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# VIETNAM'S STOCK MARKET VOLATILITY UNDER MACROECONOMIC IMPACTS

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## ABSTRACT
**Purpose** - This study investigates whether the volatility of stock market returns is determined by macroeconomic variables either as individual or as a group, within the context of Vietnam – a frontier emerging market. Six macroeconomic factors have been selected, including economic growth (GDP), consumer price index (CPI), broad money supply (M2), interest rate (represented by refinancing rate – FR), foreign exchange rate USD/VND (EX), and foreign direct investment (FDI).
**Methodology** - Using 161 monthly observations collected from August 2000 to December 2013, the paper employs general autoregressive conditional heteroskedasticity (GARCH) framework to measure stock market volatility as well as to estimate this volatility under indicated macroeconomic impacts.
**Findings** - Taking the volatility clustering into account, the GARCH (1,1) models reveal that the volatility of Vietnam's stock market returns is highly persistent, suggesting a long memory of the volatility in response of a shock. Additionally, the stock market volatility could be predicted better using previous shocks (i.e. those originating from GDP, CPI and EX) rather than the previous volatility itself.
**Conclusion** - The prediction of Vietnam's stock market volatility could be better based on the selected macroeconomic indicators. A monthly change in consumer price index appears as the most essential indicator that help predicting the volatility of the Vietnam's stock market. Any news about economic growth can be considered as the second significant factor in explaining Vietnam stock return volatility. Furthermore, the univariate analysis shows a statistical significant evidence for the impact of a change in the exchange rate (USD/VNA) on Vietnam's stock market volatility.

**Keywords:** Stock market volatility, macroeconomic factors, GARCH, emerging markets
**JEL Codes:** C5, G14, G15

## 1. INTRODUCTION

The innovation and growth of stock market has marked a significant progress towards the development of the whole economy. The stock market is not only an important channel to raise capital for corporations, but also a place to gain profits for individuals. However, at the same time it poses potential risks to the economy. The world has witnessed a number of stock market crashes as well as large volatility of stock market returns through financial crunches, such as the Asian crisis of 1997-1998 and the global financial crisis of 2007-2008. Such crashes cause a decline in corporate profits, while an increase in business failures substantially impacts on economic growth.

As a major of economic time series, stock market returns can be characterized as "conditionally heteroskedasticity", implying that the volatility of such series is non-constant over a specified period in spite of the assumption of unchanged unconditional or long run variance (Enders, 2004). Furthermore, like most high-frequency financial and economic data, stock market returns are also known as "volatility clustering", which refers to the phenomenon that a period of high/low volatility tends to be followed by periods of high/low volatility and vice versa (Mandelbrot, 1963).

Understanding the behavior of market volatility in order to make better investment decisions is extremely significant to both academicians and practitioners (i.e. risk managers, portfolio managers, investors). Therefore, several studies have been concerned with modeling and forecasting the volatility of financial time series data (Engle, 1982; French *et al*., 1987; Schwert, 1989). On the other hand, the relationship between stock market returns and macroeconomic variables has remained as an attractive topic in literature (Chen et al., 1986; Fama and French, 1989; Hsing, 2011; Kuwornu, 2012; Zakaria and Shamsuddin, 2012, etc.). However, the association between stock market volatility and macroeconomic variables has been inconclusive, especially for the case of emerging economies.

According to the "Business Perspectives on Emerging Markets 2012-2017 Report" prepared by the Global Intelligence Alliance (GIA), Vietnam is ranked seventh in the world's top emerging markets for 2012-2017, after the BRIC countries, Indonesia and South Africa. Like other emerging markets, the Vietnamese capital market has been developing rapidly and playing a growing role in the country's economic performance. However, the development of the equity market in Vietnam has been shown to be unsustainable over the years and has hidden a number of shortcomings, i.e. investment policies and changes of macroeconomic elements. This is despite the number of published papers that have emphasized the determinants of the volatility of equity returns in Vietnam still being limited. Hence, this paper aims to fulfill the literature by taking account for the volatility of stock market returns under macroeconomic impacts under the context of Vietnam – a fresh emerging market.

The paper is organised in four main sections: literature review, data and methodology, findings and discussions, and conclusion. Starting with initial understanding of Vietnam's economy and stock market, the literature review then comprehensively represents the previous findings for the relationship between macroeconomic factors and stock market volatilities in Vietnam. The data and methodoly section clarifies the main methodology, comprising of data collection, and the GARCH models. Via GARCH models, the volatility of Vietnam's stock market is firstly measured and the nexus between selected macroeconomic variables (economic growth (GDP), consumer price index (CPI), broad money supply (M2), interest rate (represented by refinancing rate – FR), foreign exchange rate USD/VND (EX), and foreign direct investment (FDI)) and the volatility of VN-Index is subsequently estimated over the sample period 2000-2013. The statistical results obtained from the specific econometric approaches are presented in the findings and discussions section. The final section concludes the major outcomes of the paper and points out some shortcomings that emerge over the course of the research and outlines areas where further work could be done to address these issues.

## 2. LITERATURE REVIEW

### 2.1. Overview of Vietnam's Economy and Vietnamese Stock Market

Before the global financial crisis in 2008, the economic growth of Vietnam was well maintained stably at the rate of around 7-8%, and hit the highest number at 8.5% in 2007. However, the financial crisis that originated from the US and then spread to the entire world from 2008, followed by the worldwide economic depression, had a negative impact on the country. Economic output fell to 6.3% in 2008 and reached a bottom of 5.4% in 2009 (WB Data). The growth in the Vietnam economy seems sluggish after that. Following a slightly recovery in 2010, it decelerated again to 6.2% in 2011, 5.2% in 2012, 5.3% in 2013 (WB Data). Most of sectors that contribute to GDP as well as the total GDP have experienced the slowest pace of growth since the reform of the "Doi Moi" system in the late 1980s, despite the stable politic environment.

On the other hand, even though the period began with the threat of deflation when inflation rate remained low after 1999 (just 4.11% in 1999), CPI began to increase from 2004 (at 7.8%) and surged to a peak of 23.1% in 2008. The inflation rate was then kept under control in 2009 and 2010, which were 7.05% and 8.86% respectively. After a rise again to reach the highest number since December 2008 to 18.7 % in 2011 (WB Data, http://data.worldbank.org/indicator/FP.CPI.TOTL.ZG?locations=VN), this index started a decreasing trend then reached low number (9.09% in 2012, 6.59% in 2013, and 4.09 in 2014).

Despite the fluctuation of inflation rate, the period 2000-2013 marked a number of significant changes in monetary system of Vietnam, such as money supply growth, credit and deposits, interest rates volatility.

**Table 1: Growth of Money Supply, Credit, CPI and GDP, and Ratio of M2/GDP 2005-2010 (percent per annum)**

| | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|
| Growth of M2 | 29.7 | 33.6 | 46.1 | 20.3 | 29.0 | 33.3 |
| M2/GDP | 75.6 | 86.9 | 108.1 | 100.4 | 115.7 | 129.3 |
| Growth in credit | 25.50 | 53.90 | 25.40 | 39.60 | 32.40 | 14.40 |
| CPI growth | 8.3 | 7.1 | 8.3 | 23.1 | 5.9 | 6.4 |
| GDP growth | 7.5 | 7.0 | 7.1 | 5.7 | 5.4 | 6.4 |

*Source: Asian Development Outlook Reports 2005-2010 (ADB), Economic Indicators (IFS, http://www.elibrary-data.imf.org/)*

Besides, with favorable economic conditions, such as low wages, its ideal location and a stable political context, Vietnam has been one of the most attractive destinations for foreign investors in the region and worldwide (WB, 2013). Particularly, foreign direct investment (FDI) retains a high figure of disbursement, reached 10.5 to 11 billion USD over the period 2010-2012. The country has been kept positive ambition to moving forward socialist-oriented market, with economic structure shifting to "industrialization and modernization".

Even though, several weaknesses (i.e. slow economic structural reforms with unreasonable investment structures, state subsidies and persistent protection, and macroeconomic instability) should be recognized and quickly addressed in order to stimulate the efficiency as well as the development of the whole economy.

In order to improve performance as well as to diversify capital mobilization channels into the economy, the government of Vietnam has been taking a number of efforts to reorganise all of the country's financial markets. One remarkable milestone on the path of Vietnamese financial market development was the launch of two securities trading centers (STCs) in the country's two main economic centers, which were Ho Chi Minh Securities Trading Center (HOSTC) and Hanoi Securities Trading Center (HASTC)[1].

