Asymmetric Effect of Macroeconomic Variables and Their Volatilities on Stock Return: A Case Study of Pakistan

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CERTIFICATE

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Acronyms

ADF	Augmented-Dickey Fuller
AIC	Akaike Information Criterion
APT	Arbitrage Pricing Theory
ARDL	Autoregressive Distributed Lagged
CP	Consumer Prices Index
EX	Exchange Rate
MS	Money Supply
IP	Industrial Production Index
SP	Stock Prices
ECM	Error Correction Model
IR	Interest Rate
NARDL	Non-linear Autoregressive Distributed Lagged
SIC	Schwarz Information Criterion
VCP	Volatility of Consumer Prices Index
VEX	Volatility of Exchange Rate
VIP	Volatility of Industrial Production Index
VIR	Volatility of Interest Rate
VMS	Volatility of Money Supply
VSP	Volatility of Stock Prices

Abstract

This study employs ARDL bound test to test that whether positive and negative changes in economic indicators affect stock market symmetrically. To study the asymmetry of economic indicators explicitly interest rate, prices, exchange rate, money supply, and output on stock return, non-linear autoregressive distributed lagged model (NARDL) is employed on Pakistan's data from January 1997 to December 2016. Analysis is divided into two parts (i) change in stock return due to positive and negative change in macroeconomic variable (ii) and change in stock return volatility due to positive and negative change in volatilities of macroeconomic variables. Study found that volatility of exchange rate and interest rate have asymmetric effect on stock return in long run and short run as well. Also, output and its volatility have asymmetric impact on stock return in long run only. Findings of the study support the view that impact of good news is not same as bad news. Therefore, it is recommended to consider the asymmetric impact of macroeconomic variables in process of policy making

Chapter 1

Introduction

1.1 Introduction

A country's economic progress depends mainly on the progress of financial sector. The stock market plays a major role in the financial sector by providing a platform for its users and providers of resources for investing in corporate stocks. It plays an active role in the economic growth and the expansion of a steady and well-ordered financial structure of an economy (Patel, 2012).

Stock market is directly affected by various macroeconomic factors and there is complex connection between these factors (Raza *et al.*, 2016). According to Arbitrage Pricing Theory (APT), the expected returns can be defined as a linear function of several macroeconomic factors. The most commonly used macroeconomic indicators are prices, money supply, interest rates, exchange rates, and output. It is very important for all investors and government agents to understand behavior of these variables when selecting among investment opportunities or formulating a policy because of relationship between stock market and economic indicators (Attari and Safdar, 2013). Chen *et al.* (1986) studied a set of macroeconomic indicators as systematic influence on stock market. Their conclusion is consistent with asset pricing theory of Ross (1976). In their study, they concluded that stock markets are vulnerable to economic news and this news can be measured as innovations in macro variables. Identification of such variables can be achieved through simple and intuitive financial theory.

In addition, the macroeconomic variables show the volatile behavior. Extreme volatility is an obstacle to the proper functioning of markets and it negatively affects the economy. Officer (1973)

argued that movements of stock return are related to volatility of macroeconomics variables. Kearney and Daly (1998), in their study, concluded that conditional volatilities of macroeconomic variables are directly associated with stock return volatility.

Moreover, researchers, in their studies, assumed that effect of positive and negative changes in macroeconomic variables on stock market is symmetric i.e. both increase and decrease in value of macroeconomic variables will have a symmetric effect on stock return. Symmetry assumption in case of financial market implies that if positive change in macro variable increases (decreases) the stock return of market then negative change should also decrease (increase) the stock return by same amount. But this might not be true always in case of risk aversion economy. Additionally, investors are likely to follow the declaration of economic policy and data to make their investment decision. They feel optimistic when they foresee profit while they feel pessimistic when they anticipate loss.

Asymmetry can be divided in two forms:

1. Asymmetry in terms of sign
2. Asymmetry in terms of magnitude

Asymmetry in terms of signs implies that different firms in stock market might respond to increase or decrease of macro variable differently. In case of asymmetry in terms of magnitude, different firms in stock market might respond differently to degree of changes (large or small) in macro variable.

For example, in case of exchange rate, appreciation and deprecation of local currency will not have similar effects in terms of magnitude and sign on stock prices because amount of increase in stock price due to depreciation of local currency might not match the amount of decrease in stock prices

when there is appreciation of local currency. Therefore, impact of "good news" and "bad news" is not same (Black, 1976).

Due to dynamic and asymmetric (non-linear) behavior of macroeconomic variables, it is essential for investors, macroeconomists and Govt. agents to understand the asymmetric effect of macro variables and their volatilities on stock market so that one can make an educated decision about their investments.

1.2 Motivation of the Study

The present study is primarily motivated by the fact that existing literature has focused on the symmetric impact of macroeconomic indicators on stock prices in case of Pakistan. This assumption might not true always. In case of exchange rate, for any firm, cost of goods imported will decline when there is appreciation of local currency which will lead to increase in profit. Higher profit will result into higher stock prices. For same firm, whenever there is depreciation in local currency, cost of goods will increase. It will lead to decline in profit but this decline in magnitude might not be same as that of increase in magnitude when currency appreciates. So, our study contributes to literature by filling this gap.

1.3 Significance of the Study

Modeling the determinants of stock return and their volatilities attracts the attention of both academicians and policy makers due to its significance for the economy. However, there might be asymmetric impact of macroeconomic variables on market. Due to this asymmetry, investor may overreact on negative shock or underreact on positive shock. This study determines the effect of macroeconomic variables and their volatilities on stock return by incorporating the asymmetric behavior of macro variables. It will help investor to make much more accurate market analysis.

1.4 Objective of the Study

Objective of the study is to test whether there is asymmetric short-run and long-run impact of macroeconomic variables and their volatilities on stock market of Pakistan.

1.5 Organization of the Study

This study is organized into five chapters. First chapter provides the introduction of relationship of macroeconomic variables and their volatilities with stock prices, significance of study and objective of study. Second chapter reviews the existing literature on asymmetric relationship. Third chapter provides theoretical framework for study and describes the data and methodology used for study. Fourth chapter discusses the empirical results. Last chapter provides conclusion and policy recommendation.

Chapter 2

Literature Review

2.1 Introduction

In this chapter, the literature on the relationship between macroeconomic indicators and stock market return is reviewed.

2.1.1 Existing Literature in Case of Pakistan

This section reviews the established literature of relationship between stock market returns and macroeconomic variables in Pakistan.

Muhammad and Rasheed (2002) examined the long-run and short-run associations between stock prices and exchange rates for four South Asian countries for the period January 1994 to December 2000. They found that no long-run and short-run associations between stock prices and exchange rates for Pakistan and India. No short-run association was also found for Bangladesh and Sri Lanka. However, there seems to be a bi-directional long-run causality between these variables for Bangladesh and Sri Lanka.

