with exchange rate. From above discussion, it is concluded that theoretical relationship of trade restrictions with exchange rate is vague and like foreign terms of trade, is subject to empirical analysis.

Trade Balance Ratio (T.B)

Current account consists of trade balance, net services balance, factor income and unilateral transfers. Trade balance is called trade surplus, when the value of tangible exports exceeds the value of tangible imports. Theoretically, exports have positive relationship with exchange rate and imports have negative relationship. This variable is constructed as follows

$$T.B_t = \frac{(Exports - imports)_t}{GDP_t} \text{----------(3.12)}$$

Where T.B is trade balance and has been measured as percentage of nominal gross domestic product. In regression equation, first difference of above equation has been used

Net Capital Inflows (NKI)

Any change in capital inflows changes the consumption and thus changes the exchange rate. Capital inflow is recorded in capital account in case there is inflow in physical assets and is recorded in financial account in case there is net inflow in financial assets such as stocks and bonds.

Capital Account Balance (K.A.B)

Capital account records all transactions related to investment in physical assets. It records acquisition of fixed assets as well as non-financial assets. However, it does not record debt forgiveness as it is reported as exceptional financing. In this study, this variable has been constructed as under

$$K.A.B_t = \frac{Net\ Capital\ Account_t}{No\min al\ GDP_t} \text{ ----------(3.13)}$$

Where $K.A.B_t$ is capital account balance

Positive value of capital account balance means that reporting country is receiving more foreign investment in physical assets than what it is doing abroad. Increased capital account balance indicates higher demand for local currency, which puts upward pressure on the exchange rate of reporting economy.

Financial Account Balance (F.A.B)

This is the third sub account of balance of payments and records direct investment, portfolio investment, derivatives investments and other investment. Just like capital account balance, positive value of financial account balance puts upward pressure on the price of local currency and vice versa. Direct investment includes investment in equity capital, reinvested earnings and some financial derivatives between affiliated companies. Positive value indicates that over all investment flow into the economy by non-residents is more than investment outflow by residents of the reporting economy. Portfolio investment includes transactions made by non-residents in financial instruments of any maturity. These include investment in bonds, money market securities and all other financial securities not reported in direct investment. This is constructed as follows

$$F.A.B_t = \frac{Net\ Financial\ Account_t}{No\min al\ GDP_t} \text{ ----------(3.14)}$$

Where F.A.B is financial account balance. In this paper, sum of capital account and financial account as percentage of Nominal GDP has been used as proxy of capital inflows

$$NKI_t = \frac{K.A.B_t + F.A.B_t}{No\min al\ GDP_t} \text{ ----------(3.15)}$$

Where

NKI_t is net capital inflow

3.2 Regression Equation

Exchange rate has been regressed on six macro economic variables. This relationship of exchange rate with economic fundamentals can be written in following equation.

$$E.R_t = \alpha_0 + \beta_1 * RIR_t + \beta_2 * RIL_{t-1} + \beta_3 * TOT_t + \beta_4 * TR_t + \beta_5 * d(TB_t) + \beta_6 * NKI_t + \varepsilon_t \text{ ---(3.16)}$$

Where

$E.R_t$ is exchange rate, measured as natural log of nominal exchange rate in direct quotation at time t

RIR_t is relative interest rate at time t

RIL_{t-1} is lagged period relative inflation level

TOT_t is terms of trade in period t

$D(TB_t)$ is the first difference in trade balance ratio

NKI_t is net capital inflows and

ε_t is error term

According to Najand and Bond (2000), Zakaria and Eatzaz (2007) and Arshad and Qayyum (2008), expected signs of coefficients (β_s) are presented in the following table

Table 1: Expected Signs of Explanatory Variables Used in Regression

Coefficient	Expected Sign	Theory/Approach
β_1	Negative/positive	Interest Rate Parity Theory/ Money Market explanation/ portfolio approach
β_2	Negative	Purchasing Power Parity Theory
β_3	Vague	Subject to empirical investigation
β_4	Vague	Subject to empirical investigation
β_5	Negative	Current Account Theory
β_6	Negative	Portfolio balance approach

Before model specification, variables have been tested for stationarity. As both stock returns and exchange rates are time series, therefore, before employing of Johansen's Cointegration and Granger Causality, stock indices and exchange rates of sample economies have been tested to find the possible existence of unit root in them.

3.3 Unit Root Investigation

In this study, two tests have been employed to find the unit root in the series under consideration. These are Augmented Dickey Fuller test and Phillip Peron's test

3.3.1 Augmented Dickey Fuller Test

Results of the regression may be spurious if we assume that the time series data is stationary, when it is not. Spurious correlation is more likely to exist in developing markets because each nominal variable, which is unadjusted for inflation has big inflationary component in it. As a result of this, these nominal variables appear to be strongly correlated. This spurious correlation inflates the values of R^2 and t-statistics. First, graphical method has been applied to visualize that whether the mean of series is dramatically increasing over time or not? Then Augmented Dickey Fuller (1981) and

Phillip Peron (1988), two formal tests, have been employed to explore the existence of unit root in series. Although there are different modification of ADF and Phillip Perron tests of unit but still they are widely used tests of unit root determinations e.g Khan and Qayyum (2008) ADF test works as under

$$X_t = \alpha . X_{t-1} + \varepsilon_t \text{ ----------(3.17)}$$

The above autoregressive model is called stationary, if value of alpha is less than 1. Subtracting X_{t-1} from both sides of equation (3.17) results in

$$(X_t - X_{t-1}) = \alpha . X_{t-1} - X_{t-1} + \varepsilon_t \text{ ----------(3.18)}$$

Taking X_{t-1} as common from right hand side of equation (3.18) results in

$$(X_t - X_{t-1}) = (\alpha - 1) . X_{t-1} + \varepsilon_t \text{ ----------(3.19)}$$

$$\Delta X_t = \beta_1 . X_{t-1} + \beta_2 . \Delta X_{t-1} + \varepsilon_t \text{ ----------(3.20)}$$

Where β_1 is equal to $(\alpha - 1)$. This is how the Augmented Dickey Fuller tests works. In equation (3.20), lagged value of X is augmented term. The null hypothesis is

H_0: $\beta_1 = 0$

H_1: $\beta_1 < 0$

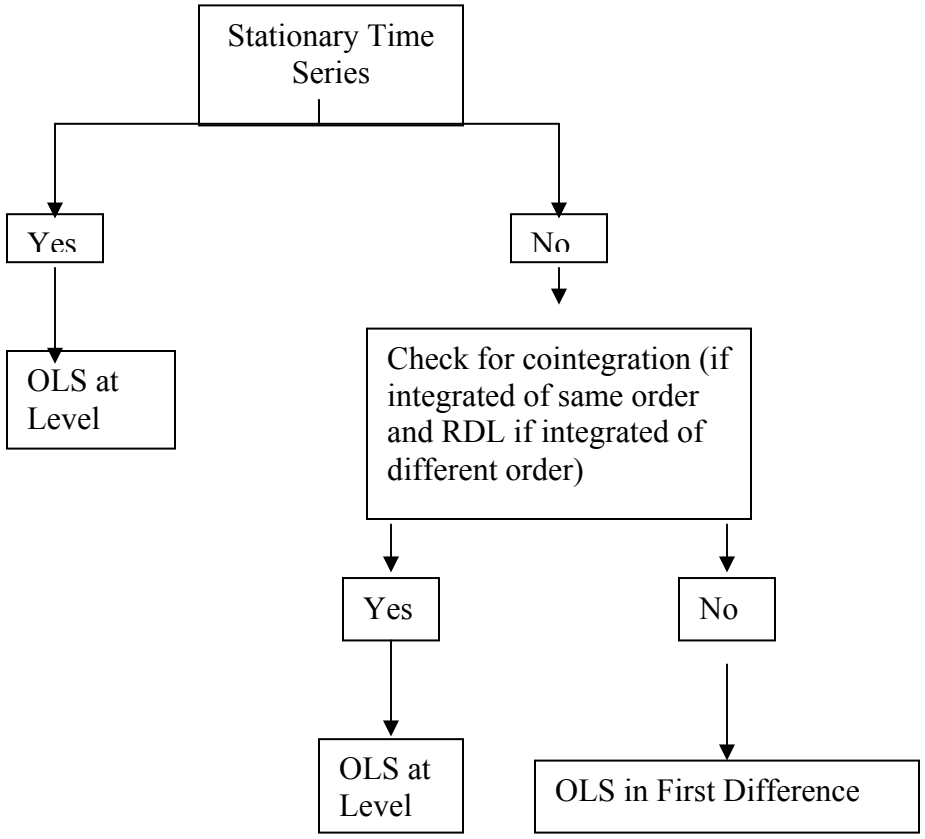
When β_1 is zero, α will be 1 and we conclude that there is unit root in the series under consideration. The rejection of null hypothesis is the rejection of existence of unit root in the series. Equation (3.20) is run with or with out intercept or trend. Decision of inclusion of intercept or no intercept is based on Schwartz criteria.

3.3.2 Phillip Peron Test

This is also used to test the existence of unit root in the series. Null hypothesis of Phillip Peron test is the same as that of ADF, which states that there is unit root in the series. ADF test is different from PP test in a sense that the former offers comparatively better size properties while the latter contains better power. Secondly, PP test also adjusts the heteroscedasticity of covariance as well as possible autocorrelation. Interpretation of both ADF and PP test is similar. Unlike ADF, PP test is non parametric and it tests for the existence of higher order serial correlation unlike ADF, which tests for first order serial correlation.

3.4 Johansen's Cointegration Technique

Johansen's (1988) Cointegration technique is employed to test whether two series move together or not over time. If two series are cointegrated, it means that long-term relationship exists between them. If non-stationary time series cause the OLS results to be spurious, following standard sequence of steps is followed



Using the first difference to control for unit root does not make economic sense as many variables when expressed in first difference form throw away economic theory. When individual variables are found to be non-stationary, it is possible for their linear combination to be stationary or cointegrated.

Johansen's Cointegration has been employed to check the existence of long run relationship among variables. Two variables are called cointegrated if they move together

over time. Johansen's cointegration is based on Eigen Values and trace Statistics. It is explained as follows

$$x_t = \alpha_0 + \sum_{j=1}^{k} \beta_j x_{t-j} + \varepsilon_t \text{ ----------(3.21)}$$

Where α_0 is n x 1 vector of constants, x_t is n x 1 vector of variables, which contain unit root and are stationary at first difference, k is number of lags, β_j is vector of coefficients and ε_t is vector of error terms. The above equation is reformulated into a vector error correction model as under

$$\Delta x_t = \alpha_0 + \sum_{j=1}^{k-1} \beta_j \Delta x_{t-j} + \delta x_{t-k} + \varepsilon_t \text{ ----------(3.22)}$$

$$\text{Where } \delta = -I + \sum_{i=j+1}^{k} \beta_j \quad \text{----------(3.23)}$$

Δ is first difference operator and I is an n x n identity matrix. Maximum Eigen value is applied to count the number of characteristic roots that insignificantly different from unit. Cointegration is superior to ordinary least square method because it provides super consistent estimation of parameters despite the presence of simultaneity, serial correlation and heteroscedasticity (Stock 1987 and Bhatti 1997)

However, if individual series are found to be stationary over time, through graphical presentation or ADF test and their mean values do not significantly increase over time, then testing the series for cointegration does not provide any additional insight. Johansen's Cointegration reports the number of cointegrating equations among dependent and explanatory variables.

3.5 Granger Causality Test

To test whether there is any association between stock and currency markets, Granger Causality test has been used. Granger Causality test is used when we know that some relationship exists between two variables but we do not know which variable causes the other to move. As in our case, same timing of stock and currency market crisis tells us that there are related. But whether this causation runs from stock market to currency

market or from currency market to stock market is the question, which Granger Causality test answers. It works as under:-

Suppose E and S are two variables representing exchange rates and stock index respectively. To see whether E granger causes S or S granger causes E, following equations are run

$$E_t = \beta_0 + \beta_1 E_{t-1} + - - - + \beta_p E_{t-p} + \alpha_1 S_{t-1} + - - - + \alpha_p S_{t-p} + \varepsilon_t \text{ ----------(3.24)}$$

Application of Granger Causality test requires two tests to run at the same time to check the relationship in each direction. So the second test is

$$S_t = \beta_0 + \beta_1 S_{t-1} + - - - + \beta_p S_{t-p} + \alpha_1 E_{t-1} + - - - + \alpha_p E_{t-p} + \varepsilon_t \text{ ----------(3.25)}$$

Equation (3.24) is test of causation running from stock market to currency market and equation (3.25) is causation test running from exchange market to stock market

Null hypothesis of Granger Causality test is that coefficient of S (α s) in equation (3.24) and coefficients of E (α s) in equation (3.25) are jointly zero. Rejection of null hypothesis in equation (3.24) means stock market granger causes exchange market while rejection of null hypothesis in equation (3.25) means that causation runs from exchange market to stock market. The number of lags in specification of Granger Causality needs to be selected on the basis of their significance for accuracy of the result. Lags are dropped until the last lag is significant. If lag 12 is significant, then there is no need to drop lags. The results of granger causality test are carefully interpreted as it just shows the statistical relationship between variables. It does not mean that one series if comes first causes the other to move. For example, Eid cards reach the market before Eid but it does not mean that Eid is caused by the arrival of cards in the market.

3.6 Forecasting with Exchange Rate Models

Following methodology has been used to forecast exchange rate by purchasing power parity, interest rate parity, adhoc model, random walk model and autoregressive integrated moving average model.

3.6.1 Forecasting with Purchasing Power Parity

Purchasing power parity can be tested by different equations. One approach is called conceptual approach and second is known as statistical test. In statistical test, quarterly

exchange rate change (in percentage) depends upon inflation differential between domestic and foreign country. Following approach has been used in this study

$$e_f = \left(\frac{(1+I_h)}{(1+I_f)} - 1 \right)$$

$$F_t = S_t * (1+e_f)$$

Putting the value from above equation, we get

$$F_t = S_t * \left[\frac{(1+I_h)}{(1+I_f)} \right] \text{----------(3.26)}$$

Where I_h and I_f are home inflation and foreign inflation rate respectively. S_t is spot rate, F_t is forecasted exchange rate and e_f is percentage change in quarterly exchange rate

3.6.2 Forecasting with Interest Rate Parity

According to Interest rate Parity theory, changes in exchange rate are influenced by domestic and foreign interest rate differential. Higher domestic interest rate leads to depreciation of local currency and vice versa. Numerically, exchange rate can be forecasted with following equation

$$F_t = S_t * \left[\frac{(1+i_h)}{(1+i_f)} \right] \text{----------(3.27)}$$

Where F_t is forecasted exchange rate and S_t is spot exchange rate at time t and i_h and i_f are home and foreign interest rates respectively

3.6.3 Random Walk Model

Random walk model negates all the underlying economic theories and predicts exchange rate on the basis of its previous behavior. Meese and Rogoff (1983) used following driftless random walk model in their study

$$S_{t+h} = S_t + \varepsilon_t \text{----------(3.28)}$$

This equation tells us that future spot rate will differ from current spot rate by random error term, which can be positive as well as negative. Thus according to this model, change in exchange rate is random and unpredictable. In the literature of exchange rate forecasting, Random Walk Model has been extensively used as benchmark model.

Following the literature, above model is used as benchmark in this study as well. However, in addition to simple random walk model, another benchmark has also been used to compare the forecasting performance of three economic models. This is auto regressive integrated moving average model, which explains exchange rate on the basis of not only previous exchange rates but also on the basis of previous error terms.

3.6.4 Autoregressive Integrated Moving Average (ARIMA)

Autoregressive integrated moving average (ARIMA) has become increasingly popular technique of exchange rate forecasting. Like random walk model, it completely ignores the role of macroeconomic variables and is a curve fitting device using current and previous values of dependent variables. Chartists or technicians completely base their forecasts on the previous movements of exchange rates and contradict potential economic theories. ARIMA can be best technique, when we have very limited information about forecasted independent variables. ARIMA has the potential of producing short-term forecasts better than theoretically satisfying economic models. If original series does not contain unit root in it, then, this is reduced to ARMA. But exchange rate of all the sample economies contain unit root and integrated of order 1, therefore, ARIMA is used, which estimates equation in the first difference form.

ARIMA consists of two processes. First process is auto regressive process, which expresses the dependent variable as a function of its lagged values while the second process is called moving average process, which expresses the dependent variable as a function of previous values of error term. ARMA can be created as under

$$S_t = \alpha_0 + \beta_1.S_{t-1} + \beta_2.S_{t-2} + \beta_p.S_{t-p} + \varepsilon_t + \delta_1.\varepsilon_{t-1}.\delta_2.\varepsilon_{t-2} + \delta_q.Y_{t-q} \text{ ----------(3.29)}$$

Before this equation can be applied, the data series needs to be stationary. Data series can be made stationary by taking its first difference. If first difference is not sufficient for making a series stationary then by taking the first difference of the first difference i.e. second difference makes the series stationary. Lag length p and q has been selected using Swartz criterion.

3.6.5 Adhoc Model of Exchange Rate

Adhoc model used in chapter 3 is not based on any specific economic theory and takes variables proposed by different exchange rate theories as explanatory variables. Regression equation is

$$E.R_t = \alpha_0 + \beta_1 * RIR_t + \beta_2 * RIL_{t-1} + \beta_3 * TOT_t + \beta_4 * TR_t + \beta_5 * d(TB_t) + \beta_6 * NKI_t + \varepsilon_t$$

Exchange rate forecasted values are the expected values obtained from above equation. Thus forecasted exchange rate can be written as under

$$F_t = \alpha_0 + \beta_1 * RIR_t + \beta_2 * RIL_{t-1} + \beta_3 * TOT_t + \beta_4 * TR_t + \beta_5 * d(TB_t) + \beta_6 * NKI_t \text{ ----(3.30)}$$

Where F_t is expected or equilibrium exchange rate, which can be obtained by subtracting the residual series from actual data.

3.7 Testing the Predictive Capacity of Exchange Rate Models

Two approaches have been employed to measure the forecasting performance of models under consideration. Firstly, graphical evaluation has been used, which provides good intuition for accuracy of forecasting techniques. Then formal investigation of predictive capacity has been investigated by four traditional measures. These measures of forecasting performance include, *Root Mean Square Error* (RMSE), Mean Absolute Error (MAE), *Median of Absolute Deviation* (MAD) and *Success Ratio* (SR).

3.7.1 Graphical Evaluation of Predictive Capacity

Graphical evaluation of forecasting performance can be a good start to compare different forecasting techniques. In these graphs, forecasted values have been plotted against realized values. Forecasted or predicted values are drawn on X-axis and realized values on Y-axis. A line at 45^o is called Perfect Forecast Line (PFL). Points lying below Perfect Forecast Line indicate upward biasness because at these points, a particular model estimates higher than realized exchange rate and all the points lying above Perfect Forecast Line indicate downward biasness because at these points, a particular model estimates less than realized exchange rates. The closer the points are to Perfect Forecast Line, the better the model is.

3.7.2 Root Mean Square Error (RMSE)

Mean Square Error has widely been used in the literature of exchange rate forecasting. It measures the distance between estimated and actual values of a series. MSE measures the average of squared error. This error may occur due to randomness or omitted variable case, which means that a particular estimator has omitted some important information, which might have improved prediction. Taking under root of Mean Square Error results in Root Means Square Error (RMSE), which is calculated as under

$$RMSE = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(F_t - S_t)^2} \text{ ----------(3.31)}$$

Where

F_t is forecasted exchange rate and S_t is actual or realized exchange rate at time t

3.7.3 Mean Absolute Error (MAE)

Mean Absolute Error is commonly used measure to test the predictive capacity of different models in time series data. As the name suggests, it measures how close the predicted values are to the actual or realized values. Like *Root Mean Square Error*, it avoids off setting effect, absolute value is used to calculate forecast error. If in the first period error is 0.10 and in the second period, it is –0.10, they will cancel each other and mean error will be zero. This does not produce accurate measure and gives misleading results. Such distortion can be avoided using absolute values. It is measured as under

$$MAE = \frac{1}{n}\sum_{i=1}^{n}\left|F_t - S_t\right| \text{ ----------(3.32)}$$

Where

F_t is forecasted exchange rate and S_t is actual or realized exchange rate at time t

3.7.4 Median of Absolute Deviation (MAD)

Root Mean Square Error (RMSE) and Mean Absolute Error (MAE) are most commonly used measures of predictive capacity of exchange rate models but these are less robust to the existence of outliers in the series. Therefore, inclusion of *Median of Absolute Deviation* is useful, which is not inflated by existence of outliers. *Median of Absolute*

Deviation has the capacity of measuring predictive capacity of models in a bulk of data, which is free from existence of outliers. This is measured as under

$$MAD = median(|F_t - median(F_t)|) \text{ ----------(3.33)}$$

Above formula of *Median of Absolute Deviation* clearly indicates that it is comparatively more resilient to the existence of outliers and is thus comparatively more robust measure of dispersion.

All the above three measures of predictive capacity have similar type of interpretation. The lower the output of these measures is, the higher the reliable a model is.

