Iran. Econ. Rev. Vol. 20, No.4, 2016. pp. 525-549

The Analysis of Real Exchange Rate Volatility and Stock Exchange Return with PANEL-GARCH Approach (Case Study: D8 Countries)

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Received: 2016/02/07 Accepted: 2016/08/07

Abstract

Stock returns of companies listed on the stock exchange is one of the most important criteria in assessing the macroeconomic. This study investigates the effect of exchange rate Volatility on the stock exchange Returns of D8 countries. It takes monthly data during the period (2008:1-2015:6) constituting 90 observations. At first we used Panel-GARCH model to estimate Exchange Rate Volatility Index, and then we used Panel data method to investigate the effect of index on the stock exchange return of D8 countries. Simulation results show that exchange rate volatility affects positively and significantly on stock exchange return in four countries, namely Iran, Pakistan, Indonesia and Bangladesh. The variables of oil price, real interest rate, inflation rate, real exchange rate and gold price have been utilized for model analysis. Results show that the variables of real exchange rate and inflation rate have negative effects but oil price has positive effect on stock returns, while interest rate and gold price do not have any significant effect.

Keywords: Stock Returns, Exchange Rate Volatility, D8 Countries, PANEL- GARCH Model.
JEL Classification: E44, E32, F31, C33.

1. Introduction

Investors decide to invest for getting more money. One of the most important factors that investors consider in their decision making is the stock returns. In fact, each investor must gain the confidence and

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trust that in the first step of their investment the principal capital will be returned and then they achieve their expected returns. They would only thereafter be able to decide for investing. Return of Stock is dependent upon several factors. One of them can be exchange rate volatility. In fact exchange rate volatility brings a kind of risk in foreign trades that can disturb export, import and investment flows. Therefore if exchange rate changes set in the proper order, it can provide acceptable state for producing, trading and investing. Foreign investors do not like to invest in assets that their value reduction would lose their stock returns. For example devaluation of the Iranian Rial causes investors to refrain holding assets such as stocks in Iran. If foreign investors sell stocks held in Iran, the price of each stock will decrease. On the other hand at the macroeconomic level, devaluation of currency may increase the value of export industries and decrease the value of import industries, and its effect on domestic production may be positive. Increasing in production is due to increase in stock price. Given the importance of the issue, stock markets play as an index for economic assessment: an increased investment in this market and capital market require an increase in stock market returns, reduction of risk and creation of favorable conditions for investment. Therefore identifying the effect of economic factors on the stock market can be a way for decision-making to managers and investors for the future. This paper examines the effect of real exchange rate volatility on the stock exchange returns of D8 developing countries. According to the purposes of our study, the following two hypotheses may be claimed:

1- Exchange rate volatility has significant effect on D8 stock returns.
2- Exchange rate volatility has positive effect on D8 stock returns.

The remainder of this paper has the following structure. Section 2 reviews the relevant literature including theoretical basis and empirical studies. Section 3 describes the data and our methodology (i.e., examining exchange rate volatility effects on the stock returns). Section 4 discusses the results with respect to our selected methodology. Finally, Section 5 provides some concluding remarks along with future extensions.

2. Literature Review

In this section, first the theoretical basis will be presented, and then most empirical studies in the field of exchange rate volatility and its effect on stock returns will be reviewed.

2.1 Theoretical Basis

2.1.1 Factors Affecting Stock Returns

Many variables have witnessed significant effect on the stock exchange return over time and hence, it is absolutely necessary to validate the effect periodically (Sujit & Kumar, 2011). Among the various factors, macroeconomic factors are widely used in studies. The macroeconomic variables used in each study are different based on the purpose of those studies. Those macroeconomic variables can be classified into four groups (Tangjitprom, 2012). The first group reflects general economic conditions such as employment level and the industrial production index. The second group includes variables concerning interest rate and monetary policy. Those variables include interest rate, term spread, default spread, etc. The third group of variables focuses on price level, which can be general price level and inflation rate or the price of key assets such as oil prices. The last group is the variables involving international activities such as exchange rate and foreign direct investment. Some studies examine macroeconomic factors in general and include many macroeconomic variables, whereas some studies have focused on specific variables or groups of variables. Chen, Ross, & Roll (1986) have used empirical evidence to extend risk factors (i.e. various macroeconomic shocks, including the industrial production index, inflation, risk premium or default spread) besides the above variables.

Exchange rate fluctuations are the degree of price volatility for an asset, rate or a certain index which are usually expressed as variance or standard deviation. Fluctuations in exchange rates or changes of assets returns are defined as the volatility, and they show the range of return changes. In traditional econometric models, a constant variance of residuals is always considered as one of the main and classical assumptions of econometrics. Heteroscedasticity model (ARCH) which was first proposed by Engle (1982) and generalized by Bollerslev (1986) is the most common way to model the variability and volatility of high frequency financial time series. Multivariate generalized arch models (M-GARCH) are used for estimating volatility spillover effects between various markets. In this way error term has a zero mean with uncorrelated series but it is heteroskedastic with given information in the past. Garch (1, 1) is the most commonly process used for many financial time series (Poon & Granger, 2003).

2.1.2 Building Investment Portfolios

Investors apply many techniques to minimize risk at the same time to optimize return. Among the methods are Markowitz model developed by Harry Markowitz in 1952 and followed by its developments which are Capital asset pricing model (CAPM) by Treynor (1962), Sharpe (1964), Lintner (1965), and Mossin (1966) independently and Arbitrage Pricing Theory (APT) by Ross (1976). CAPM takes into the account of asset's sensitivity to non-diversifiable risk (systematic risk), and is symbolized by the beta (β) in the industry, as well as the expected return of the market and the expected return of a theoretical risk-free asset. CAPM provides precise expectation of the relationship that should be monitored between the expected return of an asset and its risk (Treynor, 1962). APT can employee any figure of factor, which makes the return the function of more than one factor.it allows more than a few economic factors to predict stock returns on the other hand CAPM considers only one factor (Ross, 1976).