Nishat *et al.* (2004) used the output, prices, supply of money and interest rate to investigate the relation with market return by employing VECM approach and found that these macroeconomic variables are cointegrated and found that there are two long-run equilibrium relationships exist among these variables. Moreover, it is found that output and inflation are largest positive and negative determinant of Pakistani stock prices respectively.

Similarly, Hasan and Nasir (2008) determined relationship between Karachi Stock Exchange (KSE) and different macroeconomics variables. By using ARDL (Autoregressive Distributed Lagged) approach for cointegration based on bounds test, they found that output, Oil Prices and

Inflation dose not play role in determining equity prices in long run. While Interest Rate, Exchange Rates and Money Supply have long run relation with equity prices. Additionally, ARDL approach also captures the short-term dynamics of prices. It confirms that changes in IPI, Oil Prices and Inflation are not statistically significantly in short run. Whereas, changes in Interest Rates(IR), Exchange Rates and Money Supply have significant short-term effect.

Hasan and Javed (2009) studied the impact of monetary variables on equity market returns. They used Money Supply, Treasury Bill Rates, Foreign Exchange Rates and the Consumer Price Index as monetary variables. Cointegration analysis is used to check the existence of a long run and dynamic relationship between the equity market and monetary indicators. The study found that broad money has a positive relation with equity returns whereas interest rate and exchange rate are found to be negatively related to the Pakistani equity market.

Sohail and Hussain (2009) examined long run and short run relationship between Lahore Stock Exchange (LSE) and macro indicators i.e. Consumer Price Index, Real Effective Exchange Rate, T-bill Rate, Industrial Production Index and Money Supply. For long-run relation, Johnson Cointegration test is applied and VECM (Vector Error Correction Model) is used for short-run relation. In long-run, Inflation had a negative impact on stock prices while Industrial Production Index, Real Effective Exchange Rate and Money Supply affected stock returns effectively. Though, T-bill rates exhibited insignificant positive effect on stock return.

Khalid *et al.* (2012) used inflation, exchange Rate, treasury bill to examine the relation between macroeconomic indicators and market return by using cointegration analysis and Granger causality approach. The study results exposed that there is no co-movement between these variables and returns.

Zaheer and Rashid (2014) described the relationship between Karachi Stock Exchange (KSE) and macroeconomics indicators. They used different macroeconomic variables like, Consumer Price Index (CPI), Industrial Production Index (IPI), Money Supply, Exchange Rate and Interest Rate. They used Johnsen Cointegration to find long-run relation between these variables and found that Consumer Price Index, Exchange Rate, Money Supply and Interest Rate have negative relation with stock returns whereas IPI has positive relation with markets returns.

Ismail *et al.* (2016) explored relationship between KSE-100 and selected macroeconomics indicators. By using ARDL bound test approach, they showed that exchange rate, money supply, and real interest rate have no statistically significant impact on stock market returns. While, GDP is found to be positively related to stock returns.

2.1.2 Macroeconomic Volatility and Stock Market

The second part of the study is to link the volatility in macroeconomic variables to stock market volatility. Theoretical motivation for such relation can be described through discounted present value model for stock prices which defines that conditional variance of stock return depends on the variation of expected future cash flows, discount rate and conditional covariance between them (Schwert;1989). Consequently, value of equity on cumulative level should be conditional on well-being of economy. Hence, it is rational to think that vagueness in upcoming macroeconomic level would yield proportional change in stock return.

The earliest literature in this field was established by Officer (1973). He found that movements of stock returns are related to volatility of macroeconomic variables. After this, Schwert (1989) argued that there is weak link between volatilities of macro variables (inflation, money growth, interest rate and industrial production growth rate) and volatility of stock return but proposed that stock volatility is more likely to predict the future macroeconomic volatility. In his study, he used

generalized form of 12-month rolling standard deviation estimator used by Officer (1973) to estimate volatilities of variables and VAR model to estimate the relationship between volatilities of variables.

Chiang and Chiang (1996) observed that there is weak correlation between macroeconomic and stock market volatility. In their study, they used the data of volatility in stock return for Canada, Japan, Germany and United Kingdom and exchange rate, M2 and industrial production.

Liljeblom and Stenius (1997) used monthly data from 1920 to 1991 for Finland. They used two different methods to estimate volatilities. First, simple weighted averages of lagged absolute errors were taken. Second, GARCH model is used to estimate conditional volatilities. By using VAR approach, they found that there is significant relationship between volatilities and strong predictability from both sides.

Kearney and Daly (1998) also examined the relationship using data for Australia. In their study, they estimated volatilities by using the method of Schwert (1989) and analyzed the relationship through Generalized Least Square (GLS) method. They concluded that conditional volatilities of inflation and interest rate are directly associated with conditional volatilities of stock returns and there is indirect association of industrial production, current account deficit and money supply with market volatility.

Morelli (2002) reported that volatility in macro variables (industrial production, real estate sales, money supply, inflation and exchange rate) does not describe the dynamic behavior of stock return in UK stock market. In the study, GRACH model was used to estimate the volatilities and 12th order VAR model is used to estimate the relation among variables. These results validate the conclusion of Schwert (1989) but contradict with findings of Liljeblom and Stenius (1997).

Beltratti and Monara (2006) studied S&P 500 return volatility. They found that there is a strong

link between macroeconomic and stock market volatility in both way but causality way from macroeconomic volatility to market volatility is stronger.

2.1.3 Asymmetric Effect of Change in Macroeconomic Variables on Stock Return

In existing literature, researcher assumed that effect of changes in macroeconomic variables on stock market is symmetric. But this is not always true in case of risk averse economy.

Lobo (2000) studied the stock price adjustments to changes in federal funds rate by using asymmetric autoregressive exponential GARCH model. He found weak evidence of overreaction of market players in wake of bad news relative to good news of interest rate.

Chen (2007) examined the impacts of monetary policy variables on stock return. He concluded that monetary variables play important role in stock market, but it is not clear whether monetary variables have asymmetric effects on stock returns.

Constantinos *et al.* (2012) found that there is positive and asymmetric relation between stock return and inflation in case of Greek data. By using NARDL, they established that positive changes in inflation are the major source of changes in stock return instead of negative changes of inflation.

Jiang (2013) studied asymmetric effect of monetary policy on stock market. In his study, he used federal fund rate and money aggregate as monetary policy variables and found that there is asymmetric effect of these variables on stock return.

Oskooee and Saha (2016) conducted study on data of nine markets of different countries to test the assumption of symmetry and concluded that there is asymmetric effect of macroeconomic variables on stock return.

Raza *et al.* (2016) examined the long run and short run asymmetric impact of gold prices, oil prices and their volatilities on stock return by using non-linear ARDL model. In their study, they used monthly data of period from Jan 2008 to Jun 2015 of top ten emerging markets. They found that gold prices, oil prices and volatilities associated with them have non-linear impact on stock return.

Rocher (2017) investigates the link between changes in interest rate and stock return for nine developed countries over the period of 1999-2017. In his study, he used linear and nonlinear Ganger Causality tests and Nonlinear Autoregressive Distributed Lag (NARDL) model to capture asymmetric effect of interest rate on stock return. He concluded that relationship between these variables is not linear and in extreme economic conditions, this asymmetrical relationship tends to increase.