3.7.5 Success Ratio (SR)

Root Mean Square Error (RMSE), *Mean Absolute Error* (MAE) and *Median of Absolute Deviation* (MAD) measure how much lower the forecast error of a particular model is? However, these may not be useful for investors, whose objective is not to reduce the forecast error rather to maximize their profits. Therefore RMSE, MAE and MAD may not be the good criterion for these investors and they use *Success Ratio*, which measures the direction predictability of a particular model (Diebold and Mariano 1995). *Success Ratio* is measured as under

$$SR = \frac{1}{n}\sum_{t=1}^{n} I(r_a r_p > 0) \text{ ----------(3.34)}$$

Where

SR= *Success Ratio*

I= Indicator function, which is I ($r_a r_p$>0)=1

r_a=Actual return and

r_p=Predicted return

The above mentioned four measures of comparing forecasting performance of exchange rate models are consistent with those used by Preminger and Franck (2007)

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Interaction between Capital and Currency Markets

This section reports

4.1.1 Descriptive Statistics of Stock returns and exchange rate growth

4.1.2 Line graphs of exchange rates of sample countries

4.1.3 Line graphs of stock market indices of sample countries

4.1.4 Results of ADF and Phillip Peron Tests

4.1.5 Results of Johansen's Cointegration

4.1.6 Results of Granger Causality Test

4.1.1 Descriptive Statistics

Descriptive statistics of stock returns and exchange rates of sample countries are reported in Table 2

Stock returns and exchange rate growth have been measured by taking the first difference of natural log of relevant index and exchange rate.

Stock Returns

Table 2 reports mean monthly, median monthly, maximum monthly, minimum monthly stock returns and exchange rate growth for sample economies

Table 2: Descriptive Statistics of Stock Market Returns and Exchange Rate Growth

Country	Variable	Mean	Med	Max	Min	S.D
Pakistan	Stock Returns (KSE 100)	1.04%	1.27%	24.11%	-44.88%	10.35%
	Exchange Rate Growth	0.49%	0.02%	12.07%	-3.49%	1.90%
India	Stock Returns (BSE 30)	0.89%	1.48%	24.89%	-27.30%	8.09%
	Exchange Rate Growth	0.19%	0.06%	6.95%	-6.02%	1.69%
Indonesia	Stock Returns (Jakarta comp)	0.81%	2.14%	25.02%	-37.86%	9.81%
	Exchange Rate Growth	0.89%	0.07%	80.25%	-34.87%	10.14%
South Korea	Stock Returns (Kospi comp)	0.53%	0.66%	39.76%	-31.81%	9.96%
	Exchange Rate Growth	0.20%	-0.13%	37.60%	-16.62%	5.30%
Sri Lanka	Stock Returns (Colombo All)	0.84%	0.77%	22.52%	-18.42%	7.57%
	Exchange Rate Growth	0.45%	0.27%	62.23%	-59.73%	7.26%

Mean Monthly Stock Returns

In case of Pakistan, Mean value is 1.04% while standard deviation is 10.35%. Over analysis period, KSE 100 returns are higher than those of BSE 30 index, Jakarta Composite Index, KOSPI composite index and Colombo All Shares Index. Mean value of monthly return of KSE 100 index is 1.04% against BSE 30 index mean return of 0.89%. Jakarta Composite Index, KOSPI composite index and Colombo All shares index have monthly mean return of 0.81%, 0.53% and 0.84% respectively. Thus on monthly stock return basis, Pakistan ranks first, India second, Sri Lanka third; Indonesia fourth and South Korea is at number 5.

Maximum Monthly Stock Returns

Although on mean return basis Korea is at fifth number but its monthly maximum value is 39.76%, which is highest among all the sample economies. On maximum monthly return basis, Indonesia is at number two with maximum monthly return of 25.02%, India lies at number three with maximum monthly return of 24.89%, Pakistan is at number four with maximum value of 24.11% while Sri Lanka is at number five with maximum monthly return of 22.52%.

Minimum Monthly Stock Returns

Maximum decline of stock market in one month is of KSE 100 Index. It is -44.88%. This occurred in November 2008, when KSE 100 Index fell from 9187 to 5865 just in one month. Indonesia ranks second on the basis of maximum monthly decline with value of –37.86%, South Korea is at number three with –31.81%, India at number four with –24.89% and Sri Lanka is at number five with maximum monthly decline of –18.42%

Standard Deviation of Stock Returns

Standard deviation is measured as under root of the variance and is used as a measure of risk. The last column of table 2 reports the value of standard deviation in percentage terms. Standard deviation of Karachi Stock Exchange is highest of all. It is 10.35% against 8.09% of India, 9.81% of Indonesia, 9.96% of Korea and 7.57% of Sri Lanka. Thus on the basis of standard deviation, Karachi Stock exchange is riskiest among all the sample stock exchanges. Korea lies at number two, Indonesia is at number three, India is at number four and Sri Lanka is at number five.

Descriptive Statistics indicate that on the basis of monthly mean return, maximum monthly decline and risk, Pakistan ranks first, while on the basis of maximum monthly return, Korea ranks first and Pakistan is at number four.

Exchange Rate Growth

Exchange rate growth has been calculated by taking the first difference of the natural log of direct quotation of exchange rates of sample countries. Table 2 also reports exchange rate growth of sample countries. Over the analysis period, mean monthly exchange rates of all the sample countries have positive values, which indicates that over the analysis period, all the five currencies have depreciated against U.S Dollar.

Indonesian Rupiah has experienced highest mean depreciation against U.S Dollar. It has mean monthly depreciation of 0.89% from July 1997 to October 2009. Second highest depreciation has been observed in Pak Rupee, which has the mean value of 0.49%. Sri Lankan Rupee ranks third as it has mean value of 0.45%. South Korean Won lies at number four with mean value of 0.20% while Indian Rupee has experienced least depreciation in comparison with other sample countries with mean value of 0.19% from July 1997 to October 2009. Thus on the basis of mean monthly depreciation against

United States Dollar, Pak Rupee stands at number two among exchange rates of all the sample countries.

As far as exchange rate volatility or riskiness of a currency is concerned, standard deviation of exchange rate growth shows that Indonesian Rupiah has highest volatility against United States Dollar. Volatility of Indonesian Rupiah is 10.14%, which is followed by Sri Lankan Rupee with standard deviation of 7.26%. South Korean Won ranks third with standard deviation of 5.30%, less than that of Indonesian Rupiah and Sri Lankan Rupee but higher than that of Pakistan and Indian Rupee. Pakistan Rupee is at number four with standard deviation of 1.90% while Indian Rupee has the least volatility in comparison with other sample countries. It has standard deviation of 1.69%. So on the basis of exchange rate growth, Pakistan stands at number two while it stands on number four on the basis of volatility of currency. Among sample countries, Indian Rupee has experienced the least depreciation as well as least standard deviation against United States Dollar.

Before application of formal test of unit root, graphical method has been applied to visualize whether the mean of stock index and exchange rate is dramatically increasing over time or not.

4.1.2 Line Graphs of Exchange Rates of Sample Countries

Line graphs of time series provide good guess about existence of unit root in the series. If graph indicates continuous increasing or decreasing trend over time, time series under consideration might have unit root in it.

Figure 1: Line Graph of Pak Rs. versus U.S Dollar

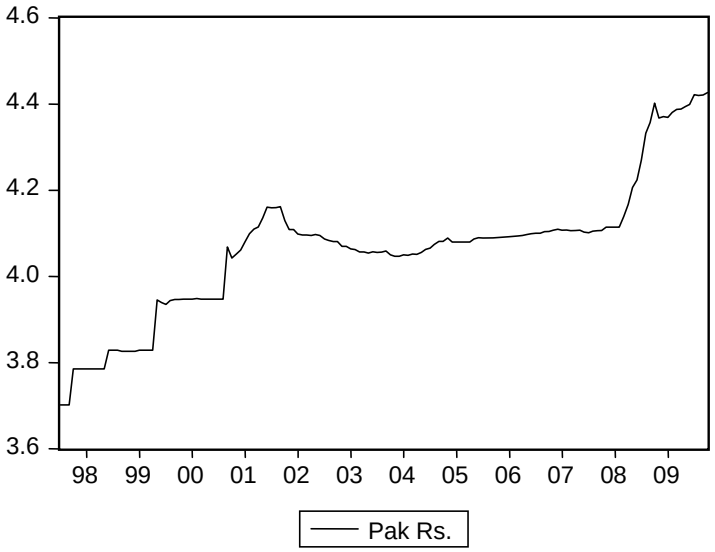


Figure 2: Line Graph of Indian Rupee versus U.S Dollar

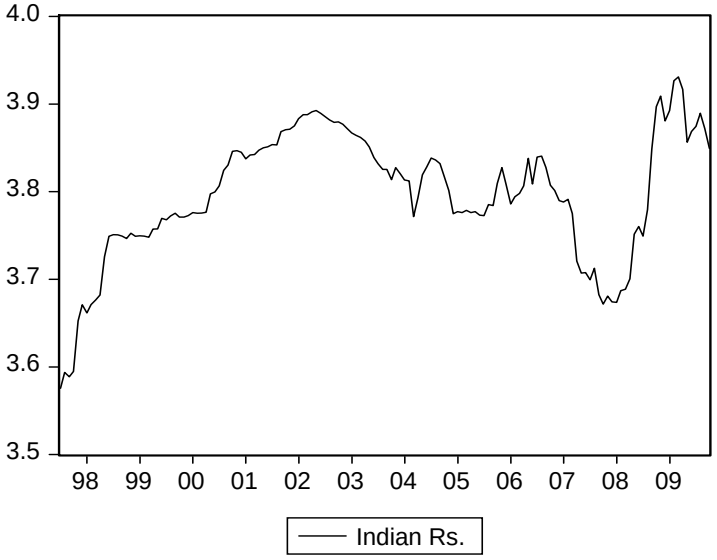


Figure 3: Line Graph of Indonesian Rupiah versus U.S Dollar

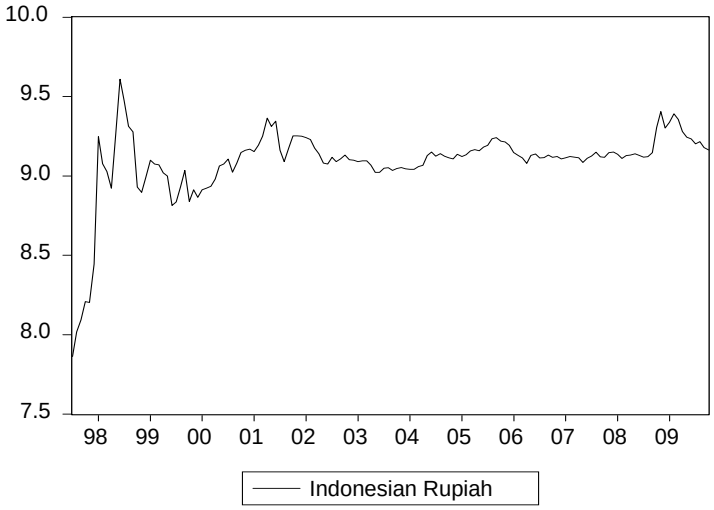


Figure 4: Line Graph of Korean Won versus U.S Dollar

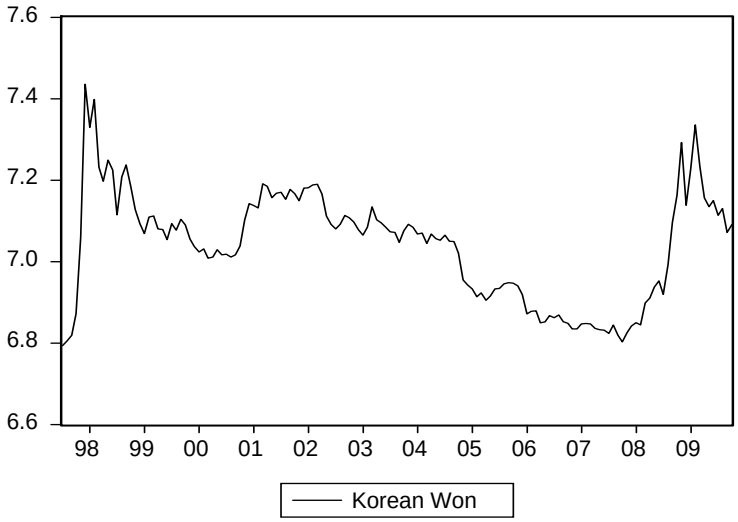
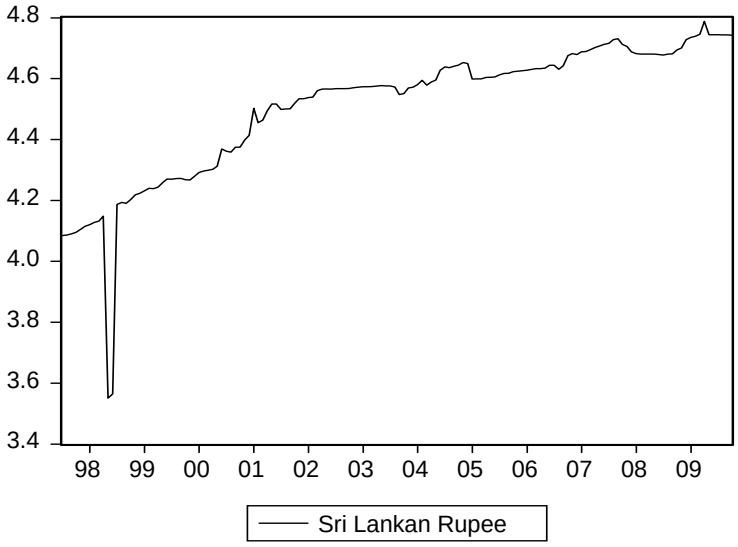


Figure 5: Line Graph of Sri Lankan Rupee versus U.S Dollar



Line graphs of all the sample countries indicate increasing trend in the series, which provides hint for existence of unit root in them.

4.1.3 Line Graphs of Stock Market Indices of Sample Countries

If stock market indices have continuous increasing or decreasing trend over time, they might have unit root in them. If a series contains unit root in it, it is called non stationary otherwise it is called stationary. To run cointegration, series need to be non-stationary at levels and integrated of same order. Line graphs provide good guess about existence of unit root. Therefore, KSE 100 index, BSE 30 Index, Jakarta Composite index, KOSPI Composite index and Colombo All Shares index are drawn as under

Figure 6: Line Graph of KSE 100 Index

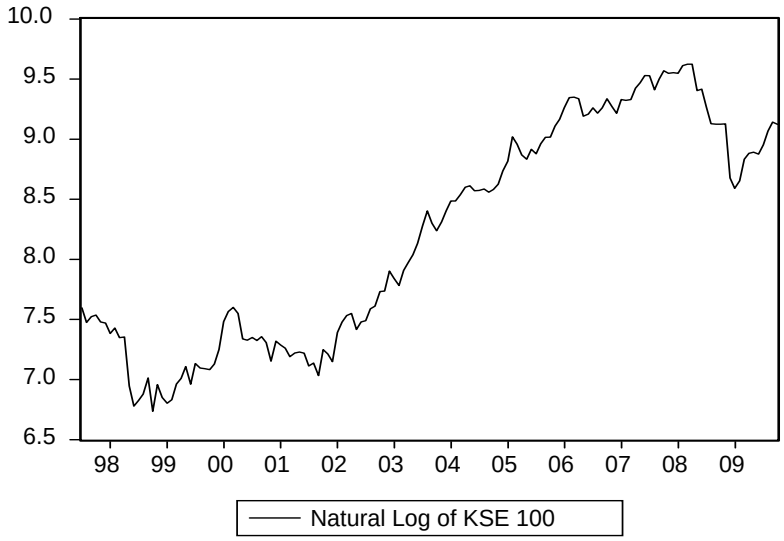


Figure 7: Line Graph of BSE 30 Index

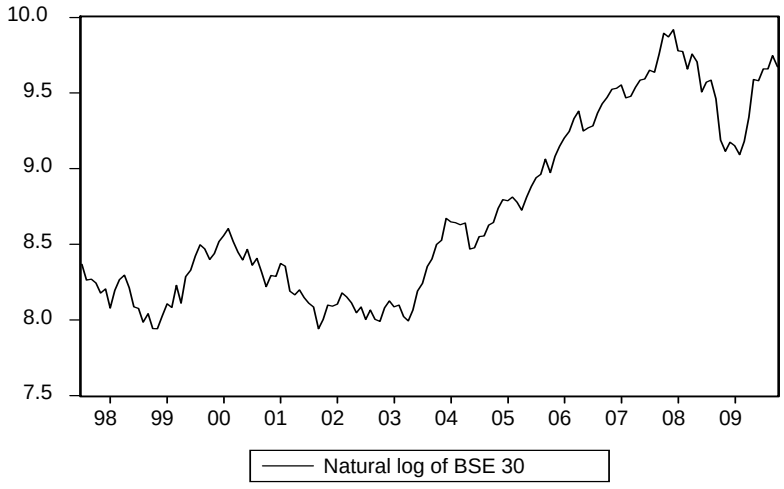


Figure 8: Line Graph of Jakarta Composite Index

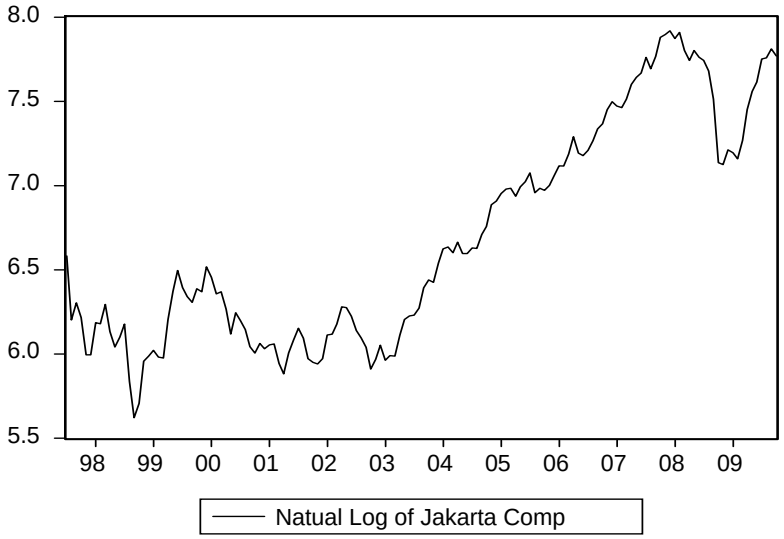


Figure 9: Line Graph of KOSPI Composite Index

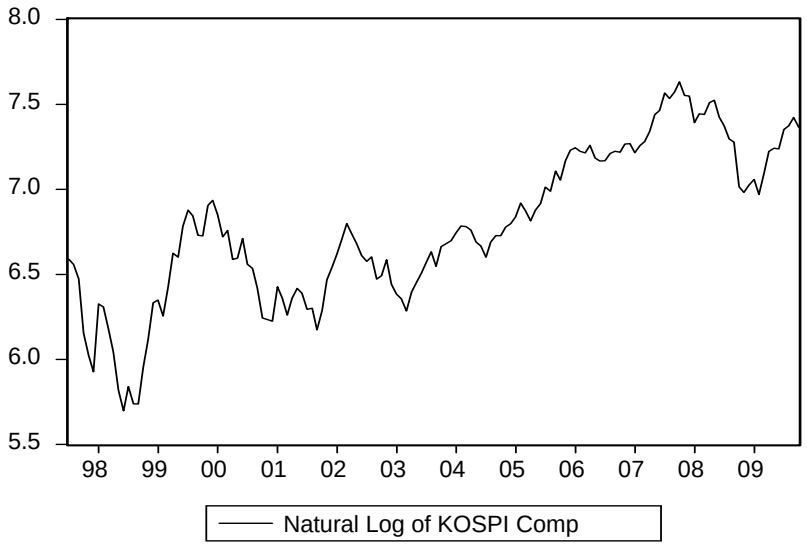
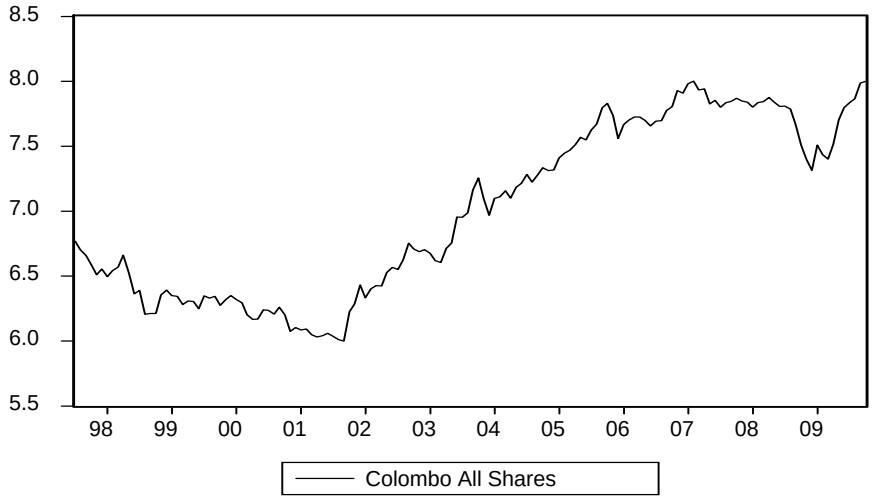


Figure 10: Line Graph of Colombo All Shares Index



Line graphs of stock market indices of sample countries provide almost same idea as the line graphs of exchange rates of sample countries provide. These also indicate increasing trend in the series and ask for formal investigation of unit root in them

4.1.4 Results of ADF and Phillip Peron Tests

Apparently, it seems that all the five series of exchange rates as well as all the five series of stock market indices of sample countries have unit root in them and hence are non stationary. However, the line graphs of exchange rate of Indian Rupee and Indonesian Rupiah do not provide clear idea about the existence of unit root in them. Formal investigation is done through application of Augmented Dickey Fuller test as well as Phillip Peron test. For both Augmented Dickey Fuller and Phillip Peron tests, lag has been selected using Schwartz information criteria. Akaike and Schwartz criteria have been used for decision of inclusion or no inclusion of intercept in the test.