Markowitz theory is the origin of portfolio theory (the modern theory of portfolio (MPT)). The main approach of this theory is the effect of portfolio diversification together with a number of high correlation securities (such as stocks and currency) instead of creating a single set of securities. This model presumes that investors are rational and markets are efficient, tends to illustrate an asset's return as a normally distributed random variable, identifies risk as the standard deviation of return, and demonstrates a portfolio. This model looks for reduction of the total variance of the portfolio return, by combining different assets whose returns are not perfectly positively (Markowitz, 1952). According to Markowitz, assets are not affected by economic conditions in the same way and they are not always move in one direction so we can reduce risks significantly through a variety of investment and combining them in a portfolio without loss of returns. It is theoretically possible to identify efficient portfolios by analyzing of information for each security on expected return, variance of return, and the interrelationship between the return for each security and for every other security as measured by the covariance (Farrell, 1997). In 1958, economist James Tobin in his essay ("Liquidity Preference as Behavior toward Risk," in Review of Economic Studies), derived 'Efficient Frontier' and 'Capital Market Line' concepts, based on Markowitz' works. Tobin's model suggested that market investors, no matter their levels of risk tolerance, will maintain stock portfolios in the same proportions as long as they "maintain identical expectations regarding the future" (Megginson, 1996, citing Tobin, 1958). Consequently, concluded Tobin, their investment portfolios will differ only in their relative proportions of stocks and bonds. According to (Bodie, Kane, & Marcus, 2011), the first step to creating a Markowitz Efficient Frontier is to determine the risk and return opportunities of the portfolios. It is denoting by the efficient frontier graph of the lowest possible variance that can be attained for a given portfolio expected return. The best risk and return that can be attained from the portfolios are provided by the portfolios that lie on the minimum-variance frontier and upward, thus portfolios are candidates for the portfolio with optimal risk and return. From set of portfolios that construct efficient frontier line, investor may choose the desired portfolio to invest by utilizing portfolio mean-variance. Portfolio has the best mean variance denote, thus it gives the highest expected return of all feasible portfolio with the minimum variance of return.

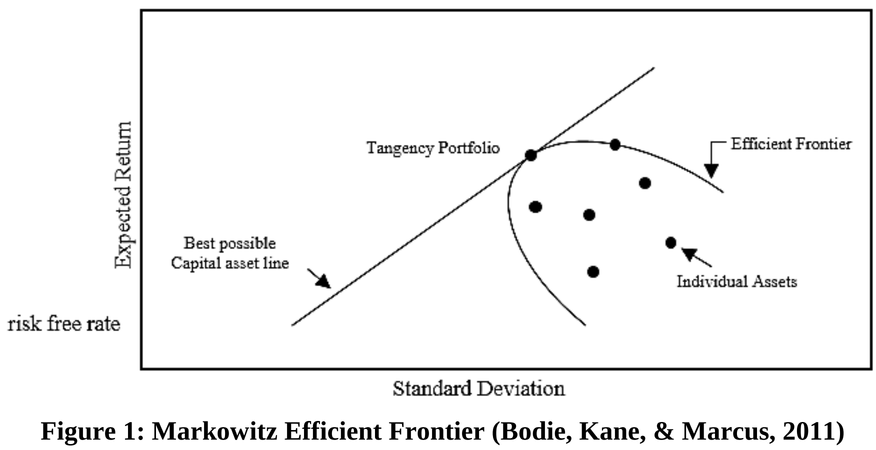

Figure 1: Markowitz Efficient Frontier (Bodie, Kane, & Marcus, 2011)

The MPT is used due to its simplicity and popularity (Zainal Abidin et al., 2004; Safarzadeh et al., 2013). In fact as long as the correlation coefficient between two assets is less than 1/0, there will be a reduction in risk by combining both assets in a portfolio. The Markowits portfolio model is optimized by minimizing the portfolio risk (Zainalbidin et al., 2004).

Changes in foreign exchange rate as an asset in the portfolio can affect demand and in turn it causes of stock price changes (Markowitz, 1959). In addition, depending on the degree of reliance on the export or import companies and exchange rate, any increase or decrease in the exchange rate can have different effects on listed companies and their resources. Exchange rate devaluation in export industries causes decreased benefit and subsequently a decrease in the company's stock price. If exchange rate decrease we should note the consequent of increase in stock price due to reduced cost of production and also reduced stock price due to the reduction in the value of exports of each company, and then the impact of exchange rate depreciation on the stock returns could be realized. It is rational that the result of this outcome in export companies is negative, but for companies relying on imports it would be positive (Bhuttacharrya & Mukherjee, 2002).

2.2 Empirical Studies

Many studies have examined the effect of exchange rate volatility on stock returns; see for example Chang et al. (2009), Zhao (2010), Subair et al. (2010), Kasman et al. (2011), Heidari & Bashiri (2012), Pedram (2012) and Heidari et al. (2013). They all have examined the effect of exchange rate volatility on just one stock market. But there are still a few studies about a panel of stock returns. Some of them are described below.

Kornas (2000) investigates the relationship between volatility in exchange rates and stock price index in six countries, namely United States, England, Japan, Germany, Canada and France, in the period of January 1986 to February 1998 using EGARCH model. The Correlation coefficient between stock returns and exchange rate changes was negative for all countries. It represents a significant interaction between stock returns and exchange rate changes.

Chun Mun (2007) examines association of exchange rate volatility and fluctuations in the international stock markets related to United States (i.e., England, France, Germany, Italy, Australia, Hong Kong, Japan and Singapore) during the period of 1990 to 2003 using EGARCH model. Results indicate that higher foreign exchange rate volatility leads to an increase in local stock market fluctuations, though fluctuations in the stock market of the United States decrease.

