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ANALYSIS OF VOLATILITY SPILLOVER OF PORTFOLIO RETURNS: EVIDENCE FROM PAKISTANI STOCK MARKET

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Abstract

The present study attempts to model and analyze the lagged asymmetric volatility spillover effect between the high/low beta portfolio returns and the economic variables returns in case of Pakistan for the time period of July 2001 to June 2015 respectively**.** The lagged effect is taken to analyze and model the previous effect of the volatility spillover of the portfolio returns and the economic variables on the current volatility spillover of the respective variables respectively. The study also attempts to study the leverage effect (asymmetry) of the respective variables by employing the EGARCH model respectively. The findings of the present study indicate the significant differing volatility spillover effect of high beta portfolio returns and the low beta portfolio returns with all of the four economic variable returns respectively.

Keywords*: Volatility Spillover, High/Low Beta Portfolio Returns, Economic Variables Returns, EGARCH Model.*

1. Introduction

Since two decades, the developing trends of the foreign investors to trade and invest in the emerging economies have also gained prominence amongst the macro-economists and the financial policy makers to analyze the interdependent co-movements of the economic factors and the stock markets respectively. Intrigued by this concept of interdependent co-movements, the researchers have tried to empirically investigate and analyze the interdependent co-movements also called as the volatility spillover effect of the financial markets across the globe (Theodossiou and Lee, 1993; Donnell and Morales, 2009), volatility spillover effect of assets within a portfolio (Morales, 2008) and the volatility spillover effect within the portfolios (Miyakoshi, 2003) respectively.

With respect to Pakistan's capital market, it has shown a tremendous growth since two decades because of its conducive approach towards the economic and the investment policies. Some of the key factors that have positively contributed to the growth of the Pakistani stock market are

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the continuous thrive for the stable macroeconomic environment, the sufficient liquidity position in the market, the modern technological developments in the stock market and the corporate sector, exchange rates stability, big acquisitions and mergers, recovery of foreign loans, decrease in the interest rates offered by banks and the proper regulatory mechanisms set by the Securities and Exchange Commission of Pakistan (SECP).

Keeping in view the inclination in the international trade and foreign investors' confidence in investments in the developing economies, the present study aims to empirically analyze and model the asymmetric volatility spillover effect between the high/low beta portfolios returns and the economic variables returns based on the daily data in case of Pakistan for the time period of July 2001 to June 2015 respectively. The daily frequency data of the key economic factors are employed in the present study that identifies the business conditions of Pakistan. Specifically, the study intends to study the lagged volatility spillover effect between the high/low beta portfolios returns and the economic variables returns to analyze the effect of the previous spillover effect of the portfolio returns on the current spillover effect of the respective variables respectively. Further, the asymmetric volatility spillover effect between the high/low beta portfolios returns and the economic variables returns is estimated and modeled by using the univariate EGARCH model respectively.

This study attempts to contribute to the existing literature in several ways. Firstly, the volatility spillover effect between the high/low beta-sorted portfolios returns and the four of the key economic factors is empirically studied as extensive research in Pakistan covers the spillover effect of the Karachi stock exchange index, currencies and the exchange rates respectively. Secondly, the lagged asymmetric spillover effect between the high/low beta portfolios returns and the economic factors by using the daily data is analyzed and modeled. Thirdly, the lagged asymmetric volatility spillover effect between the respective variables is estimated and modeled by employing the univariate EGARCH model.

The present study significantly assesses the volatility spillover effect between the high/low beta portfolio returns and four of the economic variable returns that could be beneficial and helpful for the portfolio managers, institutional investors, macro-economic policy makers and the Securities and Exchange Commission of Pakistan to develop sound regulations for modern corporate sector and efficient capital market to foster investment and economic growth in Pakistan.

As the present study attempts to study the volatility spillover effect between the economic variables and the high/low beta portfolio returns on daily basis therefore out of several macroeconomic variables; those five economic variables are taken whose data was available on daily basis and was easily accessible but nevertheless tends to be the effective economic factors that determine the business conditions of Pakistan. It could be a limitation of the study and the present study may further be extended by employing other economic variables that effectively contribute to determine the business conditions of Pakistan at annual basis respectively.

1.1 Research Questions

The research questions of the present study are;

- Does the lagged volatility spillover effect exist between the economic variables and the high/low beta portfolio returns?
- Does the lagged asymmetric volatility spillover effect exist between the economic variables and the high/low beta portfolio returns?

1.2 Research Objectives

The research objectives of the present study are;

- To investigate the lagged volatility spillover effect between the economic variables and the high/low beta portfolio returns?
- To examine the lagged asymmetric volatility spillover effect between the economic variables and the high/low beta portfolio returns?

1.3 Organization of the Study

The remainder of the study is divided into four sections. Section two reviews the relevant literature in this area, section three discusses the data and methodology, section four comprises of empirical analysis and interpretation of empirical results and section five explains the summary and conclusion.