Both *ADF as well Phillip Peron Tests* test the null hypothesis of unit root in the series. They report test statistics, which are compared to McKinnon Critical values. If ADF statistics or PP statistics exceeds critical value, null hypothesis of unit root in the series cannot be accepted and if test statistics does not exceed critical value, then null

hypothesis of unit root in the series cannot be rejected and series is said to be non-stationary.

Table 3 reports the results of Augmented Dickey Fuller test as well as Phillip Peron test of unit root. These tests have been applied on stock indices as well as on exchange rates of sample countries. Furthermore, these have been applied at levels as well as in the first difference form. Fourth column of table 3 reports the results of test statistics while column 5 and column 6 report McKinnon 1% and 5% critical values respectively.

Table 3: Results of Unit Root Investigation (ADF and PP test)

Country	Variable	Test for Unit Root in		Test Stat	1% Critical Value	5% Critical Values
Pakistan	KSE 100	ADF Test	At levels	-0.593489	-3.477	-2.8817
			First Difference	-4.538999	-3.4773	-2.8818
		PP Test	At levels	-0.502893	-3.4758	-2.8811
			First Difference	-11.54959	-3.4761	-2.8812
	Exchange Rate	ADF Test	At levels	-0.367071	-3.477	-2.8817
			First Difference	-4.359227	-3.4773	-2.8818
		PP Test	At levels	-0.839036	-3.4758	-2.8811
			First Difference	-11.65698	-3.4761	-2.8812
India	BSE 30	ADF Test	At levels	-0.625385	-3.477	-2.8817
			First Difference	-4.634732	-3.4773	-2.8818
		PP Test	At levels	-0.31794	-3.4758	-2.8811
			First Difference	-11.18571	-3.4761	-2.8812
	Exchange Rate	ADF Test	At levels	-2.49313	-3.477	-2.8817
			First Difference	-3.718518	-3.4773	-2.8818
		PP Test	At levels	-3.046072	-3.4758	-2.8811
			First Difference	-9.10529	-3.4761	-2.8812
Indonesia	Jakarta Comp	ADF Test	At levels	-0.566719	-3.477	-2.8817
			First Difference	-5.351109	-3.4773	-2.8818
		PP Test	At levels	-0.33004	-3.4758	-2.8811
			First Difference	-10.51426	-3.4761	-2.8812
	Exchange Rate	ADF Test	At levels	-7.36923	-3.477	-2.8817
			First Difference	-4.841176	-3.4773	-2.8818
		PP Test	At levels	-6.022998	-3.4758	-2.8811
			First Difference	-10.72484	-3.4761	-2.8812
Korea	KOSPI Comp	ADF Test	At levels	-1.568183	-3.477	-2.8817
			First Difference	-5.68636	-3.4773	-2.8818
		PP Test	At levels	-1.250418	-3.4758	-2.8811
			First Difference	-10.11969	-3.4761	-2.8812
	Exchange Rate	ADF Test	At levels	-2.396601	-3.477	-2.8817
			First Difference	-9.125361	-3.4773	-2.8818
		PP Test	At levels	-2.934179	-3.4758	-2.8811
			First Difference	-11.39464	-3.4761	-2.8812
Sri Lanka	Colombo All Shares	ADF Test	At levels	-0.331412	-3.477	-2.8817
			First Difference	-4.816583	-3.4773	-2.8818
		PP Test	At levels	-0.078338	-3.4758	-2.8811
			First Difference	-10.78207	-3.4761	-2.8812
	Exchange Rate	ADF Test	At levels	-1.683151	-3.477	-2.8817
			First Difference	-7.425466	-3.4773	-2.8818
		PP Test	At levels	-1.965557	-3.4758	-2.8811
			First Difference	-13.28219	-3.4761	-2.8812

In Table 3 ADF statistics reports that stock indices of all sample countries contain unit root in them at level, as ADF statistics does not exceed 1% as well as 5% critical values. The same is supported by results of Phillip Peron test on stock indices of all the five countries. However, PP test on Indian Rupee at level indicates that it does not contain unit root at 5% critical value as PP statistic is –3.046072 against 5% critical value of –2.8811, however the series contains unit root according to ADF statistics at level at both 1% as well as 5% critical values. Some sort of similar result is found for Korean Won. ADF reports that it contains unit root at level at 1% as well as 5% critical values while PP reports that it does not contain unit root at 5% critical value, however, PP supports the existence of unit root at level at 1% critical value. Both ADF and PP report that both stock indices as well as exchange rates of sample countries become stationary at first difference.

ADF statistics reports surprising results for Indonesian Rupiah over analysis period. ADF statistics at level is –7.36923 against 1% critical value of –3.477 and 5% critical value of –2.8817, which means that Indonesian Rupiah does not contain unit root. The same is supported by results of PP statistics. Both ADF and PP report that Indonesian Rupiah does not contain unit root and is stationary at level. As Indonesian Rupiah is stationary and cointegration cannot be applied on stationary series, therefore, long run relationship of stock market return of Jakarta stock exchange and Indonesian Rupiah has not been explored through use of the cointegration technique. Summarizing unit root discussion, variables under consideration contain unit root in them i.e. non stationary at level but integrated of order 1 i.e. they become stationary in first difference.

4.1.5 Results of Johansen's Cointegration

Cointegration has been used to determine the long run relationship between stock and currency markets of sample economies. Granger causality test is run to gauge the short run relationship while Johansen Cointegration technique is used to measure long run relationship (Lee and Boon, 2007). Johansen Cointegration technique has been applied on stock indices and exchange rates of four economies with lag interval of 1 to 4 under the

test assumption of linear deterministic trend in the data. However, I repeated Johansen cointegration test with other assumptions and found similar results.

Table 4: Results of Johansen's Cointegration Test on Exchange Rates and Stock Indices

	Eigen Values	L. R Stat	5 % Critical Values	1 % Critical Values	Number Of CE(s)
Pakistan	0.025157	3.725406	15.41	20.04	None
	0.000572	0.081878	3.76	6.65	At most 1
India	0.04632	7.02706	15.41	20.04	None
	0.001712	0.244988	3.76	6.65	At most 1
Korea	0.066829	13.3417	15.41	20.04	None
	0.023843	3.450838	3.76	6.65	At most 1
Sri Lanka	0.049025	8.263312	15.41	20.04	None
	0.00749	1.075086	3.76	6.65	At most 1

As likelihood ratio has not exceeded the 5% critical value or 1% critical value, therefore, Johansen Cointegration rejects any cointegrating relation between stock market indices and exchange rates of sample economies. Table 4 reports that stock market indices and exchange rates do not move together in the long time. Our findings are in line with those of Lee and Boon (2007), who found short run linear causality between stock market and exchange rate but no long run relationship between them.

4.1.6 Results of Granger Causality Test

When two variables are known to be related but the direction of their causality is not known, then granger causality is applied. In our case stock market returns and exchange rates are two series, which are assumed to be correlated. Same timing of stock market and currency crisis provides supporting evidence of possible linkage between these two markets however, direction of the causality is not known. Theoretical justification of bi directional relationship exists. Empirical investigation determines the nature of this

relationship. Null hypothesis of Granger Causality Test is that one series does not granger cause the other series. In our case, comparing the reported probability value with 0.10 will test the null hypothesis of no granger causality. First hypothesis is that exchange rates do not granger cause stock returns while the second null hypothesis is that stock returns do not granger cause exchange rates.

Table 5 reports the results of Granger Causality test. Column 2 states the null hypotheses; column 3 reports the F statistics and column 4 reports the probability values. As series under consideration are non stationary at levels and are not cointegrated, therefore Granger Causality has been employed in first difference on stock market indices and exchange rates of sample economies. Initially, lags were set equal to 10 and then dropped until the last lag was significant. In case of Pakistan, lag 8 is significant while 2, 9, 10 and 10 are significant lags in case of India, Indonesia, Korea and Sri Lanka respectively

Table 5: Results of Granger Causality Test between Stock Market Returns and Exchange Rates

Country	**Null Hypothesis**	**F Statistics**	**Probability**
Pakistan	ER does not granger cause S	1.4689	0.1754
	S does not granger cause ER	2.0701	0.0438
India	ER does not granger cause S	3.4418	0.0347
	S does not granger cause ER	0.2447	0.7833
Indonesia	ER does not granger cause S	2.9831	0.0031
	S does not granger cause ER	2.3717	0.0167
Korea	ER does not granger cause S	1.8039	0.0673
	S does not granger cause ER	1.8395	0.0611
Sri Lanka	ER does not granger cause S	1.3788	0.1986
	S does not granger cause ER	2.8437	0.0034

Note:

S is first difference of natural log of stock market index of sample countries and

E is first difference of natural log of nominal exchange rate of sample economies

Table 5 reports that causality runs from stock market to exchange rate while no causality runs from exchange rate to stock market in case of Pakistan. P-value of null hypotheses of no granger causality from exchange rate to stock market is above 0.10 thus null hypotheses can not be rejected while P-value of null hypotheses of no granger causality from stock market to exchange rate is below 0.10 and thus null hypotheses can not be accepted. Granger Causality Test reports that causality runs from stock market to currency market in case of Pakistan.

In case of India, no causality has been found running from stock market to exchange rate. However, test supports the existence of causality running from exchange rate to stock market. Thus direction of this causality is different in Pakistan and India.

In case of Indonesia, Table 5 reports the results of causality running from stock market to exchange rate and from exchange rate to stock market. The null hypothesis of no granger causality running from stock market to exchange rate or from exchange rate to stock market cannot be accepted as probability values less than 0.10. Therefore, bi directional causality has been found in case of Indonesia.

Table 5 supports the existence of bi directional causality in case of Korea as well. Null hypothesis of no granger causality running from stock market to exchange rate or from exchange rate to stock market cannot be accepted. The probability values of null hypothesis of no causality running from stock market to exchange rate and from exchange rate to stock markets are 0.0611 and 0.0673 respectively. As p values do not exceed 0.10, therefore, at 10% significance level, bi directional causality exists in Korea. Thus, empirical investigation of Korean Won and KOSPI composite index supports the existence of bi directional relationship between stock market and exchange rate.

Granger Causality results of Sri Lanka are quite similar to those of Pakistan for both types of causality. As the probability values of null hypothesis of no granger causality running from exchange rate to stock market is higher than 0.10 while less than 0.10 for no granger causality running from stock market to exchange rate. Thus, in case of Sri Lanka, causality runs from stock market to exchange rate. It supports the arguments of portfolio balance approach.

4.2 Macroeconomic Determinants of Exchange Rates

This section reports

4.2.1 Descriptive statistics exchange rate and macroeconomic variables

4.2.2 Graphical visualization of variables

4.2.3 Unit root results of Augmented Dickey Fuller and Phillip Peron test

4.2.4 Results of Johansen's Cointegration Technique

4.2.5 Results of regression equation

4.2.1 Descriptive Statistics

In the adhoc model used in this study, exchange rate is dependent variable while six macroeconomic variables have been used as explanatory variables. Use of variables in exchange rate determination has always been the center of discussion and there is consensus of researchers that knowledge about relevant variables is limited. However, different theories propose different variables. The variables used in this study include relative interest rate, relative inflation level, terms of trade, trade restriction, trade balance ratio and net capital inflows. Before, estimating parameters, descriptive statistics are reported as under

Table 6 reports the descriptive statistics of all variables of sample economies. These descriptive statistics include mean, median, maximum and minimum values. Relative inflation rate has been measured as dividing the U.S inflation rate by inflation rate of sample economies. Foreign terms of trade have been measured as dividing the U.S exports by U.S imports. Trade restrictions have been estimated as reciprocal of trade openness. It has been measured by dividing the gross domestic product by sum of imports and exports. Trade balance ratio has been calculated as dividing the trade balance by gross domestic product. Net capital inflows; have been estimated by dividing the sum of financial and capital account by gross domestic product. Descriptive statistics of explanatory variables have been discussed as under:-

Relative Interest Rate (RIR)

In Pakistan, mean relative interest rate value of 0.807 indicates that nominal interest rate in Pakistan has been higher in comparison with that in United States. According to interest rate parity theory, this should put negative pressure on the value of Pak Rupee

against U.S Dollar. Same is the case with India, Indonesia, Korea and Sri Lanka. Mean relative interest rate for India, Indonesia, Korea and Sri Lanka are 0.446, 0.566, 0.673 and 0.392 respectively. The mean values of relative interest rate are less than one for all the sample economies indicating higher interest rate in sample economies relative to that in United States. According to interest rate parity theory, under assumption of no covered interest arbitrage, this higher relative interest rate is expected to put negative pressure on the currency prices of sample economies. By looking at the maximum values of relative interest rates, it is interpreted that in India and Sri Lanka, maximum values are 0.800 and 0.804, which indicates that over the analysis period, interest rates of United States have never exceeded interest rates of India and Sri Lanka. While in case of Pakistan, Indonesia and Korea, maximum values exceed one, which tells us that over the analysis period, U.S interest rate have exceeded interest rates of sample economies in some quarters. However mean values are less than 1, which indicates that on overall basis, U.S interest rates have been less than those in sample economies.

Table 6: Descriptive Statistics of Dependent and Independent Variables of Sample Economies

		LNER	RIR	RIL	TOT	TR	TB	NKI
Pakistan	Mean	3.500	0.807	0.588	0.683	12.499	-5.749%	2.352%
	Median	3.443	0.713	0.396	0.692	12.315	-5.201%	2.657%
	Maximum	4.224	1.717	3.479	0.889	16.177	0.604%	9.877%
	Minimum	2.638	0.316	-1.698	0.509	8.891	-15.622%	-6.974%
India	Mean	3.374	0.446	0.172	0.677	24.205	-2.579%	2.617%
	Median	3.577	0.427	0.281	0.659	22.902	-2.000%	2.422%
	Maximum	3.889	0.800	4.540	0.889	41.504	0.323%	12.045%
	Minimum	2.415	0.240	-9.071	0.509	8.568	-14.224%	-1.414%
Indonesia	Mean	8.257	0.566	0.456	0.678	9.497	6.529%	0.721%
	Median	7.776	0.568	0.390	0.660	9.804	5.719%	1.542%
	Maximum	9.609	1.219	4.486	0.889	15.878	15.842%	7.338%
	Minimum	6.922	0.070	-8.847	0.509	4.635	0.290%	-23.517%
Korea	Mean	6.838	0.673	0.647	0.679	7.187	1.113%	0.383%
	Median	6.788	0.656	0.671	0.660	7.150	1.041%	1.056%
	Maximum	7.435	1.143	13.698	0.889	10.402	12.593%	6.996%
	Minimum	6.503	0.356	-22.097	0.509	3.906	-5.938%	-17.998%
Sri Lanka	Mean	4.041	0.392	0.328	0.678	6.621	-9.726%	3.922%
	Median	4.002	0.376	0.248	0.660	6.485	-10.337%	4.133%
	Maximum	4.732	0.804	3.023	0.889	9.200	3.060%	15.590%
	Minimum	3.226	0.075	-2.244	0.509	4.929	-18.826%	-6.199%

Note:

$E.R_t$ is exchange rate, measured as natural log of nominal exchange rate in direct quotation at time t

RIR_t is relative interest rate in time t

RIL_{t-1} is lagged period relative inflation level

TOT_t is terms of trade in period t

$D(TB_t)$ is change in trade balance ratio and NKI_t is net capital inflows

Relative Inflation Level (RIL)

Table 6 reports that mean values of relative inflation level are less than one in all the sample economies. This reports that relative to United States, higher inflation rates have been observed in sample economies over analysis period. One reason of relative higher interest rate in sample economies, discussed above, may be due to this higher component of inflation. As according to Fischer equation, nominal interest rate is a sum of real interest rate and inflation. If interest rates of developing economies have been found higher than that in United States, this may be due to higher component of inflation in it. Mean value for relative inflation level for Pakistan, India, Indonesia, Korea and Sri Lanka are 0.588, 0.172, 0.456, 0.647 and 0.328 respectively. These mean values indicate that over the analysis period, all sample economies have inflations higher than that in United States. Comparative to other sample economies, India has highest comparative inflation than what other economies have, as its mean value of 0.172 is less than mean values of all the remaining sample economies.

Terms of Trade (TOT)

Foreign terms of trade or simply terms of trade have been measured by dividing the exports of United States with imports of United States. As base currency used in exchange rate of all the sample economies is United States Dollar, therefore, this variable is same for all the five sample economies. The nominal difference in the mean values and other descriptive statistics of terms of trade are due to different number of observations used in the study for different countries. Although sample period consists of 1984 to 2008, however, data of some variables was missing for particular quarters, therefore, number of observations differ among sample countries. The number of observation in Indonesia and Sri Lanka are same, therefore, both have mean value of 0.678, while Pakistan, India and Korea have 0.683, 0.677 and 0.679 respectively. As all the reported descriptive statistics of terms of trade are less than one, it indicates that over the analysis period, U.S exports have never exceeded U.S imports.

Trade Restrictions (TR)

This variable has been measured as dividing gross domestic product by sum of imports and exports. In other words, this has been measured as exactly opposite to how trade openness is measured. Therefore, descriptive statistics of this variable are interpreted in the perspective of trade openness. Higher comparative values mean higher restrictions and less openness of the economy and vice versa. Table 6 reports that trade restrictions of Pakistan, India, Indonesia, Korea and Sri Lanka are 12.499, 24.205, 9.497, 7.187 and 6.621 respectively. From these results, it is interpreted that India is the country, which has highest trade restrictions comparative to other sample economies. If we rank, Pakistan comes at number 2 with mean value of 12.499, Indonesia stands at number 3 with mean value of 9.497, Korea at number 4 with mean value of 7.187 and Sri Lanka is at number 5 with mean value of 6.621. Maximum value of trade restrictions for India is 41.504, which is far higher than maximum values of other countries. This value indicates that India has GDP of 41 times of sum of imports and exports.

Trade Balance (T.B)

Trade balance ratio has been measured by dividing the trade balance with gross domestic product. Pakistan has mean value of (5.749%) indicating that over the analysis period on average, trade deficit is almost 5.7 % of gross domestic product. Mean values of Trade balance for India, Indonesia, Korea and Sri Lanka are (2.579%), 6.529%, 1.113% and (9.726%) respectively. These values indicate that trade deficit of India is less than that of Pakistan and Sri Lanka but higher than that of Indonesia and Korea. Indonesia and Korea have positive mean values, which indicate that on average, these two economies have observed trade surpluses. Indonesia has the highest value of 6.529% and Korea is at number two with 1.113%. So in our sample countries, Indonesia is having the highest trade surplus while Sri Lanka is having the highest trade deficit. By comparing the maximum and minimum value of trade balance of sample economies, Indonesia is the only country whose even minimum value is positive. Minimum value of trade balance for Indonesia is 0.290%, which indicates that over the analysis period, imports of Indonesia have never exceeded exports of Indonesia. As exports put upward pressure on the price of

currency, therefore, expected sign of this variables is negative, which indicates positive relationship between trade balance and exchange rate of sample economies

Net Capital Inflows (NKI)

Net capital inflow has been measured as the sum of financial and capital account. To use in regression equation, it has been divided by gross domestic product of respective time period. Before 1960, little or no attention was paid to the role of capital inflows or outflows in exchange rate determination. However, after the demise of Bretton Woods system, international markets have become integrated to a great extent. Capital inflows increase demand for local currency and keeping other things constant, put upward pressure on its price and vice versa. Table 6 reports the descriptive statistics of this variable in sample economies. The results of this table reveal that Sri Lanka is having the highest ratio of net capital inflows to GDP. It has mean value of 3.922%. India is at number two with mean value of 2.617%, Pakistan stands at number 3 with mean value of 2.352%, Indonesia at number 4 with mean value of 0.721% while Korea is at number 5 with mean value of 0.383%. Minimum values of this variable are negative for all the sample economies and maximum values of this variable are positive for them. This reveals that in some quarters sample economies have received foreign investment higher than what they did abroad and in some quarters they invested abroad higher than what they received during that period. However, these minimum negative values and maximum positive values are not surprising in quarterly data.