Beer et al. (2008) studied the relationship between stock prices and exchange rates for both developed and developing countries using EGARCH model with weekly data during the period of 1997 to 2004. Developed countries were USA, Canada, Japan, UK and developing countries were Hong Kong, Singapore, South Korea, India and Philippines. Their research found that in the developed countries, there are not any sustainable exchange rate fluctuations in the stock markets while in the developing countries mentioned fluctuations are stable.

These described studies have examined the effect of exchange rate volatility on stock exchange and in just one process, EGARCH model used time series. Results are varied through the studies. Some of them mentioned the positive effects and others belong to the negative effects. This study uses GARCH process with panel data in the field of exchange rate and furthermore it investigates the effect of exchange rate volatility on the stock exchange return in a two stage approach.

Using ARCH/GARCH models and panel data simultaneously is a new approach in econometrics (Keshavarz & Babaei, 2011). In what follows we introduce studies which have employed this approach. Cermeno & Grier are the pioneer researchers in this area. Cermeno & Grier (2001) examined a panel in GARCH analysis using four specific models and unique methodology to determine the best one. They proposed simple tests based on OLS and LSDV residuals to determine whether GARCH effects existed, and to test for individual effects in the conditional variance. Estimation of the model was based on direct maximization of the log-likelihood function by numerical methods. They conducted Monte Carlo studies in order to evaluate the performance of the MLE estimator for various relevant designs. They also presented two empirical applications. They investigated to see whether investment in a panel of five large U.S. manufacturing firms, and also inflation in a panel of seven Latin American countries would exhibit GARCH effects. Their panel

GARCH estimator satisfactorily captured the significant conditional heteroscedasticity in the data.

Cermeno & Grier (2006) specified a model that accounted for conditional heteroscedasticity and cross-sectional dependence within a typical panel data framework. They applied the model to a panel of monthly inflation rates of the G7 countries over the period 1978:2 – 2003:9 and found significant and quite persistent patterns of volatility and cross-sectional dependence. They then used the model to test two hypotheses about the interrelationship between inflation and inflation uncertainty, found no support for the hypothesis that higher inflation uncertainty produces higher average inflation rates and strong support for the hypothesis that higher inflation is less predictable.

Keshavarz & Babaei (2011) estimated pooled-panel models in order to examine the similarities and differences between the conditional variance structures of stocks from the same or different industries in the same equity market. Discrimination amongst the rich variety of models arising from the pooled-panel structure was undertaken within a general to specific framework of nested tests. This was done using panel samples of sector indices and stocks from the Iranian Stock market. Results showed that there were significant differences in the volatility structure of stocks from both the same sector and different sectors.

Cermeno & Suleman (2014) studied the link between country risk – measured by a country composite risk index as well as individual measures of economic, financial and political risk – and Volatility of Stock Market returns. They used monthly data for the five major Latin American markets over the period of January 1993 to December 2013 and modeled Stock return volatility as a panel-GARCH process. They found significant and persistent volatility patterns for Stock market returns as well as high, positive and highly significant cross-correlation among these Stock markets. They also found strong support for the hypothesis that higher country risk increases stock market volatility.

3. Methodology and Data Sources

Data collection in our study is based on library sources and the use of so diverse tools as articles, books, official websites of stock exchanges and the central banks of D8 countries. Statistical population in our research is all D8 countries, namely Iran, Pakistan, Bangladesh, Indonesia, Malaysia, Egypt, Nigeria and Turkey, during the period 2008:1-2015:6. Inferential statistics will be used for analyzing data. In inferential statistics, panel data with RATS software is used for testing hypothesis. According to theoretical basis many macroeconomic factors that had significant effects on the stock exchange return divided into four groups. In this study we try to apply variables from different groups. On the other hand modern portfolio theory is an investment framework for the selection and construction of investment portfolios based on the concept of diversification which aims to properly select a weighted collection of investment assets that together exhibit lower risk factors than investment in any individual asset or singular asset class. Furthermore MPT combines different assets whose returns are not perfectly positively correlated but with a high correlation. However in many empirical studies some high frequency macroeconomic factors namely, exchange rate, interest rate inflation rate, oil price and gold price have been used simultaneously. (Kasman et al., 2011; Er & Vuran, 2012; Singh et al., 2011; Malik & Surya, 2013; Al-Sharkas, 2004; Gan et al., 1992). Describing model variables are as follows:

$$R= \beta_0 + \beta_1 INF + \beta_2 LOP + \beta_3 Z + \beta_4 VOL + \varepsilon \tag{1}$$

Stock return (R) is equal to logarithmic difference[1] (growth rate) of stock index. INF is inflation rate; i.e., the logarithmic difference of consumer price index (CPI). LOP is the logarithm of oil price. The advantage of using the logarithmic form of variables is reduction in heteroscedasticity and non-stationarity. OPEC's basket price has been used for oil price variable. Z is the sensitivity analysis variable[2] that can be interest rate (INT) or real exchange rate (ER) or Gold price (G). According to Fisher's theory, real interest rate is equal to the difference of expected inflation rate and nominal interest rate. Expected inflation is the amount of inflation rate in the same month of

1. For calculating growth rate, we use this function: $\acute{X}_t = 100 * \ln(X_t / X_{t-1})$ =100*(ln(X_t) - ln(X_{t-1})), where $\acute{X}_t$ and X_{t-1} are arbitrary variables in the period t and t-1, respectively.
2. The variable in this model reexamining exchange rate volatility treatment with respect to its significant and sign.

previous year. The real exchange rate is the ratio of foreign prices to domestic prices, based on a certain money. In other words, ER=e$\frac{P_f}{P}$ where e is the official exchange rate or, in other words, the domestic value of foreign currency (USA dollars), and P and $\mathrm{P_f}$ are the base level of prices in the inside and outside of the country, respectively. Unlike the observed period, the period of exchange rate variable has been selected larger (2001:1-2015:6) because of high-accuracy measurement of panel volatility. World gold prices are in terms of US dollar. VOL is the exchange rate volatility variable which is described in the sequel.