The first trading session in Ho Chi Minh Securities Trading Center was formally opened on 28/07/2000 with only two listed stocks: Refrigeration Electrical Engineering Joint Stock Corporation (REE) and Saigon Cable and Telecommunication Material Joint Stock Company (SACOM). During March 2005, the other trading floor was officially opened in Hanoi with six listed companies and only one trading method available was negotiation.

Over the period 2000-2013, VN-Index has affirmed its role as one vital indicator to reflect the performance of the whole economy. Especially, the two years 2007-2008 experienced a booming of the Vietnam's stock market, with rapid development of the whole economy. In 2008, the VN-Index reached its historical high at 921.07 points. However, as a result of the global recession, the VN-Index hit the bottom during 2009 but has been recovering until the present. On 31 December 2013, the VN-Index closed at 504.6 points, 21.97% up on the previous year. During the same period, the trading volume has surged dramatically, with a significant contribution from foreign investors. In spite of the drastic decline of the VN-Index, the year 2009 closed with 70.4 billion shares trading on the Ho Chi Minh Stock Exchange, with the total trading value peaking at 3 trillion VND. At the end of 2013, the trading volume on HOSE was 61 million shares, valued at 869.5 billion VND, with nearly 39.8 billion shares on HNX, equivalent to 275.9 billion VND.

The background of macroeconomic environment and the equity market of Vietnam may suggest a link between the stock market volatilities and the volatilities of selected macroeconomic variables in specified phase of the Vietnam's economic development. For example, the relatopnship was captured between the years 2008-2009, when the Vietnam's economy suffered from the spread of global economic stagnation. Due to the slowdown of the economy, inflation rate and interest rates rose drastically. At the same time, the VN-Index also hit its bottom.

## 2.2. Prior Studies on Stock Market Volatilities under Macroeconomic Impacts in Vietnam

The typical empirical findings denote the efficiency of the Vietnamese stock exchange in weak form, regarding to the classifications of efficient market hypothesis (EMH – initially introduced by Fama (1970)) (Truong, Lanjouw and Lensink (2010); Phan and Zhou (2014)). It may suggest arbitrage opportunities for investors in this capital market. However, to achieve better investment decisions, as well as to provide better indications for policy makers, research on the macroeconomic determinants of stock market volatility for Vietnam should be in high demand. There is unfortunately a limited range of studies that have covered this topic.

There are few papers that focus on the linkage between macroeconomic factors and stock market returns within the context of Vietnam. Among different macroeconomic variables selected to investigate their influence on Vietnamese equity returns, most of them are international factors (i.e. USD/VND exchange rate, US real production activity).

Hussainey and Le (2009) attempted to find any linkage between two selected macroeconomic variables (industrial production together with interest rate) and Vietnam's stock market prices over the period from January 2001 to April 2008 in both domestic and international perspectives. Applying the regression model technique for domestic variables and for both domestic and international variables separately, the research found out three significant points. The first result showed that industrial production could lead to changes in stock prices. The second finding showed the influence of interest rates (both long-term and short-term) on equity prices in the different direction. The final one found that there was a stronger effect on Vietnamese stock prices from US real production activity than from the US money market.

Recently, by applying a number of statistical tests, including cointegration tests, long-run elasticity, error correction model and parameter stability test, Narayan and Narayan (2010) intended to model the linkage between two global determinants (oil prices and nominal exchange rates) and Vietnam's stock market index utilizing daily data over the period 2000-2008.

[1] "*The Strategy for the Development of Vietnam's Securities Market up to year 2010*", The Prime Minister's Decision No. 163/2003/QD-TTg.

Both oil prices and exchange rates were found to have a statistically substantial positive effect on stock prices in the long run. However, there was no evidence of a nexus between oil prices and equity prices in the short run, consisting to the conclusions of Chen et al. (1986) as well as the later studies of Kuwornu and Victor (2011) and Samadi, Bayani and Ghalandari (2012). Similar same result was found for exchange rate, as it had no impact on stock index.

Besides some formally publishes from official international sources, there are few studies on the same field that collected from local journals (i.e. university journals in Vietnam). They may help providing more adequate view on this topic. Even though, these recent papers have used limited macroeconomic variables and not observed the vital nature of stock market returns – which is volatility clustering.

For example, Huynh et al. (2014) applied two updated frameworks, namely VECM and Granger Causality tests, to find out the long run and short-run effects of macroeconomic time series (including money supply – MS, lending interest rates – ITR, consumer price index – CPI, exchange rate – EXR and industrial production – IP) on the Vietnam's stock market (VNI) over the period 2001-2013. While MS and IP had a significant negative impact on VNI, ITR and CPI had an opposite influence. Additionally, the results of Impulse Response Function showed that VNI responded to any disequilibrium originated from a shock on macroeconomic variables at a relatively slow pace.

In the most recent research, Le and Dang (2015) utilized the ARDL technique to uncover the interactions between Vietnam's stock market index and consumer price index (CPI), money supply (M2), exchange rate (E) and short-term interest rates during the time span between Jan 2001 and Dec 2013. In both long- and short-run, the results showed the presence of the linkage between VNI and macroeconomic factors. In particular, M2 and VNI were positively correlated while the remaining of macroeconomic factors negatively impact VNI.

In addition to these above researches, few recent papers have been paid more attention to the volatility of stock market in Vietnam. Do, Mcaleer, and Sriboonchitta (2009) selected Vietnam as one of the five ASEAN emerging stock markets to study the behavior of returns and volatilities and their association with the international gold market. Based on the daily sample from 28 July 2000 to 31 October 2008, the empirical result of Granger causality tests revealed the bi-directional relation between the gold and stock market in Vietnam. Additionally, the paper proved the better estimation of Vietnam's stock market volatility by the symmetric GARCH (1,1)-X model (which X represents for exogenous variables) rather than GJR (1,1) – X model, and also found the leverage effect in Vietnam's market with a positive and significant value of risk premium.

Focused on the context of Vietnam's stock market, Nguyen (2011) used time-varying GARCH (i.e. MA-EGARCH (1,1)) model to investigate the impact of the US macroeconomic announcements on stock returns and stock market volatility. Based on a selection of 12 major macroeconomic news over the period from August 2000 to September 2009, the study disclosed that the US economic variables, reflecting this country's economic prospect, could stimulate the returns of Vietnam's stock market and reduce the volatility of the index. The significant impact of the US macroeconomic announcements on the Vietnam's stock returns was also confirmed under the presence of the spillover effect from the US stock market.

Nonetheless, within literature abound, no research has been found to show the conclusive linkage between Vietnam's stock market volatility and macroeconomic factors.

## 3. DATA AND METHODOLOGY

### 3.1. Data Collection

This paper intends to estimate the volatility of Vietnam's stock market under the impacts of six macroeconomic variables, namely real economic growth (RGDP – the real growth rate of Gross Domestic Product), consumer price index (CPI – inflation rate), real money supply (RMS – measured by broad money M2), real interest rates (RIR – consisting of refinancing interest rate, deposit rate, and lending rate), real foreign exchange rate (REX – represented by USD/VND) and real foreign direct investment inward (RFDI), and real stock market returns (RVNI) based on the context of Vietnam's economy.

Stock market returns utilized in this study are grounded on the key Vietnam's stock market index, the Vietnam Ho Chi Minh Stock Index or VN-Index (officially denoted as VNI). The VN-Index is a capitalization-weighted index of all the companies actively listed on the Ho Chi Minh City Stock Exchange (HOSE), the major stock exchange in Vietnam. The index was created on 28 July 2000 with a base index value of 100. Stock returns for the period t can be computed as the percentage change of the stock market index over the period from (t-1) to t, hence it can be formulated as $\mathbf{\Delta VNI_t = \ln (VNI_t) - \ln (VNI_{t-1})}$ (where ln denotes the natural logarithm; $VNI_t$ depicts the average of stock price index at the end of month t; and $\Delta VNI_t$ refers to the return on the Vietnam's stock market on month t).

