

## Volatility Transmission Among Stock Prices, Exchange Rate, Interest Rate and Gold prices of Pakistan

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The study is conducted to determine nature of volatility transmission among four financial markets which are stock prices, exchange rate, interest rate and gold prices of Pakistan through employing the Dynamic Conditional Correlation (DCC) model using daily data from 2008 to 2018. DCC-GARCH is used to forecast future correlations and volatilities. The analysis shows strong volatility transmission among all variables taken except interest rate and exchange rate are those markets whose volatility does not make any impact on each other market volatility. It also implies that market volatility plays a significant role in formulating the dynamic strategies for government, policy makers and investors to minimize their risk level. The result also indicates that gold prices can be used as a hedge against the stock price and exchange rate fluctuations. Results of the study are helpful for policy makers and investors in decision making

**Keywords:** Volatility transmission, stock prices, gold prices, exchange rate, interest rate

### INTRODUCTION

The main purpose behind this study is to construct strong theoretical and empirical analysis across the different classes of financial asset for understanding of market information because dependencies are very significant. The idea for which this paper is written, is important by not less than two reasons; Firstly, it is important for the correlational structure between financial asset ; Secondly, economic and financial decisions have cross-market influence and concerning point to policy maker to know the impact of their decisions (Ciner, Gurdgiev, & Lucey, 2013). The increasing integration and significance of financial market given trend to study the market behavior and mechanism in which different factors of economic and market movements transferred; The previous studies make it clear that market conditions depend on international factors that proves that real economic factors or conditions and financial market performance are interlinked (Yavas & Rezayat , 2016).

The Pakistan Stock Exchange (PSX) was established on 11 January 2016 after the merger of all other established exchanges of Pakistan. In Pakistan stock market, there are 546 listed companies with Rs. 1,336,726 million of total listed capital in 2018-19 (Ministry of Finance, Govt. of Pakistan, 2019).

The investors always in search for more profitable investments and to hedge against the market shocks, which is a bit difficult in Pakistan like other developing countries as the economic conditions are always uncertain as it is difficult to predict the extent of inflation. The gold is a hedge against inflation and its role in financial market can be augmented by the fact that its value does not fall so badly even when there is financial crises in markets. By using autoregressive moving average (ARMA) with generalized autoregressive conditional heteroscedasticity (GARCH) models, it may be tried to find time fluctuating relationship between gold prices and bond interest rate. The bond yield or interest rate have association with inflation, it means that there exists a direct positive relationship between gold prices and bond yield. However, the current inflation is not predicting the

treasury bond behavior; And as the same gold also have a positive association with inflation but the magnitude of gold is greater than the bond yield with different maturity period (Zafar & Javid, 2015).

### Problem Statement

In the today's advance economy need a financial system which helps to transfer funds from the entities have surplus i.e. savers to deficient i.e. investors. Stable economy is always a need of any country; Unwavering and constant system, strategic policies of foreign exchange rate, risk control investments to encourage investors behavior, less fluctuate interest rate in economy and stable gold prices are the key factor for the progress of the country's economy (Ali & Afzal, 2012). In recent centuries, financial shocks and crises restricting from unexpected and unanticipated fluctuation in foreign and stock exchange markets become a communal phenomenon in financial markets. Many investors select the funds diversify strategy to minimize the risk that attached with their portfolio because the return's volatility and capitalization have escalate melodramatically (Farooq & Keung, 2004). This understanding develops the idea to conduct the studies to investigate volatility transmission among stock prices, exchange rate, interest rate and gold prices of Pakistan. Many researches scrutinize related queries in previous effort. The preliminary studies mainly focus on the relation between stock prices and interest rate and reported negative co-movement between the markets (Shiller & Beltratti, 1993). However, in recent studies Baele and Inghelbrecht, (2009) and Andersen et al (2007) discussed that during the contraction of business cycle a negative relationship was found while a positive relationship prevailed while in expansion phase. Some other studies also investigate the currency and gold markets on the inspiration that markets take influence from information of other market. For example, the interest rates and foreign exchange rates are correlated, and some argued that a dependency prevail between the values of foreign currency and value of stocks. The exchange rates are also very much depend upon the demand of any

currency in respect to a foreign currency or on the basis of trade balance (Eun & Shim, 1989). On the other hand the some suggest that the demand and supply of financial assets such as stock also depends upon the exchange rate (Ravazzolo & Phylaktis, 2005).