4.2.2. Graphical Visualization of Variables

Before application of formal test of unit root, graphical method has been applied to visualize whether the means of variables used in this section are dramatically increasing over time or otherwise. If a particular series is stationary at levels, cointegration does not provide any additional insight. For cointegration, series need to be non-stationary at levels and stationary in first difference form. Our sample countries are Pakistan, India, Indonesia, South Korea and Sri Lanka while data period consists of quarterly observations starting from first quarter of 1984 and ending in fourth quarter of 2008.

Line Graphs of Variables

Line graphs of time series provide good guess about the possible existence of unit root in them. If graph indicates continuous increasing or decreasing trend over time, the variable under consideration might have unit root in it. Figures 11-15 provide line graphs of variables for Pakistan, India, Indonesia, Korea and Sri Lanka respectively. On x-axis, there is number of observations, which start from first quarter of 1984 and end in last quarter of 2008. Figure 11 presents line graphs of natural log of exchange rate, relative interest rate, relative consumer price index, foreign terms of trade, trade restrictions, trade balance and net capital inflows for Pakistan. Similarly, figure 12, 13, 14 and 15 present line graphs of variables for India, Indonesia, Korea and Sri Lanka respectively. Here relative inflation has not been measured as first difference of C.P.I as it has been measured and used in regression analysis. Because objective is to check these variables for cointegration therefore, variables need to be non-stationary at levels and integrated of same order. Thus, variable relative inflation level has been replaced with relative consumer price index (RCPI). In case of Pakistan, line graphs of all variables except trade balance and trade restrictions provide hint that series under consideration might have unit root in them. Therefore, there is need to check formally whether the series under consideration contain unit root in them or not. Figure 12 presents line graph of variables used in case of India. A look at these line graphs indicates the existence of unit root in the series and asks for further exploration of integration order. Figure 13 is the graphical presentation of line graphs of variables used in case of Indonesia. These provide hint similar to that provided by line graphs of variables of India. Figure 14 presents line graphs of variables of Korea. These provide basic idea about non-stationary series. While Figure 15 presents line graphs of variables for Sri Lanka. These indicate that trade restrictions and trade balance variables need to be explored further for existence of unit root in them. However, there are certain limitations of line graphs. These provide only basic insight but lack any statistical value. Therefore, formal investigation of unit root has been conducted with the help of Augmented Dickey Fuller test (ADF) and Phillip Peron (PP) test.

Figure 11: Line Graphs of Regression Variables: Pakistan

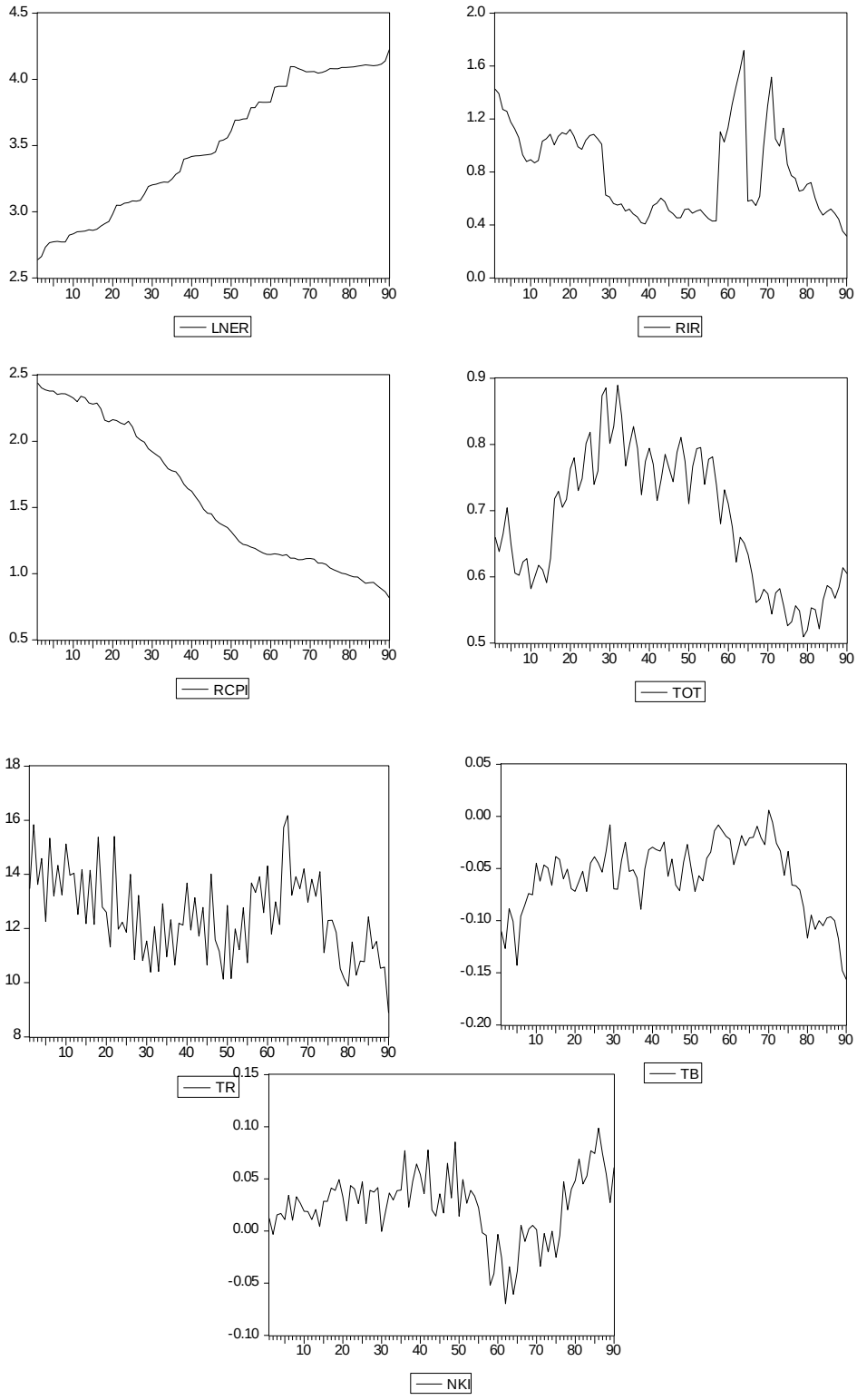


Figure 12: Line Graphs of Regression Variables: India

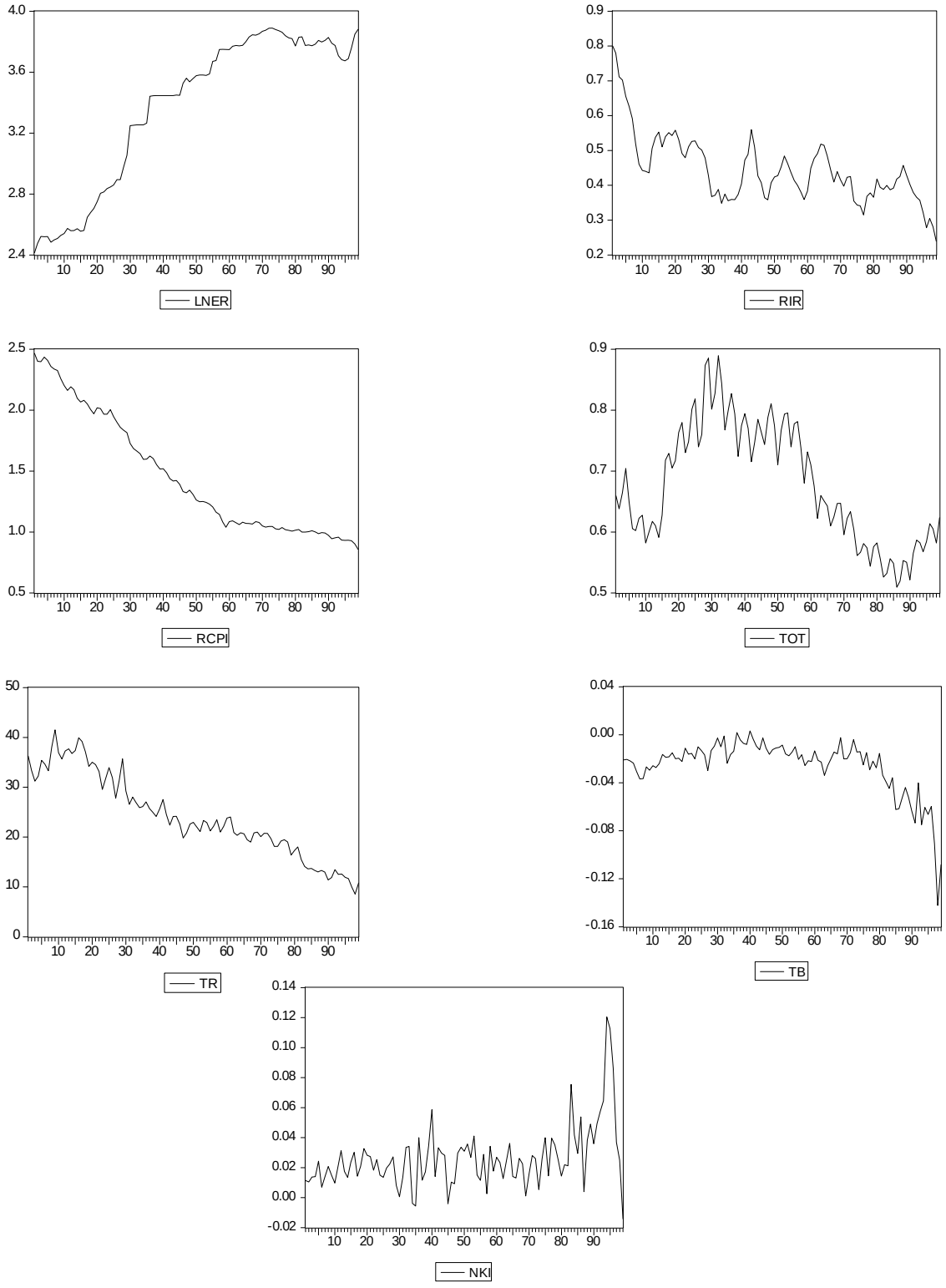


Figure 13: Line Graphs of Regression Variables: Indonesia

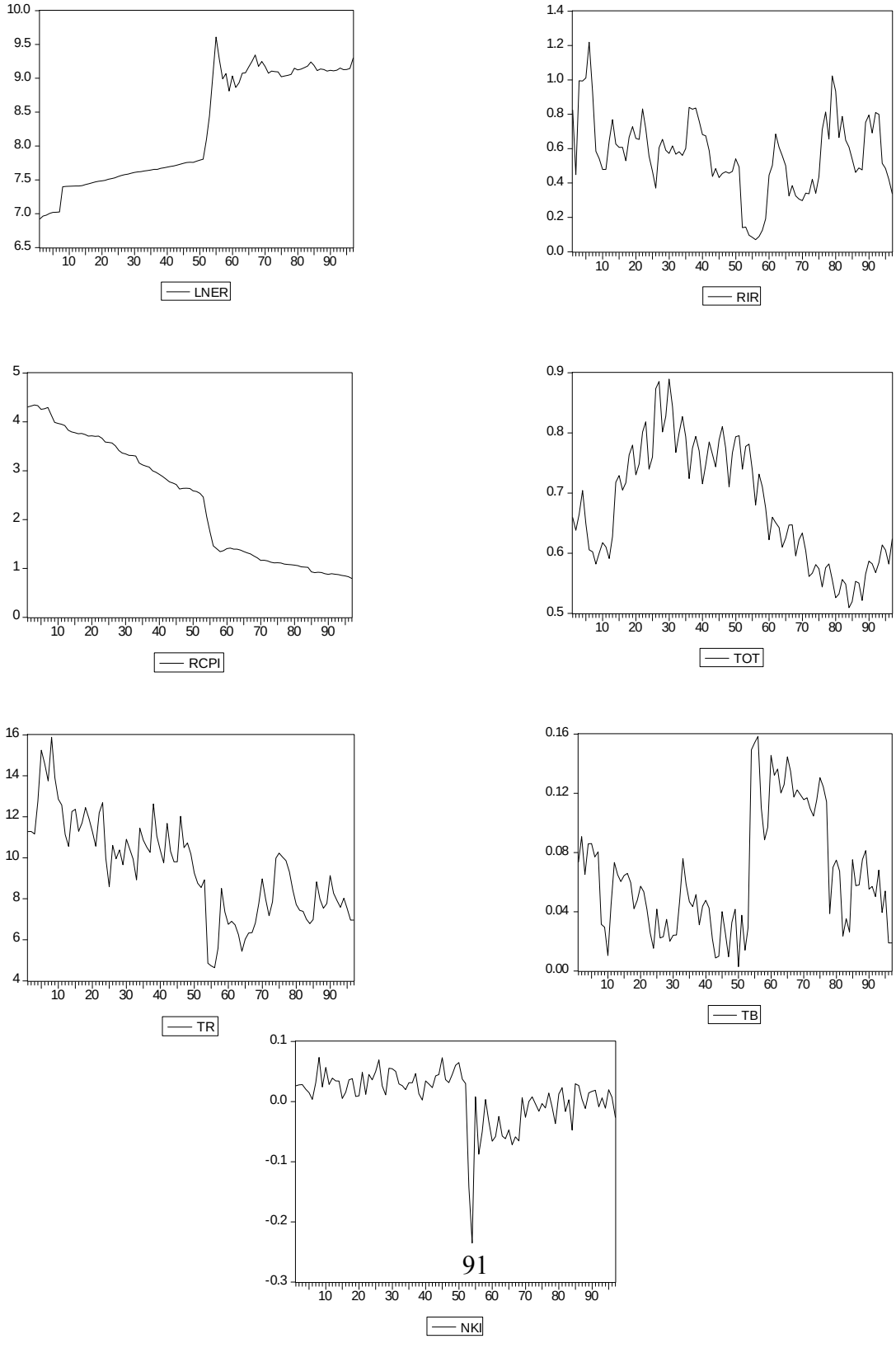


Figure 14: Line Graphs of Regression Variables: Korea

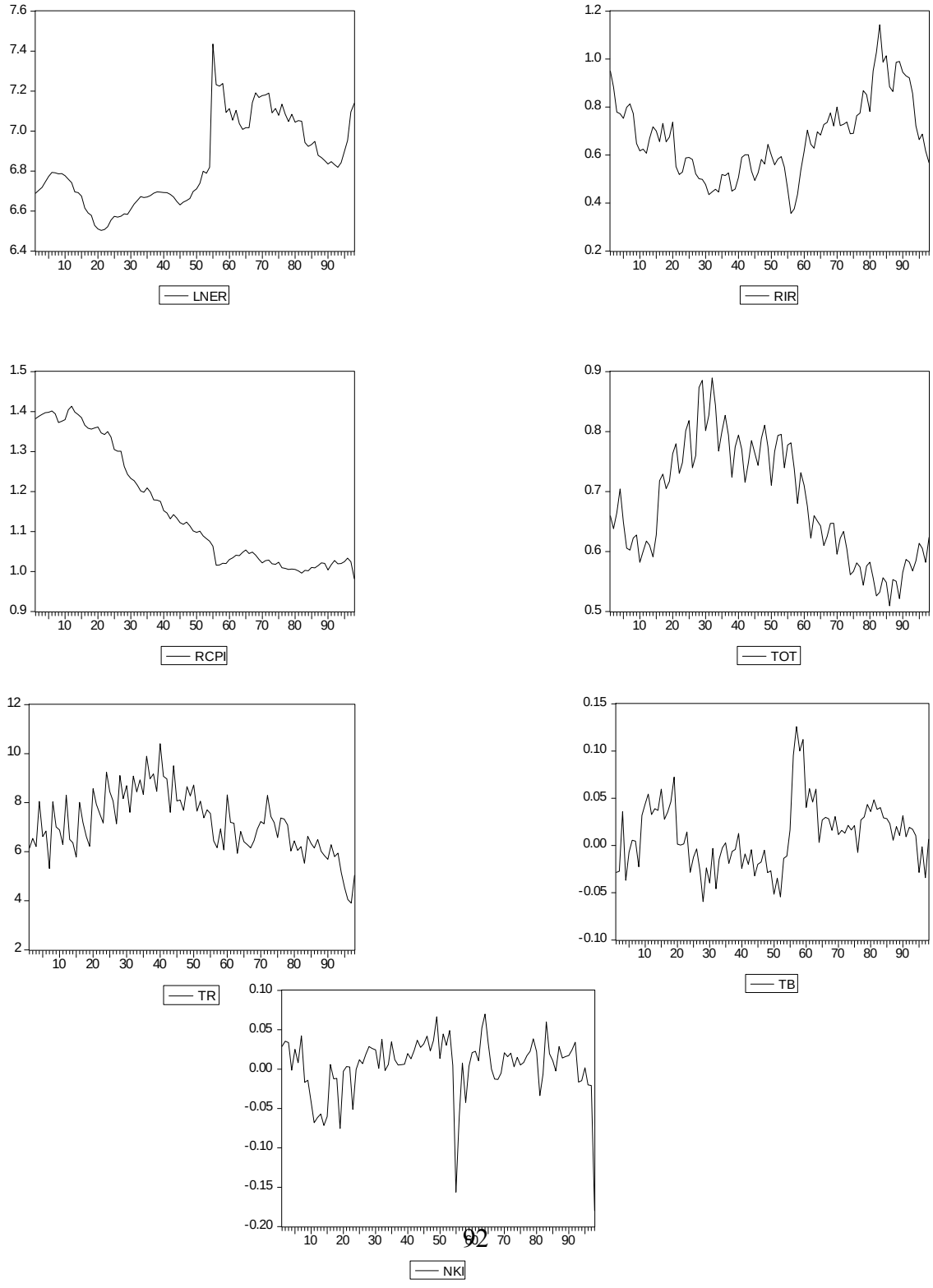
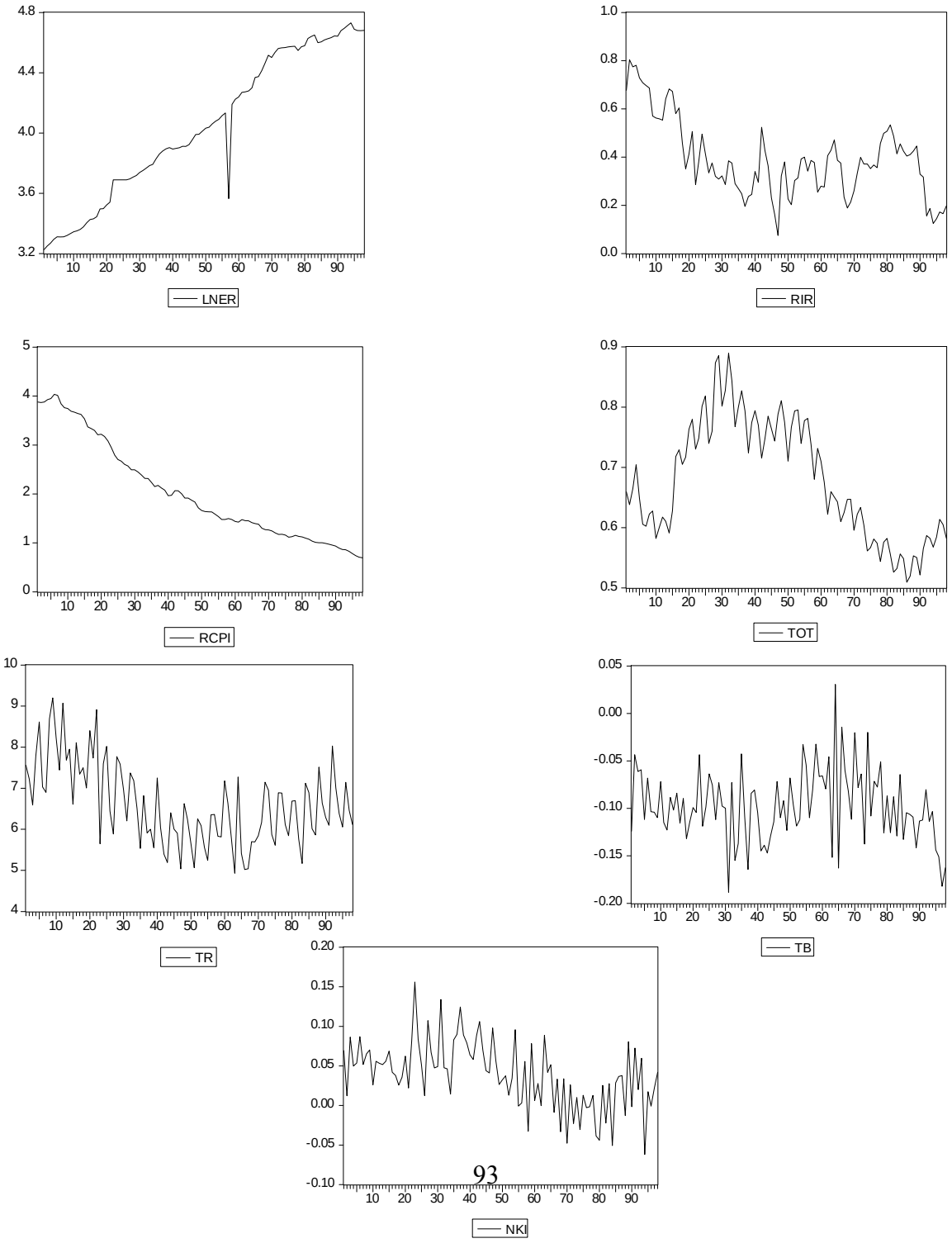