2. Literature Review

Extensive research has been conducted by numerous researchers to study the volatility spillover effect between the financial and the economic asset returns in the developed economies as well as the developing economies respectively. In a recent study, contrary to the studies given below, Xianzhi and Mwambuli (2016) find interesting result of symmetric volatility spillover effect between the foreign exchange market return and the stock market return in case of Turkey where positive and negative news have same impact on the markets respectively. Whereas, the studies mentioned henceforth show the significant asymmetric volatility spillover effect between the variables respectively. Jebran and Iqbal (2016) find significant asymmetric volatility spillover effect between the stock markets and the foreign exchange markets of the Asian countries based on the daily data of the sample respectively. An in-depth analysis of the pre and post financial crisis have been done by Mozumder, De Vita, Kyaw and Larkin (2015) to study the asymmetric volatility spillover effect between the stock prices and the exchange rates of the developing and the developed economies respectively.

Interestingly, authors find significant asymmetric spillover effect in all of the economies where the negative news has strong impact on the markets than the positive news. On the other hand, Xiong and Han (2015) find significant negative spillover effect between the foreign exchange market return and the stock market respectively. Bonga and Hoveni (2011) examine the volatility spillover effect between the foreign exchange market and the South African equity markets. Based on the multi-step EGARCH model, the authors find the spillover effect from the South African equity market to the foreign exchange market and no spillover effect in reverse respectively. Regarding the interdependent relationships within the portfolios and among the assets in each portfolio, Poblador, Abergas and Mapa (2010) find significant asymmetric interdependent relationships within the portfolio of assets and also among the assets within each portfolio respectively. Yilmaz (2010) studies the spillover effect of the East Asian stock markets by employing the Variance decaying method of the vector autoregressive model based on hundred-week rolling windows. The authors conclude that the East Asian markets seem to be interdependent thereby giving the evidence of the market return spillover effects as well as the return volatility spillover effect due to any shock that occurs within the region or worldwide.

In the sequel to the previous study, Morales and Donnell (2009) have further examined the asymmetric interdependence of the stock returns and the foreign exchange market returns of four Eastern European Markets before and after the introduction of the Euro currency by using the data on daily basis. The authors find no significant interdependence between the foreign exchange market and the stock returns of the respective countries respectively. Morales (2008) find significant interdependence of the foreign exchange market returns and the stock market indices of Latin American countries. With respect to the New Zealand and the Indian market, Choi, Fang and Fu (2010) and Mishra, Swain and Malhotra (2007) find significant asymmetric spillover effect between the foreign exchange rates and the stock market respectively. Miyakoshi (2003) has examined the spillover effect from Japan and the U.S. stock markets to the Asian stock markets. The results show that the Japanese market has no influential power on the Asian market relative to the U.S. stock market. Secondly, the spillover volatilities of both Asian and the Japanese market have a significant spillover effects because of the strong trading relationship between the Asian markets and the Japanese market respectively.

All of the studies above have employed the various methodologies of the GARCH family of models to study the asymmetric volatility spillover effect between the foreign exchange rates and stock markets based on either the daily data or the weekly data respectively.

In recent years, the Pakistani researchers have turned their attention to study the volatility spillover effect between the financial and the economic variables as very scarce studies have been conducted to study the volatility spillover effect of the financial assets respectively. Jan and Jebran (2015) in their study find significant volatility spillover effect of the G5 stock markets to the Pakistani stock market based on the weekly data of the respective markets. Based on the weekly data, Qayyum and Khan (2014) find significant interdependent co-movement of the foreign exchange market and the Pakistani stock market respectively. In another study, Qayyum and Kemal (2006) show significant interdependent mean reverting relationship between the Pakistani stock market and the foreign exchange market based on the weekly data respectively. Another significant interdependent relationship is made evident by, Khalil, Usman and Shafique (2013) between Pakistani stock market and the foreign exchange market based on the daily data respectively.

As evident from the literature above, almost all of the studies have studied the volatility spillover effect between the two variables only; the foreign exchange market and the stock market respectively. However, this study attempts to be the comprehensive study to study the asymmetric volatility spillover effect between the high/low beta portfolio returns and the four economic variables by using the daily data for the time period of July 2001 to June 2015 respectively. The lagged effect is taken to analyze and model the previous effect of the volatility spillover of the portfolio returns and the economic variables on the current volatility spillover of the respective variables respectively. The study also attempts to study the leverage effect (asymmetry) of the respective variables by employing the univariate EGARCH model.

3. Data and Methodology

The present study constructs the daily 10 equally weighted beta (β) portfolios[1] (10 stocks each) for the time period of July 2001 to June 2015. The sample of the daily stock prices has been selected on the criteria of active trading of the stock, representative of the sector and the existence of the stock for the entire period of analysis. The data have been collected from the websites of Karachi Stock Exchange and Business Recorder respectively.

Similarly, the sample of the economic variables include the stock market index (KSE-100), foreign exchange reserves (cash holdings) rates, real foreign exchange rates, oil market prices and gold market prices for the time period of July 2001 to June 2015. The data are the daily frequency data and the data for the market index and real foreign exchange rate are collected from the published manual of Economic Survey of Pakistan and the data for the foreign exchange reserves (cash holdings) are taken from the website of State Bank of Pakistan. The data for the oil prices and the gold prices are collected from the websites[2] respectively.