### **Objectives**

The objectives of the study are;

- To determine volatility transmission among four financial markets which are gold prices, interest rate, exchange rate, and stock prices.
- Give recommendation to investors or investment based on results and findings.

### **LITERATURE REVIEW**

Momentous research occurs to comprehend the relationship or interface among the different variables and economic indicators. By taking daily market data from USA and UK market with the variables oil, currency, stock, gold and bond, the dynamic correlation between these variables were investigated; And the analysis shows that bond market plays an important role as hedging against stock market, and gold considered as a hedge for exchange rate; In this study, it is also examined that all the variables are “safe haven” against each other during the decline of price (Ciner, Gurdgiev, & Lucey, 2013). Sarwar and Ahmad, (2018) and Sarwar, Mustafa, Abid, and Ahmad, (2018) are also of the same view point that interest rates has significant influence on stock price of bank. They also advocated that a suitable monetary and fiscal policy is need to have a better investment environment.

The role of the stock market is very important for any countries' economy. In addition, stock market performance is significant for the decision making of investor's, economist and policy makers; Factors included interest rate, currency strength and exchange rate that help to determine the volatility of stock exchange; To measure the impact of these two factors BEKK-MGARCH is used to know conditional variance; BEKK-MGARCH (Baba-Engle-Kraft-Kroner) model used to measure volatility transmission among exchange rate, stock exchange and interest rate; Result after the analyses showed that conditional variance interned the volatility spillover among these three sector of Turkish economy (Turkyilmaz & Balibey, 2013).

All the investors and decision makers keep an eye on the different factors of the economy that also make effect on stock market; The bond market, stock market and exchange rate relationship depends upon the undervaluation and overvaluation of domestic currency and whether the adjusted excess return have any impact on overvaluation and undervaluation of domestic return; The important markets of USA and British finds and point out the important spillover effect, revealed by high frequency forecasted data by actively traded financial market; The result of this study simultaneous spillover among stock, gold and exchange rate indices volatility (Badshah, Frijns, & Tourani-Rad, 2013).

In USA, the study on gold price, oil prices, exchange rate and stock return are important topic to know the investors behavior in marketplace. Sujit and Kumar, (2011) uses vector auto regression model to observe the situation and concluded that gold combated the loss in inflation. It is better to invest in gold

when stock prices are declining and on the other hand the exchange rate of country is higher when the economy of country is robust and levitating. Evaluation in interest rate and exchange rate is imperative due to its influence on fiscal and monetary policy of the country; On volatility transmission, financial market linkage has an effect which is important for investor before making investment decision and so for policy makers. (Kal, Arslaner, & Arslaner, 2013).

To run the smooth financial system it is necessary to understand the of role of classes of asset that reduced loss at the time of financial cries and market recession; The increase in stock price leads to increase in capital inflow that appreciate the currency and downward trend in stock price that decreases the interest rate because of this capital inflows decreases, that depreciates the currency (Kal, Arslaner, & Arslaner, 2014).

In short run gold saves the investors from losses but its time period is only 15 days, after it gold is not a safe haven against stock so investors should not buy gold for long run; Gold used as a commodity in industries as well as for business but it has a unique history throughout the trading and non-trading period as a medium of exchange that makes gold an akin to money; Market shocks and mood shown over a large number of time, the outcomes from the time period 1990s to optimism 2000 shows the consistent behavior gold market (Joscha Beckmann, Berger, & Czudaj, 2014). The results of the study analyzed by the supporting of empirical evidence and claim that the results are constant with trading based description and positive volatility relation (Krause, Ehsani, & Lien, 2014). Under Caporin and McAleer, (2012) and Aielli (2013) study, it has been shown that DCC (Dynamic Conditional Correlation) representation further down standards into two step method have no asymptotic properties.

