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An Application of GARCH while investigating volatility in stock returns of the World

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ABSTRACT

A healthy stock market is a sign of sound and healthy economy. Stock market is a volatile market affected, at times directly and most often indirectly, by many micro and macroeconomic players. Of these players interest rates and exchange rates are among the ones undertaken in this study. The rationale behind this study is to ascertain the volatility in stock returns of various stock exchanges in relevance to interest rates and exchange rates over a range of 8 countries for assorted periods. GARCH (1, 1) was deployed for investigating the possible eventualities of volatilities of stock markets. The findings were found varying for Pakistan, India, Hong Kong, Japan, United States, United Kingdom, Spain and Germany. Moreover, almost for all countries GARCH (1, 1) yielded significant results confirming the existence of volatility of stock markets for the current period of outlined countries due to volatility of those stock markets during the previous lags. The findings may help investors know the stock markets' trends which are also for some cases (nations) affected by interest rates and/or exchange rates and thus to invest accordingly.

Keywords: ARCH, GARCH, Volatility, AR-Process, Conditional Hetroskedecity.

JEL Classification: B23, R53

Introduction

A healthy stock market is a sign of sound and healthy economy. Stock market is a volatile market affected directly and indirectly by many micro and macro economic variables in the economy. Of these factors the interest rates and exchange rates are some of the most important ones.

Interest rate is essentially the price of using money. A change in monetary policy leading to a change in interest rate effects the stock market returns. When state bank increases the interest rates, the cost of borrowing goes up. Individuals and business are both affected by this. For individuals it becomes expensive to borrow money. Credit card charges, utility bills everything goes up leaving individuals with less disposable income to invest. High interest rates cause people to keep money in saving accounts to earn interest rather than investing in stock market which is deemed highly risky. When individuals invest less, generally the businesses will be affected. On the other hand Businesses are also directly affected by changes in interest rates. Businesses may borrow less due to high financial charges and thus might have less money to invest in the growth of the company leading to lower profits. When a company cuts back on growth or makes lower profits, the anticipated outlook of cash flow drops. Everything else remaining constant, it decreases the price of the company's stock. If many companies experience the same trend in decline of stock prices, the entire market or index will fall. For investors, a declination of market or stock price is not an attractive outcome. When state bank raises the interest rates, risk-free rate rises and newly extended government securities such as t-bills and bonds become more desirable (Corsetti, Meier, & Müller, 2009).

On the other hand, exchange rate is the worth of one country's currency relative to another currency (O'Sullivan & Sheffrin, 2003). Over the time, impact of exchange rate on stock returns has been significant, due to the introduction of supple exchange rates in the 70s and also due to the integration of world financial markets.

This research suggested to investigate the existence of volatility in stock returns due to variation in interest rates and exchange rates of various countries such as Pakistan, India, Hong Kong, Japan, Spain, Germany, UK and US. Previous researches have shown volatility in stock market to be driven by macroeconomic essentials (Fama, 1981). Earlier researches have mainly focused on a single country, sector or a group of micro/macro economic variables (Choi, Elyasiani, & Kopecky, 1992; Joseph & Vezos, 2006; Liow, Ibrahim, & Huang, 2006). This research concentrates on the study of entire stock exchanges instead of a few sectors or companies. In this research, the econometrical technique used to study the presence of volatility in non stationary time series data is GARCH (1, 1). The study will help investors know the stock markets' trends and how they are affected by interest rates and/or exchange rates and thus to invest accordingly.

Literature Review

Interest Rate

Joseph and Vezos (2006) on their study on US banks' stocks have found coefficient of interest rate to be varying and reflecting extent of exposure to interest-rate-related debts. Wetmore and Brick (1994) have also noted declining impact of varying interest rates on bank stock returns.