In what follows we first start with Panel GARCH Model and extend Cermeno & Grier (2006) work for describing the exchange rate volatility. Then, in the next phase, we provide a static panel for analyzing the effect of exchange rate volatility on the stock returns.

3.1 First Step: Panel GARCH Model

As a time series, exchange rate volatility modeling is as follows:

$$y_t = \mu + \phi y_{t-1} + u_t \qquad t=1,\dots,T \tag{2}$$

$$u_t \mid \Omega_{t-1} \sim \mathrm{N}(0, \Omega_t) \tag{3}$$

$$\sigma_t^2 = \alpha + \textstyle\sum_{n=1}^{p} \delta_n \sigma_{t-n}^2 + \sum_{m=1}^{q} \gamma_m u_{t-m}^2 \tag{4}$$

$$\sigma_t = \eta + \textstyle\sum_{n=1}^{p} \lambda_n \sigma_{t-n} + \sum_{m=1}^{q} \rho_m u_{t-m} u_{t-m} \tag{5}$$

This model is called model (A) or general model. It is also called various coefficient model, since all parameters (namely μ, α, η, δ_n, γ_m, λ_n and ρ_m) are different in each series. It is possible to fix some of the parameters in cross-sections. Alternative models will be displayed in this case by imposing specific restrictions on the parameters of mean equation (2), conditional variance equation (4) and conditional covariance equation (5). Besides that it facilitates model estimation, reduces the number of parameters and interprets data in high-accuracy measurement. Prior to describing alternative tests in details, it is necessary to bear two points in mind: 1- Firstly GARCH(1,1) model is used because it would significantly reduce the number of parameters to be estimated. 2- Secondly, restrictions on constant, ARCH and GARCH coefficients will be considered simultaneously because it would prevent the generation of multiple restricted models. Figure1 depicts a diagram of all restricted models that can be extracted from the general model. According to the Bollerslev model (1986) for a single time series, conditional variance and covariance equations in panel data are as follows:

$$y_{it} = \mu_i + \sum_{k=1}^{p} \phi_k y_{i,t-k} + u_{it} \qquad i=1, 2,\ldots, N \quad , \quad t=1, 2,\ldots,T \tag{6}$$

$u_{it} \sim N(0,h_{it})$

$$\sigma_{it}^2 = \alpha_i + \sum_{n=1}^{p} \delta_{in}\sigma_{i,t-n}^2 + \sum_{m=1}^{q} \gamma_{im}\, u_{i,t-m}^2 \tag{7}$$

$$\sigma_{ijt} = \eta_{ij} + \sum_{n=1}^{p} \lambda_{in}\, \sigma_{ij,t-n} + \sum_{m=1}^{q} \rho_{im}\, u_{i,t-m} u_{j,t-m} \qquad i \neq j \tag{8}$$

$$i\,,j = 1,2,\ldots,N$$

What is worth to discuss about in model A is the large number of its parameters (Hsiao, 2003). As a general model, this one cannot be used as the most efficient model in volatility data generating process (DGP). Therefore restrictions will be imposed on the estimated coefficients. These restrictions are not just to simplify the model and reduce estimated parameters, but also result in a model that describes Data in high accuracy. Imposed restrictions will be tested by using LRT statistical tests which were developed by Hendry (1995). The restrictions include next three steps:

1. Imposing Equality Constraint on the Constant Parameter of the Mean Equation

Null hypothesis is to fix the constant term in the mean equation for all cross-sectional units in the panel (model B)

$$y_{it} = \mu + \sum_{k=1}^{p} \phi_k y_{i,t-k} + u_{it} \qquad i=1,2,\ldots,N \quad , \quad t=1,2,\ldots,T \tag{9}$$

If the null hypothesis cannot be rejected, then the restriction will be retained and further restrictions will be imposed (left-hand branch of Figure2). Alternatively if LRT rejects the null hypothesis, then the varying parameters model must be retained and restrictions on the conditional variance and covariance equations must be tested (right-hand branch of Figure2). Figure2 is symmetrical and the process of placing restrictions on the variance and covariance equations is similar for both sides. Concentrating on the right-hand side, the process of restrictions is described in the next step.

2. Imposing Equality Constraints on the Slope Parameters of the Variance and Covariance Equations

Null hypothesis is that the coefficients δ_1, γ_1, λ_1 and ρ_1 are common for all units in the panel (model F). It is put against the alternative hypothesis: these coefficients are different across units in the panel (model A). By imposing these restrictions, variance and covariance equations change as follows:

$$\sigma_{it}^2 = \alpha_i + \sum_{n=1}^{p} \delta_n \sigma_{i,t-n}^2 + \sum_{m=1}^{q} \gamma_m u_{i,t-m}^2 \quad (10)$$

$$\sigma_{ijt} = \eta_{ij} + \sum_{n=1}^{p} \lambda_n \sigma_{ij,t-n} + \sum_{m=1}^{q} \rho_m u_{i,t-n} u_{j,t-m} \quad i \neq j \quad (11)$$

3. Imposing Equality Constraints on the Mean Variance in the Variance Equation and the Mean Covariance in the Covariance Equation