Problem of inconsistency is highlighted by researcher, but projected 'solution' tranquil or facing the same problem of afflicting DCC result representation. He also discourses the targeting and changing in DCC to allow consistent valuation. Nevertheless, the researcher assume estimator of changed or modified (Dynamic Conditional Correlation) DCC representation and depiction asymptotically usual under “standard” symmetry circumstances, without describing what state might be (Aielli, 2013).

### **THEORETICAL FRAMEWORK**

The theoretical frameworks show the relationship between the taken variables and support the argument with the previous theories.

#### **Stock market and exchange rate**

According to phenomenon of Fama (1981) theory explained importance of major macro-economic variables in relation to change in stock prices; Due to this, Maysami and Koh (2000) show results that interest rate and exchange rate are important determinant of stock prices; On other side Tabak (2006) conducted the study to determine volatility transmission in Brazilian financial market and its economy disclosed that there is absence of relationship between these two variables. The Dornbusch and Fischer, (1980) had given goods market approach, and Frankel (1993) had given portfolio theory, these

are two main theories that fundamental empirical studies relationship between currency exchange rate and stock prices return are finest mixed.

**Stock market and gold**

Conferring to the conducted study by Levin and E.R (2006), metal gold is one of the exchangeable thing and considered as a liquidate asset whereas stocks are observed as return on value means growth from possible real price rises plus dividends; This point of view grew the attention in 19<sup>th</sup> century where there was stable economic and political environment with robust property rights and less turmoil in countries like USA.

**Gold and exchange rate**

The short-run and long run determining factor of gold price has examined by Levin and E.R (2006), the self-governing variables used that are taken by researcher are USD exchange rate, gold price, credit risk, political risk and inflation rate; in this study Cointegration technique has been used from period 1976 to 2005. The linkage between USD exchange rate and gold prices had been focus the intense examination; A vital and significant literature review characteristics a value of gold as guard of exchange rate fluctuations (Marzo & Zagaglia, 2012). The modification and variation in properties of gold and relationship of gold with equity market is very much important for examination from the last few years; Previous reports and studies reported that gold qualities while risky had tendency to make available appreciated divergent qualities (Baur & Lucey, 2010).

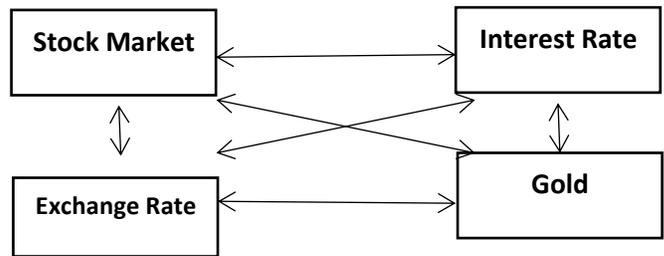
**Gold and interest rate**

Like the other assets, gold prices also influenced by worldwide supply and demand side of market; And meanwhile it takes and ended a decade to generate a deposit into an operational mine, supply of gold changes very slowly; All basic and real important action in yellow metal comes from demand side; The big trump card or wild card through which equation comes from investors investment demand, which influence by fluctuating at the huge margin; Interest rate drives gold all immense moves, so interest rate affect the gold through the demand side of investors; Now’s a traders trust on higher and rising rates delay gold demand of investment as investors transfer their capital and funds to higher return bonds (Zeal LLC, 2015)..

**Exchange rate and interest rate**

Monetary policy effect exchange rate and interest rate is meaningfully affected through the behavior of actual output. Modern Portfolio Theory (MPT) described the process by which the portfolio is selected is divided into two stages; First stage include the observations and experience with belief on the future performance of financial markets assets; The second stage start with the previous relevant pure beliefs and ends with choice of diversified portfolio; it is an investment based theory for the risk averse investors to construct portfolio in such a way to maximizes their returns with lower risk (Markowitz, 1952) if actual output is fixed, a monetary growth in short run, lesser interest rates and source of increase in exchange rate exceed the long run depression; when output, on other side responds to the aggregate demand, the interest rate and exchange rate diminishes; while, when exchange rate decreases, it may no

more exceed and interest rate may rise (Exchange Rates and the Current Account, 1980). Diagrammatical representation of the variables shown below;



**Figure1:** Framework of the Study

The above figure shows that there is correlation among every variable all variables gold prices, interest rate, stock prices and exchange rate are inter-linked and have effect on each other.