The real returns of the Vietnam's stock market index can be calculated after adjusting by price level or inflation rate. Other macroeconomic series used in the research are generated in detail as provided in Table 2. Also note that all of the variables are obtained in real values after adjusting by the price deflator or inflation rate. Based on characteristics of macroeconomic time series, all of the variables in real values are transformed into natural logarithmic forms before being applied in the econometric models. The purpose of transforming variables into natural logarithmic format is to handle highly skewed distributions that are most likely appropriate to macroeconomic variables. Gelman and Hill (2007) also stated a preference for using natural logs because coefficients on the natural-log scale are directly interpretable as approximate proportional differences. Furthermore, to perform the percentage changes on displayed series based on monthly periods, their first differences are subsequently converted.

**Table 2: Definitions and Transformation of Macroeconomic Variables**

| Variables | Definitions of Variables | Transformation |
|---|---|---|
| GDP<br>(Economic Growth) | Measured by the monthly percentage change in the real Gross Domestic Product, that is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. | $\Delta LRGDP_t = \ln(RGDP_t) - \ln(RGDP_{t-1})$<br>(Real monthly economic growth) |
| IR<br>(Interest rates) | Measured by the monthly percentage change in interest rate.<br>• Refinancing interest rate (FR): the interest rate that the State Bank of Vietnam (central bank in Vietnam) charges commercial banks and depository institutions on loans they receive from the discount window.<br>• Deposit rate (DR): is the average deposit rate of all commercial banks applied for their deposits based on monthly intervals.<br>• Lending rate (LR): is the average lending rate of all commercial banks applied for their loans based on monthly intervals. | $\Delta LRIR_t = \ln(RIR_t) - \ln(RIR_{t-1})$<br>(Monthly growth rate of real interest rates) |
| CPI (Inflation Rate) | Measured by the monthly percentage change in consumer price index, that is the cost to the average consumer of acquiring a basket of goods and services. | $\Delta LCPI_t = \ln(CPI_t) - \ln(CPI_{t-1})$<br>(Monthly growth rate of consumer price index) |
| MS<br>(Money Supply) | Measured by the monthly percentage change in broad money M2 (money and quasi money), comprising of currency outside banks, demand deposits other than those of the central government, and the time, savings, and foreign currency deposits of resident sectors other than the central government. This is the official calculation method for money supply generally used by Vietnam government statistical office. | $\Delta LMS_t = \ln(RMS_t) - \ln(RMS_{t-1})$<br>(Monthly growth rate of real broad money supply) |
| EX<br>(Exchange Rate) | Measured by the monthly percentage change in the real exchange rate USD/VND. | $\Delta LREX_t = \ln(REX_t) - \ln(REX_{t-1})$<br>(Monthly change in real exchange rate) |
| FDI<br>(Foreign Direct Investment) | Measured by the monthly percentage change in the implemented foreign direct investment. | $\Delta LRFDI_t = \ln(RFDI_t) - \ln(RFDI_{t-1})$<br>(Monthly change in real foreign direct investment) |

Source: The World Bank Data (http://www.data.worldbank.ord/indicator), The State Bank of Vietnam (http://www.sbv.gov.vn), and The General Statistics Office of Vietnam (http://www/gso.gov.vn).

While the chosen macroeconomic series are provided by the General Statistics Office of Vietnam (GSO), the Vietnam stock market index are collected from the official websites of the Ho Chi Minh Stock Exchange (HOSE) (http://www.banggia2.ssi.com.vn/). All series are gathered on a monthly basis spanning the period from the time the stock market officially launched in Vietnam from August 2000 until December 2013, except for the economic growth rate due to the fact that the range of GDP data is only available on a quarterly basis. Fortunately, the quarterly data of real GDP is subsequently successfully converted to monthly data using the statistical software Eviews Version 8.0. Hence, all of the variables are gathered in the same frequency to be applied to further statistical estimations.

There are 161 observations overall on each of the seven candidate variables and hence 160 observations on each after taking their first differences providing for the statistical analysis. These data are analysed using the statistical software Eviews 8.0 (the most updated version until 2014). This software is equipped as an easy-to-use statistical, econometric, and economic modeling package. More specific, it is one of the most powerful programmes for time series estimation and forecasting, especially in macroeconomics.

### 3.2. Measuring Stock Market Volatility via GARCH Models

Three so-called methods to measure the conditional variance of stock returns are historic volatility, exponential weighted moving average (EWMA) and autoregressive conditional heteroskedasticity (ARCH). However, historic volatility and correlation forecasting methods (also known as equally weighted moving average) and EWMA reveal several unrealistic assumptions that may lead to the problem of mispricing volatility. According to Alexander (1998), the first methods equal all weighted moving averages, which means that the impact of an event does not matter when it occurs long time ago or recently. Wherein, even given more weight on more resent observations, the second method assumes constant volatility term structures while the fact usually characterizes volatility with a cluster.

The most popular one, due to its efficiency for modeling conditional time- varying variance in recent empirical, is the ARCH approach, which was originally designed by Engle (1982). This approach estimates changes of information flows, both recent and old, on volatility. Although the standard ARCH models fail to take into account some other properties of financial time series data (i.e. leptokurtosis, asymmetric volatility), a number of extended ARCH models have been introduced to produce better predictions of volatility (i.e. GARCH, EGARCH, TGARCH).

One limitation of the original work by Engle (1982) is that the system requires a large number of lags to precisely fit the model. Bollerslev (1986) is therefore attributed to the current technique, the so-called generalized autoregressive conditional heteroskedasticity (GARCH). The idea of the standard GARCH (p,q) is based on a joint estimation of the conditional mean equation and the conditional variance equation. Specifically, Bollerslev (1986) suggests that conditional variance of returns is determined by both the squared residuals of the mean equation and its past own values. The maximum log likelihood method is utilized to generate a GARCH model. The standard GARCH (p, q) is represented by the two following equations.

First, it is the conditional mean equation which can be illustrated by a typical autoregressive moving average (ARMA) process, representing impact of the news on the volatility from the last period.

$$R_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i R_{t-i} + \sum_{j=1}^{q} \gamma_j \varepsilon_{t-j} + \varepsilon_t \qquad \text{(Eq. 1)}$$

where Rt denotes returns of the variables of interest at time t, Rt-i denotes a set for the mean of Rt conditional on the past information, $\varepsilon_{t-j}$ denotes moving average components, $\varepsilon_t$ is the heteroskedastic error term for the present period, parameter $\alpha_0$ is the constant, and p and q are the orders of the processes. To summarize, this chapter employs a series of GARCH using three major types of distribution to model the volatility of Vietnam's equity returns over the time span from August 2000 to December 2013. While the generalized error distribution (GED) exposes its high power in most cases, the simplest form within the GARCH family (i.e. GARCH (1,1)) followed by a specification of ARMA orders (i.e. ARMA (0,5) were proven to be sufficient for the current research context.

By successfully passing a variety of diagnostic checks, the ARMA (0,5)-GARCH (1,1) model is able to verify its adequacy in modeling stock market returns for the case of Vietnam, both in univariate and in multivariate analyses. Either ignoring or including exogenous macroeconomic variables, the residuals produced from all of the models appear with freedom of autocorrelation up to the 36th lag, no presence of ARCH effect up to the 12th lag, and attain normal distribution.

The second one represents a persistent coefficient via conditional variance equation:

$$h_t = \alpha_0 + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^{p} \delta_j h_{t-j} \qquad \text{(Eq. 2)}$$

where p, q are correspondingly the numbers of ARCH parameters ($\varepsilon_{t-i}^2$) and GARCH parameters ($h_{t-j}$). In which, the error process is that:

$$\varepsilon_t = v_t \sqrt{h_t} \qquad \text{(Eq. 3)}$$

Where $\sigma_v^2 = 1$; $\{v_t\}$ is a white-noise process, the conditional and unconditional means of $\varepsilon_t$ are equal to zero (for the more details in mathematics, see Enders (2004)).

The size of $\alpha_i$ and $\delta_j$ defines the short-run dynamics of the volatility of the underlying variable while the sum of these two parameters determines the persistence of the volatility to a specific shock (Alexander, 2007). In another words, if the sum of $\alpha_i$ and $\delta_j$ is very close to one, the volatility is very persistent to the shock.