Figure 15: Line Graphs of Regression Variables: Sri Lanka



4.2.3 Formal Investigation of Unit Root

Formal investigation has been conducted by employing ADF test and Phillip Peron test. Phillip Peron test tests the series for existence of higher order serial correlation while, ADF tests for auto regression at level 1. Country wise results of unit root in all variables are reported in table 7 to table 11. Table 7 reports the results of ADF and PP test applied on dependent and independent variables of Pakistan. In case of Pakistan, both ADF and PP tests report that series under consideration contain unit root at level as test statistics are less than critical values, while in first difference, test statistics exceed critical values indicating that series become stationary and are integrated of order 1. Although PP indicates that trade restrictions and net capital inflows are stationary at level but removing intercept from test reports that they contain unit root at levels and become stationary in first difference. Table 8 reports the results of unit root investigation of dependent and independent variables in case of India. In case of India, both ADF and PP report the existence of unit root in all the series at levels and stationarity in first difference form. However, PP test when employed on relative interest rate report that series is stationary at levels, which again reports the existence of unit root when underlying assumption of test is changed from no intercept to intercept. Decision of inclusion of intercept or no intercept has been made on the basis of Schwartz info criterion. Table 9 reports the results of unit root analysis of variables in case of Indonesia. The results reveal that all variables contain unit root at levels and become stationary in first difference form. However, PP reports that net capital inflows are stationary at levels as well. Because PP measured higher order serial correlation, therefore, if ADF reports that there is unit root and PP says that no unit root exists; we cannot ignore the results of ADF. Table 10 reports the results of unit root investigation in Korea and presents results similar to those found in other sample economies. Table 11 reports the results of ADF

and PP test applied on variables of Sri Lanka. In case of Sri Lanka, both ADF and PP test report that at levels, variables contain unit root in them, while in first difference form become stationary so they are integrated of order 1. However, in case of net capital inflows, ADF reports that variable is non-stationary at level as test stat (-3.2225) is less than 1% critical value (-3.5) but PP test reports that series is stationary at levels as well as in first difference form. On the basis of this, it is argued that there is first order serial correlation, reported by ADF but there is no higher order serial correlation even at levels. For trade restrictions and trade balance, PP test has been run assuming no trend and intercept in the series. This results in existence of unit root at levels and stationarity in first difference forms

Table 7: Unit Root Investigation of Dependent and Explanatory Variables: Pakistan

	Exchnage Rate (Ln ER)				Relative Interest Rate (RIR)				Relative Inflation (RIL)			
	ADF		Phillip Peron		ADF		Phillip Peron		ADF		Phillip Peron	
	At levels	First Diff	At levels	First Diff	At levels	First Diff	At levels	First Diff	At levels	First Diff	At levels	First Diff
Test Stat	-0.77926	-6.092464	-1.108467	-8.541315	-2.825459	-5.550772	-2.888267	-9.194728	-0.983528	-3.758576	-1.011062	-6.899487
1% Critical Value	-3.5064	-3.5073	-3.5047	-3.5055	-3.5064	-3.5073	-3.5047	-3.5055	-3.5064	-3.5073	-3.5047	-3.5055
5% Critical Value	-2.8947	-2.8951	-2.8939	-2.8943	-2.8947	-2.8951	-2.8939	-2.8943	-2.8947	-2.8951	-2.8939	-2.8943

	Terms of Trade (TOT)				Trade Restriction (TR)				Trade Balance (TB)			
	ADF		Phillip Peron		ADF		Phillip Peron		ADF		Phillip Peron	
	At levels	First Diff	At levels	First Diff	At levels	First Diff	At levels	First Diff	At levels	First Diff	At levels	First Diff
Test Stat	-0.580855	-7.613718	-1.157617	-10.68913	-2.586342	-10.90018	-6.6517	-29.66423	-0.898392	-6.215562	-1.918033	-12.20231
1% Critical Value	-3.5064	-3.5073	-3.5047	-3.5055	-3.5064	-3.5073	-3.5047	-3.5055	-3.5064	-3.5073	-3.5047	-3.5055
5% Critical Value	-2.8947	-2.8951	-2.8939	-2.8943	-2.8947	-2.8951	-2.8939	-2.8943	-2.8947	-2.8951	-2.8939	-2.8943

	Net Capital Inflows (NKI)			
	ADF		Phillip Peron	
	At levels	First Diff	At levels	First Diff
Test Stat	-2.011062	-6.779094	-3.826504	-17.43517
1% Critical Value	-3.5064	-3.5073	-3.5047	-3.5055
5% Critical Value	-2.8947	-2.8951	-2.8939	-2.8943

Table 8: Unit Root Investigation of Dependent and Explanatory Variables: India

	Exchnage Rate (Ln ER)				Relative Interest Rate (RIR)				Relative Inflation (RIL)			
	ADF		Phillip Peron		ADF		Phillip Peron		ADF		Phillip Peron	
	At levels	First Diff	At levels	First Diff	At levels	First Diff	At levels	First Diff	At levels	First Diff	At levels	First Diff
Test Stat	-1.5501	-4.926479	-2.01572	-7.872517	-2.82128	-4.423212	**-3.21415**	-7.257711	-0.42671	-5.897539	-0.82927	-8.720648
1% Critical Value	-3.4993	-3.5	-3.4979	-3.4986	-3.4993	-3.5	-3.4979	-3.4986	-4.056	-4.057	-4.054	-4.055
5% Critical Value	-2.8915	-2.8918	-2.8909	-2.8912	-2.8915	-2.8918	-2.8909	-2.8912	-3.4566	-3.4571	-3.4557	-3.4561

	Terms of Trade (TOT)				Trade Restriction (TR)				Trade Balance (TB)			
	ADF		Phillip Peron		ADF		Phillip Peron		ADF		Phillip Peron	
	At levels	First Diff	At levels	First Diff	At levels	First Diff	At levels	First Diff	At levels	First Diff	At levels	First Diff
Test Stat	-0.70859	-8.482861	-1.25891	-11.61735	-2.67238	-7.717708	-3.87958	-11.35676	1.263067	-8.714057	-0.26954	-14.54577
1% Critical Value	-3.4993	-3.5	-3.4979	-3.4986	-4.056	-4.057	-4.054	-4.055	-3.4993	-3.5	-3.4979	-3.4986
5% Critical Value	-2.8915	-2.8918	-2.8909	-2.8912	-3.4566	-3.4571	-3.4557	-3.4561	-2.8915	-2.8918	-2.8909	-2.8912

	Net Capital Inflows (NKI)			
	ADF		Phillip Peron	
	At levels	First Diff	At levels	First Diff
Test Stat	-1.93564	-6.20709	-2.72618	-13.10082
1% Critical Value	-2.5873	-2.5875	-2.5868	-2.5871
5% Critical Value	-1.9434	-1.9435	-1.9434	-1.9434

Table 9: Unit Root Investigation of Dependent and Explanatory Variables: Indonesia

	Exchnage Rate (Ln ER)				Relative Interest Rate (RIR)				Relative Inflation (RIL)			
	ADF		Phillip Peron		ADF		Phillip Peron		ADF		Phillip Peron	
	At levels	First Diff	At levels	First Diff	At levels	First Diff	At levels	First Diff	At levels	First Diff	At levels	First Diff
Test Stat	-1.18964	-5.19464	-1.16823	-7.4892	-3.2306	-4.7556	-3.45483	-10.7582	-1.12228	-4.77917	-0.87701	-5.11485
1% Critical Value	-3.5007	-3.5015	-3.4993	-3.5	-3.5007	-3.5015	-3.4993	-3.5	-3.5007	-3.5015	-3.4993	-3.5
5% Critical Value	-2.8922	-2.8925	-2.8915	-2.8918	-2.8922	-2.8925	-2.8915	-2.8918	-2.8922	-2.8925	-2.8915	-2.8918

	Terms of Trade (TOT)				Trade Restriction (TR)				Trade Balance (TB)			
	ADF		Phillip Peron		ADF		Phillip Peron		ADF		Phillip Peron	
	At levels	First Diff	At levels	First Diff	At levels	First Diff	At levels	First Diff	At levels	First Diff	At levels	First Diff
Test Stat	-0.71848	-8.08624	-1.26373	-11.234	-1.62904	-7.48922	-2.0445	-11.2846	-2.41194	-7.5575	-2.74059	-11.1947
1% Critical Value	-3.5007	-3.5015	-3.4993	-3.5	-3.5007	-3.5015	-3.4993	-3.5	-3.5007	-3.5015	-3.4993	-3.5
5% Critical Value	-2.8922	-2.8925	-2.8915	-2.8918	-2.8922	-2.8925	-2.8915	-2.8918	-2.8922	-2.8925	-2.8915	-2.8918

	Net Capital Inflows (NKI)			
	ADF		Phillip Peron	
	At levels	First Diff	At levels	First Diff
Test Stat	-2.86042	-7.4102	-4.97798	-14.9609
1% Critical Value	-3.5007	-3.5015	-3.4993	-3.5
5% Critical Value	-2.8922	-2.8925	-2.8915	-2.8918

Table 10: Unit Root Investigation of Dependent and Explanatory Variables: Korea

	Exchnage Rate (Ln ER)				Relative Interest Rate (RIR)				Relative Inflation (RIL)			
	ADF		Phillip Peron		ADF		Phillip Peron		ADF		Phillip Peron	
	At levels	First Diff	At levels	First Diff	At levels	First Diff	At levels	First Diff	At levels	First Diff	At levels	First Diff
Test Stat	-1.239629	-4.671221	-1.47877	-11.30198	-1.99898	-6.18258	-2.34075	-9.121091	-1.29697	-4.55369	-1.03066	-7.299216
1% Critical Value	-3.5	-3.5007	-3.4986	-3.4993	-3.5	-3.5007	-3.4986	-3.4993	-3.5	-3.5007	-3.4986	-3.4993
5% Critical Value	-2.8918	-2.8922	-2.8912	-2.8915	-2.8918	-2.8922	-2.8912	-2.8915	-2.8918	-2.8922	-2.8912	-2.8915

	Terms of Trade (TOT)				Trade Restriction (TR)				Trade Balance (TB)			
	ADF		Phillip Peron		ADF		Phillip Peron		ADF		Phillip Peron	
	At levels	First Diff	At levels	First Diff	At levels	First Diff	At levels	First Diff	At levels	First Diff	At levels	First Diff
Test Stat	-0.71534	-8.414026	-1.28157	-11.69681	-1.61078	-13.8722	**-3.52841**	-24.15601	-2.85103	-6.94683	**-3.97192**	-14.70695
1% Critical Value	-3.5	-3.5007	-3.4986	-3.4993	-3.5	-3.5007	-3.4986	-3.4993	-3.5	-3.5007	-3.4986	-3.4993
5% Critical Value	-2.8918	-2.8922	-2.8912	-2.8915	-2.8918	-2.8922	-2.8912	-2.8915	-2.8918	-2.8922	-2.8912	-2.8915

	Net Capital Inflows (NKI)			
	ADF		Phillip Peron	
	At levels	First Diff	At levels	First Diff
Test Stat	-2.757404	-7.140117	**-4.2632**	-11.60951
1% Critical Value	-3.5	-3.5007	-3.4986	-3.4993
5% Critical Value	-2.8918	-2.8922	-2.8912	-2.8915

Table 11: Unit Root Investigation of Dependent and Explanatory Variables: Sri Lanka

	Exchnage Rate (Ln ER)				Relative Interest Rate (RIR)				Relative Inflation (RIL)			
	ADF		Phillip Peron		ADF		Phillip Peron		ADF		Phillip Peron	
	At levels	First Diff	At levels	First Diff	At levels	First Diff	At levels	First Diff	At levels	First Diff	At levels	First Diff
Test Stat	-1.03055	-8.34069	-1.06793	-18.6603	-2.80364	-6.57632	-2.51485	-10.7789	-3.5	-5.18514	-1.85149	-6.7315
1% Critical Value	-3.5	-3.5007	-3.4986	-3.4993	-3.5	-3.5007	-3.4986	-3.4993	-2.8918	-3.5007	-3.4986	-3.4993
5% Critical Value	-2.8918	-2.8922	-2.8912	-2.8915	-2.8918	-2.8922	-2.8912	-2.8915	-2.17371	-2.8922	-2.8912	-2.8915

	Terms of Trade (TOT)				Trade Restriction (TR)				Trade Balance (TB)			
	ADF		Phillip Peron		ADF		Phillip Peron		ADF		Phillip Peron	
	At levels	First Diff	At levels	First Diff	At levels	First Diff	At levels	First Diff	At levels	First Diff	At levels	First Diff
Test Stat	-0.60213	-8.53293	-1.098	-11.5812	-2.71787	-17.8799	**-0.68032**	-25.63366	**-3.30225**	-12.1694	**-1.72925**	-34.0521
1% Critical Value	-3.5	-3.5007	-3.4986	-3.4993	-3.5	-3.5007	-2.5871	-2.5873	-3.5	-3.5007	-2.5871	-2.5873
5% Critical Value	-2.8918	-2.8922	-2.8912	-2.8915	-2.8918	-2.8922	-1.9434	-1.9434	-2.8918	-2.8922	-1.9434	-1.9434

	Net Capital Inflows (NKI)			
	ADF		Phillip Peron	
	At levels	First Diff	At levels	First Diff
Test Stat	-3.22256	-10.6817	**-7.57447**	-27.7194
1% Critical Value	-3.5	-3.5007	-3.4986	-3.4993
5% Critical Value	-2.8918	-2.8922	-2.8912	-2.8915

4.2.4 Results of Johansen's Cointegration and Vector Error Correction

As formal investigation of variables has indicated that all economic series used in this study contain unit root at levels i.e. they are non-stationary and become stationary in first difference form, therefore, long run relationship among variables has been explored by employing Johansen's cointegration technique. Tables 12 to table 16 report the results of Johansen's cointegration test for Pakistan, India, Indonesia, Korea and Sri Lanka respectively. Table 12 indicates that at 5% significance level, there are three cointegrating equations in Pakistan. Likelihood ratio reports three cointegrating equations in case of India reported in table 13. Table 14 reports the results of Johansen's cointegration test in Indonesia. LR test indicates that there are three cointegrating equations in case of Indonesia. Table 15 reports the results of Johansen's cointegration in case of Korea. In this table, LR indicates the existence of two cointegrating equations. While table 16 reports the results of cointegration in case of Sri Lanka. In this table LR indicates the existence of three cointegrating equations among variables. Thus table 12 to table 16 reports the existence of long run relationship among exchange rate and economic variables used in the study.

Table 12: Results of Johansen's Cointegration: Pakistan

Eigen Value	L. R Stat	5 % Critical Values	1 % Critical Values	Number of CEs
0.402356	158.4322	124.24	133.57	None **
0.33278	113.6482	94.15	103.18	At most 1 **
0.325109	78.44488	68.52	76.07	At most 2 **
0.25721	44.23614	47.21	54.46	At most 3
0.128556	18.36734	29.68	35.65	At most 4
0.067589	6.395801	15.41	20.04	At most 5
0.003527	0.307377	3.76	6.65	At most 6

LR stat indicates three cointegrating equations at 5% significance level

Table 13: Results of Johansen's Cointegration: India

Eigen Value	L. R Stat	5 % Critical Values	1 % Critical Values	Number of CEs
0.413788	153.1617	124.24	133.57	None **
0.289336	101.8907	94.15	103.18	At most 1 *
0.260493	69.10139	68.52	76.07	At most 2 *
0.168087	40.13127	47.21	54.46	At most 3
0.136499	22.46467	29.68	35.65	At most 4
0.078293	8.375725	15.41	20.04	At most 5
0.005703	0.549038	3.76	6.65	At most 6

LR stat indicates three cointegrating equations

Table 14: Results of Johansen's Cointegration: Indonesia

Eigen Value	L. R Stat	5 % Critical Values	1 % Critical Values	Number of CEs
0.484371	171.2807	124.24	133.57	None **
0.391021	109.0181	94.15	103.18	At most 1 **
0.255422	62.39673	68.52	76.07	At most 2
0.170958	34.67257	47.21	54.46	At most 3
0.085803	17.04905	29.68	35.65	At most 4
0.062619	8.616393	15.41	20.04	At most 5
0.026637	2.537862	3.76	6.65	At most 6

LR stat indicates two cointegrating equations

Table 15: Results of Johansen's Cointegration: Korea

Eigen Value	L. R Stat	5 % Critical Values	1 % Critical Values	Number of CEs
0.385361	162.9212	124.24	133.57	None **
0.350398	116.6828	94.15	103.18	At most 1 **
0.273258	75.70022	68.52	76.07	At most 2 *
0.214646	45.37774	47.21	54.46	At most 3
0.122724	22.42373	29.68	35.65	At most 4
0.086622	9.985067	15.41	20.04	At most 5
0.014395	1.377502	3.76	6.65	At most 6

LR stat indicates three cointegrating equations

Table 16: Results of Johansen's Cointegration: Sri Lanka

Eigen Value	L. R Stat	5 % Critical Values	1 % Critical Values	Number of CEs
0.396284	134.4931	109.99	119.8	None **
0.233207	86.55126	82.49	90.45	At most 1 *
0.205942	61.32509	59.46	66.52	At most 2 *
0.177801	39.41818	39.89	45.58	At most 3
0.144279	20.81972	24.31	29.75	At most 4
0.061145	6.017688	12.53	16.31	At most 5
0.00025	0.023707	3.84	6.51	At most 6

LR stat indicates three cointegrating equations

Error correction mechanism has been applied in this study to capture the short run dynamics of exchange rate behavior of sample economies. Coefficients of cointegrating equations show the speed of adjustment in case of short run disequilibrium. In case of Pakistan, coefficients of all the three cointegrating equations are significant indicating

that adjustment of disequilibrium is due to first error correction term, second error correction term and third error correction term. Colum 1 indicates that exchange rate adjusted by almost 12% in one quarter and it takes almost 8 quarters (1/0.122=819) to completely eliminate the disequilibrium. Coefficient of second error shows slower but that of third error term indicates speedy adjustment than first error term

Table 17: Results of Vector Error Correction Mechanism

Variables	D(LNERPK)	D(LNERIND)	D(LNERINDN)	D(LNERKR)	D(LNERSL)
Vecm1(-1)	-0.122 (-3.98)	-0.210 (-2.74)	-0.130 (-2.80)	0.072 (1.22)	-0.043 (-1.05)
Vecm2(-1)	0.054 (4.09)	-0.103 (-3.88)	-0.071 (-2.61)	-0.116 (-1.08)	-0.099 (-1.18)
Vecm3(-1)	-0.135 (-4.43)	-0.180 (-3.03)		0.055 (1.58)	-0.015 (-1.13)
D(RIR(-1))	-0.032 (-1.55)	-0.041 (-0.37)	-0.165 (-2.40)	0.028 (0.20)	0.097 (0.81)
D(RIL(-1))	0.292 (1.79)	0.141 (0.84)	0.440 (2.65)	0.256 (0.28)	0.150 (0.72)
D(TOT(-1))	-0.051 (-0.62)	-0.049 (-0.42)	0.770 (2.94)	-0.29 (-1.36)	0.033 (0.12)
D(TR(-1))	0.002 (1.01)	0.004 (1.89)	-0.020 (-2.02)	0.014 (1.16)	-0.014 (-1.12)
D(T.B(-1))	-0.201 (-1.24)	-0.263 (-0.73)	0.430 (0.97)	0.301 (0.68)	0.073 (0.30)
D(N.K.I(-1))	-0.176 (-1.32)	-0.015 (-0.06)	0.061 (0.14)	-0.598 (-1.93)	0.038 (0.14)
C	0.021 (5.15)	0.014 (3.18)	0.035 (3.26)	0.007 (0.89)	0.027 (2.50)

Note:
LNERPK,LNERIND,LNERINDN,LNERPKR and LNERSL are natural log of exchange rates of Pakistan, India, Indonesia, Korea and Sri Lanka respectively.
() shows t values

In case of India, short run disequilibrium is adjusted by again all the three cointegrating equations. Coefficients of all the three error correction terms are significant. Coefficient of first error correction term indicates that almost 20% of disequilibrium is adjusted in one quarter and it takes almost 5 quarters to completely eliminate short run disequilibrium. However, error correction terms 2 and 3 shows relatively slower adjustments. In case of Indonesia, both cointegrating equations have significant negative coefficients indicating that almost 13 % of disequilibrium disappears in one quarter.