**METHODOLOGY**

Different research methodologies have been used for research purpose to find the accurate ways to conduct research and reached at the conclusions. We have taken secondary data. The study include for financial time series are which are gold prices, interest rate, exchange rate and stock prices. DCC GARCH is model is applied to determine volatility transmission among these financial time series.

**Research Design**

This study has used secondary data of four financial markets of Pakistan. These financial markets include stock market, currency market, gold market, and interest rate. Data is taken from official websites and reports.

**Data collection**

The data have been taken from secondary source and this study is the quantitative in nature. Unit of analysis for Financial market data is country’s stock exchange, in which “KSE 100 index” from Pakistan stock exchange is used for Pakistan financial market, Kibor rate is used for interest rate, for exchange rate conversion rate of dollar USD and Rupee has taken and gold prices has taken for the analyses of gold price. All the data have been taken from the period 2005 to 2015. The frequency of the data is daily data. And the abbreviations that is used are the following:

- Stock price = stprice
- Exchange rate = exrate
- Interest rate = intrate
- Gold = gld

**1)Unit root test**

A unit root test (ADF) Augmented Dickey–Fuller test, examine and tests whether variable non-stationary or unit root exist. Null hypothesis of null nature is referred to existence of a unit root problem. In general terms, equation of unit root can be written as  $y_t = \alpha + \beta y_{t-1} + \epsilon_t$

**2)Descriptive statistics**

Descriptive statistics are short-term expressive coefficients that sum up a specified data and number set, which can be moreover an illustration of the complete population or a sample of it. Descriptive statistics are fragmented down into measures of

spread or measures of variability and measures of central tendency.

### 3) Autocorrelation

Autocorrelation is a representative of data by which relationship between values of the similar variables are founded on correlated objects. It interrupts the hypothesis and assumption of instance individuality, which motivates most of the conservative models. It generally occurs in those categories of datasets in which data, as an alternative of existence randomly chosen, is comes from the similar source. The trend in data can also be identified by autocorrelation that is present within the variables.

### 4) ARCH Test (Autoregressive Conditional Heteroskedasticity)

ARCH is another problem that normally exist in financial time series. This is a situation in which conditional variance of error term is not constant. Due to the existence of ARCH linear regression model cannot produce valid estimators. Therefore, ARCH family models are used to estimate financial time series.

### 5) Dynamic Conditional Correlation (DCC) GARCH

A new model for measuring and predicting correlations as well as volatilities is examined. The specification of the correlation dynamics is extended to allow asymmetries important for financial practice. Suppose we have returns,  $a_t$ , from  $n$  assets with expected value 0 and covariance matrix  $H_t$ .

$$r_t = \mu t + a_t$$

$$a_t = H^{1/2} z_t$$

$$H_t = D_t R_t D_t$$

$$r_t | \mathcal{F}_{t-1} \sim F(0, H_t), H_t = D_t R_t D_t$$

$$\varepsilon_t \equiv D_t^{-1} r_t, E_{t-1}(\varepsilon_t \varepsilon_t') = P$$

Let

$$\varepsilon_t = D_t^{-1} r_t$$

be standardized residuals then

$$\bar{R} = \frac{1}{T} \sum_{t=1}^T \varepsilon_t \varepsilon_t'$$

Then a DCC(p,q) process is given as

$$Q_t = \bar{R} + \sum_{i=1}^p \alpha_i (\varepsilon_{t-i} \varepsilon_{t-i}' - \bar{R}) + \sum_{j=1}^q \beta_j (Q_{t-j} - \bar{R})$$

The DCCGARCH model is as follows:

$$Q_t = (1 - \sum_{m=1}^M a_m - \sum_{n=1}^N b_n) \bar{Q}_t + \sum_{m=1}^M a_m a_{t-1} a_{t-1}' + \sum_{n=1}^N b_n Q_{t-1}$$

DCC GARCH model is not suitable for data have different dynamic structure as it assumed that constant dynamic structure. The model will not be able to estimate risk correctly if structural breaks exist in data. Moreover, DCC model is not workable for large number of assets.