Summary

Considering above literature, we can conclude that macroeconomic variables have direct relation with assets price. Any change in macroeconomic variables also change the price of stock in market. Additionally, in literature, researchers used the assumption of symmetric effect of macro indicators and their volatilities on stock market and there is a gap in empirical identification of asymmetric effect of change in macroeconomic variables and their volatilities on stock returns in case of Pakistan. Therefore, in this study, we try to find the impact of macroeconomic factors and their volatilities on stock return by testing the assumption of symmetry.

Chapter 3

Data & Methodology

3.1 Introduction

This chapter discusses the theoretical as well as empirical framework of the study and also provides the economic technique that is suitable to inspect the asymmetric impact of macroeconomic indicators and their volatilities on stock market of Pakistan.

3.1.1 Theoretical Framework

The theoretical background of the determinants of stock returns are presented by Ross (1976) under Arbitrage Pricing Theory (APT). It incorporates the influence of more than one variable on returns and does not have any limiting assumptions. APT argued that return of asset can be described as a linear function of several macro-economic indicators and degree to change in each indicator can characterized by a beta coefficient.

$$R = \alpha_{\circ} + \beta_1 F_1 + \beta_2 F_2 + \beta_3 F_3 + \cdots + \beta_n F_n + \varepsilon$$

Where R represents return on asset, $\alpha_{\circ}$is constant, β_n is sensitivity of asset to nth factor, F_n is a macroeconomic factor and ε is random shock.

APT does not itself reveals about which macroeconomic variables should be used to model stock return. In case of Pakistan, number of studies tried to test the APT by using different macroeconomic variables. The most important macroeconomic indicators used by most of the researcher in case of Pakistan are interest rate, exchange rate, inflation, money supply and output (Nishat *et al.*,2004; Hasan and Nasir, 2008; Hasan and Javed, 2009; Sohail and Hussain, 2009; Khalid *et al.*, 2012; Zaheer and Rashid, 2014; Ismail *et at.*, 2016).

Asset Pricing Theory suggests that variables that affect the investment opportunity or level of consumption should also affect asset prices (Merton, 1973; Breeden, 1979). Therefore, in risk averse economy, assets affected by such undiversifiable risk factors should get risk premium (Ross 1976) and change in macroeconomic variables simultaneously affect firm's cash flows and discount rate, making these macro factors best example of such extra market risk variables. The commonly used macroeconomic variables in the analysis of stock return are described as;

i. Interest Rate

Theoretical motivation for relationship between interest rate and stock return can be described through discounted cash flow model (Schwert, 1989). Stock price can be defined as:

$$S.P = \frac{E(cf)}{i}$$

Where $S.P$ is price of stock, cf is cash flows and i is discount factor. Above equation implies that any factor that disturbs the interest rate i and expected cash flows cf will influence the stock return. In other words, any factor that affects the dividend or economy's pricing mechanism will also affect the stock returns. Moreover, increase in interest rate will increase the opportunity cost of holding money. This will lead to substitution between securities and stock and will, inevitably, fall the price of stock. Thus, we expect a negative relation between interest rate and stock return.

ii. Inflation

Any change in expected rate of inflation would influence nominal rate of interest as well as nominal expected cash flows. Fisher (1930) presented a proposition known as Fisher effect. According to Fisher effect, nominal interest rate can be described as sum of real interest rate and expected inflation rate. Mathematically,

$$i = r + \pi^e$$

Where i is nominal interest rate, r is real interest rate and π^e is expected inflation rate. It states that nominal interest rate reflects all information about the future level of inflation rate. This proposition that nominal returns contain market assessment of expected inflation can be applied to all assets. Intuitively, because stocks represent the claim against real assets and they are considered as hedge against inflation, their return should compensate the expected and unexpected change in inflation. From Fisher effect, it can be inferred that there is one to one positive relation between inflation and stock return. On other hand, increase in inflation will increase the cost of input of goods produced which will lead to decline in profitability and in result, stock price will fall. It implies that there is negative relationship between inflation and stock return. Empirical studies also found that there is negative relation between inflation and stock return (Fama and Schwert, 1977; Gultekin, 1983)

iii. Exchange Rate

Effect of fluctuations in exchange rate on stock return depends on the nature of firm whether firm is export orient or import oriented. When firms are export oriented, depreciation in local currency will make domestic company more competitive because of change in input-output prices and demand for their products. This will lead to an increase in exports and stock price of the firm will increase (a positive relation). Whereas, if the firm is import oriented, depreciation of home currency will increase the cost of imported inputs. This will lead to decrease in profitability of firm and stock price will also decline (a negative relation). Therefore, change in exchange rate affects output, thereby changes stock return (Dornbusch and Fischer,1980).

iv. Money Supply

Relationship between supply of money and market returns can be positive or negative. Fama (1981) described this relationship and he concluded that inflation is positively related to growth rate of money. It implies that increase in supply of money may lead to positive change in interest rate and therefore, lower the return on equity (a negative relation). On other hand, Monetary portfolio theory states that any change in money supply will affect the equilibrium of money. It will then alter the composition and price of assets in investor's portfolio (Cooper,1974; Rozeff ,1974). Moreover, change in money supply may impact on real economic variables and it will have a lagged influence on stock return (Rogalski and Vinso,1977). These propositions suggest that there is positive relationship. Empirical studies also suggest a significant relation between supply of money and stock market (Sprinkel,1964; Palmer,1970; Keran,1971; Hamburger and Kochin,1972).

v. Output

Discounted cash flow model of stock implies that return on stock is function of future cash flows and any factor that disturbs the expected cash flows will eventually influence the stock return. Additionally, cash flows are very sensitive to economic condition of economy because if the economy is growing then output will increase and firm should experience increased profitability as well as future cash flows. Thus, there is positive relationship between output and stock return (Fama,1981; James *et al.*, 1985; Schwert, 1990; Harris and Opler, 1990; Mukherjee and Naka, 1995).

3.1.3 Econometric Framework

The objective of study is to examine the asymmetric impact of macroeconomic variables and their volatilities on stock return. For this, first we must estimate the volatility of each macro variable. To estimate variation from monthly data, we have used the procedure introduced by Schwert (1989). It is generalization of the 12-month rolling standard deviation estimator used by Officer (1973). This method is almost same as Autoregressive Conditional Heteroskedasticity (ARCH) model of Engle (1982). The detail of the procedure is as follow:

Step 1: Estimate an AR(12) model for variables, including dummy variables D_{jt} to allow for different monthly mean return. i.e.

$$X_t = \sum_{j=1}^{12} \alpha_j D_{jt} + \sum_{i=1}^{12} \beta_i X_{t-i} + \varepsilon_t \tag{3.1}$$

Step 2: Obtain the errors from equation (3.1) and estimate AR(12) model for absolute values of residuals including dummy variables to allow for different monthly standard deviations.

$$|\hat{\varepsilon}_t| = \sum_{j=1}^{12} \gamma_j D_{jt} + \sum_{i=1}^{12} \rho_i |\hat{\varepsilon}_{t-i}| + u_t \tag{3.2}$$

The regressand $|\hat{\varepsilon}_t|$ from equation (3.2) is an estimate of standard deviation of variables like $\hat{\sigma}_t$. The estimated values from equation (3.2) $|\hat{\varepsilon}_t|$ estimate the conditional standard deviation of X_t. Standard deviation specification estimated from equation (3.2) are more robust than variance specification based on $\hat{\varepsilon}_t^2$ (Davidian and Carroll, 1987). The volatility series for all variables is measured from above procedure.