Ferrer , Gonza'lez, and Soto (2010) studied linear and non-linear exposure of interest rate on different Spanish industries and found that interest rate exposure is heterogeneous with magnitude differing significantly across sectors. Also linear contour was found reasonably more significant than non linear one. It was found that some industries like banking, real estate and construction, electrical and utilities were more prone to interest rate risk as was also verified by substantial investigation in other countries. The negative sign of exposure indicated that interest rate sensitive industries gained from decreasing interest rates. In Spain, during the pre-euro period, construction and real estate were highly interest rate sensitive while banking industry showed evidence of positive and significant exposure to varying short-term and long-term rates. With the introduction of Euro, there was a significant decrease in the extent of interest rate exposure for most of the industries.

Hussainey and Ngoc (2009) initiated that short term as well as long term interest rates did not affect stock prices in the similar way in Vietnam Stock Exchange.

Impact of significant interest rate risk has been observed by Hyde (2007) in industries of France and Germany. Unexpected variation in market excess returns, real interest rates and exchange rate changes contain considerable information pertaining to potential excess returns, potential real interest rates and potential cash flows. Unexpected variation in real interest rates owes more to amendments in prospects of future excess returns than to news concerning future dividends.

Liu and Shrestha (2008) found interest rates and currency values negatively associated to stock prices in Chinese stock market. Even though the stock market is governed by speculation and short-term volatility, it does respond to variation in macro-economic variables in the long run.

Pal and Mittal (2011) found interest rates to have had considerable impact on S&P CNX Nifty whereas no significant impact was found of interest rates on BSE Sensex. The study was supported by Ahmed (2008) that stock market was not affected by just few but rather many other macroeconomic variables affect the Indian capital market.

Coleman and Tettey (2008) found treasury bill rate to have had positive but statistically feeble impact on performance of Ghana Stock exchange. Though lending rate had a significant impact on the performance of the exchange but high lending rate negatively impacted businesses in Ghana. Adjasi (2009) on a similar study found that amplified uncertainty in interest rates increased the volatility on the GSE (Ghana Stock Exchange).

Wickremasinghe (2011) on his study on SriLankan economy observed bidirectional causal relationship between 3 month FDR and ASPI (All Share Price Index). Stock prices were found to be predictable using macroeconomic variables. At longer horizons, M1 played an important role in highlighting the forecast variance in stock return. Negative response was observed from ASPI at all horizons under study when shocks were given to equation of M1.

Exchange Rate

Joseph and Vezos (2006) on their study on the understanding of stock returns to exchange rates in US banks and found strong deviation in FX rate sensitivity by financial division of banks. According to results found, coefficients of FX rate sensitivity were characteristically positive for both OLS and EGARCH. The impact of FX rates was not prominent regardless of employing high frequency data.

Liow, Ibrahim, and Huang (2006) observed the association among the anticipated risk on property stocks and several key macroeconomic risk aspects in markets of Singapore, Japan, Hong Kong and UK. Even though it's well known that property takings respond to variation in macroeconomic variables, any distinct forecasting of the association among anticipated risk on property assets and key macroeconomic variables was found complexed.

El-Masry (2006) investigated the outcome of FX rate exposure on stock returns of UK industries and found that a greater proportion of considerable FX rate exposure is accredited for the trade-weighted nominal exchange rate. The results also offer a greater support for real and trade weighted nominal exchange rates affecting industries' stock returns. Moreover his work also highlighted that a greater fraction of industries gain with the appreciation of pound.

Hyde (2007) investigation on stock returns of 33 industry portfolios in France, Germany, Italy and UK yielded significant results of the existence of exchange rate exposure. The study was supported by previous literature with the difference that industry portfolios of Germany were found more sensitive to variation in exchange rates than formerly acknowledged. While industries in all four countries studied faced significant exchange rate risk, it also showed that though exchange rate exposure was apparently insignificant, its effect on expectations concerning excess returns, real interest rates and future dividends was significant.

Liu and Shrestha (2008) observed existence of a durable association among Chinese stock market and macro economic variables. A negative and inverse relationship was observed between currency value and stock prices. Though stock market was observed risky in the short run, outcomes proved that economic rudiments prevail in the long run. Regardless of short term unpredictability, as Chinese market has a negative association with USA and other developed markets, it can offer shareholders with variegation and superior long-term returns.