### Data Analysis

This research study and deal with financial markets of Pakistan to know volatility transmission among them. Researchers deliberated, theoretically, these variables and explained the main components of these variables in configuration with earlier researches that have been done in this arena. Based on this empirical and theoretical discussion, the study tries to find the correlation between stock market, interest rate, exchange rate and gold. So, in this regard, for this purpose, the method that is

used in this research is Dynamic Conditional Correlation Method (DCC) for the analysis.

### 2) Descriptive Statistics Analysis in e-views.

## RESULTS

**Table 2: Descriptive Statistics Analysis**

	STPRICE	EXRATE	INTRATE	GLD
Mean	15891.97	100.5508	9.871117	108975.4
Median	12247.91	85.55000	9.400000	119565.3
Maximum	36228.88	49239.35	16.84000	170833.9
Minimum	4815.340	0.298375	0.000000	37088.46
Std. Dev.	8408.534	835.4433	2.002787	37600.88
Skewness	1.002433	56.80831	0.006677	-0.413945
Kurtosis	2.663320	3322.919	2.428271	1.988950
Jarque-Bera	487.3313	1.66E+09	37.21588	168.9124

value of data set is close to the average mean and large standard deviation means that data set are very much away and disperse from average mean value.

The skewness measure is greater than 0 when the distribution is skewed and positive the data are skewed in right side. It means that right tail of distribution is more skewed and long than the left side as it is in case of above stock prices, exchange rate and interest rate and negative skewness means that tilt or tail is more on left side than the right side of the distribution as it is here in gold prices. The kurtosis measure is 0 for a normal distribution. Positive values imply a leptokurtic distribution with higher standard deviation and higher peak than the normal distribution, while negative values imply a platykurtic distribution which means that flatter than a normal distribution.

### 3) ARCH Test Stock price (ARCH LM Test)

**Table 3: Heteroskedasticity Test: ARCH**

Stock prices		
F-statistic	1555887.	Prob. F(1,2827)
Obs*R-squared	2823.869	Prob. Chi-Square(1)

### Exchange rate

F-statistic	0.000327	Prob. F(1,3605)
Obs*R-squared	0.000327	Prob. Chi-Square(1)

### Interest rate

F-statistic	1721.077	Prob. F(1,2728)
Obs*R-squared	1056.071	Prob. Chi-Square(1)

### Gold prices

F-statistic	447329.3	Prob. F(1,2371)
Obs*R-squared	2360.489	Prob. Chi-Square(1)

### Interpretation

For financial time series data Arch model is used to know the tendency to volatility clustering. In LM test we can use number of lags that means many lags can be applied in this ARCH LM test. In this model Prob. Chi-Square (1) is 0.0000 which is less than 0.5 percent, so we reject the null hypothesis except exchange rate series whose probability is more than 5%.

### 4) Dynamic Conditional Correlation (DCC) GARCH

**Table 4: Statistical Analyses of Dynamic Conditional Correlation (DCC) model in Stata, 1 Model**

	Coefficient	S.E.	P Value
<b>Stock Price</b>			0.0000
Exchange Rate	1.400489	0.398215	0.0000
Interest Rate	-2015.639	57.43	0.0000
Gold	0.10266	0.003039	0.0000
Constant	22026.11	436.2438	0.0000
ARCH_Stock Price Constant	1.61e+07	465895.7	0.0000

### Interpretation

The above model has variance model and arch effect. Depend variable is stock price (stprice) and independent variable is exchange rate, interest rate and gold. To know the volatility transmission effect, we have considered the P-value significance level. The P-value of all the independent variable are 0.000 which is less than 5% so we reject the null hypothesis and all series are highly significant and it means that volatility of exchange rate, interest rate and gold effects the volatility transmission of stock price. And here ARCH effect is also significant because its P-value is also less than 5%.