Given that volatility can be measured through conditional variance by GARCH models, identifying the determinants of stock market volatility can be further examined to facilitate the forecasting ability of stock market movements. In order to investigate the association between various macroeconomic indicators and Vietnam's stock market volatility, the following statistical analysis will be structured with three major stages: (i) modeling volatility clustering for Vietnam's stock market returns; (ii) constructing GARCH models to identify the impact of each macroeconomic variables on the volatility of Vietnam's security prices; (iii) employing GARCH models to identify the macroeconomic influences as a group on Vietnam's stock market volatility.

Since the literature shows that the simple model GARCH (1,1) is adequate to describe data and produce significant results (Connolly, 1989; Fan and Yao, 2003; Floros, 2007; etc.), this paper uses standard GARCH (1,1) models to estimate the volatility of Vietnam's stock market returns. Via GARCH models using different types of distribution, the paper studies the influence of macroeconomic forces (either as individual or as a group) on stock market volatility in both univariate and multivariate perspectives. In specific, the conditional mean equation is kept unchanged, while the variance equation is adjusted to include from individual macroeconomic factors (univariate analysis) to all the six macroeconomic factors (multivariate analysis).

## 4. FINDINGS AND DISCUSSIONS

### 4.1. Statistical Description of Vietnam Stock Market Returns

Analysis of a statistical description and a stationarity test must be carried out on the time series of Vietnam stock returns to ensure the appropriateness of generalized autoregressive conditional heteroskedasticity (GARCH) models (Bollerslev, 1986) to apply into the context of the Vietnam's stock market. The results from the ADF, PP, and KPSS tests show that the real equity prices in Vietnam are found as a non-stationary time series at levels, but stationary at first differences.

**Table 3: ADF, PP, KPSS Results on Log Levels and First Differences**

| **ADF Results** | **Level** | | | **First Difference** | | |
|---|---|---|---|---|---|---|
| **Variables** | **Trend** | **Trend and Intercept** | **None** | **Trend** | **Trend and Intercept** | **None** |
| LRVNI | -2.696 | -2.932 | 0.371 | -7.269* | -7.268* | -7.259* |
| LRGDP | 0.367 | -2.486 | 2.575 | -2.804 | -2.772 | -1.145 |
| LCPI | -2.638 | -3.146 | 0.192 | -3.179* | -3.238 | -3.185* |
| LRMS | -0.324 | -2.443 | 5.568 | -7.991* | -7.967* | -2.917* |
| LRFR | -1.930 | -2.821 | -1.315 | -10.077* | -10.076* | -10.101* |
| LREX | -0.002 | -1.270 | 1.464 | -15.037* | -15.095* | -14.912* |
| LRFDI | -2.602 | -3.204 | 0.526 | -18.330* | -18.286* | -18.338* |

| **PP Results** | **Level** | | | **First Difference** | | |
|---|---|---|---|---|---|---|
| **Variables** | **Trend** | **Trend and Intercept** | **None** | **Trend** | **Trend and Intercept** | **None** |
| LRVNI | -2.397 | -2.480 | 0.546 | -7.000* | -7.009* | -6.995* |
| LRGDP | 1.801 | -2.149 | 5.377 | -8.239* | -8.912* | -7.084* |
| LCPI | -2.627 | -2.617 | 0.254 | -4.737* | -4.758* | -4.747* |
| LRMS | -0.261 | -2.407 | 7.747 | -8.192* | -8.169* | -5.283* |
| LRFR | -2.041 | -2.540 | -1.346 | -10.369* | -10.367* | -10.390* |
| LREX | -1.142 | -2.634 | 1.018 | -21.595* | -20.193* | -20.975* |
| LRFDI | -2.945* | -4.127* | 0.843 | -20.489* | -20.554* | -20.115* |

| **KPSS Results** | **Level** | | **First Difference** | |
|---|---|---|---|---|
| **Variables** | **Trend** | **Trend and Intercept** | **Trend** | **Trend and Intercept** |
| LRVNI | 0.726 | 0.153 | 0.086* | 0.051* |
| LRGDP | 1.554 | 0.402 | 0.389* | 0.110* |
| LCPI | 0.644 | 0.138* | 0.080* | 0.026* |
| LRMS | 1.572 | 0.144* | 0.053* | 0.052* |
| LRFR | 1.090 | 0.078* | 0.071* | 0.050* |
| LREX | 1.016 | 0.294 | 0.117* | 0.050* |
| LRFDI | 0.966 | 0.172 | 0.088* | 0.066* |

*Source: Output of Unit Root Tests from Eviews 8.0 (* denotes the statistical significance at 5 percent level)*

Thus, the study is progressed with a statistical description to check the other statistical properties of this underlying financial time series, including tail-heaviness, autocorrelation, and volatility clustering.

**Table 4: Descriptive Statistics for Vietnam's Stock Market Returns**

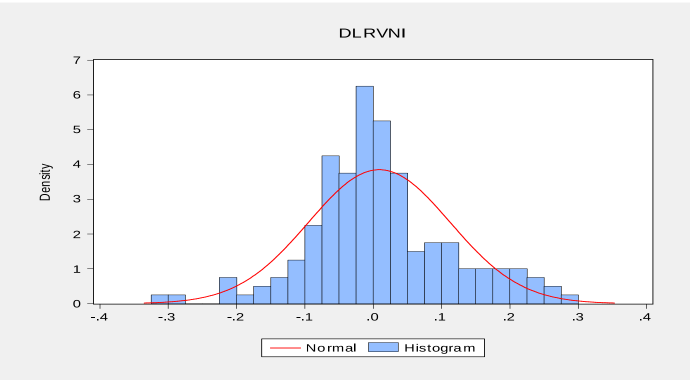
| Mean | Max. | Min. | Std. Dev. | Skewness | Kurtosis | Jarque-Bera | Prob. | Obs. |
|---|---|---|---|---|---|---|---|---|
| 0.0089 | 0.2778 | -0.3053 | 0.1036 | 0.1865 | 3.6464 | 3.7130 | 0.1562 | 160 |

*Source: Output of Descriptive Statistics of Vietnam's stock market Returns by Eviews 8.0*

The unconditional standard deviation of 0.1036 indicates a volatile level of 10.36% for Vietnam stock returns during the time span 2000 – 2013. The null hypothesis of non-normality is rejected for the case of Vietnam's equity returns, according to the Jarque-Bera result. It suggests that Vietnam stock return series are normally distributed, supporting the Gaussian assumption of normal distribution in theory. However, the values of skewness and excess kurtosis are both greater than zero (0.18 and 0.64 respectively), which are different from those of a standard normality. It refers to a leptokurtic distribution for the series with a high peak, thin mid-range, and fat tails. The series also exhibits an asymmetric skewed distribution, while the right tail is relatively heavier than the left. It implies that Vietnam's stock investors tend to receive positive returns.

Overall, the distribution of Vietnam's stock market returns follows normality, but not in the standard form. This can also be observed from the graph of the histogram and the normal distribution of Vietnam stock returns (Figure 1).

**Figure 1: Histogram and the Normal Distribution of Vietnam's Stock Sarket Returns**




*Source: Output of Histogram and the Normal Distribution of Vietnam's stock market Returns by Eviews 8.0*

To apprehend the volatility of Vietnam's stock market returns over the sample period August 2000 to December 2013, the following section estimates the GARCH (1,1) model with no exogenous variables. These are comprised of two major stages: modeling the mean equation and estimating the variance equation. The residuals (or shocks) derived from the specified mean equation are used for the second equation conductive to the estimation of the Vietnam's stock market return volatility

## 4.2. Modeling Volatility Clustering for Vietnam Stock Market Returns

### 4.2.1. Modeling the Conditional Mean Equation

The study follows the Box-Jenkins procedures in order to select an appropriate econometric model (that is, free of serial dependence) for a conditional mean equation. In particular, Hipel et al. (1977) summarized the procedure of selecting autoregressive-moving-average (ARMA) terms into three main steps: model identification, model estimation, and model diagnostic checks. The right orders for the ARMA model might be found via visual examination of the autocorrelation function (ACF) and partial correlation function (PACF) of the stationaries series (Box-Jenkins, 1976; Tsay, 2010). Besides, given that the most autocorrelations that can be safely examined is up to one quarter of the number of observations (Enders 2015, p.130), the study uses the Ljung-Box Q-statistics test to plot the ACF and PACF for the 20 first autocorrelations (as the number of observations under the study is 160 in total).