Second correction term shows slower adjustment. However, in case of Korea and Sri Lanka, coefficients of error correction terms are insignificant indicating that error corrections terms fail to make adjustments significantly.

4.2.5 Results of Regression Equation

Unit root investigation reported that variables used in study contain unit root at level and are integrated of order 1. Later results of Johansen's cointegration revealed that variables are cointegrated, therefore, regression has been run at level. Table 18 reports the results of regression equation in which exchange rate has been regressed on six explanatory variables. These variables are relative interest rate (β_1), relative inflation level (β_2), foreign terms of trade (β_3), trade restrictions (β_4), trade balance ratio (β_5) and net capital inflows (β_6). Table 1 reports the expected direction of these coefficients and relevant theories. β_2, β_5, and β_6 have negative expected signs while β_1, β_3 and β_4 have vague relationships and are subject to empirical investigation. Value of R^2 indicates the explanatory power of adhoc model. In case of Pakistan, 54% variation in exchange rate has been explained by set of macroeconomic variables while 86%, 86%, 35% and 78% variation in exchange rate has been explained in case of India, Indonesia, Korea and Sri Lanka respectively. Jarque-Bera (JB) statistics tests the null hypothesis of normal distribution. Probability values, reported under Jarque-Bera statistics indicate that error terms in case of sample economies are normally distributed.

Table 18: Results of Regression Results

	Pakistan		India		Indonesia		Korea		Sri Lanka	
	Coefficients	T-statistics	Coefficients	T-statistics	Coefficients	T-statistics	Coefficients	T-statistics	Coefficients	T-statistics
β_1	**-0.806265**	-5.369223	**-0.788669**	-2.858545	-0.309095	-1.750429	**-0.614541**	-2.862935	**-1.640634**	-9.160113
β_2	0.08538	1.599008	-0.011107	-0.900806	-0.011584	-0.417177	-0.001513	-0.275492	-0.004274	-0.099911
β_3	**-2.504357**	-6.704061	**0.504076**	2.280557	**-3.207428**	-8.700834	**-1.826077**	-4.470395	**-2.510172**	-8.852323
β_4	**-0.110839**	-3.916628	**-0.054776**	-15.24806	**-0.216782**	-11.11293	-0.019269	-0.846264	**-0.100133**	**-3.692236**
β_5	0.805353	0.417237	2.257107	1.392897	**-4.641329**	-3.239521	0.105499	0.137748	-0.438202	-0.995382
β_6	**-7.247476**	-5.092317	**-3.119618**	-3.14977	**-2.06629**	-2.253505	0.118801	0.216507	**-2.598663**	-3.891199
C	7.370659	16.35213	4.796784	26.69742	12.69304	46.49105	8.630307	23.33465	7.153477	30.17659

$$E.R_t = \alpha_0 + \beta_1 * RIR_t + \beta_2 * RIL_{t-1} + \beta_3 * TOT_t + \beta_4 * TR_t + \beta_5 * d(TB_t) + \beta_6 * NKI_t + \varepsilon_t$$

R^2=0.5496	R^2=0.8657	R^2=0.8632	R^2=0.3547	R^2=0.7827
JB=0.8905 (0.6406)	JB=1.00 (0.6063)	JB= 4.3772 (0.1121)	JB=12.55664 (0.1877)	JB=1.3502 (0.5091)

Note:

$E.R_t$ is exchange rate, measured as natural log of nominal exchange rate expressed in direct quotation in time t

RIR_t is relative interest rate in time t

RIL_{t-1} is lagged period relative inflation level

TOT_t is terms of trade in period t

$D(TB_t)$ is change in trade balance ratio

NKI_t is net capital inflows and

ε_t is error term

Pakistan

In Pakistan, β_1 is -0.806265, which indicates that there is negative relationship between exchange rate and relative interest rate. As exchange rate has been measured as natural log of direct quotation, therefore, negative sign indicates that if foreign interest rate exceeds domestic interest rate, foreign currency depreciates. T- statistics is -5.369223 (higher than 2), which indicates that negative relationship between exchange rate and relative interest rate is significant. Thus direction of β_1 is similar to what is expected according to interest rate parity theory or money market equilibrium approach, wherein, increase in interest rate reduces the demand for money. Keeping money supply constant, something must happen to bring equilibrium in money market. This is possible through depreciation of local currency because depreciation of local currency increases the income of resident by increasing the local currency value of foreign bonds. Interest rate parity theory argues that higher nominal interest rate means higher level of expected inflation, which deteriorates the country competitiveness and affects the exchange rate negatively. β_2 is 0.085380 but t-statistics is 1.599008 (less than 2), indicating that over the analysis period, exchange rate between Pakistan Rupee and United States Dollar is insignificantly related with relative inflation level. β_3 is -2.504357, indicating positive relationship between price of local currency and foreign terms of trade. U.S terms of trade have been used as foreign terms of trade. It measures the impact of change in price of foreign exports and foreign imports on exchange rate. Direction of this impact depends upon whether income effect is higher than substitution effect or substitution effect is higher than income effect. If coefficient is negative, it is interpreted as under. Rise in foreign exports increases the income level of foreign nationals. This increased income level affects the price of foreign currency negatively through increased consumption. This is equivalent to local currency appreciation. However, if rise in price of exportable shifts resources from non-exportable to exportable, it results in less production of non-tradeables and ultimately in rise of their prices. When price of exportable falls relative to price of non-tradable, competitiveness of foreign country increases in international market and puts upward pressure on price of its currency. However, in Pakistan, coefficient has negative direction and t statistics is -6.704061(higher than 2), which indicates that foreign terms of trade are negatively and significantly affecting the

exchange rate between Pakistan Rupee and U.S Dollar. Negative direction reveals that over the analysis period, income effect is higher than substitution effect. β_4 is coefficient of trade restrictions imposed by governments of sample economies. Expected direction of this variable is vague. It depends upon whether trade restrictions have been imposed on exports or imports. If these are imposed on exports, they affect the local currency negatively and if these are imposed on imports, they affect local currency positively. Value of β_4 is -0.110839, which indicates that there is negative relationship between trade restrictions imposed by government of Pakistan and price of foreign currency. This is similar to positive relationship between trade restriction and price of local currency. Direction of this coefficient seems rational, as Pakistan is less likely to impose restrictions on exports. Value of t statistics is -3.916628, which is higher than 2 indicating that trade restrictions imposed by Pakistan affect the price of Pak Rupee positively and significantly against U.S Dollar. β_5 is coefficient of trade balance, which has been measured as percentage of gross domestic product. Its value is 0.805353 and t statistics is 0.417237 (less than 2), which indicates insignificant relationship between exchange rate and trade balance. β_6 is coefficient of net capital inflows, which is sum of capital and financial account expressed as percentage of gross domestic product. Value of coefficient is -7.247476, which indicates positive relationship with local currency. The direction of coefficient is similar to expected direction. It indicates that net inflows of capital have positive effect on price of local currency and vice versa. This finding is in accordance with portfolio balance approach. Value of t statistics (-5.092317) is higher than 2 suggesting that net capital inflows are significantly positively related to the price of local currency against U.S Dollar.

India

β_1 is -0.7886, which reveals that there is negative relationship between exchange rate and relative interest rate. This negative coefficient is similar to what is expected by interest rate parity theory or money market explanation approach. Value of t statistics is -5.369223, which is higher than 2 indicating significant relationship. β_2 is -0.011107 but t-statistics is -0.900806 (less than 2), indicating that over the analysis period, exchange rate between Indian Rupee and U.S Dollar is insignificantly related with relative inflation level. β_3 is coefficient of foreign terms of trade with value of 0.504076 and t statistics of

2.280557 (higher than 2). This indicates that U.S terms of trade are significantly related with exchange rate between Indian Rupee and U.S Dollar. However, direction of coefficient is positive, opposite to that found in case of Pakistan. This positive direction indicates that substitution effect over comes income effect. In simple words, increase in price of exportable causes shift of resources from non-tradable to tradeables. Resultantly, this increases the price of non-tradable. The relative less price of exportable causes improvement in U.S trade balance and puts upward pressure on price of Dollar. Negative direction of β_3 in Pakistan and positive in India affirm that the expected direction of this variable is vague and is subject to empirical analysis. β_4 is coefficient of trade restrictions imposed by governments of sample economies. Value of β_4 is -0.054776, which indicates that there is negative relationship between trade restrictions imposed by government of Pakistan and price of foreign currency. This is similar to positive relationship between trade restriction and price of local currency. Direction of this coefficient is same in Pakistan and India. Value of t statistics is -15.24806, which is higher than 2 indicating that trade restrictions imposed by India affect the price of Indian Rupee positively and significantly against U.S Dollar. Negative sign of β_4 in Pakistan and India indicates that both countries use import duties and quotas as trade restrictions. By imposing tariffs and quotas on imports, governments improve the conditions of trade balance account, which ultimately puts upward pressure on the price of local currency.β_5 is coefficient of trade balance, which is measured as the difference between exports and imports. Trade balance has been expressed as percentage of gross domestic product. Value of β_5 is 2.257107 with t statistics of 1.392897. As value of t is less than 2, therefore relationship between trade balance and exchange rate is insignificant over the analysis period. Thus in both Pakistan and India, exchange rates are insignificantly related to trade balance. β_6 is coefficient of net capital inflows, which is sum of capital and financial account expressed as percentage of gross domestic product. Value of coefficient is -3.119618, which indicates positive relationship with local currency. The direction of coefficient is similar to expected direction as well as what has been found in case of Pakistan. It indicates that net inflows of capital have positive effect on the price of local currency and vice versa. This finding is in accordance with portfolio balance approach. Value of t statistics (-3.149770) is higher than 2 suggesting that net capital inflows have significant positive relationship

with the price of local currency against U.S Dollar. Thus direction of this coefficient and significant t values indicate that exchange rate is driven more by capital mobility than what it is controlled by tradability of tangible goods.

Indonesia

β_1 is -0.309095, which reveals that there is negative relationship between relative interest rate and exchange rate. This negative coefficient is similar to what is expected by interest rate parity theory. Value of t statistics is -1.750429, which is less than 2 indicating insignificant relationship. β_2 is -0.011584 but t-statistics is -0.417177 (less than 2), indicating that over the analysis period, exchange rate between Indonesian Rupiah and U.S Dollar is insignificantly related to relative inflation level. β_3 is the coefficient of foreign terms of trade with value of -3.207428 and t statistics of -8.700834 (higher than 2). This indicates that U.S terms of trade are significantly related to exchange rate between Indonesian Rupiah and U.S Dollar. However, direction of coefficient is negative, opposite of that found in case of India and similar to that found in case of Pakistan. This negative coefficient and above than 2 t statistics indicate that foreign terms of trade are negatively and significantly affecting the exchange rate between Indonesian Rupiah and U.S Dollar. Negative direction reveals that over the analysis period, income effect is higher than substitution effect. In other words, increase in price of exportable raises the income level of foreign nationals, which affects the price of foreign currency negatively. Negative sign of β_3 in Pakistan and Indonesia and positive sign in India proves that expected direction of this variable is vague and is subject to empirical analysis. Without empirical investigation, direction of this coefficient cannot be documented because; it depends upon the relative intensity of income and substitution effect. β_4 is coefficient of trade restrictions imposed by governments of sample economies. Value of β_4 is -0.216782, which indicates negative relationship between trade restrictions imposed by government of Indonesia and price of foreign currency. This is similar to direct relationship between trade restriction and price of local currency. Direction of this coefficient is same in case of Pakistan, India and Indonesia. Value of t statistics is -11.11293, which is higher than 2 indicating that trade restrictions imposed by Indonesia affect the price of Indonesian Rupiah positively and significantly against U.S Dollar. Negative sign of β_4 in Pakistan, India and Indonesia indicates that these three

countries use import duties and quotas as trade restrictions. By imposing tariffs and quotas on imports, governments improve the conditions of trade balance account, which ultimately puts upward pressure on the price of local currency.. β_5 is the coefficient of trade balance, which is measured as the difference between exports and imports. Trade balance has been expressed as percentage of gross domestic product. Value of β_5 is -4.641329 with t statistics of -3.239521. As value is higher than 2, therefore relationship between trade balance and exchange rate is significant over the analysis period. This sign is exactly what is expected by current account theory. According to this theory, exchange rate moves in response to changes in exports and imports. In Indonesia, exchange rate is positively and significantly related with trade balance. This result is opposite to what has been found in Pakistan and India. Thus in both Pakistan and India, current account approach seems not existing while in Indonesia, it seems to exist. β_6 is coefficient of net capital inflows, which is sum of capital and financial account expressed as percentage of gross domestic product. Value of coefficient is -2.066290, which indicates positive relationship between capital inflows and price of local currency. The direction of coefficient is similar to expected direction and to what has been found in Pakistan and India. It indicates that net inflows of capital have positive effect on the price of local currency and vice versa. This finding is again in accordance with portfolio balance approach. Value of t statistics (-2.253505) is higher than two suggesting that net capital inflows have significant positive relationship with the price of local currency against U.S Dollar. Regression results indicate that in case of Indonesia, exchange rate between Indonesian Rupiah and U.S Dollar is significantly driven by both capital mobility as well as tradability of tangible goods.

Korea

β_1 is -0.614541, which reveals negative relationship between nominal interest rate and exchange rate. This negative coefficient is similar to what is expected by interest rate parity theory. Value of t statistics is -2.862935, which is higher than 2 indicating significant relationship between nominal interest rate and exchange rate of Korean Won against U.S Dollar. β_2 is -0.001513 but t-statistics is -0.275492 (less than 2), indicating that over the analysis period, exchange rate between Korean Won and U.S Dollar is insignificantly related with relative inflation level. β_3 is coefficient of foreign terms of

trade with value of -1.826077and t statistics of -4.470395 (higher than 2). This indicates that U.S terms of trade are significantly related to exchange rate between Korean Won and U.S Dollar. However, direction of this coefficient is negative, opposite of that found in case of India and similar to that found in case of Pakistan and Indonesia. This negative coefficient and above 2 t statistics indicate that foreign terms of trade are negatively and significantly affecting the exchange rate between Korean Won and U.S Dollar. Furthermore, it reveals that over the analysis period, income effect is higher than substitution effect. In simple words, increase in price of exportable raises the income level of foreign nationals, which affects the price of foreign currency negatively. Negative sign of β_3 in Pakistan, Indonesia and Korea and positive sign in India proves that relationship between exchange rate and foreign terms of trade is vague and can be documented only after empirical investigation of the concerned variables. In Pakistan, Indonesia and Korea, Income effect seems overcoming the substitution effect while opposite has been found in India. β_4 is coefficient of trade restrictions imposed by governments of sample economies. Value of β_4 is -0.019269, which indicates that there is negative relationship between trade restrictions imposed by government of Korea and price of foreign currency. This is similar to positive relationship between trade restriction and price of local currency. Similar direction of this coefficient has been found in Pakistan, India, Indonesia and Korea. However in the first three economies, the relationship was significant while in Korea, value of t statistics is -0.846264, which is less than 2 indicating that trade restrictions imposed by Korea affect the price of Korean Won against U.S Dollar insignificantly. Negative sign of β_4 in Pakistan, India, Indonesia and Korea indicates that these countries use import duties and quotas as trade restrictions. By imposing tariffs and quotas on imports, governments improve the conditions of trade balance account, which ultimately puts upward pressure on the price of local currency. However, this relationship has been found insignificant in Korea. β_5 is coefficient of trade balance, which is measured as the difference between exports and imports. Trade balance has been expressed as percentage of gross domestic product. Value of β_5 is 0.105499 with t statistics of 0.137748. As value is less than 2, therefore relationship between trade balance and exchange rate is insignificant over the analysis period. The result of this coefficient is same in Pakistan, India and Korea but different in Indonesia. In Pakistan,

India and Korea, t values of β_5 are less than 2 indicating insignificant relationship while it is above 2 in Indonesia indicating significant relationship. β_6 is coefficient of net capital inflows, which is sum of capital and financial account expressed as percentage of gross domestic product. Value of coefficient is -0.118801, which indicates negative relationship with the price of local currency. Direction of this coefficient is opposite to expected direction as well as what has been found in case of Pakistan, India and Indonesia. This finding is in contradiction with portfolio balance approach, according to which it has positive relationship with local currency. However, value of t statistics (0.216507) is less than 2 suggesting that net capital inflows do not have significant relationship with the price of local currency against U.S Dollar. The regression results of Korea indicate that Korean Won is not significantly driven by net capital inflow. It is affected more by relative nominal interest rate and foreign terms of trade.

Sri Lanka

β_1 is -1.640634, which reveals that there is negative relationship between relative interest rate and exchange rate. This negative coefficient is similar to what is expected by interest rate parity theory and money market explanation. Value of t statistics is -9.160113, which is higher than 2 indicating significant relationship. β_2 is -0.004274 but t-statistics is -0.099911 (less than 2), indicating that over analysis period, the exchange rate between Sri Lankan Rupee and U.S Dollar is insignificantly related to relative inflation level. β_3 is the coefficient of foreign terms of trade with value of -2.510172 and t statistics of -8.852323 (higher than 2). This indicates that U.S terms of trade are significantly related to exchange rate between Sri Lankan Rupee and U.S Dollar. However, the direction of this coefficient is negative, opposite of that found in case of India and similar to that found in case of Pakistan, Indonesia and Korea. This negative coefficient and above than 2 t statistics indicate that foreign terms of trade are negatively and significantly affecting the exchange rate between Sri Lankan Rupee and U.S Dollar. Furthermore, negative direction reveals that over the analysis period, income effect exceeds substitution effect. In other words, increase in the price of exportables raises the income level of foreign nationals, which ultimately affects the price of foreign currency negatively. Negative signs of β_3 in Pakistan, Korea, Indonesia and Sri Lanka and positive sign in case of India prove that relationship between foreign terms of trade and exchange rate behavior is

vague and is not clear. It is subject to empirical analysis of variables under consideration. Without empirical investigation, direction of this coefficient cannot be guessed because; it depends upon whether income effect crosses substitution effect or substitution effect crosses income effect. β_4 is coefficient of trade restrictions imposed by governments of sample economies. Value of β_4 is -0.100133, which indicates that there is negative relationship between trade restrictions and price of foreign currency. This is exactly similar to positive relationship between trade restriction and price of local currency. Direction of this coefficient is same in Pakistan, India, Indonesia, Korea and Sri Lanka. Except Korea, all the sample economies report positive relationship between trade restrictions and price of local currencies. The negative sign of β_4 in Pakistan, India, Indonesia and Sri Lanka indicates that all the sample economies use import duties and quotas as trade restrictions. By imposing tariffs and quotas on imports, governments improve the conditions of trade balance account, which ultimately puts upward pressure on the prices of local currencies. β_5 is coefficient of trade balance, which is measured as the difference between exports and imports. Trade balance has been expressed as percentage of gross domestic product. Value of β_5 is -0.438202 with t statistics of -0.995382. As value is less than 2, therefore relationship between trade balance and exchange rate is insignificant over the analysis period. Direction of β_5 is same in Indonesia and Sri Lanka but t statistics report that in Indonesia, trade balance has significant relationship with exchange rate, while in Sri Lanka; trade balance has insignificant relationship with exchange rate. However, direction of this coefficient is different from that found in case of Pakistan, India and Korea. β_6 is coefficient of net capital inflows, which is sum of capital and financial account expressed as percentage of gross domestic product. Value of coefficient is -2.598663, which indicates positive relationship with local currency. The direction of this coefficient is similar to expected direction as well as what has been found in Pakistan, India and Indonesia, while different from that found in Korea. It indicates that net inflows of capital have positive effect on the price of local currency and vice versa. This finding is in accordance with portfolio balance approach. Value of t statistics (-3.891199) is higher than two suggesting that net capital inflows have significant positive relationship with the price of local currency against U.S Dollar. Thus direction of this coefficient and significant t values indicate that

exchange rate is driven more by capital mobility than what it is caused by tradability of tangible goods.

4.3 Comparative Performance of Exchange Rate Models

Results of comparative performance of exchange rate models in sample economies are discussed firstly on the basis of graphical evaluation and then on the basis of statistical measures.