In next step, we use Autoregressive Distributed Lagged (ARDL) bound test approach for relationship between macro indicators and stock market. ARDL bound test was introduced by

Pesaran *et al.* (2001) to incorporate the problem of testing the presence of relationship between variables when it is not sure that variables are trend stationary or difference stationary. In this study, we will use ARDL bound testing approach because it resolves the issue of order of integration by assuming that the variables are combination of both $I(1)$ and $I(0)$. The ARDL model approach to bound testing;

$$\Delta Y_t = \delta_0 + \sum_{i=1}^{l1} \alpha_i \Delta Y_{t-1} + \sum_{i=0}^{l2} \alpha_k \Delta X_{k,t-i} + \delta_1 Y_{t-1} + \beta_k X_{k,t-1} + u_t \qquad (3.3)$$

Where

l is the ARDL model maximum lag order and X_k shows the vector of variables.

Volatility of macro variable can be introduced in ARDL bound test model as:

$$\Delta VSP_t = \delta_0 + \sum_{i=1}^{l3} \alpha_i \Delta VSP_{t-1} + \sum_{i=0}^{l4} \varphi_k \Delta VX_{k,t-i} + \delta_1 VSP_{t-1} + \beta_k VX_{k,t-1} + u_t \qquad (3.4)$$

Where VSP_t and $VX_{k,t}$ represent the volatility of stock prices and volatility of macro variables respectively.

A common feature of the previous studies is assumption that the macro variables has symmetric effect on stock return. To test the assumption of symmetry, we use Non-linear ARDL approach our study. This approach was introduced by Shin *et al.* (2014). In this test, differenced series for each variable in equation (3.3) and (3.4) is decomposed into its positive and negative series. Then two new time series for each macro variable are generated. One representing increase in variable as partial sum of positive changes denoted by POS and other representing decreased in variable as partial sum of negative changes denoted by NEG.

$$POSX_t = \sum_{i=1}^{t} \Delta LnX_i^+ = \sum_{i=1}^{t} \max(\Delta LnX_i, 0) \quad (3.5a)$$

$$NEGX_t = \sum_{i=1}^{t} \Delta LnX_i^- = \sum_{i=1}^{t} \min(\Delta LnX_i, 0) \quad (3.5b)$$

Similarly, for volatility of each macro variables, series is decomposed into two variables $POSVt$ and $NEGVt$ as:

$$POSV_t = \sum_{j=1}^{t} \Delta LnV_j^+ = \sum_{j=1}^{t} \max\left(\Delta LnV_j, 0\right) \quad (3.6a)$$

$$NEGV_t = \sum_{j=1}^{t} \Delta LnV_j^- = \sum_{j=1}^{t} \min\left(\Delta LnV_j, 0\right) \quad (3.6b)$$

The next step is to plug these series into ARDL volatility model to get Non-linear ARDL.

$$\Delta Y_t = \delta_0 + \sum_{i=1}^{l5} \alpha_i \Delta Y_{t-1} + \sum_{i=0}^{l6} \omega_{k,i} \Delta POSX_{k,t-i} + \sum_{i=0}^{l7} \vartheta_{k,i} \Delta NEGX_{k,t-i} + \delta_1 Y_{t-1} + \tau_k POSX_{k,t-1} + \theta_k NEGX_{k,t-1} + u_t \quad (3.7)$$

and

$$\Delta VSP_t = \delta_0 + \sum_{i=1}^{l8} \alpha_i \Delta VSP_{t-1} + \sum_{i=0}^{l9} \varphi_{k,i} \Delta POSV_{k,t-i} + \sum_{i=0}^{l10} \rho_{k,i} \Delta NEGV_{k,t-i} + \delta_2 VSP_{t-1} + \beta_k POSV_{k,t-1} + \gamma_k NEGV_{k,t-1} + u_t \quad (3.8)$$

Non-linearity in this model is introduced by including the POS and NEG variables where POS is increase in variable as partial sum of positive changes and NEG is decrease in variable as partial

sum of negative changes. Shin *et al.* (2014) reasoned that POS and NEG should be treated as one variable and same values of bound test that were used to establish the cointegration in linear model should be applied, irrespective of one extra variable in non-linear ARDL.

Once error-correction model is estimated and cointegration is established, we will test for asymmetry. The short-run asymmetry will be established if the number of lags on ΔPOS variable is different from the number of lags on ΔNEG variable. Second, the short-run asymmetry effects of each macro variable and its volatility will be observed if the sign or value of coefficient estimate attached to ΔPOS_{t-i} and ΔNEG_{t-i} is different. Wald test will be used to test this asymmetry. Third, short-run cumulative or impact asymmetry effects of each macro variable and its volatility will be established. For this purpose, we will test the hypothesis to determine whether the sum of short-run coefficients estimates attached to ΔPOS_{t-i} and ΔNEG_{t-i}variables are statistically different or not by applying the Wald test. Finally, to check long-run asymmetry effect of each variable, we will test the long-run normalized coefficient estimates of POS and NEG are significantly different, if it is not statically different it means the variable has symmetric effect on stock return. Again, for this purpose, Wald test is be used to test the asymmetry which follows χ^2 distribution with one degree of freedom.

3.2 Source of Data

The monthly data for macroeconomic variables from Jan 1997 to Dec 2016 are collected from State Bank of Pakistan Publications and International Financial Statistics (IFS). Stock price data is collected from the website of Pakistan Stock Market.

Table 3. 1 Data Description

Sr. No.	Variables	Symbol	Definition/Construction	Source
1	Interest Rate	IR	Call money rate is used as a proxy of interest rate.	IFS
2	Consumer Price Index	CP	Consumer price index 2010=100 is used for price level.	IFS
3	Exchange Rate	EX	PKR/USD Exchange rate is used.	IFS
4	Money Supply	MS	Broad Money M2 is used as money supply of Pakistan.	SBP
5	Output	IP	Industrial production index is used as proxy of monthly output	IFS
6	Stock Price	SP	KSE100 index is used for stock prices.	PSX

Chapter 4

Empirical Results and Discussion

4.1 Introduction

This chapter reveals information about analysis with testing the properties of time series. The steps mentioned in previous chapter have been followed in this chapter by splitting them into two parts i.e. analysis on return series and analysis on volatility series.