The further restrictions will be imposed on model F. The null hypothesis is: α_1 and η_{12} are the same for all units in the panel. By imposing these restrictions and in the case that LRT rejects previous restrictions (model H), then equations 7 and 8 will be changed as follows:

$$\sigma_{it}^2 = \alpha_1 + \sum_{n=1}^{p} \delta_{in} \sigma_{i,t-n}^2 + \sum_{m=1}^{q} \gamma_{im} u_{i,t-m}^2 \quad (12)$$

$$\sigma_{ijt} = \eta_{12} + \sum_{n=1}^{p} \lambda_{in} \sigma_{ij,t-n} + \sum_{m=1}^{q} \rho_{im} u_{i,t-m} u_{j,t-m} \quad i \neq j \quad (13)$$

If LRT rejects these restrictions, then we conclude that model A is the best model. If restrictions on the slope parameters of variance and covariance equations can be accepted, then equations 7 and 8 will be changed as follows (model G):

$$\sigma_{it}^2 = \alpha_1 + \sum_{n=1}^{p} \delta_n \sigma_{i,t-n}^2 + \sum_{m=1}^{q} \gamma_m u_{i,t-m}^2 \quad (14)$$

$$\sigma_{ijt} = \eta_{12} + \sum_{n=1}^{p} \lambda_n \sigma_{ij,t-n} + \sum_{m=1}^{q} \rho_m u_{i,t-m} u_{j,t-m} \quad i \neq j \quad (15)$$

Following the proposed framework in Figure 2, likelihood ratio test (LRT) is used to determine which model would be the most appropriate model for the DGP (Keshavarz & Babaei, 2011). Because of its rapidly convergence, the BFGS[1] algorithm is used in all cases (Nocedal, 2006). To estimate model A, the log likelihood function must be maximized as follows:

1. Broyden, Fletcher, Goldfarb, & Shanno (1957)

$$l= - \left(\frac{NT}{2}\right)\ln 2\pi - \frac{1}{2}\sum_{t=1}^{T}\ln|\Omega_t| - \frac{1}{2}\sum_{i=1}^{N}\sum_{t=1}^{T}(y_t - i_N\,\mu_i - \phi y_{t-1})'\,\Omega_t^{-1}(y_t - i_N\mu_i - \phi y_{t-1}) \quad (16)$$

The covariance matrix Ω_t is time dependent and its diagonal and off-diagonal elements are given by equations (7) and (8) respectively. Likewise and with fixing the parameters that correspond to the imposed restrictions on the model, the above function will be used for estimating parameters of all models. Now with describing exchange rate volatility and its estimation along with other variables in the equation (1), we set to describe equation (1) with using panel data in the following second step.

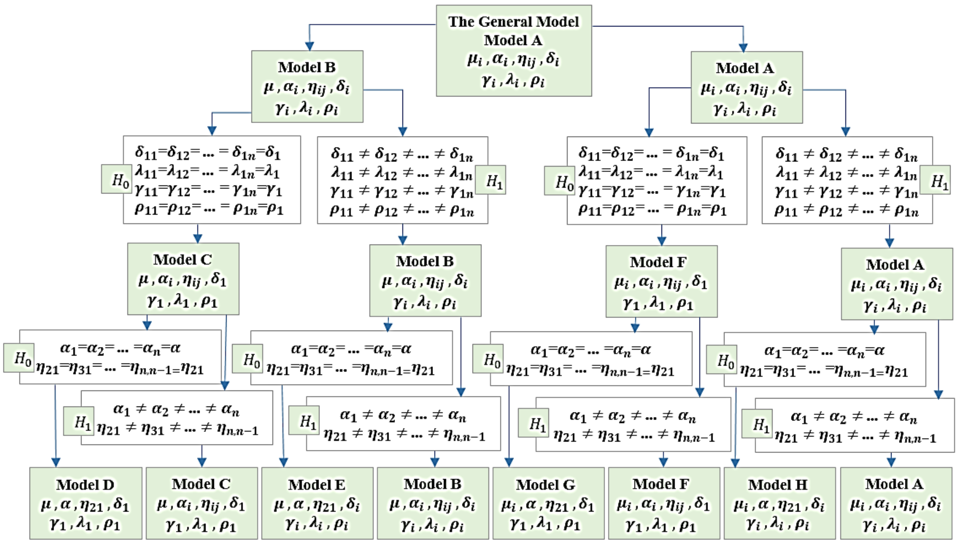

Figure 2: General Volatility Modeling Framework: Testing from General to Specific Volatility Models with a GARCH(1,1) Structure. H_0=Null hypothesis, H_1=Alternative hypothesis (Extended Cermeno & Grier approach, 2006)
Source: Bakry, W. K. (2006: 172).

3.2 Second Step: Static Panel

From the regression model which is $Y_{it} = \beta X_{it} + \alpha W_i + \varepsilon_{it}$ it is observed that if W_i includes just a constant term (α) to be the same for all groups, then it is a pooled regression. If W_i is not visible but has correlation with X_{it}, then each group has an independent constant term (α_i) that is called fixed effects. If αW_i is random and independent of x_{it} then $E(\alpha W_i) = \alpha$ and the regression model is a panel random effects. For distinguishing between pooled effects and fixed effects we will use the F-limer test, and for distinguishing between fixed effects and random effects we will use the Hausman test.

4. Estimation and Results

4.1 Exchange Rate Volatility

First we must check exchange rate stationarity and heteroscedasticity. Non-stationary data may cause spurious regression, and heteroscedasticity causes error terms not to be fixed. Table 1 implies that exchange rate variable is Non-stationary at the level but is stationary in first difference. In this study, the first difference is calculated in terms of growth rate. Our reason is that it will remove Non stationary effects of time series (Pesaran, Shin, & Smith, 2000).