Pal and Mittal (2011) studied the effect of macroeconomic pointers on Indian Capital markets and established that FX rates have no considerable effect on S&P CNX Nifty but it does significantly impact BSE Sensex. The results were supported by a similar study by Mohammad, Hussain, and Ali (2009) on Karachi Stock Exchange.

Coleman and Tettey (2008) experientially examined the effect of macroeconomic pointers on stock market conduct of Ghana Stock Exchange (GSE). It was observed that exchange rate losses did not affect the equities on the market, rather the shareholders benefited from the market as the cedi depreciated.

Tai (2010) found substantial support for time-change foreign exchange risk premium in Japanese stock market. Though FX risk was not revealed to be determined in the unconditional two-factor model, analysis of conditional asset pricing model using MGARCH-M access yielded significant exchange rate betas. Industry returns and risk factors of first and second time were projected concurrently.

Wickremasinghe (2011) investigated the short and long-run association between the stock prices on Sri Lankan stock market and the macroeconomic variables. The results indicated that macroeconomic variables could predict stock prices in Sri Lanka. Bi directional causal relationship was observed between All Share Price Index (ASPI) and USD exchange rate. The stock prices were also found to clarify the projected variance in USD exchange rates.

Brooks, Iorio, Faff, Fry, and Joymungul (2010) undertook an analysis on FX rate exposure of Australian firms and found that a greater part of firms experienced affirmative FX rate exposure than negative one. The strongest degree of exposure was observed in the energy, materials and industrial sectors. Australian firms illustrated irregularity and time variation in exchange rate exposure with varying results in different sectors.

GARCH

Homoskedasticity is the square of the anticipated value of error term equals variance of all error terms taken collectively. While heteroskedasticity is the opposite; the anticipated value of error terms may not be equal to the variance of all error terms simultaneously (Engle, 1982).

Two models, ARCH (autoregressive conditional heteroskedasticity) and GARCH (Generalized autoregressive conditional heteroskedasticity) were established to manage with time series heteroskedasticity. Their purpose was to measure volatility, aiding financial decisions such as risk analysis, derivative pricing and portfolio selection (Engle, 1982).

If r_t is the independent variable i.e. the return on a portfolio or an asset, 'm' the mean value and 'h' the variance in relation to a preceding information set, the 'r', the return in present will be correspondent to the estimated value of r based on preceding information (mean of r) plus square root of variance (i.e. standard deviation of r) multiplied by the error term of the current period (Engle, 1982).

The GARCH (1, 1) model, established by Bollerslev (1986) as a simplification of Engle (1982) has proven rather successful in estimating conditional variances. The (1, 1) is a customary annotation where the first figure denotes the number of autoregressive lag appearing in the equation, whereas the second figure denotes the number of lags of a variable, incorporated in the moving average component. Thus a standard GARCH (1, 1) model for variance is:

$$h_t = \omega + \alpha h_{t-1}\varepsilon_{t-1}^2 + \beta h_{t-1}$$

The above model predicts the variance of current period t return as a weighted average of constant, previous period's forecast and previous period's squared error (Engle, 1982).

The GARCH models are provisionally heteroskedastic but generally encompass a constant unconditional variance. Also one of the most prominent aspects of the ARCH/GARCH model is the acknowledgement that volatility can be estimated using historical data (Engle, 1982).

According to Engle (1982), the GARCH (1, 1) is the most simplest of the volatility models. The model is modifiable. A GARCH (p, q) model is a generalized form of GARCH (1, 1) with added lag terms, used for longer spans of data (daily or hourly).

Various researchers have employed GARCH and its modifications in modeling financial time series data exhibiting time varying volatility, particularly on stock returns and various micro and macro economic variables.

Joseph and Vezos (2006) employed EGARCH and OLS estimation methods to evaluate US banks' stock returns volatility. While coefficients of FX rate sensitivity were characteristically positive for both models, the coefficients of interest rate sensitivity were found to be varying and reflecting extent of exposure to interest-rate-related debts.

Liow, Ibrahim, and Huang (2006) applied GARCH and GMM with results indicating that both the estimated risk and the conditional volatilities of risk for all 4 markets (Singapore, Japan, Hong Kong and UK) were time changing and vigorously associated to the conditional volatilities of the macroeconomic factors.