**Table 5: Correlogram of Vietnam's Stock Market Returns**

| Lag | Autocorrelation | Partial Correlation | | AC | PAC | Q-Stat | Prob. |
|---|---|---|---|---|---|---|---|
| 1 | .\|**** \| | .\|**** \| | 1 | 0.497 | 0.497 | 40.197 | 0.000 |
| 2 | .\|* \| | *\|. \| | 2 | 0.148 | -0.131 | 43.788 | 0.000 |
| 3 | .\|. \| | .\|. \| | 3 | -0.022 | -0.054 | 43.866 | 0.000 |
| 4 | .\|. \| | .\|* \| | 4 | 0.029 | 0.112 | 44.008 | 0.000 |
| 5 | .\|* \| | .\|* \| | 5 | 0.136 | 0.108 | 47.079 | 0.000 |
| 6 | .\|. \| | **\|. \| | 6 | -0.036 | -0.238 | 47.299 | 0.000 |
| 7 | *\|. \| | .\|. \| | 7 | -0.083 | 0.050 | 48.465 | 0.000 |
| 8 | .\|. \| | .\|. \| | 8 | -0.058 | 0.036 | 49.040 | 0.000 |
| 9 | .\|* \| | .\|* \| | 9 | 0.103 | 0.126 | 50.849 | 0.000 |
| 10 | .\|. \| | *\|. \| | 10 | 0.070 | -0.127 | 51.685 | 0.000 |
| 11 | .\|. \| | .\|. \| | 11 | -0.005 | 0.044 | 51.689 | 0.000 |
| 12 | *\|. \| | *\|. \| | 12 | -0.123 | -0.134 | 54.326 | 0.000 |
| 13 | *\|. \| | .\|. \| | 13 | -0.105 | 0.027 | 56.276 | 0.000 |
| 14 | *\|. \| | **\|. \| | 14 | -0.138 | -0.213 | 59.642 | 0.000 |
| 15 | *\|. \| | .\|. \| | 15 | -0.184 | -0.014 | 65.722 | 0.000 |
| 16 | *\|. \| | *\|. \| | 16 | -0.181 | -0.078 | 71.629 | 0.000 |
| 17 | *\|. \| | .\|. \| | 17 | -0.147 | 0.034 | 75.539 | 0.000 |
| 18 | .\|. \| | .\|. \| | 18 | 0.038 | 0.068 | 75.801 | 0.000 |
| 19 | .\|. \| | .\|. \| | 19 | 0.057 | 0.020 | 76.408 | 0.000 |
| 20 | .\|. \| | .\|. \| | 20 | 0.028 | -0.052 | 76.557 | 0.000 |

*Source: Output of Correlogram of Vietnam's stock market Returns by Eviews 8.0*

Both ACF and PACF geometrically decrease from their highest values from the first lag. However, they do not show any cut-off even at higher orders of autocorrelation. It suggests a possibility that either pure AR/MA term or a mixed ARMA term can be included in the conditional mean equation under GARCH models. Thus, in order to specify the best-fitting ARMA model, the study follows the trial and error method suggested from the current literature and uses a goodness-of-fit statistic with reference to smaller information criteria. The study estimates several combinations of ARMA (p,q) models up to five lags. Furthermore, the theory advocates that the lower order of AR/MA terms (means the simpler the model), the better it is; since the assembly of AR term and MA term is sometimes possible to cancel off each other's effect. Therefore, a pure AR/MA order is also put in concern under this analysis.

The estimates of information criterion (including Schwartz information criterion (SIC) and Akaike information criterion (AIC)) from different possible ARMA models are reported in Table 6.

**Table 6: Estimated Information Criterion for the ARMA Orders**

| **SIC** | | **MA Terms** | | | | | |
|---|---|---|---|---|---|---|---|
| | Lag | 0 | 1 | 2 | 3 | 4 | 5 |
| | 0 | -1.6706 | -1.9013 | **-1.9200** | -1.8883 | -1.9131 | -1.9107 |
| | 1 | **-1.9159** | -1.8969 | -1.8824 | **-1.9373** | -1.9028 | -1.8733 |
| **AR Terms** | 2 | -1.8993 | -1.8897 | -1.8731 | -1.8416 | -1.8820 | -1.8574 |
| | 3 | -1.8769 | -1.8631 | -1.8572 | -1.8426 | -1.8571 | -1.8862 |
| | 4 | -1.8575 | -1.8339 | -1.8018 | -1.8231 | -1.8306 | -1.7983 |
| | 5 | -1.8393 | -1.8841 | -1.8554 | -1.8576 | -1.7964 | -1.8396 |
| **AIC** | | **MA Terms** | | | | | |
| | Lag | 0 | 1 | 2 | 3 | 4 | 5 |
| **AR Terms** | 0 | -1.6898 | -1.9397 | -1.9776 | -1.9651 | -2.0092 | **-2.0260** |
| | 1 | -1.9545 | -1.9548 | -1.9596 | -2.0338 | -2.0186 | -2.0084 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 2 | **-1.9575** | -1.9673 | -1.9700 | -1.9579 | -2.0178 | -2.0125 |
| | 3 | -1.9548 | -1.9604 | -1.9740 | -1.9789 | -2.0128 | -2.0614 |
| | 4 | -1.9552 | -1.9512 | -1.9387 | -1.9795 | -2.0066 | -1.9938 |
| | 5 | -1.9571 | -2.0216 | -2.0125 | -2.0343 | -1.9928 | **-2.0555** |

*Source: Output of Estimated Information Criterion by Eviews 8.0*

The most appropriate one is hence elected as ARMA(0,5) or a pure MA(5) model, where the residuals are found as a random process. The estimation of ARMA(0,5) via the least squares method is provided as follows.

**Table 7: OLS Estimation of ARMA (0,5) Model**

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 0.009085 | 0.013155 | 0.690595 | 0.4909 |
| MA(1) | 0.611844 | 0.079249 | 7.720518 | 0.0000 |
| MA(2) | 0.233479 | 0.092671 | 2.519438 | 0.0128 |
| MA(3) | 0.047212 | 0.094322 | 0.500544 | 0.6174 |
| MA(4) | -0.13904 | 0.092694 | -1.499995 | 0.1357 |
| MA(5) | 0.180873 | 0.079445 | 2.276718 | 0.0242 |
| R-squared | 0.3288 | F-statistic (p-value) | | 15.0897 (0.0000) |
| Adjusted R-squared | 0.3070 | Durbin-Watson stat | | 1.9975 |

*Source: Output of OLS Estimation by Eviews 8.0*

The ARMA(0,5) model passes various important diagnostic checks, including Breusch-Godfrey Test for Autocorrelations, ARMA structure and expected residuals tests for stationary.

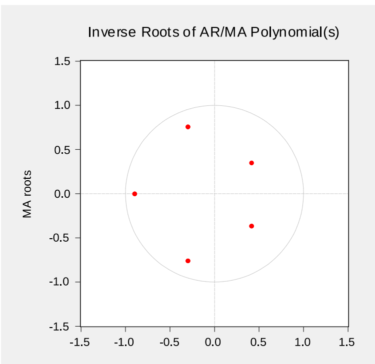
**Table 8: Diagnostic Tests for ARMA(0,5) Model**

**Breusch-Godfrey Test for Autocorrelations in ARMA(0,5) Model**

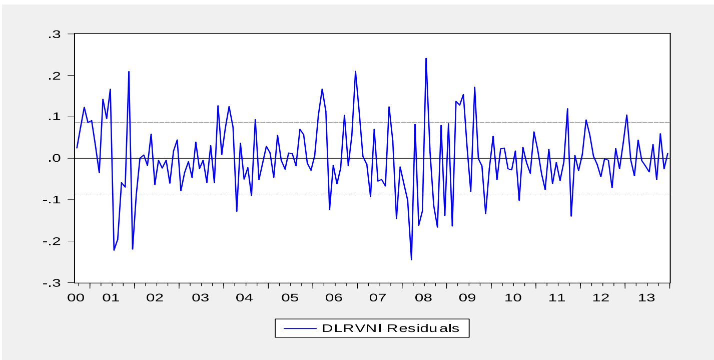
| Lag | F-Test | P-value |
|---|---|---|
| 1 | 0.0038 | 0.9507 |
| 2 | 0.2451 | 0.7829 |
| 4 | 0.8541 | 0.4932 |
| 8 | 0.6946 | 0.6959 |
| 12 | 0.8219 | 0.6277 |

*Source: Output of Breusch-Godfrey Test by Eviews 8.0*

**ARMA Structure of the Regression Model**




**Estimated Residuals of ARMA (0,5) Model**




*Source: Outputs of ARMA Structure and Estimated Residuals of ARMA (0,5) Model by Eviews 8.0*

### 4.2.2. Estimation of Vietnam Stock Market Volatility

The conditional mean equation is well specified by adding five moving average terms; thus, the ARMA (0,5)-GARCH (1,1) process is applied to estimate the conditional volatility of Vietnam's stock market returns. This section runs a standard GARCH model at the first stage, and extends to two other advanced GARCH models in its family under the subsequent section to account for leverage effect – one common characteristic of a financial series.