The daily stock returns of 100 listed firms and the economic variables returns are calculated by the following logarithmic formula[3];

$$R_f = \ln(p_t)\text{-}\ln\left(p_{t\text{-}1}\right) \qquad (1)$$

Where R_f indicates the return of the variable, ln indicates logarithm, p_t indicates current day price and p_{t-1} indicates the previous day price of a firm.

[1] The equally weighted beta portfolios are constructed based on the simple mathematical computations and also supported by empirical literature.[2]http://research.stlouisfed.org/fred2/series/DCOILWTICO/downloaddatafor oil prices and http://www.usagold.com/reference/prices/history.htmlfor gold prices. [3]This formula computes the continuous growth rate (Asteriou and Hall, 2007) and as the sample data of the present study comprises of the daily frequency data therefore the respective formula is employed to compute the daily stock returns respectively.

Following Fama & Macbeth (1973), the daily frequency portfolios sorted on beta are computed as;

$$\widehat{\beta_i} = \frac{\widehat{cov}(\widetilde{R_m},\widetilde{R_a})}{\hat{\sigma}^2 m(\widetilde{R_m})} \qquad (2)$$

$\widehat{cov}\left(\widetilde{R_m},\widetilde{R_a}\right)$ is covariance between the market return and the asset return. In the above equation, βi's of portfolios tend to behave as the precise estimates of β's than the βi's of individual stocks. The portfolio returns are believed to be dependent on their own historical information in addition to other factors. In order to specify the effect of the return's own previous information, the Autoregressive Moving Average (ARMA) models are most commonly applied. The ARMA (m, n) GARCH (p, q) model is expressed as;

$$R_{pt} = \alpha_0 + \sum_{j=1}^{m} \alpha_1 R_{pt-j} + \sum_{k=1}^{n} \alpha_{2k} \varepsilon_{t-k} + \varepsilon_t \qquad (3)$$

$\varepsilon t \approx N(0, h_t)$

$$h_t = \beta_0 + \sum_{j=1}^{p} \beta_{1j} h_{t-j} + \sum_{i=1}^{q} \beta_{2i} \varepsilon_{t-i}^2 \qquad (4)$$

where, R_{pt} is the portfolio returns, α_{1j} and α_{2k} estimates the autoregressive and moving average term h_t is conditional variance, β_{1j} and β_{2i} estimates the GARCH and ARCH coefficients respectively and ε_t is error term that depends on previous information.

To absorb possible asymmetric effect of the portfolio returns volatility spillover behavior and the economic variable volatility spillover behavior, the EGARCH model is employed to capture asymmetric effect respectively.

The exponential GARCH (EGARCH) was firstly presented by Nelson (1991). The Conditional Variance equation of the model can be expressed as;

$$\log h_t = \beta_0 + \sum_{j=1}^{p} \beta_{1j} \log h_{t-j} + \sum_{i=1}^{q} \beta_{2i} \left(\left| \frac{\varepsilon_{t-i}}{\sqrt{h_{t-i}}} \right| - E\left[\left| \frac{\varepsilon_{t-i}}{\sqrt{h_{t-i}}} \right| \right] \right) + \sum_{k=1}^{r} \beta_{3k} \frac{\varepsilon_{t-k}}{\sqrt{h_{t-k}}} \qquad (5)$$

In the above equation, the leverage effects are exponential, not quadratic, because dependent variable is log of the conditional variance. To detect the leverage effect the hypothesis that $\beta_{3k} < 0$ can be tested. However, if $\beta_{3k} \neq 0$ still there exists asymmetric behaviour.

To examine the volatility spillover effect between the high/low beta portfolio returns and the economic variables, the EGARCH model is used as shown below;

$$\log h_{rpi} = \beta_0 + \sum_{j=1}^{p} \beta_{1j} \log h_{t-j} + \sum_{i=1}^{q} \beta_{2i} \left(\left| \frac{\varepsilon_{t-i}}{\sqrt{h_{t-i}}} \right| - E\left[\left| \frac{\varepsilon_{t-i}}{\sqrt{h_{t-i}}} \right| \right] \right) + \sum_{k=1}^{r} \beta_{3k} \frac{\varepsilon_{t-k}}{\sqrt{h_{t-k}}} + \sigma_{Xt} \qquad (6)$$

Where h_{rpi} indicates the high/low beta portfolio returns and σ_{Xt} indicates the volatility of the economic variable returns respectively. The volatility σ_{Xt} is estimated by first estimating the EGARCH model by ARMA specification and then extracting and plugging the GARCH variance from equation 5 into equation 6 respectively. The significant σ shows the volatility spillover effect between the high/low beta portfolio returns and the economic variables returns respectively.

3.1 Research Hypotheses

$H_{1)}$ There exists the lagged volatility spillover effect exist between the economic variables and the high/low beta portfolio returns.