4.1.1 Analysis on Return Series

The descriptive statistics, unit root test and estimated results for stock prices (SP) and macroeconomic variables i.e. interest rate (IR), consumer price index (CP), exchange rate (EX), money supply (M2) and industrial production index (IP) are reported below.

Descriptive Statistics

The descriptive statistics of interest rate and log of each other variable is given below in Table 4.1. The statistics in table show some indication about stock prices and macroeconomic variables.

Table 4. 1 Descriptive Statistics

	SP	IR	CP	EX	MS	IP
Mean	3.81	0.88	1.85	1.83	3.54	1.91
Median	3.96	0.95	1.79	1.78	3.56	1.98
Maximum	4.67	1.30	2.18	2.03	4.11	2.08
Minimum	2.92	-0.13	1.55	1.60	2.99	1.65
Std. Dev.	0.49	0.24	0.21	0.12	0.33	0.14
CV	12.86	27.27	11.35	6.55	9.32	7.32
Kurtosis	1.78	6.47	1.51	1.82	1.68	1.66
Jarque-Bera	16.5	242.3	25.05	13.94	17.28	28.15
Probability (JB)	0.00	0.00	0.00	0.00	0.00	0.00

Mean is positive for all variables because they show increasing trend over time. Series of stock prices have highest standard deviation among all which implies that stock price are more volatile than macroeconomic variables, but standard deviation is not relative statistic so, we can not rely on this. Instead of standard deviation, coefficient of variation (CV) in percentage is used to examine the volatile behavior of variable. It seems that exchange rate is least volatile, and interest is most volatile variable.

Excess kurtosis is statistically significant and positive for interest rate which indicates that monthly series of interest rate is heavy tailed and have leptokurtic distribution. JB test is used to indicate the distribution of each series. Null hypothesis of JB test is “series is normal”. P-value of JB test for each series is less than 5% (rejection of null) which indicates that data series are not normal.

Unit Root Test

In our study, we used ARDL bound test to estimate long run relationship between variables. It is the requirement of said test that series can be integrated of order zero or one i.e. I(0) or I(1) but not integrated of order two I(2). Moreover, Pesaran *et al.* (2001) has given tables of critical values for bound test with assumption that the dependent variable is I(1). Therefore, to make sure that none of the variables are I(2) and dependent variables is I(1), augmented Dickey-Fuller (ADF) test is employed. Regression model with trend and drift for ADF test can be written as:

$$\Delta Y_t = \alpha + \beta t + \rho Y_{t-1} + \sum_{i=1}^{l} \Delta Y_{t-i} + \varepsilon_t \qquad (4.1)$$

For above equation, we test for the significance of ρ using following hypothesis:

$$H_o: \ \rho = 0$$

$$H_a: \ \rho < 0$$

ADF test result of each series at level and 1st difference at 5% level of significance is given in Table 4.2 and Table 4.3 respectively.

Table 4. 2 Unit Root Test (At Level)

Variable	ADF Test Statistic	Critical Value	Decision
IR	-0.95	-1.94	Non-Stationary
CP	-1.87	-3.42	Non-Stationary
EX	-1.26	-2.87	Non-Stationary
MS	-0.93	-2.87	Non-Stationary
IP	-1.59	-2.87	Non-Stationary
SP	-2.14	-3.42	Non-Stationary

Table 4. 3 Unit Root Test (At 1st Difference)

Variable	ADF Test Statistic	Critical Value	Decision
IR	-16.8	-1.94	Stationary
CP	-3.78	-1.94	Stationary
EX	-8.84	-1.94	Stationary
MS	-3.00	-2.87	Stationary
IP	-2.40	-1.94	Stationary
SP	-14.8	-1.94	Stationary

Results of ADF test reveal that each series is non-stationary at level while they become stationary when we take 1st difference. So, we can say that each series is I(1) and it is safe to employ ARDL bound test approach.

Linear ARDL Bound Test

Although main motive of the study is to test the assumption of symmetry in case of Pakistan by employing non-linear ARDL bound test, we have also estimated linear ARDL model for comparison. Schwarz Information Criterion (SIC) is used for selection of optimum lag because Akaike Information Criterion (AIC) is considered as inconsistent when $T \to \infty$ and this problem seems to be overcome by SIC which is recommended for large sample instead of AIC (Charemza & Deadman, 1997). Maximum of two lag are used on each 1st differenced variable by Schwarz Information Criterion (SIC). Then parsimonious model is selected via general to specific methodology which is presented in Table 4.4.

Table 4. 4 Linear ARDL Model

Variable	Coefficient	Std. Error	Prob.
C	-0.09	0.08	0.24
$\Delta \mathrm{IR}_t$	-0.03	0.01	0.03
$\Delta \mathrm{CP}_t$	0.31	0.79	0.69
$\Delta \mathrm{CP}_{t-1}$	-0.54	0.78	0.48
$\Delta \mathrm{CP}_{t-2}$	-1.61	0.78	0.04
$\Delta \mathrm{EX}_t$	-0.53	0.34	0.12
$\Delta \mathrm{MS}_t$	0.06	0.36	0.86
$\Delta \mathrm{IP}_t$	1.98	0.79	0.01
SP_{t-1}	-0.11	0.03	0.00
IR_{t-1}	-0.01	0.01	0.17
CP_{t-1}	-0.06	0.15	0.68
EX_{t-1}	-0.20	0.10	0.06
MS_{t-1}	0.24	0.15	0.10
IP_{t-1}	0.08	0.13	0.53
$\boldsymbol{R^2}$	**0.15**	$\boldsymbol{\chi^2_{SC}}$	**11.02 [0.52]**
$\boldsymbol{F_{PSS}}$	**2.91**	$\boldsymbol{\chi^2_H}$	**11.62 [0.47]**

In Table 4.4, χ^2_{SC}, χ^2_H and F_{PSS} denote LM tests for serial correlation, heteroscedasticity and PSS F-statistics testing the null hypothesis of "No Cointegration" respectively. Figures in square parentheses represents associated p-values. P-values of autocorrelation test and heteroscedasticity test is greater than 5% which implies that there is no issue of autocorrelation and heteroscedasticity.

Moreover, value R^2 is 15% because in this study time series data is used for analysis and whenever time series data is used it is normal to get low value of R^2.

Pesaran *et al.* (2001) tabulated the 5% critical values for $k = 5$ which are $F_{crit} at\ I(0) = 2.62$ and $F_{crit} at\ I(1) = 3.79$ while calculated value of F-statistics (F_{PSS}) is less than $F_{crit} at\ I(1)$and greater than $F_{crit} at\ I(0)$. Therefore, there is no conclusive evidence of linear relationship between stock prices and macroeconomic variables.