Adjasi (2009) employed EGARCH model to estimate the impact of macroeconomic uncertainty on stock prices on Ghana Stock Exchange (GSE). The results proved significant positive volatility spill outs from interest rate and cocoa prices to the stock prices on GSE.

Tai (2010) exploited the MGARCH-M model to approximate the asset pricing model. Using Japanese industry data he studied the links between stock returns and exchange rate changes. Substantial evidence was generated yielding significant exchange rate betas. Both first and second moments of risk factors and industry returns were projected concurrentl y.

Brooks, Iorio, Faff, Fry, and Joymungul (2010) employed the vector GARCH approach to observe the time change and asymmetric nature of Australian firms to exchange rate risk disclosure. Results indicated a larger portion of firms experiencing positive exchange rate disclosure than negative one.

Research Hypotheses

Based on the model GARCH (1, 1), the following hypotheses were created and studied for each country separately.

H_1: The volatility in stock returns for past period predicts the volatility in stock returns in the current period.

H_2: The heteroskedasticity in stock returns for past period predicts the volatility in stock returns in the current period.

H_3: FX acts as a catalyst while volatility in stock returns in X is predicted.

H_4: Interest rate acts as a catalyst while volatility in stock returns in X is predicted.

Replacing X, each of the above hypotheses was studied for Pakistan, India, Hong Kong, Japan, Spain (pre Euro), Spain (post Euro), Germany (pre Euro), Germany (post Euro), UK and US respectively.

Methodology

For each of the eight countries Pakistan, India, Hong Kong, Japan, Germany, Spain, US and UK, the variables taken for investigation were included the market index, interest rates (discount rates) and US dollar mutual exchange rate (denominated as the home currency per unit of US dollar). The data for market index was taken from Yahoo Finance while that for exchange rates and interest rates was taken from FRED Federal Reserve Economic Data/ IMF and also from Hong Kong Monetary Authority, Financial Markets Association of Pakistan and OANDA. The data frequency is monthly, ensuring an adequate number of observations. A lower frequency (e.g. quarterly or annually) never reveal an ample representation of volatility, while a higher frequency (e.g. daily) includes settlements and clearing delays thus gives an ample room for revealing volatility in stock returns (Baillie & DeGennaro, 1990; Elyasiani & Mansur, 1998). For Germany and Spain, the data was split into pre and post Euro and was analyzed accordingly. Moreover the exchange rate for US was taken as a broad index of currencies. The Major currency index included the Euro Area, Canada, Japan, United Kingdom, Switzerland, Australia, and Sweden.

The market indices selected for each country are: KSE-100 (Pakistan), SENSEX (India), HenSeng (Hong Kong), Nikkei-225 (Japan), DAX (Germany), IBEX 35 (Spain), FTSE 100 (UK) and Nasdaq (US).

The sample period for all countries varied according to data availability.

Table 1: Sample period for countries under study

Country	Sample Period	Observations
Pakistan	2001:07 to 2010:11	113
India	1997:07 to 2011:10	172
Hong Kong	1992:06 to 2011:11	234
Japan	1990:01 to 2011:11	263
Germany	1990:11 to 2011:11	253
Spain	1993:02 to 2011:11	226
UK	1990:01 to 2011:11	263
US	1990:01 to 2011:11	263

GARH (1, 1) was used to study the existence of volatility in stock returns in various stock exchanges of the World. The model enables estimation of conditional volatility by modeling jointly the stock returns, interest rates and exchange rates. GARCH (1, 1) was also applied by Low, Ibrahim, and Huang (2005) in their research. The model developed consists of three terms; (i) the mean, (ii) the ARCH term (lag of squared residuals) and (iii) the GARCH term (previous period's volatility). Both ARCH and GARCH coefficients should be positive. If coefficients are negative they indicate presence of leverage effects. The sum of the ARCH and GARCH coefficients determine the extent of perseverance in shocks to volatility. Persistence holds if the sum is less than or equal to unity. The mean and coefficients of ARCH and GARCH will be significant if $p < 0.05$ and model will be significant if $f > 3.84$.