H_2) There exists the lagged asymmetric volatility spillover effect exist between the economic variables and the high/low beta portfolio returns

4. Empirical Results

In the 1st step of analysis, the Augmented Dickey Fuller stationarity test (ADF) is employed on the portfolio stock returns and the economic variables both at trend and trend and intercept respectively. The results have shown the presence of unit root at trend level which is further tested at trend and intercept at 1st difference respectively. At 1st difference, however, the results indicate the rejection of unit root and confirm that the variables at 1st difference have shown stationarity respectively.

The descriptive statistics of the portfolio returns and the economic variables returns are reported in table 1. The results reveal that the portfolio returns are either negatively skewed or positively skewed with the values greater than 0 providing evidence of asymmetry. Likewise, the kurtosis values of each of the entire portfolio returns are lower or higher than the value 3 indicating the leptokurtic distribution with extreme values and thicker tails. Another test of normality, the Jarque-bera (JB) test is employed to test the normality of the data of the variables undertaken in the research study. The results of p value of JB test supports the non-normality of the stock returns respectively thereby confirming for the leptokurtic distribution of the stock returns respectively. Similar results are observed for the economic variable returns respectively.

Table 1. Descriptive Statistics of Economic Variables

Portfolios Returns	**Mean**	**S.D**	**Skewness**	**Kurtosis**	**JB-test**	**P-value**	**Obs**
RP1	0.79	10.46	-0.21	24.12	89145.3	0.00	3225
RP2	0.92	14.63	0.76	13.55	8540.8	0.00	3299
RP3	0.67	17.94	0.15	45.08	8193.7	0.00	3264
RP4	0.65	18.40	-0.97	24.35	61266	0.00	3199
RP5	0.66	22.10	0.35	22.25	8618.77	0.00	3200
RP6	0.67	23.15	0.35	18.45	5764.12	0.00	3219
RP7	0.68	17.99	-0.67	41.22	5228.9	0.00	3316
RP8	0.69	18.55	0.19	15.15	6032.62	0.00	3189
RP9	0.62	22.01	-1.65	17.99	50430.2	0.00	3189
RP10	0.62	22.53	-0.57	19.99	5680.86	0.00	3269
Economic Variables							
OIL	0.78	0.69	-0.25	4.28	142.02	0.00	3193

EX	0.88	0.21	0.99	4.76	138.05	0.00	3193
FXR	0.89	0.55	-0.29	3.40	319.36	0.00	3170
RM	0.84	0.45	0.65	6.57	151.39	0.00	3189
GOLD	0.45	0.85	0.55	3.92	315.38	0.00	3189

In the present study, the volatility spillover effect is estimated between the entire ten high/low portfolio returns and the economic variables returns respectively. However, the most interesting cases that are of volatility spillover effect between the highest beta portfolio return 1 and the economic variables and that of the lowest beta portfolio returns 10 and the economic variable returns that are the foreign reserve returns, foreign exchange rate of returns, the gold market returns and the oil market returns for the time period of July 2001 to June 2015 are reported in the respective section.

4.1 Empirical Results of Volatility Spillover effect between the High Beta Portfolio Returns and the Economic Variables.

Starting with the results of the autoregressive term of the previous portfolio return 1 on the previous market return in the conditional mean equation turns out to be insignificant and the results of the conditional variance indicate no volatility interdependent effect between the previous most risky portfolio return 1 and the previous market return respectively. Hence, it could be suggested that the stock market return (KSE-100 index) does not find any significant volatility interdependent relationship with the portfolio returns. The results of the autoregressive term of the previous most risky portfolio return 1 and the return spillover value of the previous return portfolio 1 on the previous foreign exchange return in the conditional mean equation turn out to be insignificant with the coefficient values of -0.01 and -23.15 respectively. The results of the variance equation of the EGARCH model indicate the significant negative interdependent effect from the foreign exchange return to the most risky portfolio returns respectively. The results imply that any effect of depreciation in the home currency i.e. Pak-Rupee depreciation has a downward effect on the stock prices Yang and Doong (2004).

The results of the autoregressive term of the previous most risky portfolio return 1 and the return spillover value of the previous return portfolio 1 on the previous foreign exchange reserve return in the conditional mean equation turns out to be insignificant. Whereas, the results of the conditional variance equation indicate that the most risky portfolio returns have significant asymmetric interdependent relationship with the foreign exchange reserve return but the two variables do not have any significant effect on one another respectively.

The autoregressive term of the previous most risky portfolio return 1 and the return spillover value of the previous return portfolio 1 on the previous oil return in the conditional mean equation turn out to be insignificant and the results of the conditional variance equation show significant coefficient values of 0.04,-0.009, -0.01 and -0.009 respectively. The results are in line with the work of Alsubaie and Najand (2008) where the stock market movements are positively affected by any increase and decrease in the international oil prices respectively.

The results of the autoregressive term of the previous most risky portfolio return 1 is significant with the coefficient value of -0.03 and the return spillover value of the previous return portfolio 1 on the previous gold return in the conditional mean equation turns out to be insignificant with the coefficient values of -0.99 respectively. The volatility interdependent effect from the gold return to the previous most risky portfolio returns is insignificant with the coefficient value of -0.001 respectively. The results imply that the most risky portfolio returns are influenced to any shocks/surprises that may occur in the gold market and that the portfolio returns are dependent on the gold market respectively.