4.3.1 Graphical Evaluation

In graphical evaluation, Perfect Forecast Line has been drawn. This line is at 45^0 between predicted and realized values of exchange rate. All the points lying below PFL indicate upward biasness in the model and all the points lying above PFL indicate downward biasness in the model. Figure 16, 17, 18, 19 and 20 are graphical evaluation of purchasing power parity (PPP), interest rate parity (IRP), random walk model (RWM), autoregressive integrated moving average (ARIMA) and adhoc model in case of Pakistan, India, Indonesia, Korea and Sri Lanka respectively. Figure 16 shows that in Pakistan, purchasing power parity (PPP), interest rate parity (IRP) and adhoc model do not exhibit any upward or downward biasness in them as points lie above as well as below Perfect Forecast Line. However, random walk model and autoregressive integrated moving average model (ARIMA) exhibit some kind of downward biasness in them because points are continuously lying above Perfect Forecast Line. Figure 17 indicates that in India, none of the exchange rate models exhibits any upward or downward biasness in it because in all the models, points lie above as well as below Perfect Forecast Line. Thus Figure 17 negates the existence of any consistent biasness in exchange rate models used. Figure 18 provides graphical evaluation of purchasing power parity (PPP), interest rate parity (IRP), random walk model (RWM), autoregressive integrated moving average model (ARIMA) and adhoc model in Indonesia. Its interpretation is somewhat similar to that of figure 17. All the five models have points lying above as well as below Perfect Forecast Line; therefore, figure 18 also rejects the existence of any upward or downward biasness of models. Figure 19 is graphical evaluation of exchange rate models in Korea. This figure shows that in Korea, purchasing power parity and interest rate parity exhibit some kind of downward biasness in them because more points are lying above Perfect

Forecast Line. However, random walk model, autoregressive integrated moving average and adhoc model do not exhibit any biasness in them as points lie above as well as below Perfect Forecast Line. Figure 20 is graphical evaluation of exchange rate models in case of Sri Lanka. This figure negates the possibility of any kind of biasness in exchange rate models except autoregressive integrated moving average model, which shows some kind of downward biasness. There are certain limitations of graphical evaluation of comparative performance of exchange rate models. Graphs only provide basic insight into comparative predictive capacity of models. They do not compare models on the basis of any statistical measure. Second section of results reports statistical performance of exchange rate models using *Root Mean Square Error* (RMSE), Mean Absolute Error (MAE), *Median of Absolute Deviation* (MAD) and *Success Ratio* (SR).

Figure 16: Graphical Evaluation of Exchange Rate Models: Pakistan

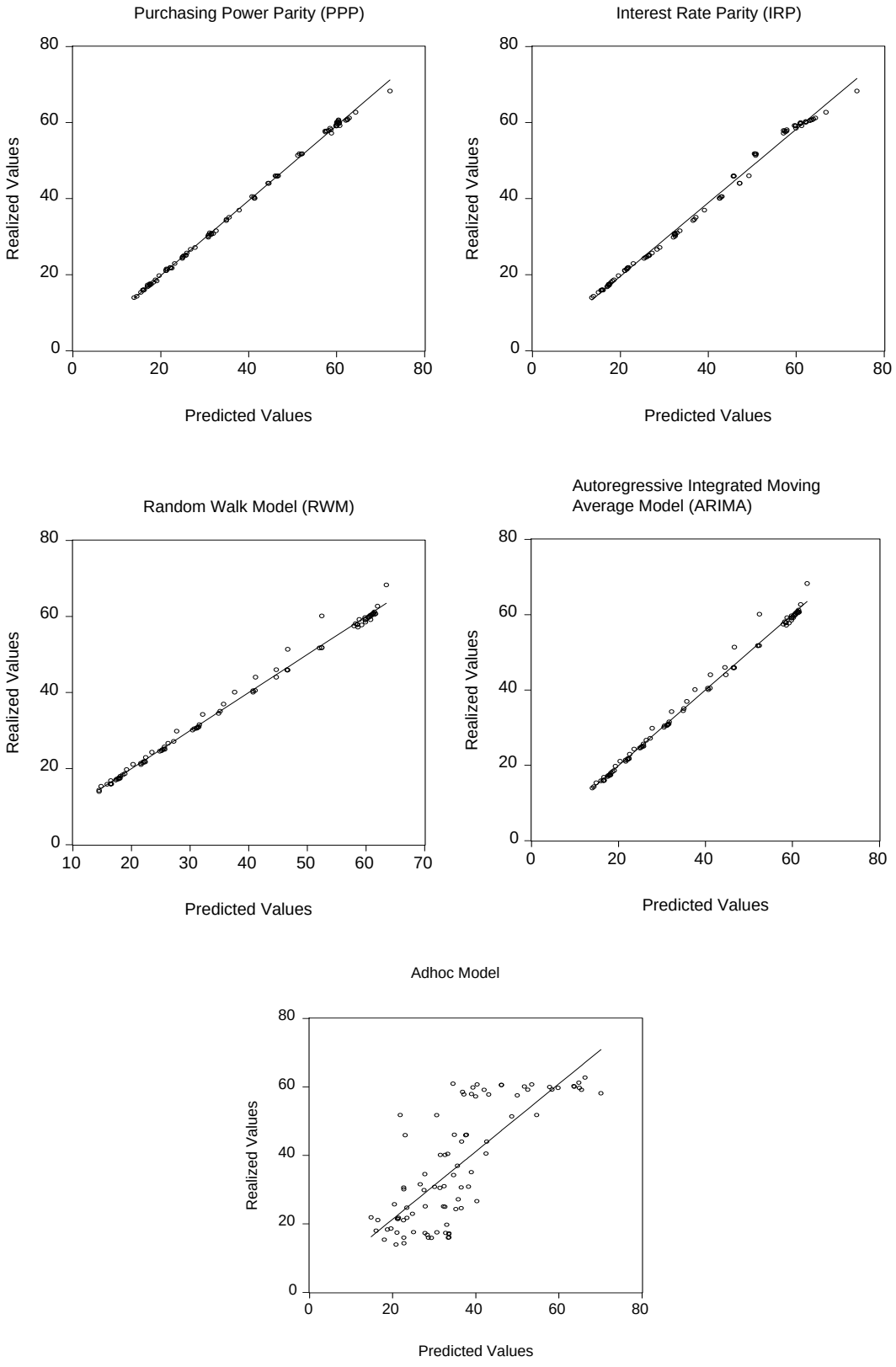


Figure 17: Graphical Evaluation of Exchange Rate Models: India

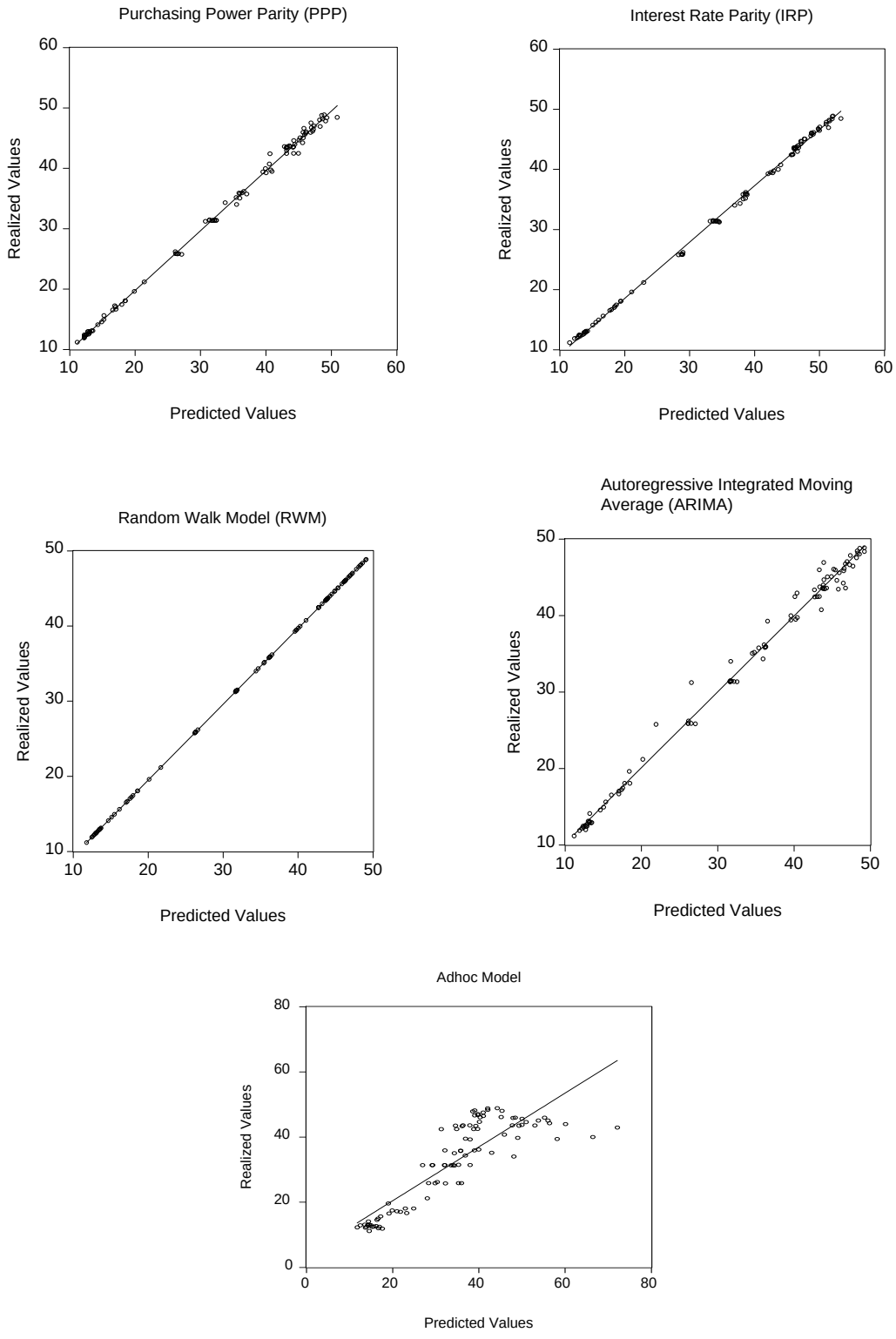


Figure 18: Graphical Evaluation of Exchange Rate Models: Indonesia

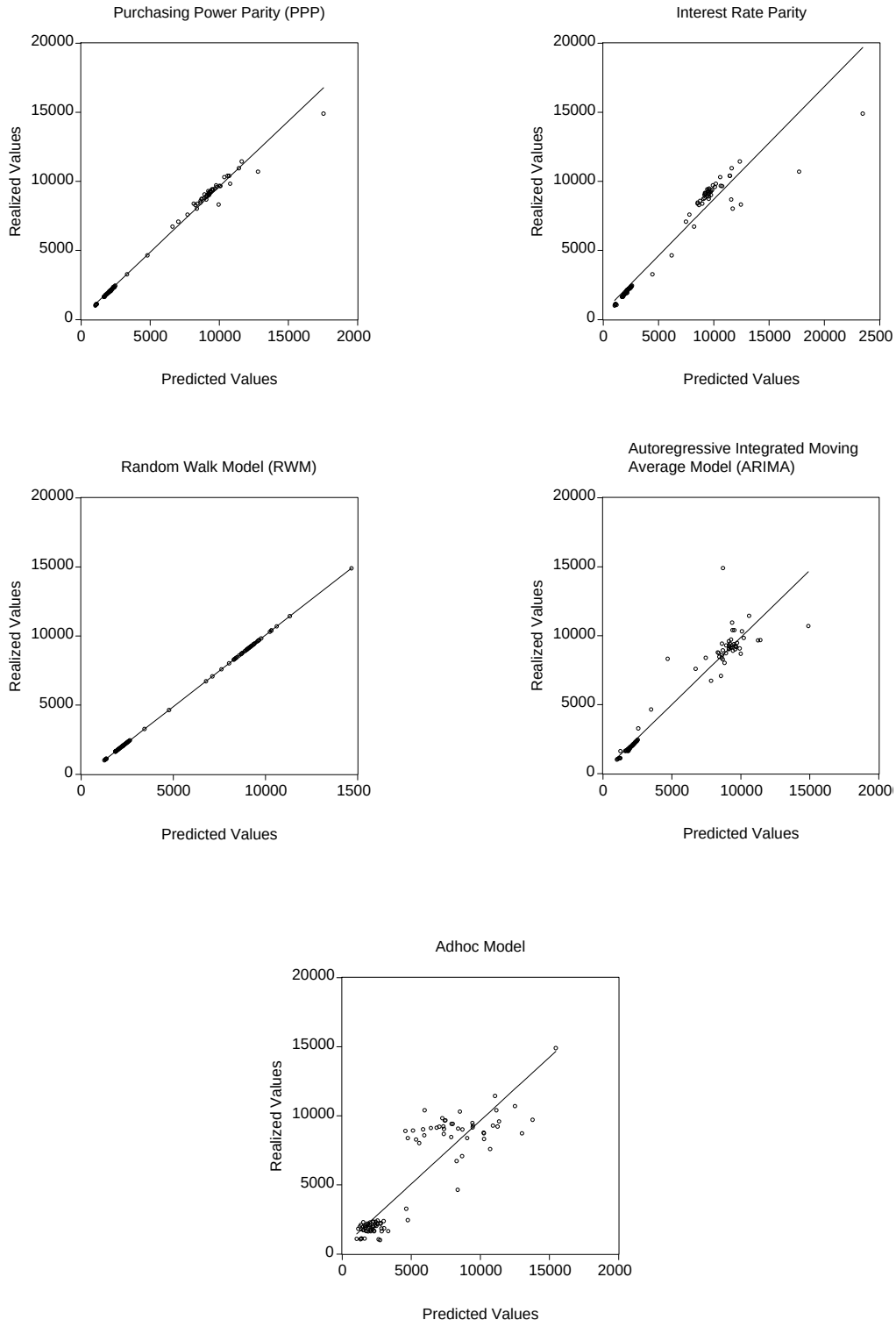


Figure 19: Graphical Evaluation of Exchange Rate Models: Korea

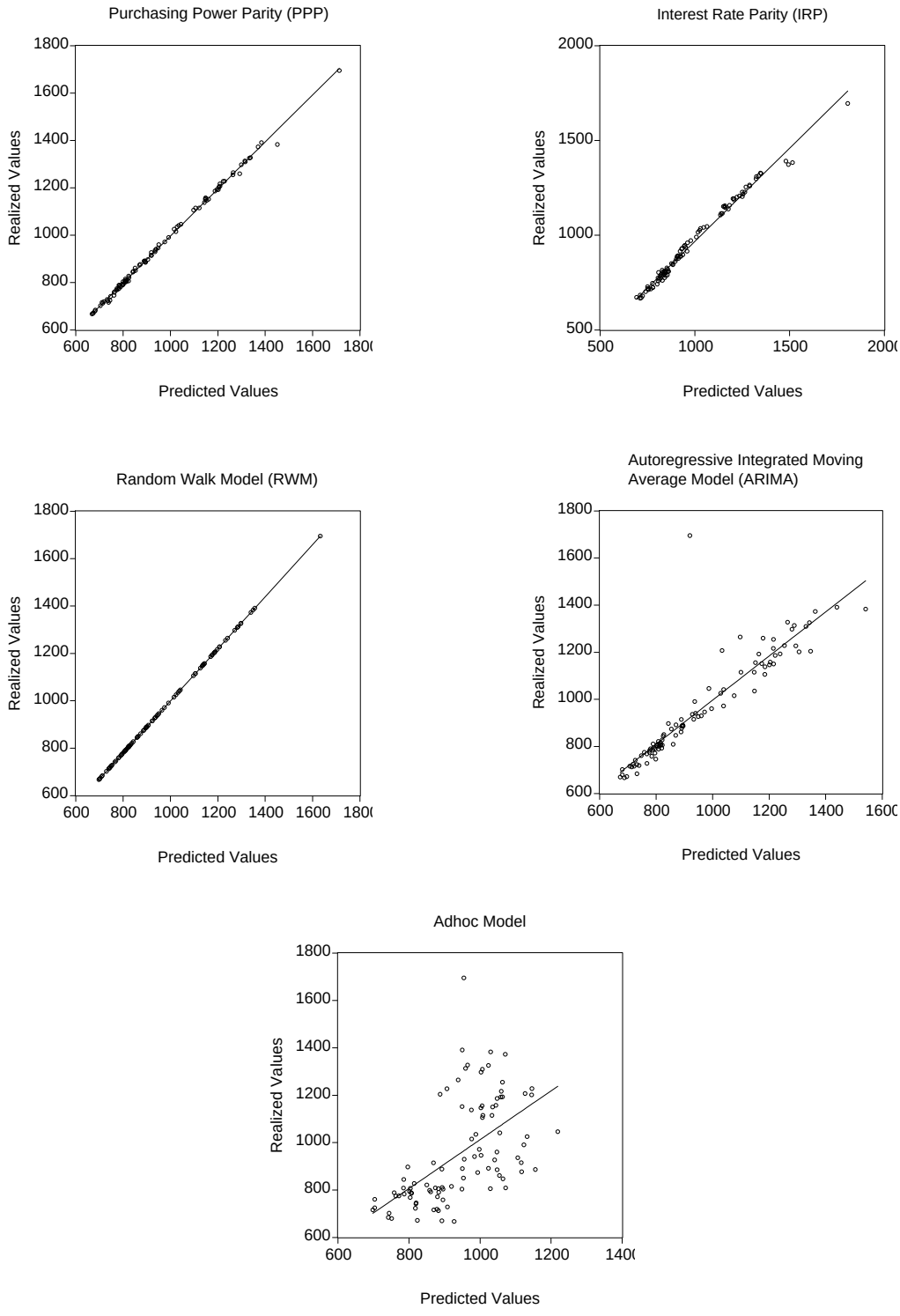
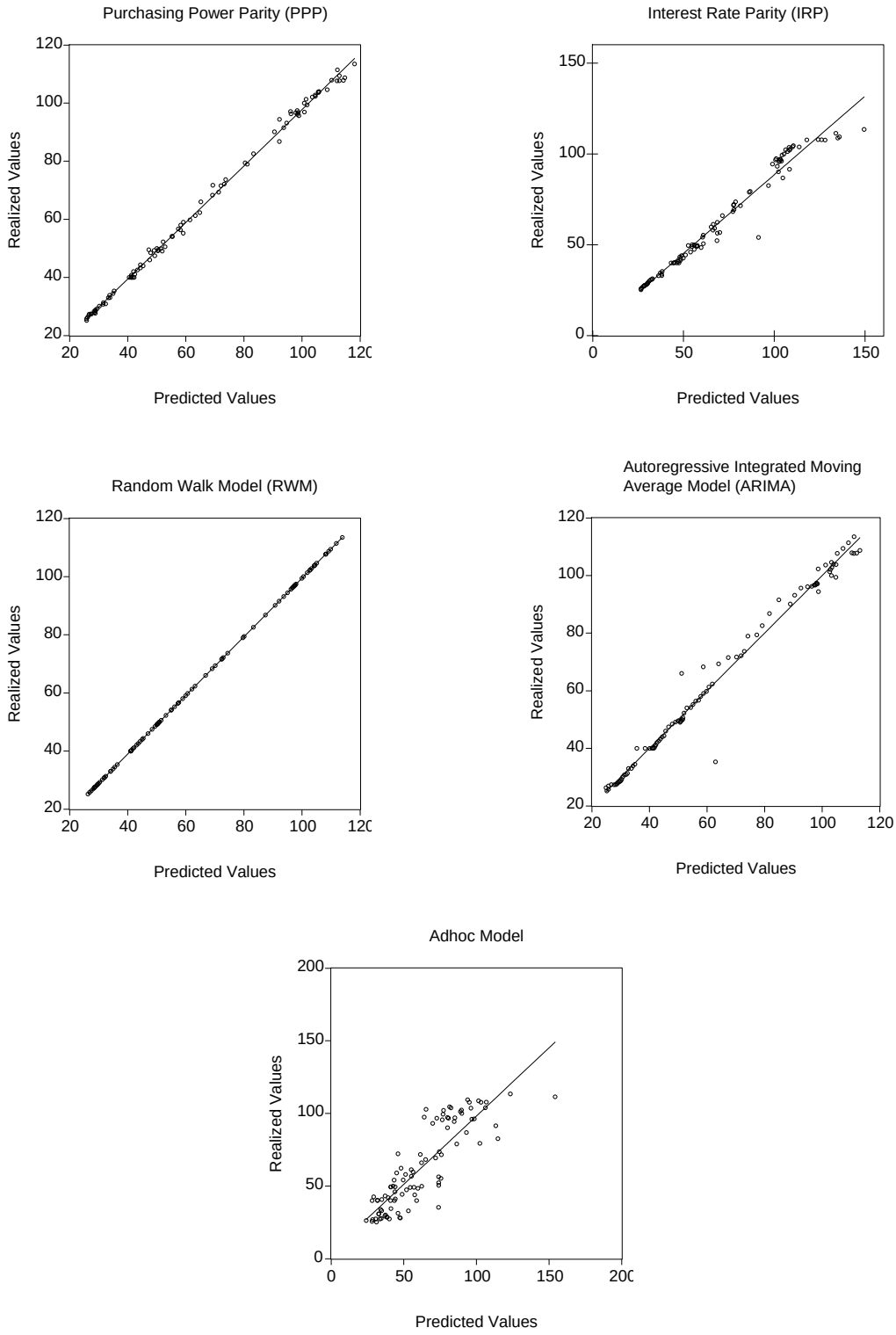


Figure 20: Graphical Evaluation of Exchange Rate Models: Sri Lanka



4.3.2 Statistical Evaluation of Exchange Rate Models

Table 19 reports the results of predictive capacity of exchange rate models on the basis of statistical measures. Exchange rate models include purchasing power parity; interest rate parity, adhoc model, random walk model and auto regressive integrated moving average model. Of these five models, first three are based on fundamentalism while the other two are based on Chartism. The Chartism based models totally ignore the contribution of economic fundamentals in determination of exchange rate behavior. Country wise results are reported in table 19.