Table 9, 10, and 11 in sequence report the estimates of the mean and variance equations of the ARMA(0,5)-GARCH(1,1) model for Vietnam's stock market using three different types of distribution: normal (Gaussian) distribution, student's t-distribution, and generalized error distribution (GED).

**Table 9: ARMA(0,5)-GARCH(1,1) Estimates with Normal Distribution**

| **Panel (a): Mean Equation** | | | | |
|---|---|---|---|---|
| **Variable** | **Coefficient** | **Std. Error** | **z-Statistic** | **Prob.** |
| $\mu$ | 0.0089 | 0.0101 | 0.8799 | 0.3789 |
| MA(1) | 0.5189 | 0.0889 | 5.8385 | 0.0000 |
| MA(2) | 0.1732 | 0.1031 | 1.6789 | 0.0932 |
| MA(3) | 0.0376 | 0.0925 | 0.4065 | 0.6844 |
| MA(4) | -0.1318 | 0.0779 | -1.6906 | 0.0909 |
| MA(5) | 0.1448 | 0.0683 | 2.1206 | 0.0340 |
| **Panel (b): Variance Equation** | | | | |
| $\omega$ | 0.0007 | 0.0004 | 1.5587 | 0.1191 |
| $u_{t-1}^2$ | 0.3252 | 0.1322 | 2.4607 | 0.0139 |
| $h_{t-1}$ | 0.5972 | 0.1389 | 4.2992 | 0.0000 |
| Log-Likelihood = 185.657 | | | | |
| AIC = -2.208 | | | | |
| SIC = -2.035 | | | | |

*Source: ARMA (0,5) – GARCH(1,1) Estimation with Normal Distribution by Eviews 8.0*

**Table 10: ARMA(0,5)-GARCH(1,1) Estimates with Student's t-Distribution**

| **Panel (a): Mean Equation** | | | | |
|---|---|---|---|---|
| **Variable** | **Coefficient** | **Std. Error** | **z-Statistic** | **Prob.** |
| $\mu$ | 0.0054 | 0.0091 | 0.5934 | 0.5529 |
| MA(1) | 0.5082 | 0.0870 | 5.8431 | 0.0000 |
| MA(2) | 0.1802 | 0.0970 | 1.8574 | 0.0633 |
| MA(3) | 0.0299 | 0.0896 | 0.3344 | 0.7381 |
| MA(4) | -0.1676 | 0.0786 | -2.1330 | 0.0329 |
| MA(5) | 0.1145 | 0.07318 | 1.5645 | 0.1177 |
| **Panel (b): Variance Equation** | | | | |
| $\omega$ | 0.0006 | 0.0004 | 1.4783 | 0.1393 |
| $u_{t-1}^2$ | 0.3483 | 0.1561 | 2.2319 | 0.0256 |
| $h_{t-1}$ | 0.5935 | 0.1473 | 4.0299 | 0.0001 |
| Log-Likelihood = 185.723 | | | | |
| AIC = -2.209 | | | | |
| SIC = -2.036 | | | | |

*Source: ARMA (0,5) – GARCH(1,1) Estimation with Student's t-distribution by Eviews 8.0*

**Table 11: ARMA(0,5)-GARCH(1,1) Estimates with GE Distribution**

| Panel (a): Mean Equation | | | | |
|---|---|---|---|---|
| **Variable** | **Coefficient** | **Std. Error** | **z-Statistic** | **Prob.** |
| $\mu$ | 0.0050 | 0.0088 | 0.5716 | 0.5676 |
| MA(1) | 0.5258 | 0.0872 | 6.0316 | 0.0000 |
| MA(2) | 0.1837 | 0.0972 | 1.8896 | 0.0588 |
| MA(3) | 0.0337 | 0.0917 | 0.3671 | 0.7135 |
| MA(4) | -0.1607 | 0.0794 | -2.0256 | 0.0428 |
| MA(5) | 0.0866 | 0.0735 | 1.1790 | 0.2384 |
| **Panel (b): Variance Equation** | | | | |
| $\omega$ | 0.0006 | 0.0004 | 1.4032 | 0.1606 |
| $u_{t-1}^2$ | 0.3435 | 0.1649 | 2.0837 | 0.0372 |
| $h_{t-1}$ | 0.5967 | 0.1554 | 3.8391 | 0.0001 |
| Log-Likelihood = 186.179 | | | | |
| AIC = -2.215 | | | | |
| SIC = -2.042 | | | | |

*Source: ARMA (0,5)-GARCH(1,1) Estimation with GE Distribution by Eviews 8.0*

From the results of the log likelihood and information criterions (AIC and SIC) shown in the three relevant tables above, the model with conditional distribution of generalized error (GED) seems to be the most accurate one, as it exhibits larger log likelihood and smaller information criterion values in comparison with the estimates of normal and student's distributions. This finding reveals its consistency with the recent results of Gao et.al (2012); who found that a GARCH model based on GED is the best fitted-model for volatility compared with two other densities (normal and student's t). Thus, the following analysis focuses on the ARMA (0,5)-GARCH (1,1) model using GED distribution with fixed parameter at 1.5.

Considering Panel (a) in Table 11, the coefficient of the error term in the mean equation appears insignificant, but it is close to the value of the unconditional mean given in Table 5 (which are 0.005 and 0.009 respectively). Besides, the coefficients of the moving average terms show the significance at 5% conventional level at degree one and four only. This implies that Vietnam's stock returns follow a trend and can be predicted based on their historical values. Panel (b) in Table 11 reveals that the coefficients of the error term, ARCH term and GARCH term have expected positive signs, which significantly satisfy the restriction on non-negativity in conditional variance. It signifies that this specified ARMA (0,5)-GARCH (1,1) model seems to be satisfactory to capture the Vietnam's stock return volatility.

Additionally, the sum of the ARCH coefficient ($\alpha_1$) and the GARCH coefficient ($\beta_1$) are less than one and nearly close to one, i.e., $\alpha_1 + \beta_1 = 0.9402 < 1$. It successively infers the stationarity of the unconditional variance ($h_t$ < 1) and the high persistency of Vietnam's stock return volatility. The output of the Wald test is also supportive for the long memory of Vietnam stock return volatility in response to a shock (Table 12). In particular, the F-test result cannot reject the null hypothesis of the integration in the conditional volatility of the equity returns at the significance level of 5%.

**Table 12: Wald Test for the Persistence of Vietnam's Stock Market Volatility**

| Wald Test | | | |
|---|---|---|---|
| Test Statistic | Value | df | Probability |
| t-statistic | -0.6023 | 151 | 0.5478 |
| F-statistic | 0.3628 | (1, 151) | 0.5478 |
| Chi-square | 0.3628 | 1 | 0.5469 |
| Null Hypothesis: $\alpha_1 + \beta_1 = 1$ | | | |
| Null Hypothesis Summary: | | | |
| Normalized Restriction (= 0) | | Value | Std. Err. |
| $-1 + \alpha_1 + \beta_1$ | | -0.0598 | 0.0993 |
| Restrictions are linear in coefficients. | | | |

*Source: Output of Wald Test by Eviews 8.0*

Furthermore, since the coefficient of the ARCH term is less than the coefficient of the GARCH term ($\alpha_1 < \beta_1$), the Vietnam's stock market volatility is likely influenced by the volatility rather than the related news from the previous period.