Table 1: Panel Unit Root Test

Tests	Variable	Level		First difference	
		Statistic	Prob	Statistic	Prob
Levin-Lin-Chu	ER	-1.1391	0.1273	-2.3351	0.0098
Im-Pesaran-Shin	ER	-0.6160	0.2689	-17.0816	0.0000

Resource: Calculations of Research Using RATS9.0 Software

Heteroscedasticity must be checked in the next stage with using the arch test to investigate the existence of heteroscedasticity in error terms of each country regression equation. As the contents of Table 2 imply, only in four countries (namely Iran, Pakistan, Indonesia and Bangladesh) LRT rejects the null hypothesis. Multivariate ARCH test (last row in Table 2) also confirms heteroscedasticity in the four countries. Consequently there exist volatilities in the exchange rate of those four countries.

Table 2: Heteroscedasticity Test

Country	Statistic	Prob
Iran	32.303	0.00001
Pakistan	11.918	0.03592
Indonesia	23.905	0.00023
Bangladesh	13.759	0.01722
Turkey	5.267	0.38416
Nigeria	1.182	0.94661
Egypt	0.141	0.99962
Malaysia	4.607	0.43960

Selected panel	2039.291	0.0000

Resource: Calculations of Research Using RATS9.0 Software

In what follows we estimate the M-GARCH model for the four proposed models (namely models A, B, F, G) and then compare them to each other with using the general to specific algorithm. According to tests, we use AR(3) model for conditional mean equation. The currency growth rates of the four countries are depicted in Figure 3. Several structural breaks can be observed in Figure 3.

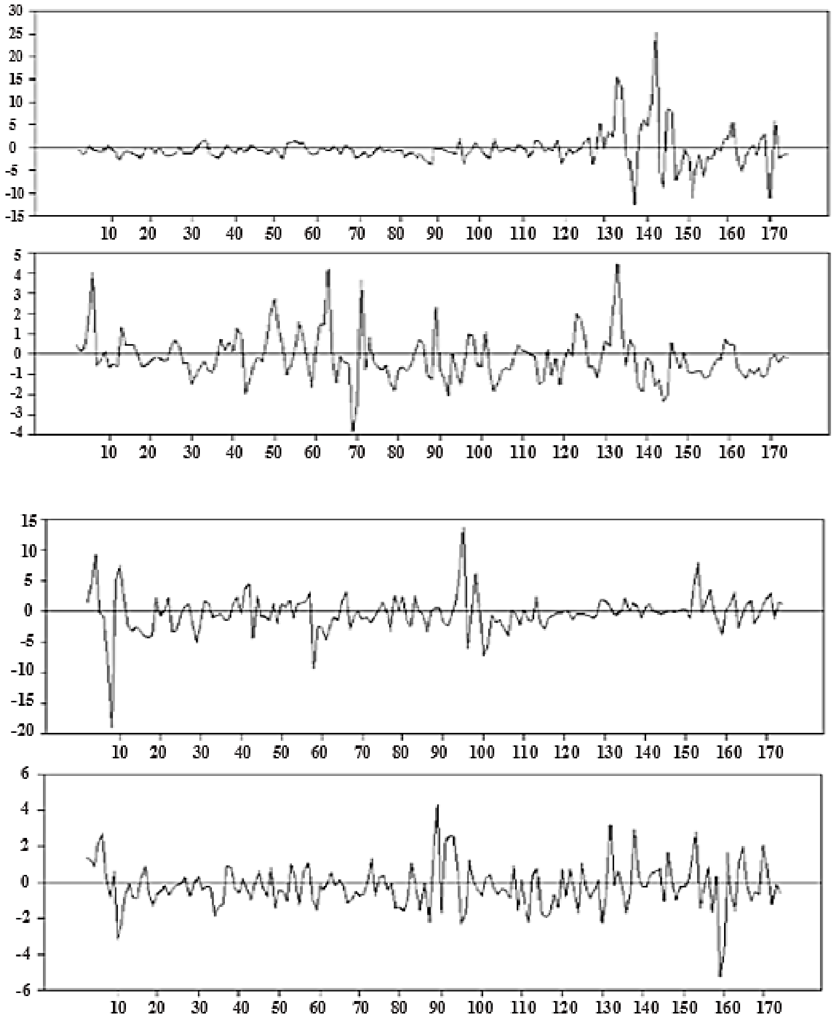

Figure 3: Currency Growth Rate

From up to down: Iran- Bangladesh- Indonesia- Pakistan (Reference: RATS9.0)

Therefore we need to define dummy variables (dum_{ij}) for those countries where trends have structural breaks. Since positive outliers data exist besides negative ones, we define one dummy variable for each to consider these impacts on the model individually (i=1, 2, 3, 4 represent Indonesia, Bangladesh, Pakistan and Iran respectively and j=1, 2 represent positive and negative outliers respectively).

if: Currency growth rate(Iran) ≥ 4; dum_{41}==1;0 (A)
Currency growth rate (Iran) ≤ -4; dum_{42}==1;0 (B)
if: Currency growth rate (Indonesia) ≥ 3; dum_{11}==1;0 (C) (17)
Currency growth rate (Indonesia)≤-4; dum_{12}==1;0 (D)
if: Currency growth rate (Pakistan)≤ -3; dum_{32}==1;0 (E)

These restrictions state that in Iran where the currency growth rates are greater than 4, dum_{41} is equal to one and for other points it is zero. If the currency growth rates are less than -4 (equation B) dum_{42} for those points is equal to one and for other points is is zero. Equations C, D and E are interpreted in the same way. Conditional mean equations in terms of dummy variable are as follows:

$$y_{i,t}= \mu_i + \phi_1 y_{i,t-1} + \phi_2 y_{i,t-2} + \phi_3 y_{i,t-3} + D_{i1}\, dum_{i1} + D_{i2}\, dum_{i2} + u_{i,t} \qquad (18)$$

Considering the modeling results with using the methodology proposed and after estimating the parameters of model A and restricted model B and comparing these two models with the function of LRT, results (Table 3) indicate that the restriction imposed on the model A is not valid. This restriction was therefore rejected. Following this phase and rejecting mean equation constraint, we can proceed to impose next restrictions and reach model F (Figure 2). After estimating the parameters of model F and comparing LRT statistic with critical values, the null hypothesis that imposed on the model A (i.e., equality hypothesis of slope parameters of variance and covariance equations) is not rejected since LRT value is less than critical values at all significantly levels. With imposing next proposed restrictions (model G) and estimating the parameters and comparing the LRT statistic with critical values, the null hypothesis (i.e., equality constant terms in variance and covariance equations) is rejected. Table 3 implies that the best model in this study for modeling exchange rate volatility of the four countries is model F.