4.2 Empirical Results of Volatility Spillover between the Low Beta Portfolio Returns 10 and the Economic Variables.

The results of the autoregressive term of the previous market return on the portfolio return 10 and the return spillover value of the previous market return on the previous portfolio returns 10 in the conditional mean equation show the insignificant coefficient values of -0.01 and -0.01 respectively. The asymmetry and the volatility interdependent effect from the previous market return to the least risky portfolio returns 10 is insignificant with coefficient values of-0.001 and 0.005 respectively.

The results of the autoregressive term of the previous least risky portfolio return 10 is significant with the coefficient values of -0.03 on the previous foreign exchange return and the return spillover value of the previous return portfolio 10 on the previous foreign exchange return in the conditional mean equation turn out to be significant with the coefficient values of -1.17 respectively. The asymmetry from the previous portfolio return 1 to the previous foreign exchange return indicates the significant positive volatility effect from the foreign exchange return to the least risky portfolio returns respectively.

The results of the autoregressive term of the previous least risky portfolio return 10 show significant coefficient values of -0.03 and the insignificant return spillover value of the previous portfolio returns 10 on the previous foreign exchange reserve return in the conditional mean equation with the coefficient values of 9.06 respectively. The results of the conditional variance equation show the significant coefficient values of 0.16, 0.93 and -1.96 respectively and show the insignificant coefficients value of asymmetry to be 0.004 respectively. The results indicate that the least risky portfolio returns have significant asymmetric relationship with the foreign exchange reserve return as well as the significant volatility interdependent effect on one another respectively.

The results of the autoregressive term of the previous most risky portfolio return 10 and the return spillover value of the previous return portfolio 10 on the previous oil return in the conditional mean equation turns out to be significant with the coefficient values of -0.03 and -2.93 respectively. The results of the variance equation of the EGARCH model indicate that the low beta portfolio returns tend not to respond quickly to any shocks/surprises that may occur in the oil market respectively.

Lastly, the results of the autoregressive term of the previous most risky portfolio return 10 is significant with the coefficient value of -0.03 and the return spillover value of the previous return portfolio 1 on the previous gold return in the conditional mean equation turns out to be insignificant with the coefficient values of -1.99 respectively. The results of the conditional variance equation show the imply that the least risky portfolio returns do not quickly respond to any shocks/surprises that may occur in the gold market and there exists no interdependence between the least risky portfolio returns 10 and the gold market respectively. The similar results are found for almost all of the rest of the low beta portfolio returns respectively.

Table 2. Empirical Results of Volatility Spillover from Rp1 (-1) to Rm (-1) and Volatility Spillover from Rm (-1) to Rp1 (-1) by using EGARCH-M model

VOLATILITY SPILLOVER FROM RP1(-1) to RM(-1)		
	Coefficient	***P-value***
Mean Equation		
Constant (ω)	-3.37	0.45
RP1(-1) (β_1)	-0.01	0.44
Return Spillover RM(-1) (β_2)	-8.41	0.50
Variance Equation		
Constant	1.92	0.00
ARCH Effect (α)	0.37	0.00
Asymmetry (θ)	-0.049	0.13
GARCH Effect (β)	0.30	0.00
Volatility Spillover RP1(-1) to RM(-1) (δ_1)	-1.21	0.41
Diagnostics		
R-Square		0.04
Adjusted R-squared		0.012
AIC		8.57
Log likelihood		-13716.7
VOLATILITY SPILLOVER FROM RM(-1) to RP1(-1)		
Mean Equation		
Constant (ω)	-0.04	0.02
RM(-1) (β_1)	0.09	0.00
Return Spillover RP1(-1) (β_2)	-0.07	0.50
Variance Equation		
Constant	-4.17	0.00

ARCH Effect (α)	0.45	0.00
Asymmetry (θ)	-0.16	0.00
GARCH Effect (β)	0.34	0.00
Volatility Spillover RM(-1) to RP1(-1) (δ_1)	0.001	0.21
Diagnostics		
R-Square		0.07
Adjusted R-squared		0.07
AIC		5.75
Log likelihood		9297.2

Table 3. Empirical Results of Volatility Spillover from Rp1 (-1) to Fxr (-1) and Volatility Spillover from Fxr (-1) to Rp1 (-1) by using EGARCH-M model

VOLATILITY SPILLOVER FROM RP1(-1) to FXR(-1)		
	Coefficient	**P-value**
Mean Equation		
Constant (ω)	-77.45	0.072
RP1(-1) (β_1)	-0.017	0.313
Return Spillover FXR(-1) (β_2)	23.15	0.085
Variance Equation		
Constant	6.02	0.10
ARCH Effect (α)	0.34	0.001
Asymmetry (θ)	-0.061	0.04
GARCH Effect (β)	0.54	0.008
Volatility Spillover RP1(-1) to FXR(-1) (δ_1)	-1.61	0.18
Diagnostics		
R-Square		0.5509
Adjusted R-squared		0.1182
AIC		8.56
Log likelihood		-13709.3