Findings and Results

For Pakistan**,** the results show that 1 unit increase in FX will result in 53.58853 changes in stock return while 1 unit increase in Discount rate will result in 603.6259 change in stock return. Results show that even when FX and discount rates are zero, stock return is -3485.965. The p value of both the variables and constant is < 0.05 which shows that their results are significant. Due to drastic change in discount rates owing to stock market crash of 2007, 2 dummy variables were added to the data. The number 0 was assigned to months where the values were constant while 1 was assigned to change in FX or discount rate, whether positive or negative. From the table, the coefficient of GARCH is found significant while ARCH is found insignificant. The negative value of GARCH (-1) shows that volatility in lag1 would affect volatility for current lag in such a way that if volatility is less in lag1 it gets increased for current lag. As F is very small therefore, overall model is insignificant suggesting that model is not fit to explain the volatility.

Since the auto correlations is found positive which reflects hat previous observations positively affect current observations of stock return in the equity market of Pakistan.

Results show that for India, 1 unit increase in FX will result in -1362.765 changes in stock return and 1 unit increase in Discount rate will result in -3140.296 changes in stock return. Even when FX or discount rates are zero, stock return is 89642.17. The p value of both the variables and the constant is < 0.05 which shows that results are significant. ARCH and GARCH coefficients (1.24 and -0.37) are statistically significant. The sum of these coefficients is 0.87 pointed out that shocks to fickleness have a continual effect. The negative value of GARCH(-1) shows that volatility in lag1 would affect volatility for current lag in such a way that if volatility is less in lag1 it gets increased for current lag. Overall the model is significant as adjusted R^2 is 23.4% and F is 11.45 > 3.84. DW is 0.064 which shows that data has positive autocorrelation. This means that previous observations positively affect current observations of stock return.

Table 2: Estimation of GARCH and ARCH Terms

Country	Variance Equation			OLS			Adjusted R-Squared
	Constant	GARCH (-1)	RESID (-1)^2	Coefficient of FX	Coefficient of Discount rate	Constant	
	P-Value	P-Value	P-Value	P-Value	P-Value	P-Value	F statistic
Pakistan	761413	0.733	1.081	53.589	603.626	-3485.965	0.006
	0.026	0.002	0.065	0.007	0.013	0.013	0.902
India	5858714	-0.372	1.236	-1362.765	-3140.296	89642.170	0.234
	0.000	0.000	0.005	0.000	0.000	0.000	11.450
Hong Kong	2499200	-0.065	0.924	107543.600	-200.113	-820455.600	0.178
	0.002	0.526	0.001	0.000	0.019	0.000	11.112
Japan	133779	0.314	0.811	91.188	1790.219	1533.259	0.428
	0.088	0.011	0.002	0.000	0.000	0.006	40.277
Spain (pre Euro)	2208128	-0.564	2.016	-32.885	-778.180	16049.980	0.383
	0.034	0.000	0.139	0.325	0.000	0.004	9.678
Spain (post Euro)	285351.400	-0.147	1.354	-3543.761	-117.093	13551.210	0.117
	0.018	0.002	0.007	0.000	0.208	0.000	5.092

Country	Variance Equation			OLS			Adjusted R-Squared
	Constant	GARCH (-1)	RESID (-1)^2	Coefficient of FX	Coefficient of Discount rate	Constant	
	P-Value	P-Value	P-Value	P-Value	P-Value	P-Value	F statistic
Germany (pre Euro)	206580.200	-0.537	0.970	3626.913	-384.536	-1639.453	0.713
	0.005	0.000	0.001	0.000	0.000	0.023	49.285
Germany (post Euro)	969636.400	-0.456	0.833	-2967.748	509.032	6393.291	0.132
	0.007	0.020	0.025	0.000	0.000	0.000	5.696
UK	208883.700	-0.423	1.249	-11615.870	-346.259	13116.920	0.162
	0.001	0.000	0.000	0.000	0.000	0.000	11.158
US	746.907	0.228	0.878	-12.164	-206.690	3259.883	0.280
	0.234	0.034	0.001	0.000	0.000	0.000	1978.785