**Table 13: Diagnostic Checks for Residuals from ARMA(0,5)-GARCH(1,1)**

| **Panel (a): The Ljung-Box Q Statistics** | | | | |
|---|---|---|---|---|
| **Lag** | **Q-statistic *(p-value)*** | | **$Q^2$-statistic *(p-value)*** | |
| 8 | 2.712 | 0.438 | 6.8454 | 0.553 |
| 12 | 9.1331 | 0.243 | 9.5443 | 0.656 |
| 16 | 10.989 | 0.444 | 12.702 | 0.694 |
| 20 | 18.663 | 0.229 | 15.16 | 0.767 |
| 24 | 25.054 | 0.159 | 18.797 | 0.763 |
| 28 | 33.024 | 0.081 | 25.034 | 0.626 |
| 32 | 34.128 | 0.162 | 29.256 | 0.606 |
| 36 | 40.11 | 0.127 | 29.854 | 0.755 |

| **Panel (b): ARCH-LM Test** | | |
|---|---|---|
| Lag | F-Test | p-value |
| 1 | 0.0093 | 0.9233 |
| 2 | 0.7765 | 0.4618 |
| 4 | 0.54 | 0.7066 |
| 8 | 0.856862 | 0.5546 |
| 12 | 0.796237 | 0.6537 |

| **Panel (c): Normality Test** | |
|---|---|
| Skewness | 0.2489 |
| Kurtosis | 3.323 |
| Jarque-Bera *(p-value)* | 2.3473(0.3092) |

*Source: Output of Ljung Box Q-statistics, ARCH-LM Test, and Normality Test by Eviews 8.0*

To verify the satisfactoriness for the underlying ARMA (0,5)-GARCH (1,1) model with GED distribution, Table 13 summarizes the results of a variety of diagnostic tests. Regarding the outcomes, the Q-statistics and Q2-statistics from the Ljung-Box test (Panel (a) in Table 12) respectively exhibit no serial correlation on standardized residuals and squared standardized residuals obtained from the ARMA (0,5)-GARCH (1,1) model up to the 36th lag at the significance level of 5%. Panel (b) in Table 13 shows the evidence given by ARCH-LM test that all the ARCH effects are successfully removed from the residuals obtained from the ARMA (0,5)-GARCH (1,1) model since the F-statistics fails to reject the null hypothesis of hemoskedasticity on the residuals up to the 12th lag at 5% significance level. Further, the series of residuals is revealed as normality since the null hypothesis is accepted by the Jarque-Bera statistic in Panel (c)-Table 13. Compared to the original data in Table 2, the excess kurtosis from Panel (c)-Table 14 is obtained with a smaller value (reduce from 0.6464 to 0.3230) and seems to be closer to zero or a standard normality.

These above analyses strongly support the adequacy of the standard GARCH (1,1) process in modeling the volatility of Vietnam's stock market returns.

### 4.2.3. Vietnam Stock Market Volatility under Macroeconomic Impacts

As the ARMA (0,5)-GARCH (1,1) model has proved its adequacy in modeling the volatility of Vietnam's stock market returns, the following analysis is based on this specification to examine the stock return volatility together with the presence of other explanatory variables (i.e. macroeconomic factors). The following analysis is broken down into two sub-sections. The first part accounts for the impact of an individual macroeconomic variable (including real economic growth, consumer price index, real money supply, real refinancing rate, real exchange rate, and real foreign direct investment). Henceforward, six relevant univariate models are constructed. The second part investigates Vietnam stock return volatility under the aggregate influence of six selected macroeconomic variables by a multivariate GARCH model. It is noted that all of the models under this section are subsequently inspected with three types of distribution, where the most appropriate one is adopted using the same technique as in the previous analysis in Section 4.2.2.

#### 4.2.3.1. The Univariate GARCH (1,1) Analysis

The estimates of the volatility of Vietnam's stock market returns accounting for the impact of separate macroeconomic variable are organized in Table 13. The estimation of a univariate GARCH process in the current study includes two equations, which can be formulated as follows:

Equation of conditional mean:

$$Y_t = \mu_t + u_t + \sum_{i=1}^{5} \theta_i u_{t-i} \quad \text{(Eq. 4)}$$

Equation of conditional variance:

$$h_t = \omega_k + \alpha_{k1} u_{t-1}^2 + \beta_{k1} h_{t-1} + \varphi_{kt} X_{kt} \quad \text{(Eq. 5)}$$

Before proceeding with the GARCH model, the appropriate type of distribution for every individual GARCH process is selected using the same method used from prevous section. Specifically, the estimated values of log likelihood and information criterions (AIC and SIC) are first reported for all of the GARCH models under consideration. The best-fitted model must then show the larger log-likelihood value and/or smaller AIC and SIC values.

Under the certain outcomes from Table 14, the generalized error distribution with fixed parameter at 1.5 seems to be an applicable choice for most of the models. One exceptional case is realized for the GARCH system where economic growth is added as an explanatory variable, and where student's t-distribution is selected instead of GE.

**Table 14: Specification of Distribution Type for Different GARCH Models**

| | Normal | Student's t | GED |
|---|---|---|---|
| LL ($\Delta RGDP$) | 188.3066 | **188.3112** | 188.1900 |
| AIC ($\Delta RGDP$) | -2.2288 | **-2.2289** | -2.2274 |
| SIC ($\Delta RGDP$) | -2.0366 | **-2.0367** | -2.0352 |
| LL ($\Delta CPI$) | 187.1821 | 187.2973 | **187.8106** |
| AIC ($\Delta CPI$) | -2.2148 | -2.2162 | **-2.2226** |
| SIC ($\Delta CPI$) | -2.0226 | -2.0240 | **-2.0304** |
| LL ($\Delta RMS$) | 185.7185 | 185.7299 | **186.1847** |
| AIC ($\Delta RMS$) | -2.1965 | -2.1966 | **-2.2023** |
| SIC ($\Delta RMS$) | -2.0043 | -2.0044 | **-2.0101** |
| LL ($\Delta RFR$) | 185.6569 | 185.7263 | **186.1792** |
| AIC ($\Delta RFR$) | -2.1957 | -2.1966 | **-2.2022** |
| SIC ($\Delta RFR$) | -2.0035 | -2.0044 | **-2.0100** |
| LL ($\Delta REX$) | 181.1692 | 185.9076 | **188.2806** |
| AIC ($\Delta REX$) | -2.1396 | -2.1988 | **-2.2285** |
| SIC ($\Delta REX$ | -1.9474 | -2.0066 | **-2.0363** |
| LL ($\Delta RFDI$) | 185.6571 | 185.7286 | **186.1808** |
| AIC ($\Delta RFDI$) | -2.1957 | -2.1966 | **-2.2023** |
| SIC ($\Delta RFDI$) | -2.0035 | -2.0044 | **-2.0101** |

*Source: Output of Estimated Log Likelihood and Information Criterions by Eviews 8.0*

While the residuals or shocks of Vietnam stock returns are assumed to be the same, all of the specified models differ from the added explanatory variable. Panel (b) in Table 16 summarizes the results of all of the variance equations for six particular models. It can be seen that the six different models produce similar outcomes regarding the significance of the coefficients of error terms ($\omega$), ARCH terms ($\alpha_1$), and GARCH terms ($\beta_1$). Accordingly, they are all achieved with positive and significant values. It satisfies the conditions for a non-negativity of condition variance required by GARCH models. In addition, the ARCH coefficients are smaller than the GARCH coefficients under all of the cases in Panel (b) Table 16. It suggests the short-run dynamics of the volatility of Vietnam stock returns; that is, the volatility is influenced more by its previous period's variance than by its previous period's shock.