In case of Pakistan, on the basis of *Root Mean Square Error* (RMSE) and *Mean Absolute Error* (MAE), purchasing power parity approach seems performing better against other two fundamentalists' approaches as well as against two chartists' approaches. RMSE of PPP is 0.76 against 1.66, 1.34, 1.34 and 10.86 of interest rate parity (IRP), random walk model (RWM), auto regressive integrated moving average (ARIMA) and adhoc model respectively. MAE posits results similar to those presented by RMSE. MAE of PPP is 0.52 against 1.23, 0.78, 0.78 and 8.46 of interest rate parity (IRP), random walk model (RWM), auto regressive integrated moving average (ARIMA) and adhoc model respectively. In case of Pakistan, RWM and ARIMA perform equally well on the basis of RMSE as both have same RMSE of 1.34. Third measure of predictive capacity of exchange rate models is *Median of Absolute Deviation* (MAD). *Median of Absolute Deviation* has advantage over *Root Mean Square Error* and *Mean Absolute Error*, as its calculation procedure is more resilient to outliers. On the basis of MAD, adhoc model is having better predictive capacity as compared to its competitors. MAD of adhoc model is 8.49 against 14.57, 15.75, 13.78 and 13.96 of PPP, IRP, RWM and ARIMA respectively. So IRP is showing least performance against other fundamentalists' and chartists' approaches. On the basis of this result, it can be argued that economic fundamentals do not outperform random walk and other auto regressive models because of presence of outliers in the series. Once the effect of these outliers is controlled, economic models may have the better predictive capacity against traditional benchmark random walk model. The forth measure of predictive capacity is *Success Ratio* (SR), *Success Ratio* is used by investors whose objective is not to reduce forecast errors rather to earn profit. SR

indicates that IRP has 83% accurate prediction regarding direction of exchange rate against 80%, 81%, 77% and 60% of PPP, RWM, ARIMA and adhoc model respectively.

Table 19: Results of Comparative Performance of Exchange Rate Models

		RMSE	MAE	MAD	SR
Pakistan	**PPP**	0.76	0.52	14.57	0.80
	IRP	1.66	1.23	15.75	0.83
	RW	1.34	0.78	13.78	0.81
	ARIMA	1.34	0.78	13.96	0.77
	Adhoc	10.86	8.46	8.49	0.60
India	**PPP**	0.72	0.52	9.75	0.79
	IRP	2.62	2.42	11.67	0.90
	RW	1.18	0.77	9.53	0.68
	ARIMA	2.65	2.46	9.72	0.90
	Adhoc	8.48	5.68	9.41	0.46
Indonesia	**PPP**	412.42	153.58	1,314.33	0.79
	IRP	1,356.13	526.75	1,442.73	0.81
	RW	164.75	136.79	1,209.55	1.00
	ARIMA	992.43	460.06	1,263.64	0.60
	Adhoc	1,704.44	1,153.72	1,656.86	0.57
Korea	**PPP**	10.38	6.51	130.16	0.89
	IRP	40.09	32.44	109.56	0.94
	RW	93.59	42.00	117.29	0.60
	ARIMA	92.14	38.99	135.29	0.69
	Adhoc	182.82	136.39	90.62	0.46
Sri Lanka	**PPP**	2.01	1.46	24.39	0.73
	IRP	10.11	7.58	30.30	0.79
	RW	4.42	1.63	23.06	0.80
	ARIMA	10.22	7.71	29.62	0.79
	Adhoc	14.10	11.00	18.93	0.51

Note:

RMSE is root mean square error
MAE is mean absolute error
MAD is median of absolute deviation
SR is success ratio
PPP is purchasing power parity

IRP is interest rate parity
RW is random walk
ARIMA is auto regressive integrated moving average

In case of India, on the basis of *Root Mean Square Error* (RMSE) and *Mean Absolute Error* (MAE), purchasing power parity approach seems performing better against other two fundamentalists' approaches as well as against two chartists' approaches. RMSE of PPP is 0.72 against 2.62, 1.18, 2.65 and 8.48 of interest rate parity (IRP), random walk model (RWM), auto regressive integrated moving average (ARIMA) and adhoc model respectively. MAE posits results similar to those presented by RMSE. MAE of PPP is 0.52 against 2.42, 0.77, 2.42 and 5.68 of interest rate parity (IRP), random walk model (RWM), auto regressive integrated moving average (ARIMA) and adhoc model respectively. In case of India, RWM outperforms ARIMA on the basis of RMSE as well as MAE. RMSE of RWM is 1.18 against 2.65 of ARIMA. Similarly MAE of RWM is 0.77 against 2.46 of ARIMA Third measure of predictive capacity of exchange rate models is *Median of Absolute Deviation* (MAD). *Median of Absolute Deviation* has advantage over *Root Mean Square Error* and *Mean Absolute Error*, as its calculation procedure is more resilient to outliers. On the basis of MAD, adhoc model is having better predictive capacity as compared to its competitors. MAD of adhoc model is 9.41 against 9.75, 11.67, 9.53 and 9.72 of PPP, IRP, RWM and ARIMA respectively. So IRP is showing least performance against other fundamentalists' and chartists' approaches. On the basis of this result, it can be argued that economic fundamentals do not outperform random walk and other auto regressive models because of presence of outliers in the series. Once the effect of these outliers is controlled, economic models may have better predictive capacity against traditional benchmark random walk model. RMSE, MAE and MAD show similar results in Pakistan and India. Both RMSE and MAE indicate that purchasing power parity is performing better than its competitor models while MAD indicates that performance of adhoc model is better than that of its competitors in both Pakistan as well as in India. The fourth measure of predictive capacity is *Success Ratio* (SR), *Success Ratio* is used by many investors whose objective is not to reduce forecast errors rather to make money. SR indicates that IRP and ARIMA have 90% accurate prediction regarding direction of exchange rate against 79%, 68%, and 46% of PPP, RWM, and adhoc model respectively. So results of SR are almost

similar in India and Pakistan. In both countries, SR favors IRP in determining the direction of exchange rate.

In case of Indonesia, on the basis of *Root Mean Square Error* (RMSE) and *Mean Absolute Error* (MAE), random walk model (RWM) seems performing better against other three fundamentalists' approaches as well as against one chartists' approach. RMSE of RWM is 164.75 against 412.42, 1356.13, 992.43 and 1704.44 of purchasing power parity (PPP), interest rate parity (IRP), auto regressive integrated moving average (ARIMA) and adhoc model respectively. In case of Indonesia, RWM outperforms not only ARIMA on the basis of RMSE as well as MAE but also all the three models based on economic fundamentals. MAE posits results similar to those presented by RMSE. MAE of RWM is 136.79 against 153.58, 526.75, 460.06 and 1153.72 of purchasing power parity (PPP), interest rate parity (IRP), auto regressive integrated moving average (ARIMA) and adhoc model respectively. The third measure of predictive capacity of exchange rate models is *Median of Absolute Deviation* (MAD). *Median of Absolute Deviation* has advantage over *Root Mean Square Error* as well as *Mean Absolute Error* because its calculation procedure is more resilient to outliers. Like RMSE and MAE, MAD also favors random walk model. Thus in Indonesia, even after controlling the effect of outliers, random walk outperforms economic models. This result is different from that observed in Pakistan and India. In both Pakistan and India, MAD supports adhoc model while in Indonesia, it favors random walk model on the basis of all the three criteria i.e. RMSE, MAE and MAD. MAD of random walk model is 1209.55 against 1314.33, 1442.73, 1263.64 and 1656.86 of purchasing power parity (PPP), interest rate parity (IRP), auto regressive integrated moving average (ARIMA) and adhoc model respectively. So adhoc model is showing least performance against other fundamentalists' and chartists' approaches. On the basis of this result, it can be argued that economic fundamentals do not outperform random walk and other auto regressive models in all the countries. Their performance is country specific. Because in Indonesia, even after controlling the effect of outliers, economic models have failed to beat naïve random walk model and autoregressive integrated moving average model. In Indonesia, RWM stands at number 1 and is followed by ARIMA on the basis of RMSE, MAE and MAD. The fourth measure of predictive capacity is *Success Ratio* (SR). Many investors,

whose objective is to earn profit, use Success Ratio. SR indicates that random walk model is predictor of direction with no mistake over the analysis period as its results are 100%. So in Indonesia, all the four criteria RMSE, MAE, MAD and SR vote for random walk model, which is clearly beating other fundamentals' based as well as Chartism based approaches. SR of RWM is 100% against 79%, 81%, 60% and 57% of purchasing power parity (PPP), interest rate parity (IRP), auto regressive integrated moving average (ARIMA) and adhoc model respectively. *Success Ratio* is not currency specific like RMSE, MAE and MAD. Its results can be compared across the economies. In India and Pakistan, SR favors IRP while in Indonesia, SR supports random walk model again documenting that exchange rate models perform differently in different countries.

In case of Korea, on the basis of *Root Mean Square Error* (RMSE) and *Mean Absolute Error* (MAE), purchasing power parity seems performing better than other two fundamentalists' and two chartists' approaches. RMSE of PPP is 10.38 against 40.09, 93.59, 92.14 and 182.82 of interest rate parity (IRP), random walk model (RWM), auto regressive integrated moving average (ARIMA) and adhoc model respectively. In case of Korea, ARIMA outperforms RWM on the basis of RMSE as well as MAE. RMSE of ARIMA is 92.14 against 93.59 of RWM. Similarly MAE of ARIMA is 38.99 against 42.00 of RWM. MAE posits results similar to those presented by RMSE. MAE of PPP is 6.51 against 32.44, 42.00, 38.99 and 136.39 of interest rate parity (IRP), random walk model (RWM), auto regressive integrated moving average (ARIMA) and adhoc model respectively. Third measure of predictive capacity of exchange rate models is *Median of Absolute Deviation* (MAD). *Median of Absolute Deviation* has advantage over *Root Mean Square Error* and *Mean Absolute Error*, as its calculation procedure is more resistant to the existence of outliers in the series. On the basis of MAD, adhoc model exhibits better predictive capacity as compared to its competitors. MAD of adhoc model is 90.62 against 130.16, 109.56, 117.29 and 135.29 of PPP, IRP, RWM and ARIMA respectively. So ARIMA is showing least performance against other fundamentalists' and chartists' approaches. On the basis of this result, it can be argued that economic fundamentals do not outperform random walk and other auto regressive models like ARIMA because of presence of outliers in the series. Once the effect of these outliers is controlled, economic models may have better predictive capacity against traditional

benchmark random walk model. RMSE, MAE and MAD show similar results in Pakistan, India and Korea. The fourth measure of predictive capacity is *Success Ratio* (SR), *Success Ratio* is used by many investors because objective of many investors is not to reduce forecast errors but to earn profit. SR indicates that IRP has 94% accurate prediction regarding direction of exchange rate movement against 89%, 60%, 69% and 46% of PPP, RWM, ARIMA and adhoc model respectively. So results of SR are almost similar in Korea, India and Pakistan. In these three countries, SR favors IRP in determining the direction of exchange rate.

In case of Sri Lanka, on the basis of *Root Mean Square Error* (RMSE) and *Mean Absolute Error* (MAE), purchasing power parity approach seems performing better against other two fundamentalists' approaches as well as against two chartists' approaches. RMSE of PPP is 2.01 against 10.11, 4.42, 10.22 and 14.10 of interest rate parity (IRP), random walk model (RWM), auto regressive integrated moving average (ARIMA) and adhoc model respectively. In case of Sri Lanka, random walk model outperforms ARIMA on the basis of RMSE as well as MAE. RMSE of RWM is 4.42 against 10.22 of ARIMA. Similarly MAE of RWM is 1.63 against 7.71 of ARIMA. MAE posits results similar to those presented by RMSE. MAE of PPP is 1.46 against 7.58, 1.63, 7.71 and 11.00 of interest rate parity (IRP), random walk model (RWM), auto regressive integrated moving average (ARIMA) and adhoc model respectively. Third measure of predictive capacity of exchange rate models is *Median of Absolute Deviation* (MAD). *Median of Absolute Deviation* offers benefit over *Root Mean Square Error* and *Mean Absolute Error*, as the procedure at which its calculation is based, is more resistant to the existence of outliers in the series. On the basis of MAD, adhoc model exhibits better predictive capacity as compared to its competitors. MAD of adhoc model is 18.93 against 24.39, 30.30, 23.06 and 29.62 of PPP, IRP, RWM and ARIMA respectively. So IRP is showing least performance against other fundamentalists' and chartists' approaches. On the basis of this result, it can be argued that economic fundamentals do not outperform random walk and other auto regressive models like ARIMA because of presence of outliers in the series. Once the effect of these outliers is controlled, economic models may have better predictive capacity against traditional benchmark random walk model. RMSE, MAE and MAD show similar results in Pakistan, India, Korea and Sri

Lanka. The fourth measure of predictive capacity is *Success Ratio* (SR), *Success Ratio* is used by many investors because objective of many investors is not to reduce forecast errors but to earn profit. SR indicates that random walk model has 80% accurate prediction regarding direction of exchange rate movement against 73%, 79%, 79% and 51% of PPP, IRP, ARIMA and adhoc model respectively. So results of SR support different models in different countries. In Pakistan, India and Korea, SR gives vote to IRP while in Indonesia and Sri Lanka, SR favors random walk model. In these two countries, random walk model beats the PPP, IRP, ARIMA and adhoc model in prediction of direction of exchange rate.

CHAPTER 5

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

In this study, short run and long run relationship between stock market indices and exchange rates has been empirically investigated. To explore the short run linear relationship, Granger Causality test has been used, while to check for the existence of long run relationship, Johansen Cointegration technique has been applied. Empirical investigation of monthly stock index values and exchange rates, starting from July 1997 to October 2009, indicate that causality runs from stock market to currency market in Pakistan and Sri Lanka while from currency market to stock market in case of India, however bi directional relationship exists between these two financial markets of Indonesia and Korea. Thus Pakistan and Sri Lanka support the transmission channel of portfolio balance approach in the short run, while India supports the transmission channel of traditional approach toward relationship between capital and currency markets. However, in case of Indonesia and Korea, feedback relationship has been gauged between stock market and exchange rates. This feedback relationship is consistent with findings of Ajayi and Mougoue (1996).

This empirical investigation indicates that causation should be necessary part of designing exchange rate policies. Then risk management process may also consider the linkage between stock market and exchange rates. Another practical application of these findings is that investors may use this linkage between stock market and foreign exchange market in hedging their open exposure arising due to changes in currency rates. However, in the long run, our empirical investigation neither supports traditional approach nor portfolio approach towards relationship of stock market and exchange rates. In the long run, it supports asset approach, which says that there may not be any link between stock market and exchange rate market. Results of Johansen Cointegration test support the arguments of asset market theory, which postulates that exchange rate is just like an asset, whose price is determined on the basis of its discounted future prices. According to this approach any factor, which affects exchange rate in future will be reflected in prevailing currency price. So this theory argues that there may not be any link between exchange rates and stock markets. These findings are consistent with those documented by Ratner (1993) and Nieh and Lee (2001)

The findings of this section of study provide policy recommendation to regulators of these markets that in the long run, exchange rate volatility cannot be controlled through stock market regulations. However, short run causality has been found running from exchange rate to stock market in India. These results are helpful for investors in making investment decisions. In addition, these provide guidance in designing exchange rate policy. Johansen Cointegration does not support any long run relationship in any of the sample economies. It means that there are other economic factors, which might affect the movement of exchange rates in these economies in the long run.

No long run causality was found running from stock market to exchange rate. This created need to further explore the determinants of exchange rate movements in the sample economies. Keeping in view this inability of stock returns to explain currency behavior in the long run, the exchange rates of sample economies was regressed on a set of explanatory variables proposed by different theories. There is consensus among researchers that understanding about variables of exchange rate behavior is limited. The adhoc model has been therefore used in this study. The regression results suggest link between macroeconomic variables and exchange rate behavior in sample economies. On the other hand, empirical investigation of exchange rate and macroeconomic fundamentals reveal that a set of common factors causes exchange rates of sample Asian economies to move. Our results also suggest the existence of negative relationship between nominal interest rate and exchange rate behavior in all the sample economies. Furthermore, they indicate that exchange rate between Pak Rupee and U.S Dollar is explained significantly by relative interest rate differential, foreign terms of trade, trade restrictions and net capital inflows. Regression results report that exchange rate between Indian Rupee and U.S Dollar is explained by relative interest rate differential, foreign terms of trade, trade restrictions and net capital inflows. Thus in both, Pakistan and India, the exchange rate is caused by same set of explanatory variables. The only difference is the direction of relationship of exchange rate with foreign terms of trade. In Pakistan, foreign terms of trade are negatively related with price of foreign currency, while in India it is positively related with price of foreign currency. However, in Indonesia, relative interest rate and relative inflation level do not significantly affect exchange rate between Indonesia Rupiah and U.S Dollar. Variables significantly affecting the exchange rate

between Indonesian Rupiah and U.S Dollar are foreign terms of trade, trade restriction, trade balance and net capital inflows. In case of Korea, only two significant variables explaining the exchange rate behavior between Korean Won and U.S Dollar are relative interest rate and foreign terms of trade. Other variables do not significantly explain the behavior of exchange rate in Korea. Lastly, for Sri Lanka, the results are almost similar to those observed in case of Pakistan and India. The significant variables are relative interest rate, foreign terms of trade, trade restrictions and net capital inflows. Thus exchange rate between Pak Rupee and U.S Dollar, Indian Rupee and U.S Dollar and Sri Lankan Rupee and U.S Dollar are explained by same set of explanatory variables.

Results of Johansen's cointegration technique reveal that exchange rates of all the five sample economies seem to have long run relationship with macroeconomic fundamentals. This long run relationship can be determined by three cointegrating equations in respect of exchange rate between Pak Rupee and U.S Dollar, Indian Rupee and U.S Dollar, Korean Won and U.S Dollar and Sri Lankan Rupee and U.S Dollar, while by two cointegrating equations in respect of exchange rate between Indonesian Rupiah and U.S Dollar. This reveals that exchange rate stability can be achieved more efficiently through economic fundamentals rather than regulations of stock market, because causality between stock market and exchange rate has been found only in the short run. The sample economies have some common determinants in exchange rates. For example, the regression results support that exchange rates of Pakistan, India and Sri Lanka seem to be commonly influenced by relative interest rate, foreign terms of trade, trade restrictions and net capital inflows. Indonesian Rupee shares foreign terms of trade and trade restrictions as common factors with Pakistan, India and Sri Lanka, while Korean Won shares relative interest rate and foreign terms of trade with Pakistan, India and Sri Lanka. Among these sample economies, the exchange rates between Pak Rupee and U.S Dollar, Indian Rupee and U.S Dollar and Sri Lankan Rupee and U.S Dollar seem more sensitive to changes in macroeconomic fundamentals, while that between Korean Won and U.S Dollar seems comparatively less sensitive to changes in economic fundamentals.

Since last three decades, after work of Meese and Rogoff (1983), a hot debate is raging on the predictive capacity of exchange rate models. In this study, *in the sample forecasting* performance has been used as criteria for comparative predictive capacity of

exchange rate models. The fundamentals based approaches namely; purchasing power parity theory, interest rate parity theory and adhoc model have been compared to two naïve and extensively used as benchmark models. These are simple random walk model and auto regressive integrated moving average model. Using one graphical and four statistical measures of forecasting performance, it is concluded that economic models do not perform consistently in all the sample economies. For example in Pakistan, India, Korea and Sri Lanka, the *Root Mean Square Error*, *Mean Absolute Error* and *Median of Absolute Deviation* support fundamentals based models, while same measure of *Root Mean Square Error*, *Mean Absolute Error* and *Median of Absolute Deviation* favor random walk model in Indonesia. In Indonesia, the results are consistent with the findings of Musa (1979), Meese and Rogoff (1983), Wolff (1988) and Rossi (2006). *Root Mean Square Error*, *Mean Absolute Error* and *Median of Absolute Deviation* exhibit almost similar results in Pakistan, India, Korea and Sri Lanka. Both RMSE and MAE indicate that purchasing power parity is performing better than its competitive models, while MAD indicates that performance of adhoc model is better than its competitors in these economies. However, they reveal that random walk model has outperformed economic models in Indonesia. In case of Indonesia, our findings are consistent with those of Kuan and Liu (1995), Brooks (1997), Balke and Fomby (1994), Van et al. (1999). In conclusion, this study provides empirical support to the argument that economic fundamentals are not senseless or irrelevant in exchange rate determination. Their role in explaining exchange rate behavior cannot be ignored. It is the existence of outliers in the series, which contaminates the results. Such contamination of results by outliers has also been documented by Balke and Fomby (1994), Ledolter (1989), Hotta (1993) and Van et al. (1999). Once this contamination is controlled through MAD, the adhoc model based on different economic fundamentals has the power to beat other exchange rate models based on single fundamental variable, like purchasing power parity and Interest rate parity and auto regression models, like random walk model and autoregressive integrated moving average model.

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