VOLATILITY SPILLOVER FROM FXR(-1) to RP1(-1)		
Mean Equation		
Constant (ω)	0.076	0.131
FXR(-1) (β_1)	0.99	0
Return Spillover RP1(-1) (β_2)	0.001	0.0012
Variance Equation		
Constant	-16.04	0.009
ARCH Effect (α)	-0.003	0.09
Asymmetry (θ)	0.006	0.04
GARCH Effect (β)	0.0087	0.85
Volatility Spillover FXR(-1) to RP1(-1) (δ_1)	-0.0015	0.05
Diagnostics		
R-Square		0.99
Adjusted R-squared		0.99
AIC		-14.77
Log likelihood		23795.67

Table 4. Empirical Results of Volatility Spillover from Rp1 (-1) to Ex (-1) and Volatility Spillover from Ex (-1) to Rp1 (-1) by using EGARCH-M model

VOLATILITY SPILLOVER FROM RP1(-1) to EX(-1)		
	Coefficient	**P-value**
Mean Equation		
Constant (ω)	-12.66	0.618
RP1(-1) (β_1)	-0.014	0.414
Return Spillover EX(-1) (β_2)	2.379	0.710
Variance Equation		
Constant	5.34	0.024
ARCH Effect (α)	0.37	0.009
Asymmetry (θ)	-0.04	0.148

GARCH Effect (β)	0.34	0.009
Volatility Spillover RP1(-1) to EX(-1) (δ_1)	-0.85	0.134
Diagnostics		
R-Square		0.52
Adjusted R-squared		0.12
AIC		8.57
Log likelihood		-13716
VOLATILITY SPILLOVER FROM EX(-1) to RP1(-1)		
Mean Equation		
Constant (ω)	0.006	0
EX(-1) (β_1)	0.99	0
Return Spillover RP1(-1) (β_2)	0.008	0.380
Variance Equation		
Constant	-3.12	0.005
ARCH Effect (α)	0.948	0.005
Asymmetry (θ)	0.077	0.032
GARCH Effect (β)	0.66	0.005
Volatility Spillover RP10(-1) to RP1(-1) (δ_1)	0.001	0.23
Diagnostics		
R-Square		0.44
Adjusted R-squared		0.59
AIC		11.42
Log likelihood		18417.99

Table 5. Empirical Results of Volatility Spillover from Rp1 (-1) to Oil (-1) and Volatility Spillover from Oil (-1) to Rp1 (-1) by using EGARCH-M model

VOLATILITY SPILLOVER FROM RP1(-1) to OIL(-1)		
	Coefficient	**P-value**
Mean Equation		

Constant (ω)	-5.32	0.54
RP1(-1) (β_1)	-0.01	0.54
Return Spillover OIL(-1) (β_2)	0.26	0.80
Variance Equation		
Constant	4.81	0.009
ARCH Effect (α)	0.31	0.001
Asymmetry (θ)	-0.06	0.03
GARCH Effect (β)	0.39	0.007
Volatility Spillover RP1(-1) to OIL(-1) (δ_1)	-0.52	0.007
Diagnostics		
R-Square		0.49
Adjusted R-squared		0.1243
AIC		8.562
Log likelihood		-13699.6
VOLATILITY SPILLOVER FROM OIL(-1) to RP1(-1)		
Mean Equation		
Constant (ω)	0.180	0.057
OIL(-1) (β_1)	0.99	0
Return Spillover RP1(-1) (β_2)	0.002	0.45
Variance Equation		
Constant	-6.271	0.008
ARCH Effect (α)	0.041	0.013
Asymmetry (θ)	0.009	0.33
GARCH Effect (β)	-0.012	0.842
Volatility Spillover OIL(-1) to RP1(-1) (δ_1)	-0.00096	0.42
Diagnostics		
R-Square		0.625
Adjusted R-squared		0.648
AIC		4.62
Log likelihood		7485.441

Table 6. Empirical Results of Volatility Spillover from Rp1 (-1) to Gold (-1) and Volatility Spillover from Gold (-1) to Rp1 (-1) by using EGARCH-M model

VOLATILITY SPILLOVER FROM RP1(-1) to GOLD(-1)		
	Coefficient	**P-value**
Mean Equation		
Constant (ω)	10.58	0.197
RP1(-1) (β_1)	-0.031	0.047
Return Spillover GOLD(-1) (β_2)	-0.994	0.355
Variance Equation		
Constant	0.164	0.178
ARCH Effect (α)	0.122	0.008
Asymmetry (θ)	-0.01	0.413
GARCH Effect (β)	0.95	0
Volatility Spillover RP1(-1) to GOLD(-1) (δ_1)	-0.04	0.006
Diagnostics		
R-Square		0.89
Adjusted R-squared		0.827
AIC		8.673
Log likelihood		-13899.4
VOLATILITY SPILLOVER FROM GOLD(-1) to RP1(-1)		
Mean Equation		
Constant (ω)	-0.08	0.008
GOLD(-1) (β_1)	0.99	0
Return Spillover RP1(-1) (β_2)	0.005	0.799
Variance Equation		
Constant	-1.801	0.03
ARCH Effect (α)	0.104	0.004
Asymmetry (θ)	0.093	0.004