For Hong Kong, the results show that 1 unit increase in FX will result in 107543.6 changes in stock return and 1 unit increase in Discount rate will result in -200.1127 changes in stock return. Findings further reveals that if FX and discount rates are zero, stock return is -820455.6. The p value of both the variables and the constant is < 0.05 which shows that results are significant. The insignificance of the GARCH coefficient shows that previous lag volatility doesn't matter for volatility in stock return for current lag. Overall the model is significant as adjusted R^2 is 17.83% and F is 11.11 > 3.84. DW is 0.111 which shows that data has positive autocorrelation. This means that previous observations positively affect current observations of stock return.

For Japan, the results show that 1 unit increase in FX will result in 91.18814 changes in stock return and 1 unit increase in Discount rate will result in 1790.219 changes in stock return. Results moreover show that even when FX or discount rates are zero, stock return is 1533.259. The p value of both the variables and the constant is < 0.05 which reflects that results are significant. ARCH and GARCH coefficients (0.81 and 0.31) are statistically significant. The sum of these coefficients is 1.12 which specifed that shocks to fickleness have a permanent effect. The positive value of GARCH (-1) shows that volatility in lag1 affects volatility for current lag in such a way that if volatility is more in lag1 it gets increased for current lag. Overall the model is found significant for Japan as adjusted R^2 is 42.84% and f is 40.28 > 3.84. DW is 0.097 which shows that data has positive autocorrelation. This means that previous observations positively affect current observations of stock return for this nation.

For Spain (pre Euro period), it was found out that 1 unit increase in Discount rate results in -778.1797 change in stock return. Even when FX and discount rates are zero, stock return is 16049.98. The p value of discount rate and the constant is < 0.05 which shows that their results are significant but since p value of FX is not < 0.05 so that means that FX does not impact stock return. While ARCH coefficient is insignificant, the significant negative value of GARCH (-1) shows that volatility in lag1 affects volatility for current lag in such a way that if volatility is less in lag1 it gets increased for current lag. Overall the model is significant as adjusted R^2 is 38.27% and f is 9.68 > 3.84. DW is 0.262 which shows that data has positive autocorrelation. This means that previous observations positively affect current observations of stock return.

For Spain (Post Euro period), it was revealed that 1 unit increase in FX results in 3543.761 negative change in stock return. Even when FX and discount rates are zero, stock return is 13551.21. The p value of FX and the constant is < 0.05 which shows that their results are significant whereas p value of Discount rate which is not <0.05 shows that volatility in stock return is only catalyzed by FX. ARCH and GARCH coefficients (1.35 and -0.1.5) are statistically significant. The sum of these coefficients is 1.2 which denoted that shocks to fickleness have a permanent effect. The negative value of GARCH(-1) shows that volatility in lag1 affects volatility for current lag in such a way that if volatility in stock return is less in lag1 then it gets increased for current lag of stock return. Overall the model is significant as adjusted R^2 is 11.73% and F is 5.09 > 3.84. DW is 0.073 which shows that data has positive autocorrelation. This means that previous observations positively affect current observations of stock return.

For Germany (pre Euro period), the results show that 1 unit increase in FX results in 3626.913 change in stock return and 1 unit increase in Discount rate results in -384.5355 change in stock return. Results show that even when FX and discount rates are zero, stock return is -1639.453. The p value of both the variables and the constant is < 0.05 which shows that results are significant i.e. the volatility in stock return in. ARCH and GARCH coefficients (0.97 and -0.54) are statistically significant. The sum of these coefficients is 0.43 which pointed out that shocks to fickleness have a temporary effect. The negative value of GARCH (-1) shows that volatility in lag1 affects volatility for current lag in such a way that if volatility is less in lag1 it gets increased for current lag. Overall the model is significant as adjusted R^2 is 71.3% and F is 49.28 > 3.84. DW is 0.161 which shows that data has positive autocorrelation. This means that previous observations positively affect current observations of stock return.