Table 3: Likelihood Ratio Tests

Section I				Critical values		
Model A versus Model B	**Model A**	**Model B**	**LLR**	10%	5%	1%
D8 Selected panel	-1169.68	-1173.12	6.88	6.25	7.81	11.34
Critical values				Section II		
Model A versus Model F	**Model A**	**Model F**	**LLR**	10%	5%	1%
D8 Selected panel	-1169.68	-1172.30	5.24	23.54	26.30	32.00
Section III				Critical values		
Model F versus Model G	**LLR**	**Model G**	**Model F**	10%	5%	1%
D8 Selected panel	-1172.30	-1184.31	24.02	13.36	15.51	20.09

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Table 4 contains the estimated parameters of model F where t-statistics are put in parentheses and ***, **, * represent significance levels of 1%, 5% and 10%, respectively.

Table 4: Model F

Fixed Parameters of Variance and Covariance Equations Slopes					
Variance	δ	0.647 (12.559)***			
	γ	0.256 (5.687)***			
Covariance	λ	1.040 (2365.812)***			
	ρ	-0.011 (-124.356)***			
Mean	ϕ_1	0.227 (10.348)***			
	ϕ_2	-0.105 (-3.347)***			
	ϕ_3	0.086 (4.671)***			
		Indonesia	**Bangladesh**	**Pakistan**	**Iran**
$\boldsymbol{\mu_i}$		-0.173 (-1.666)*	-0.235 (-8.199)***	-0.187 (-6.715)***	-0.477 (-7.548)***
$\boldsymbol{\alpha_i}$		0.640 (4.033)***	0.126 (2.933)***	0.166 (4.084)***	0.318 (4.371)***
$\boldsymbol{D_{i1}}$		6.720 (5.539)***			14.147 (15.266)***
$\boldsymbol{D_{i2}}$		-10.786 (-7.423)***		-3.615 (-12.705)***	-14.966 (-17.175)***
$\boldsymbol{\eta_{ij}}$		**j=1**	**j=2**	**j=3**	**j=4**
i=2		-0.001 (-20.717)***			
i=3		-0.011 (-69.566)***	-0.003 (-43.425)***		
i=4		-0.016 (-29.900)***	-0.005 (-23.908)**	-0.012 (-63.980)***	

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As the sum of the slope parameters of variance equation is almost one (exactly 0.9), we examine to see whether the model is in IGARCH structure. As is clear from Table 5, it rejects the null hypothesis and therefore the model is not in IGARCH structure.

Table 5: IGARCH Diagnostic Test

D8 Selected panel	unrestricted	restricted	LLR	0%	5%	1%
	-1172.30	-1176.35	8.09	2.71	3.84	6.63

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Now we focus on the second step and discuss how to model the impact of exchange rate volatility on stock returns.

4.2 Effect of Exchange Rate Volatility on the Stock Returns

In this step, we examine the effects of volatility derived from the previous step on stock returns. First we must consider stationary variables. For this purpose, Im, Pesaran, & Shin (IPS) proposed a test (Table 6). As is clear, the variables of volatility, inflation, interest rate, oil price and stock return are stationary; though real exchange rate and gold price are not. Therefore we calculate growth rate of exchange rate and gold price to change them into stationary variables.

Table 6: Panel Unit Root Test

Test	**Variable**	**Level**		**First Difference**	
		Statistic	**Prob**	**Statistic**	**Prob**
IPS	VOL	-4.9269	0.000		
	INF	-3.6018	0.000		
	INT	-4.7194	0.000		
	LOP	-3.3507	0.000		
	ER	0.9813	0.837	-9.5952	0.000
	G	-0.3940	0.347	-3.8978	0.000
	R	-7.8520	0.000		

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In the next phase and with using diagnostics tests, we must compare pooled, random and fixed effects panels and select the best model. With respect to the F-Limer & Hausman tests probabilities (Table 7) panel fixed effects is the best in model 1. To assess the strength of model 1, new variables, namely interest rate, gold price and exchange rate, have been added to model 1 one by one and then the value and sign of exchange rate volatility have been reexamined. Table 7 presents estimation of panel fixed effects of model 1 and also models with respect to the above variables (models 2-4 have been created by adding real interest rate, real exchange rate and gold price respectively). In all models, diagnostics tests show that fixed effects are the best models. The Wooldridge and LR tests determine autocorrelation and homoscedasticity in panel-data models respectively.