Non-Linear ARDL Bound Test

To test the assumption of symmetry, we employed non-linear ARDL bound test. Non-linearity in ARDL model is introduced by including the POS and NEG series created from partial sum concept. Differenced series for each macroeconomic variable is decomposed into its positive and negative changes. Two new time series for each macro variable is generated. One representing increase in variable as partial sum of positive changes and other measuring decreased in variable as partial sum of negative changes. Instead of original series, decomposed positive and negative series are used in ARDL model and following model is estimated:

$$\Delta Y_t = \delta_0 + \sum_{i=1}^{l} \alpha_i \Delta Y_{t-1} + \sum_{i=0}^{m} \omega_{k,i} \Delta X_{k,t-i}^{+} + \sum_{i=0}^{n} \vartheta_{k,i} \Delta X_{k,t-i}^{-} + \delta_1 Y_{t-1} + \tau_k X_{k,t-1}^{+} + \theta_k X_{k,t-i}^{-} + u_t \quad (4.3)$$

Where Y_t, $X_{k,t}^{-}$and $X_{k,t}^{+}$ represent the stock prices, negative and positive series of each macroeconomic variable respectively. Again, SIC is used for optimal lag selection (one lag) and general to specific methodology is used to find parsimonious model. Results of non-linear ARDL (NARDL) is given in Table 4.5.

Table 4. 5 Non-Linear ARDL Model

Variable	Coefficient	Std. Error	Prob.
C	0.45	0.10	0.00
ΔIR_t^-	-0.009	0.03	0.78
ΔIR_t^+	-0.09	0.03	0.01
ΔIR_{t-1}^+	-0.007	0.03	0.80
ΔIR_{t-2}^+	-0.06	0.02	0.03
ΔCP_t^-	1.19	3.24	0.71
ΔCP_t^+	0.26	1.09	0.80
ΔEX_t^-	-1.78	0.95	0.06
ΔEX_t^+	-0.68	0.40	0.09
ΔMS_t^-	-0.09	1.26	0.94
ΔMS_t^+	0.09	0.46	0.84
ΔIP_t^-	0.89	1.81	0.62
ΔIP_t^+	2.93	1.29	0.02
SP_{t-1}	-0.15	0.035	0.00
IR_{t-1}^-	-0.04	0.02	0.05
IR_{t-1}^+	-0.02	0.02	0.25
CP_{t-1}^-	-1.44	1.56	0.35
CP_{t-1}^+	0.17	0.23	0.47
EX_{t-1}^-	-0.02	0.42	0.95
EX_{t-1}^+	-0.50	0.15	0.00
MS_{t-1}^-	-0.10	0.73	0.89
MS_{t-1}^+	0.23	0.27	0.39
IP_{t-1}^-	0.56	0.45	0.21
IP_{t-1}^+	-0.21	0.28	0.44
$\boldsymbol{R^2}$	**0.20**	$\boldsymbol{\chi^2_{SC}}$	**13.1 [0.35]**
$\boldsymbol{F_{PSS}}$	**2.86**	$\boldsymbol{\chi^2_H}$	**13.4 [0.34]**

High p-value of $\boldsymbol{\chi^2_{SC}}$ and $\boldsymbol{\chi^2_H}$ implies that there is no problem of serial autocorrelation and heteroscedasticity. In case of long run relationship between stock prices and five macroeconomic

variables (decomposed into ten partial sum positive and negative changes), true value of "k" lies between 5 and 10. But, test will be undersized when $k = 5$ and oversized when $k = 10$. By employing $k = 5$ critical values, it will give us more conservative test (Shin *et al.*,2014). Therefore, at pragmatic level, rejection of H_0 of no long run relationship at $k = 5$ critical values will evident that there exist sure and strong long run relationship between variables.

Results shows that calculated value of $F_{PSS} = 2.86$ lies between upper and lower critical values i.e. $F_{crit} at\ I(0) = 2.62$ and $F_{crit} at\ I(1) = 3.79$ which implies that cointegration between variables might exist (inconclusive evidence). Kremers *et al.* (1992) argued that negative and significant coefficient of lagged ECM term supports the adjustment towards the long run equilibrium which is another indication of cointegration. Following this argument, lagged ECM term is generated from normalized long run coefficient of NARDL model. Lagged variables are replaced by ECM term and new model is estimated at same optimal lag.

Table 4. 6 Error Correction Model

Variable	Coefficient	Std. Error	Prob.
C	0.45	0.07	0.00
ΔIR_t^-	-0.009	0.03	0.76
ΔIR_t^+	-0.09	0.02	0.00
ΔIR_{t-1}^+	-0.007	0.02	0.78
ΔIR_{t-2}^+	-0.06	0.02	0.02
ΔCP_t^-	1.19	2.98	0.68
ΔCP_t^+	0.26	0.92	0.77
ΔEX_t^-	-1.78	0.87	0.04
ΔEX_t^+	-0.68	0.37	0.06
ΔMS_t^-	-0.09	1.10	0.93
ΔMS_t^+	0.09	0.44	0.83
ΔIP_t^-	0.89	1.61	0.57
ΔIP_t^+	2.93	1.03	0.00
ECM_{t-1}	-0.15	0.02	0.00

In above table, negative and significant lagged term of ECM shows that there exists long run relationship between stock prices and macroeconomic variables and speed of adjustment is 15%.

As shown in above table, number of lags of positive series of interest rate is different from the lags of negative series of interest rate, it implies that the interest rate has asymmetric effect on stock prices in short run. Moreover, sign of coefficient of short run negative series of money supply is

different from sign of positive series of money supply. To confirm this asymmetry, Wald-coefficient test is applied on short run coefficient of each variable i.e. the sum of coefficients attached to positive variable is significantly different from the sum of coefficients attached to negative variable, mathematically:

$$H_0: \quad \sum \omega_{k,i} = \sum \vartheta_{k,i}$$

$$H_a: \quad \sum \omega_{k,i} \neq \sum \vartheta_{k,i}$$

Test results are given in Table 4.7.

Table 4. 7 Short Run Asymmetry (Wald Test)

Variable	F-Stat	Decision
IR	4.56 [0.03]	Asymmetric
CP	0.05 [0.80]	Symmetric
EX	1.03 [0.30]	Symmetric
MS	0.01 [0.90]	Symmetric
IP	0.60 [0.43]	Symmetric

Wald test result for asymmetry confirms that interest rate has asymmetric effect on stock prices in short run while all other variables (consumer price index, exchange rate, money supply and industrial production index) have symmetric impact of stock prices. To see how many of these variables show long run asymmetric impact on stock prices, we applied Wald coefficient test on long run normalized coefficient of each variable from equation (4.3).

$$H_0: \ {\widehat{\tau_k}}/{-\widehat{\delta_1}} = {\widehat{\theta_k}}/{-\widehat{\delta_1}}$$

$$H_a: \ {\widehat{\tau_k}}/{-\widehat{\delta_1}} \neq {\widehat{\theta_k}}/{-\widehat{\delta_1}}$$

Results are shown in Table 4.8.