For Germany, in Post Euro period, the results show that 1 unit increase in FX result in -2967.748 change in stock return and 1 unit increase in Discount rate results in 509.0321change in stock return. Results show that even when FX and discount rates are zero, stock return is 6393.291. The p value of both the variables and the constant is < 0.05 which shows that results are significant. ARCH and GARCH coefficients (0.83 and -0.46) are statistically significant. The sum of these coefficients is 0.37 which denoted that shocks to fickleness have no continual effect. The negative value of GARCH (-1) shows that volatility in lag1 would affect volatility for current lag in such a way that if volatility is less in lag1 it gets increased for current lag. Overall the model is significant as adjusted R^2 is 13.2% and f is 5.70 > 3.84. DW is 0.086 which shows that data has positive autocorrelation. This means that previous observations positively affect current observations of stock return.

For UK the results show that 1 unit increase in FX results in -11615.87 changes in stock return and 1 unit increase in Discount rate results in -346.2585 changes in stock return. The findings further show that when FX or discount rates are zero, stock return is 13116.92. The p value of both the variables and constant is < 0.05 which shows that results are significant. ARCH and GARCH coefficients (1.248 and -0.423) are statistically significant. The sum of these coefficients is 0.825 which confirmed that shocks to fickleness have somehow a continual effect. The negative value of GARCH (-1) shows that volatility in lag1 would affect volatility for current lag in such a way that if volatility is less in lag1 it gets increased for current lag. Overall the model is significant as adjusted R^2 is 16.24% and F is 11.15 > 3.84. DW is 0.042 which shows that data has positive autocorrelation. This means that previous observations positively affect current observations of stock return.

For US, the findings show that 1 unit increase in FX result in 12.16350 change in stock return and 1 unit increase in Discount rate results in 206.6901change in stock return. While, if FX and discount rates are zero, stock return still remains 3259.883. The p value of both the variables and the constant is < 0.05 which shows that results are significant. ARCH and GARCH coefficients (0.88 and 0.23) are statistically significant. The sum of these coefficients is 1.11 which denoted that shocks to fickleness have a permanent effect. Due to drastic change in discount rates owing to stock market crash of 2000, 2 dummy variables were added to the data. The number 0 was assigned to months where the values were constant while 1 was assigned to change in FX or discount rate, whether positive or negative. The R^2 is 0.279510 at F 1978.785, thus the model is concluded as significant. DW is 0.029 which shows that data has positive autocorrelation. This means that previous observations positively affect current observations of stock return.

Table 3: Hypotheses Assessment Summary

Hypotheses	Empirical Conclusion
H_1: The volatility in stock returns for past period predicts the volatility in returns in the current stock period.	Accepted for Pakistan, India, Japan, Spain (both Pre & Post Euro), Germany (Both Pre & Post Euro) UK and US. Rejected for Hong Kong only.
H_2: The conditional heteroskedasticity in stock returns for past period predicts the volatility in stock returns in the current period.	Accepted for Pakistan, India, Hong Kong, Japan, Spain (Post Euro), Germany (Both Pre & Post Euro) UK and US. Rejected for Pakistan and Spain (Pre Euro).
H_3: FX acts as a catalyst while volatility in stock returns in X is predicted.	Accepted for Pakistan, India, Japan, Hong Kong, Spain, (Post Euro), Germany (Both Pre & Post Euro) UK and US. Rejected for Spain (Post Euro) only.
H_4: Interest rate acts as a catalyst while volatility in stock returns in X is predicted.	Accepted for all outlined Countries.

Discussion and Conclusion

The findings of this concludes that the volatility in equity markets in connection with the stock returns are catalyzed by the interest rates for all outlined nations while also catalyzed by Exchange rates (FX) for all outlined nations except of Spain for Post Euro period. The findings further reveals that the GARCH term (i.e. the volatility in stock returns for past period) matters significantly for the volatility in stock return during the current period for all outlined nations except of Hong Kong. While, the ARCH term (i.e. the conditional heteroskedasticity in stock returns for past period) also matters for the volatility of equity markets in terms of stock returns for all of the studied countries except of Pakistan and Spain for Pre euro periods.

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