GARCH Effect (β)	0.600	0.007
Volatility Spillover GOLD(-1) to RP1(-1) (δ_1)	-0.0012	0.374
Diagnostics		
R-Square		0.92
Adjusted R-squared		0.92
AIC		-5.99
Log likelihood		9698.8

Table 7. Empirical Results of Volatility Spillover from Rp10 (-1) to Rm (-1) and Volatility Spillover from Rm (-1) to Rp10 (-1) by using EGARCH-M model

VOLATILITY SPILLOVER FROM RP10(-1) to RM(-1)		
	Coefficient	**P-value**
Mean Equation		
Constant (ω)	-0.626	0.880
RP10(-1) (β_1)	-0.036	0.023
Return Spillover RM(-1) (β_2)	-12.25	0.047
Variance Equation		
Constant	0.046	0.648
ARCH Effect (α)	0.156	0.002
Asymmetry (θ)	0.005	0.718
GARCH Effect (β)	0.935	0
Volatility Spillover RP10(-1) to RM(-1) (δ_1)	1.556	0.051
Diagnostics		
R-Square		0.6
Adjusted R-squared		0.6
AIC		8.68
Log likelihood		-13897.4
VOLATILITY SPILLOVER FROM RM(-1) to RP10(-1)		

Mean Equation		
Constant (ω)	-0.070	0.00
RM(-1) (β_1)	-0.002	0.84
Return Spillover RP10(-1) (β_2)	0.002	0.90
Variance Equation		
Constant	-6.179	0.002
ARCH Effect (α)	0.119	0.005
Asymmetry (θ)	-0.003	0.797
GARCH Effect (β)	0.045	0.136
Volatility Spillover RM(-1) to RP10(-1) (δ_1)	0.002	0.99
Diagnostics		
R-Square		0.37
Adjusted R-squared		0.36
AIC		-5.708
Log likelihood		9218.77

Table 8. Empirical Results of Volatility Spillover from Rp10 (-1) to Ex (-1) and Volatility Spillover from Ex (-1) to Rp10 (-1) by using EGARCH-M model

VOLATILITY SPILLOVER FROM RP10(-1) to EX(-1)		
	Coefficient	**P-value**
Mean Equation		
Constant (ω)	5.34	0.811701
RP10(-1) (β_1)	-0.03	0.030737
Return Spillover EX(-1) (β_2)	-1.77	0.746458
Variance Equation		
Constant	3.27	0.006
ARCH Effect (α)	0.29	0.001
Asymmetry (θ)	-0.02	0.29
GARCH Effect (β)	0.80	0.001

Volatility Spillover RP10(-1) to EX(-1) (δ_1)	-0.69	0.005
Diagnostics		
R-Square		0.29
Adjusted R-squared		0.31
AIC		8.69
Log likelihood		-13917.2
VOLATILITY SPILLOVER FROM EX(-1) to RP10(-1)		
Mean Equation		
Constant (ω)	0.0003	0.017
EX(-1) (β_1)	0.999	0
Return Spillover RP10(-1) (β_2)	0.001	0.690
Variance Equation		
Constant	-2.837	0.001
ARCH Effect (α)	1.640	0.024
Asymmetry (θ)	-0.149	0.091
GARCH Effect (β)	0.842	0
Volatility Spillover EX(-1) to RP10(-1) (δ_1)	0.005	0.001
Diagnostics		
R-Square		0.98
Adjusted R-squared		0.98
AIC		-11.47
Log likelihood		18475.05

Table 9. Empirical Results of Volatility Spillover from Rp10 (-1) to Fxr (-1) and Volatility Spillover from Fxr (-1) to Rp10 (-1) by using EGARCH-M model

VOLATILITY SPILLOVER FROM RP10(-1) to FXR(-1)		
	Coefficient	**P-value**
Mean Equation		
Constant (ω)	-30.95	0.789

RP10(-1) (β_1)	-0.03	0.024
Return Spillover FXR(-1) (β_2)	9.06	0.801
Variance Equation		
Constant	6.344	0.0005
ARCH Effect (α)	0.161	0.001
Asymmetry (θ)	0.004	0.74
GARCH Effect (β)	0.93	0
Volatility Spillover RP10(-1) to FXR(-1) (δ_1)	-1.96	0.0006
Diagnostics		
R-Square		0.55
Adjusted R-squared		0.9
AIC		8.682
Log likelihood		-13900.2
VOLATILITY SPILLOVER FROM FXR(-1) to RP10(-1)		
Mean Equation		
Constant (ω)	0.0007	0.13
FXR(-1) (β_1)	0.99	0
Return Spillover RP10(-1) (β_2)	0.00	0.001
Variance Equation		
Constant	-16.040	0.00
ARCH Effect (α)	-0.003	0.09
Asymmetry (θ)	0.006	0.04
GARCH Effect (β)	0.008	0.85
Volatility Spillover FXR(-1) to RP10(-1) (δ_1)	-0.001	0.055
Diagnostics		
R-Square		0.99
Adjusted R-squared		0.99
AIC		-14.77
Log likelihood		23795.67