Table 4. 8 Long Run Asymmetry (Wald Test)

Variable	F-Stat	Decision
IR	25.5 [0.00]	Asymmetric
CP	0.88 [0.34]	Symmetric
EX	1.20 [0.27]	Symmetric
MS	0.23 [0.62]	Symmetric
IP	3.06 [0.08]	Asymmetric

From above results, it is evident that interest rate has negative relation with stock prices and there is asymmetric effect of changes in interest rate on stock prices in long run as well as short run. This asymmetry in interest rate implies that stock prices incorporates the increase in interest rate faster than the decrease in interest rate. These results are consistent with the conclusion of Lobo (2000). Moreover, industrial production index shows asymmetric effect on stock prices in short run at 10% level of significance

4.1.2 Analysis on Volatility series

To estimate variation from monthly data, method introduced by Schwert (1989) is used which is generalization of the 12-month rolling standard deviation estimator used by Officer (1973). This method is almost same as Autoregressive Conditional Heteroskedasticity (ARCH) model of Engle

(1982). First, we estimated AR(12) model for each variables using equation (3.1) to obtain errors. Then, AR(12) model for absolute values of errors is estimated from equation (3.2). The fitted values from equation $|\hat{\varepsilon}_t|$ is estimated the conditional standard deviation of variable, given information available before month t. The unit root tests and estimated results for stock prices volatility and volatility of macroeconomic variables (interest rate, consumer price index, exchange rate money supply and industrial production index) are reported below.

Unit Root Test

Again, to make sure that none of the variables are I(2) and dependent variables is I(1), augmented dickey fuller (ADF) test is employed. ADF test result of each series at level and 1st difference at 5% level of significance is given in Table 4.9 and Table 4.10 respectively.

Table 4. 9 Unit Root Test (At Level)

Variable	ADF Test Statistic	Critical Value	Decision
VIR	-1.25	-1.94	Non-Stationary
VCP	-0.61	-1.94	Non-Stationary
VEX	-0.61	-1.94	Non-Stationary
VMS	-0.13	-1.94	Non-Stationary
VIP	-0.30	-1.94	Non-Stationary
VSP	-1.49	-1.94	Non-Stationary

Table 4. 10 Unit Root Test (At 1st Difference)

Variable	ADF Test Statistic	Critical Value	Decision
VIR	-4.70	-1.94	Stationary
VCP	-6.88	-1.94	Stationary
VEX	-5.94	-1.94	Stationary
VMS	-7.14	-1.94	Stationary
VIP	-8.82	-1.94	Stationary
VSP	-5.39	-1.94	Stationary

where

VIR= Volatility of Interest Rate

VCP= Volatility of Consumer Price Index

VEX= Volatility of Exchange Rate

VMS= Volatility of Money Supply

VIP= Volatility of Industrial Production Index

VSP= Volatility of Stock Prices

Results of ADF test of volatility series of each variable reveals that each series is non-stationary at level while they become stationary when we take 1st difference. So, we can apply Linear and Non-Linear ARDL bound test.

Linear ARDL Bound Test

Officer (1973) and Schwert (1989) relate the movement of stock market volatility to volatility of macroeconomic variables. To examine the linear relation of stock market volatility with macroeconomic volatility, linear ARDL model is established by using equation (3.4). Again, Schwarz Information Criterion (SIC) is used for selection of optimum lag. Maximum of twelve lags are imposed on each 1st differenced variable by Schwarz Information Criterion (SIC). Then parsimonious model is selected via general to specific methodology which is reported below in Table 4.11

Table 4. 11 Linear ARDL Model

Variable	Coefficient	Standard Error	Prob.
C	0.01	0.01	0.29
ΔVSP_{t-1}	-0.53	0.12	0.00
ΔVSP_{t-2}	-0.53	0.12	0.00
ΔVSP_{t-3}	-0.56	0.12	0.00
ΔVSP_{t-4}	-0.53	0.12	0.00
ΔVSP_{t-5}	-0.41	0.11	0.00
ΔVSP_{t-6}	-0.22	0.09	0.02
ΔVSP_{t-7}	-0.21	0.08	0.01
ΔVSP_{t-8}	-0.04	0.06	0.43
ΔVIR_t	0.01	.004	0.00
ΔVCP_t	1.64	1.06	0.12
ΔVCP_{t-1}	-2.66	1.07	0.01
ΔVEX_t	1.13	0.38	0.00
ΔVEX_{t-1}	-0.20	0.53	0.69
ΔVEX_{t-2}	1.58	0.40	0.00
ΔVEX_{t-3}	0.72	0.36	0.04
ΔVMS_t	-1.64	0.34	0.00
ΔVIP_t	-1.47	5.22	0.77
ΔVIP_{t-1}	-12.5	5.17	0.01
VSP_{t-1}	-0.33	0.12	0.00
VIR_{t-1}	.009	.003	0.00
VCP_{t-1}	2.54	1.71	0.13
VEX_{t-1}	0.19	0.66	0.77
VMS_{t-1}	-1.45	0.41	0.00
VIP_{t-1}	-2.43	4.41	0.58
$\boldsymbol{R^2}$	**0.78**	$\boldsymbol{\chi^2_{SC}}$	**20.28 [0.06]**
$\boldsymbol{F_{PSS}}$	**5.86**	$\boldsymbol{\chi^2_H}$	**7.85 [0.79]**

P-values of autocorrelation test (χ^2_{SC}) and heteroscedasticity test (χ^2_H) is greater than 5% which implies that there is no problem of autocorrelation and heteroscedasticity. Critical values for $k = 5$ are $F_{crit} at\ I(0) = 2.62$ and $F_{crit} at\ I(1) = 3.79$ while calculated value of F-statistics (F_{PSS}) is far greater than $F_{crit} at\ I(1)$and $F_{crit} at\ I(0)$. Therefore, there is strong evidence of long run linear relationship between stock prices volatility and volatility of macroeconomic variables and model shows strong convergence towards equilibrium with convergence speed of 33%. Volatility of interest has positive and strongly related to volatility of stock prices. It implies that whenever there is increase in uncertainty of interest rate, it will also increase stock price volatility. Volatilities of consumer price index and exchange rate show positive while industrial production index has negative and insignificant relationship with stock price volatility. Whereas, money supply fluctuations have negative and significant impact on stock prices uncertainty.

Non-Linear ARDL Bound Test

In literature, researcher assumed that movement of stock price volatility is related to movement of volatility of macroeconomic indicators symmetrically (Officer, 1973; Schwert, 1989; Chiang and Chiang, 1996; Liljeblom and Stenius, 1997; Kearney and Daly, 1998; Morelli, 2002; Beltratti and Monara, 2006). To test this assumption, Non-Linear ARDL bound test is used. SIC is used for optimal lag selection and general to specific methodology is used to find parsimonious model. Results of non-linear ARDL (NARDL) is given below in Table 4.12.