### 1)Model

	Coefficient	Standard Error	P Value
<b>Exchange Rate</b>			
Stock Price	0.0037009	0.0010523	0.000
Interest Rate	-0.5956725	3.638446	0.870
Gold	0.00023	0.00019	0.221
Constant	12.7941	32.29351	0.692
ARCH_Stock Price Constant	42417.15	1231.64	0.000

### Interpretation

The above model has variance model and arch effect. The number of observations are 2,418 in this model. Depend variable is exchange rate (exrate) and independent variable is stock price, interest rate and gold. To know the volatility transmission effect, we have considered the P-value significance level. The P-value of independent variable stock price is 0.000 which is less than 5% so we reject the null hypothesis and it means that volatility of stock prices effect exchange rate volatility and interest rate p-value is 87% which is more than 5% so it tells that interest rate volatility does not effects the exchange rate volatility and gold prices p-value is 22% which is also more than 5% so it also does not make any impact on exchange rate volatility transmission effect. Here the ARCH effect is also significant because its P-value is also less than 5%.

### 2)Model

	Coefficient	Standard Error	P Value
<b>Interest Rate</b>			
Stock Price	-0.0001695	4.83	0.000
Exchange Rate	-0.000019	0.0001115	0.870
Gold	0.000415	6.50	0.000
Constant	7.808	0.8659	0.000
ARCH_Stock Price Constant	1.349659	0.39174	0.000

### Interpretation

The above model has variance model and arch effect. Depend variable is interest rate (intrate) and independent variable is stock price, exchange rate and gold. To know the volatility transmission effect, we have considered the P-value significance level. The stock price and gold prices that are independent variables its P-value is 0.000 which is less than 5% so we reject the null hypothesis and it means that volatility of stock price and gold effects the volatility transmission of interest rate. On the other hand, exchange rate of P-value is 87% that is more than 5% so it means its volatility does not affect the volatility of interest rate. And here ARCH effect is also significant because its P-value is also less than 5%.

### 3)Model

	Coefficient	Standard Error	P Value
<b>Gold</b>			
Stock Price	3.162343	0.936099	0.000
Exchange Rate	2.7098	2.215176	0.221
Interest Rate	15218.34	238.2409	0.0000
Constant	-86446.34	3001.543	0.000
ARCH_Stock Price Constant	4.94e+08	1.44e+07	0.000

### Interpretation

The above model has variance model and arch effect. Dependent variable is gold (gld) and independent variable is stock price, exchange rate and interest rate. To know the volatility transmission effect, we have considered the P-value significance level. The P-value of all the independent variable are 0.000 which is less than 5% so we reject the null hypothesis and it means that volatility of stock price and interest rate effects the volatility transmission of stock price, except exchange rate variable whose p-value is 22% which is more than 5% so it volatility does not effects the gold prices volatility. And here ARCH effect is also significant because its P-value is also less than 5%.

### Conclusion

In this research, the relationship and volatility transmission among variables is investigated by applying Dynamic Conditional Correlations model (DCC) among stock prices, exchange rate, interest rate and gold prices of Pakistan. The analysis is helpful and useful to find out and conclude that volatility is transmitted among these financial markets. Our most important and prime results in this study of the empirical analysis is that in stock market volatility transmission and exchange rate volatility both affected each other markets as the same stock price affect interest rate and gold prices and gold prices and interest rate affects the stock market volatility but exchange rate and interest rate both does make any impact on each other market fluctuations and gold prices and interest rate also does not have any impact on each other market volatility.

The volatility transmission in these market changes the investor's behavior to make their investment less risky and more secure by portfolio diversification and exchange rate does not affect the interest rate volatility. On the other side, gold prices of Pakistan changes with the passage of time and it's because of the market variables in which stock prices and interest rate is included.

Results revealed that gold prices can be regarded as a hedge against fluctuations of all other market except interest rate.

### Recommendations

Policy makers in Pakistan should consider that exchange rate is mainly influenced from changes in stock market as results of the study has shown that neither other financial markets have impact on exchange rate not exchange rate has any impact on other financial markets except stock market. Policy makers must also consider that any change in interest rate has impact on investor's decision. Investors can use exchange market as hedge for changes in stock market of Pakistan. In this study direct impact of one market is determined on other market for future studies indirect impact among these financial markets can also be examined.

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