Table 10. Empirical Results of Volatility Spillover from Rp10 (-1) to Oil (-1) and Volatility Spillover from Oil (-1) to Rp10 (-1) by using EGARCH-M model

VOLATILITY SPILLOVER FROM RP10(-1) to OIL(-1)		
	Coefficient	**P-value**
Mean Equation		
Constant (ω)	18.9	0.05
RP10(-1) (β_1)	-0.03	0.02
Return Spillover OIL(-1) (β_2)	-2.93	0.02
Variance Equation		
Constant	0.54	0.00
ARCH Effect (α)	0.14	0.00
Asymmetry (θ)	0.00	0.95
GARCH Effect (β)	0.94	0
Volatility Spillover RP10(-1) to OIL(-1) (δ_1)	-0.07	0.00
Diagnostics		
R-Square		0.08936
Adjusted R-squared		0.05
AIC		8.67
Log likelihood		-13891.9
VOLATILITY SPILLOVER FROM OIL(-1) to RP10(-1)		
Mean Equation		
Constant (ω)	0.05	0.00
OIL(-1) (β_1)	0.99	0
Return Spillover RP10(-1) (β_2)	-0.004	0.64
Variance Equation		
Constant	-2.75	0.00
ARCH Effect (α)	0.03	0.06
Asymmetry (θ)	0.01	0.47

GARCH Effect (β)	0.63	0.00
Volatility Spillover OIL(-1) to RP10(-1) (δ_1)	0.00	0.42
Diagnostics		
R-Square		0.861
Adjusted R-squared		0.867
AIC		-4.61
Log likelihood		7458.3

Table 11. Empirical Results of Volatility Spillover from Rp10 (-1) to Gold (-1) and Volatility Spillover from Gold (-1) to Rp1 (-1) by using EGARCH-M model

VOLATILITY SPILLOVER FROM RP10(-1) to GOLD(-1)		
	Coefficient	**P-value**
Mean Equation		
Constant (ω)	10.80	0.35
RP10(-1) (β_1)	-0.03	0.02
Return Spillover GOLD(-1) (β_2)	-1.99	0.27
Variance Equation		
Constant	0.07	0.72
ARCH Effect (α)	0.14	0.007
Asymmetry (θ)	0.01	0.49
GARCH Effect (β)	0.95	0
Volatility Spillover RP10(-1) to GOLD(-1) (δ_1)	-0.01	0.73
Diagnostics		
R-Square		0.07
Adjusted R-squared		0.07
AIC		8.67
Log likelihood		-13895.5
VOLATILITY SPILLOVER FROM GOLD(-1) to RP10(-1)		

Mean Equation		
Constant (ω)	0.01	0.07
GOLD(-1) (β_1)	0.99	0
Return Spillover RP10(-1) (β_2)	-0.003	0.96
Variance Equation		
Constant	-3.87135	0.00
ARCH Effect (α)	0.14	0.00
Asymmetry (θ)	0.12	0.00
GARCH Effect (β)	0.60	0.00
Volatility Spillover GOLD(-1) to RP10(-1) (δ_1)	-0.00	0.77
Diagnostics		
R-Square		0.63
Adjusted R-squared		0.62
AIC		6.00
Log likelihood		9698.6

5. Summary and Conclusion

The present study attempts to model and analyze the lagged asymmetric volatility spillover/interdependent effect between high/low beta portfolio returns and the economic variable returns in case of Pakistan for the time period of July 2001 to July 2015 respectively. This study attempts to be the comprehensive study to examine and analyze an asymmetric volatility interdependent effect between the high/low betas sorted portfolio returns and the four economic variables returns by using the daily data for the time period of July 2001 to June 2015 respectively. The lagged effect is taken to analyze and model the previous effect of the volatility spillover effect of the portfolio returns and the economic variables on the current volatility spillover of the respective variables respectively. The study also attempts to examine the leverage effect (asymmetry) of the respective variables by employing the EGARCH model respectively. The interesting results of the volatility spillover effect of the high beta portfolio returns 1 and the low beta portfolio returns 10 with four of the economic variables are discussed in detail in the respective study. Conclusively, the findings of the present study indicate the significant differing volatility spillover effect of high beta portfolio returns and the low beta portfolio returns with all of the four economic variable returns respectively. The present study significantly implicates the volatility spillover effect between the high/low beta portfolio returns and the four of the economic variables respectively. The present study may benefit the portfolio managers, institutional investors, macro-economic policy makers and the Securities and Exchange Commission of Pakistan to develop sound regulations for modern corporate sector and efficient capital market to foster investment and economic growth in Pakistan. Specifically, it is an attempt to determine the business conditions of Pakistan and the dividend stream and discount rate necessary for the flow of capital funds for the institutional investments by considering the anomalies of asymmetric interdependent effect of the financial asset returns respectively.

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