Table 4. 12 Non-Linear ARDL Model

Variable	Coefficient	Standard Error	Prob.
C	0.07	0.01	0.00
ΔVIR_t^-	0.01	0.01	0.13
ΔVIR_t^+	0.02	0.01	0.02
ΔVCP_t^-	0.90	1.64	0.58
ΔVCP_t^+	1.79	1.60	0.26
ΔVEX_t^-	-1.08	0.63	0.08
ΔVEX_{t-1}^-	-1.85	0.38	0.00
ΔVEX_t^+	2.15	0.51	0.00
ΔVEX_{t-1}^+	-2.23	0.66	0.00
ΔVMS_t^-	0.34	0.71	0.62
ΔVMS_t^+	-2.26	0.44	0.00
ΔVIP_t^-	7.02	9.13	0.44
ΔVIP_t^+	7.56	8.36	0.36
VSP_{t-1}	-0.83	0.06	0.00
VIR_{t-1}^-	0.01	0.01	0.47
VIR_{t-1}^+	0.01	0.01	0.38
VCP_{t-1}^-	-1.47	1.58	0.35
VCP_{t-1}^+	-1.41	1.57	0.36
VEX_{t-1}^-	1.37	0.76	0.07
VEX_{t-1}^+	1.02	0.75	0.17
VMS_{t-1}^-	-0.14	0.66	0.83
VMS_{t-1}^+	-0.20	0.61	0.74
VIP_{t-1}^-	-8.20	6.46	0.20
VIP_{t-1}^+	-3.67	6.70	0.58
$\boldsymbol{R^2}$	**0.82**	$\boldsymbol{\chi^2_{SC}}$	**5.00 [0.09]**
$\boldsymbol{F_{PSS}}$	**17.2**	$\boldsymbol{\chi^2_H}$	**19.1 [0.09]**

Diagnostic tests show that there is no problem of autocorrelation or heteroskedasticity. Shin *et al.* (2014) reasoned that same critical values should be used to test non-linear long run relationship which were used to test the linear relationship. Therefore, at $k = 5$, critical values are $F_{crit}\ at\ I(0) = 2.62$ and $F_{crit}\ at\ I(1) = 3.79$ and $F_{PSS} = 17.2$ which is far greater than upper bound. Therefore, there exist strong long run relationship between variables.

We can see that sign of differenced positive variable of exchange rate is different from negative component of changes in exchange rate. Similarly, in case of money supply, sign and magnitude of differenced positive variable of money supply is not same as negative partial sum of volatility of money supply which indicates the short run asymmetry in both variables. To validate this, we have employed Wald test. Test results are shown in Table 4.13.

Table 4. 13 Short Run Asymmetry (Wald Test)

Variable	F-Stat	Decision
VIR	0.54 [0.46]	Symmetric
VCP	0.13 [0.72]	Symmetric
VEX	6.41 [0.01]	Asymmetric
VMS	9.98 [0.00]	Asymmetric
VIP	0.01 [0.93]	Symmetric

Test results show that in short run impact of volatilities of exchange rate and money supply on volatility of stock prices is not symmetric which implies that in case of exchange rate, amount of increase in stock price due to depreciation of currency does not match the amount of decrease in stock prices when there is appreciation of currency. Similarly, in short run, increase and decrease in volatility of money supply does not have similar effect on stock volatility.

In order to check that whether this short run asymmetry covert into long run asymmetry or not, we applied Wald test on long run coefficients of non-linear ARDL model. Test results are given in Table 4.14.

Table 4. 14 Long Run Asymmetry (Wald Test)

Variable	F-Stat	Decision
VIR	0.07 [0.78]	Symmetric
VCP	0.04 [0.84]	Symmetric
VEX	3.99 [0.04]	Asymmetric
VMS	0.21 [0.64]	Symmetric
VIP	2.97 [0.08]	Asymmetric

Wald test result confirms that exchange rate volatility does not have symmetric impact on stock volatility in long run. But in case of money supply, assumption of symmetry holds. Additionally, in long run, there is also asymmetric relation between industrial production index volatility and stock volatility, but relation is insignificant.

Chapter 5

Conclusion and Policy Recommendation

5.1 Conclusion

Arbitrage Pricing Theory (APT) suggests that there is linear relationship between stock returns and macroeconomic variables. There exists voluminous literature that have examined this linear relationship with the assumption of symmetric relationship between variables. But, this assumption might not true always because the impact of "good news" and "bad news" might not be same.

In this study, we have employed non-linear ARDL approach to test the asymmetry between stock return and macroeconomic variables in case of Pakistan. Moreover, following the work of Officer (1973) and Schwert (1989), we have also examined the asymmetry between volatility of stock return and volatilities of macroeconomic variables. For this analysis, five most important macroeconomic variables are selected namely interest rate, consumer price index, exchange rate, money supply, and output.

The discounted price model suggests that there should be negative relation between interest rate and stock returns. Results confirm the negative relationship between stock return and interest rate but also show that there is asymmetric effect of interest rate on stock return in long run as well as in short run. The negative changes in interest rate affects more the stock market than positive changes in interest rate. It implies that increases in stock return of market due to decrease in interest rate is not same in magnitude as decrease in stock return due to increase in interest rate. It supports the view that investors have higher risk aversion to downside risk and then react faster to decrease in interest rate. Additionally, output also have asymmetric but insignificant effect on stock return.

While, study results show that assumption of symmetry holds in case of exchange rate, consumer price index and money supply in long run as well as in short run.

In case of volatility analysis, generalized 12-month rolling standard deviation method, suggested by Schwert (1989), is used to estimate the volatility of each variable. Then these estimated volatilities of all variables are used to examine the linear as well as non-linear relationship between variables.

In case of exchange rate volatility, results show that exchange rate volatility creates excess volatility in asset prices, but this relationship is found insignificant. When non-linear ARDL model is estimated, relationship becomes significant at 10% level of significance. Moreover, we found that volatility of exchange rate has asymmetric affect on stock return volatility in short run and long run. It suggests that increase in volatility of asset prices due to increase in exchange rate volatility is not same in magnitude as decrease volatility of asset prices due to decrease in currency volatility. In long run, negative change in volatility of exchange rate have greater impact on volatility of stock return as compared to the positive change in volatility of exchange rate. Moreover, volatility of output also has asymmetric effect on stock volatility at 10% level of significance. While volatilities of all other variables have symmetric impact on asset price volatility.

5.2 Policy Recommendation

Finding of our study have some policy implication that could give valuable information for policy making and management purposes. The results of study suggest that the impact of interest rate on stock market of Pakistan is not symmetric in long run as well as in short run. Additionally, volatility in money supply also have asymmetric impact on stock volatility in short run. Therefore, policy maker, while making policy, should understand that the stock market does not respond to increase and decrease in interest rate symmetrically. This consideration will help them to design better policy as the decrease in interest rate will have bigger effect on market than increase in interest rate. Likewise, investors should also consider the asymmetric behavior of interest rate toward stock market and should adjust their investment portfolios according to announcement of monetary policy to maximize their profits.

Moreover, study found relationship between exchange rate and stock market is negative which implies that most of the firms trading in Pakistan Stock Exchange are import oriented. Subsequently, uncertainty in exchange rate will seriously affects the firm's position. Also, stock market volatility is affected by volatility of exchange rate asymmetrically. Therefore, it is recommended that stabilization policy should be put in place keeping in view of asymmetric behavior to strengthen the local currency.

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