Table 7: Panel Fixed Effects Estimation

Variable	**Model 1**	**Model 2**	**Model 3**	**Model 4**
VOL	0.244 (3.67)***	0.239 (3.54)***	0.243 (3.72)***	0.244 (3.66)***
INF	-0.231 (-3.49)***	-0.226 (-3.36)***	-0.234 (-3.59)***	-0.231 (-3.47)***
LOP	2.780 (2.54)**	2.721 (2.47)**	3.019 (2.81)***	2.778 (2.52)**
INT		-0.025 (-0.43)		
D(ER)			-0.398 (-3.84)***	
D(G)				-0.001 (-0.01)
R^2	0.046	0.044	0.082	0.043
F-statistic	3.836 [0.001]	3.306 [0.002]	5.529 [0.000]	3.279 [0.002]
Diagnostics Tests				
F-Limer	3.557 [0.015]	2.882 [0.036]	3.735 [0.012]	3.530 [0.015]
Hausman	10.671 [0.005]	8.647 [0.034]	11.206 [0.011]	10.590 [0.014]
Wooldridge	931.555 [0.000]	932.370 [0.000]	5483.028 [0.000]	657.181 [0.000]
LR	1.62 [0.655]	0.91 [0.822]	1.62 [0.654]	1.74 [0.628]

▪ Upper numbers are panel coefficients.
▪ Numbers in parentheses and brackets represent t-statistic and significant level respectively.
▪ ***, **, * represent 1%, 5% and 10% significant levels respectively.
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Finally, we use F-GLS estimation (Restricted Model) to fit the model without heteroscedasticity and autocorrelation (Robinson, 1987). Table 8 presents F-GLS estimation that is final model in this step.

Table 8: F-GLS Estimation

Variable	Model 1	Model 2	Model 3	Model 4
Constant	-8.604 (-1.79)*	-8.131 (-1.69)*	-9.692 (-2.05)**	-8.774 (-1.80)*
ER	0.184 (3.03)***	0.176 (2.90)***	0.186 (3.13)***	0.184 (3.04)***
INF	-0.077 (-1.66)*	-0.085 (-1.81)*	-0.079 (-1.72)*	-0.077 (-1.65)*
LOP	2.212 (2.04)**	2.107 (1.94)*	2.447 (2.30)**	2.247 (2.05)**
INT		-0.08 (-1.48)		
D(ER)			-0.396 (-3.81)***	
D(G)				0.018 (0.22)
Chi square statistic	12.22 [0.007]	14.47 [0.006]	27.25 [0.000]	12.27 [0.016]

- Upper numbers are panel coefficients and chi-2 statistic in last row.
- Numbers in parentheses and brackets represent t-statistic and significant level respectively.
- ***, **, * represent 1%, 5% and 10% significant levels respectively.

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According to Table 8, the exchange rate volatility in all GLS estimations is positive and significant at the one percent level. Moreover, it has a high strength among the factors affecting the stock returns. Probabilities of other variables in the four models have also been presented. Results can be summarized as follows:

- Oil price is significant and positive.
- Inflation and exchange rate growth are significant and negative.
- Interest rate is significant at %14 level and has a relatively high level of confidence (%86) with negative sign.
- Gold price is not significant.

Now let consider each variable separately: increasing one unit in the exchange rate volatility causes an increase of 184 units in the stock returns. The significant and positive exchange rate volatility confirms the portfolio theory. Increasing risk and volatility in the currency market has functioned as a competitor and alternative asset of stock market, which in turn has made investors not to invest in the foreign exchange market like before. As a consequence, they are induced to invest in stock market in order to reduce the risk, prevent losses and earn more profits. This causes a flow of liquidity to the market and an increase in the returns. One unit of increase in the currency growth rate reduces 396 units in returns. With increasing exchange rates and a weakening currency, investors will not have enough confidence to invest and earn profits. Therefore investment decreases and stock returns will reduce. Increasing one unit in inflation rate causes a reduction of 0.077 unit in stock returns. In terms of inflation the nominal profit of companies will increase after a period of time. In this case, profitability has not increased in fact; rather, nominal earnings have been increased by inflation. When the nominal benefit increases, nominal stock prices will also increase. Another effect of inflation is to reduce the intrinsic value of stocks. Whenever inflation is high, real earnings quality of companies (economic profit) comes down. Each unit of increase in interest rate reduces returns by 0.08 unit. Rate of return is not appropriate in the face of risk and this macroeconomic variable is a competitor and alternative asset of stock market. On the other hand, investment rate increases by reducing the interest rate. The reason is that a decrease in interest rate makes implementation of the investment projects that have a low rate of return commodious. Rising the interest has a reverse effect of course. Finally, each unit of increase in the oil price causes an increase of $\frac{2/212}{90/489}$ = 0/024 unit in stock returns.[1]

5. Conclusion and Future Extensions

As mentioned in section 1, this study investigates the effect of exchange rate volatility on the stock exchange returns of D8 countries. In order to achieve this purpose, our research was divided into two steps. In the first step we applied general to specific algorithm for estimating volatility index. The algorithm started with a general model (model A) and then a series of specific restrictions were imposed to achieve a more specific model. The results of likelihood ratio test (LRT) implied that exchange rates were unstable in four countries, namely Iran, Pakistan, Indonesia and Bangladesh, and panel data model with fixed effects was the best model to explain the structure of exchange rate volatility in these countries. After estimation the volatility index, we examined its impact on the stock returns in the

1. For calculating oil price value, the logarithm of oil price has been divided to its mean.

second step. According to the Diagnostics tests, panel data models with fixed effects were the best models to examine the effect of exchange rate volatility on stock returns. However panel F-GLS was applied because of fitting the model without heteroscedasticity. Exchange rate volatility affects positively and significantly on stock exchange return in the four countries. this is consistent with portfolio theory and confirms both hypothesis (significant and positive effect of exchange rate volatility on stock return). For model analysis, we added some variables (interest rate, inflation, gold price, exchange rate and oil price). The variables of real exchange rate and inflation rate have negative effects but oil price has positive effect on stock returns, while interest rate and gold price do not have any significant effect. According to the results those who involved in the task of stock pricing should keep in mind the role of alternative markets such as currency market. Moreover, fluctuations in other macroeconomic variables must be included in stock pricing. As one offer we can examine and compare affecting exchange rate volatility on stock returns of developed and developing countries in the form of two panels. In addition, analysis can be done with dynamic panel techniques like DOLS and GMM. In this study, there were no exogenous variables in the variance and covariance equations, though due to effective factors in each country, their effects can also be considered.

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