**Table 15: Estimates of Vietnam Stock Return Volatility under the Impact of Individual Macroeconomic Variable**

| | | | | | | |
|---|---|---|---|---|---|---|
| **Panel (a): The Conditional Mean Equation** | | | | | | |
| **Explanatory Variable** | $\Delta LRGDP$ | $\Delta LCPI$ | $\Delta LRMS$ | $\Delta LRFR$ | $\Delta LREX$ | $\Delta LRFDI$ |
| **Parameters** | **Coefficient *(p-value)*** | | | | | |
| $\mu$ | 0.005 | 0.005 | 0.005 | 0.005 | 0.007 | 0.005 |
| | *0.489* | *0.567* | *0.571* | *0.569* | *0.380* | *0.578* |
| *MA(1)* | **0.444*** | **0.539*** | **0.525*** | **0.526*** | **0.531*** | **0.526*** |
| | *0.000* | *0.000* | *0.000* | *0.000* | *0.000* | *0.000* |
| *MA(2)* | 0.155 | **0.200*** | 0.183 | 0.184 | **0.175*** | 0.183 |
| | *0.091* | *0.035* | *0.061* | *0.059* | *0.022* | *0.059* |
| *MA(3)* | -0.012 | 0.011 | 0.033 | 0.034 | 0.047 | 0.033 |
| | *0.877* | *0.901* | *0.727* | *0.716* | *0.591* | *0.717* |
| *MA(4)* | **-0.206*** | **-0.222*** | **-0.160*** | **-0.161*** | **-0.113** | **-0.160*** |
| | *0.005* | *0.005* | *0.046* | *0.043* | *0.134* | *0.044* |
| *MA(5)* | 0.123 | 0.052 | 0.087 | 0.087 | 0.110 | 0.087 |
| | *0.091* | *0.461* | *0.244* | *0.240* | *0.061* | *0.238* |
| **Panel (b): The conditional Variance Equation** | | | | | | |
| $\omega$ | **0.001*** | **0.000*** | **0.001*** | **0.001*** | **0.001*** | **0.001*** |
| | *0.040* | *0.096* | *0.324* | *0.164* | *0.137* | *0.191* |
| $u_{t-1}^2$ | **0.450*** | **0.306*** | **0.341*** | **0.344*** | **0.313*** | **0.344*** |
| | *0.027* | *0.028* | *0.039* | *0.038* | *0.004* | *0.037* |
| $h_{t-1}$ | **0.489*** | **0.653*** | **0.599*** | **0.596*** | **0.584*** | **0.596*** |
| | *0.001* | *0.000* | *0.000* | *0.000* | *0.000* | *0.000* |
| $\Delta LRGDP$ | **-0.016*** | - | - | - | - | - |
| | *0.033* | | | | | |
| $\Delta LCPI$ | - | **0.053*** | - | - | - | - |
| | | *0.002* | | | | |
| $\Delta LRMS$ | - | - | 0.002 | - | - | - |
| | | | *0.922* | | | |
| $\Delta LRFR$ | - | - | - | 0.000 | - | - |
| | | | | *0.986* | | - |
| $\Delta LREX$ | - | - | - | - | **0.029*** | |
| | | | | | *0.047* | |
| $\Delta LRFDI$ | - | - | - | - | - | 0.000 |
| | | | | | | *0.958* |
| **Panel (c): Diagnostic Checking** | | | | | | |
| Ljung-Box Q-Statistics for Autocorrelations | | | | | | |
| *Q(6)* | 2.744 | 2.655 | 2.130 | 2.149 | 1.611 | 2.120 |
| | *0.098* | *0.103* | *0.144* | *0.143* | *0.204* | *0.145* |
| *Q(12)* | 8.871 | 8.873 | 8.999 | 9.139 | 9.152 | 9.156 |
| | *0.262* | *0.262* | *0.253* | *0.243* | *0.242* | *0.242* |
| *Q(24)* | 24.843 | 23.477 | 24.873 | 25.072 | 25.376 | 25.087 |
| | *0.166* | *0.217* | *0.165* | *0.158* | *0.149* | *0.158* |
| *Q(36)* | 40.189 | 37.911 | 39.926 | 40.124 | 40.046 | 40.159 |
| | *0.125* | *0.183* | *0.131* | *0.126* | *0.128* | *0.126* |
| Ljung-Box Q2-Statistics for Heteroskedasticity | | | | | | |
| $Q^2(1)$ | 0.089 | 0.104 | 0.010 | 0.010 | 0.000 | 0.008 |
| | *0.765* | *0.747* | *0.922* | *0.921* | *0.985* | *0.931* |

| | | | | | | |
|---|---|---|---|---|---|---|
| *$Q^2(8)$* | 4.457 | 6.296 | 6.927 | 6.857 | 6.695 | 6.878 |
| | *0.814* | *0.614* | *0.545* | *0.552* | *0.570* | *0.550* |
| *$Q^2(16)$* | 14.735 | 13.802 | 12.453 | 12.718 | 10.538 | 12.665 |
| | *0.544* | *0.613* | *0.712* | *0.693* | *0.837* | *0.697* |
| *$Q^2(24)$* | 19.755 | 18.672 | 18.623 | 18.818 | 15.210 | 18.756 |
| | *0.711* | *0.769* | *0.772* | *0.762* | *0.914* | *0.765* |
| *$Q^2(36)$* | 25.459 | 27.653 | 29.724 | 29.911 | 22.316 | 29.822 |
| | *0.905* | *0.839* | *0.760* | *0.753* | *0.964* | *0.756* |
| ARCH-LM Test for Heteroskedasticity | | | | | | |
| *ARCH-LM(1)* | 0.087 | 0.101 | 0.009 | 0.010 | 0.000 | 0.007 |
| | *0.769* | *0.751* | *0.924* | *0.922* | *0.986* | *0.932* |
| *ARCH-LM(4)* | 0.505 | 0.707 | 0.541 | 0.540 | 0.591 | 0.541 |
| | *0.732* | *0.589* | *0.706* | *0.707* | *0.670* | *0.706* |
| *ARCH-LM(8)* | 0.502 | 0.734 | 0.872 | 0.859 | 0.956 | 0.863 |
| | *0.853* | *0.662* | *0.542* | *0.553* | *0.473* | *0.549* |
| *ARCH-LM(12)* | 0.769 | 0.780 | 0.793 | 0.797 | 0.722 | 0.795 |
| | *0.681* | *0.670* | *0.658* | *0.658* | *0.728* | *0.655* |
| Normality Test | | | | | | |
| Skewness | 0.393 | 0.272 | 0.241 | 0.249 | 0.111 | 0.245 |
| Kurtosis | 3.456 | 3.248 | 3.319 | 3.324 | 3.458 | 3.327 |
| Jarque-Bera | 5.494 | 2.381 | 2.231 | 2.352 | 1.732 | 2.307 |
| p-value | *0.064* | *0.304* | *0.328* | *0.309* | *0.421* | *0.316* |

** denotes the significance at 5% conventional level*

*Source: Output of Estimated ARMA (0,5) – GARCH(1,1) by Eviews 8.0*

Furthermore, the sums of the ARCH and GARCH coefficients ($\alpha_1 + \beta_1$) are less than one and close to one for all of the corresponding models. It indicates the high persistence of Vietnam stock return volatility in response to a shock. This outcome is coherent with the results from the model without any exogenous macroeconomic variable. In other words, either including one exogenous macroeconomic variable in the GARCH process or not, the impact of a shock to the conditional variance is persisted for a long time span before dying off. It is likely reasonable that since Vietnam is known as a small economy, any shocks to the stock market seem to last longer in comparison with other developed economies due to the market's slow adjustment process to adapt to any sudden change.

Regarding to the macroeconomic influences on the volatility of stock returns in Vietnam, there are three statistical significant relations recognized at the 5% significance level, which originated from economic growth, consumer price index and exchange rate. Put differently, any changes in these three macroeconomic indicators are expected to contribute to a better explanation for stock return volatility in the Vietnam's market.

The negative coefficient of economic growth in the variance equation implies that the growth of real economic output may help the stock market be less volatile. Particularly, an increase of 1% in real GDP is expected to decrease the volatility of Vietnam stock returns by 1.6%. At the same time, stock return volatility is positively influenced by changes in CPI and in the real exchange rate USD/VND. A rise of 1% in CPI and 1% in real USD/VND can explain a 5.3% and 2.9% spread in stock return volatility respectively. The findings can be rationally explained by the fact that any surge in price level or depreciation in home currency may reflect the higher risk to investors in making investment decisions, less confidence then leads to higher volatility of stock market.

On the other hand, the coefficients associated with changes in real money supply, refinancing rate and foreign direct investment imply a non-significant impact on Vietnam stock return volatility at 5% significance level during the sample period. This means that there is no additional improvement in explaining the volatility of Vietnam's stock market by containing these three macroeconomic variables to the current GARCH process.

The lower part of Table 15 (Panel (c)) comprises of three major diagnostic tests (autocorrelation, heteroskedasticity, and normality) for different specified AMRA(0,5)-GARCH(1,1) models. For all the cases being studied, residuals obtained from each model reveal no autocorrelation problem (by the Ljung-box Q-statistics), no ARCH effect left (by the results of Ljung-Box Q2-statistics and ARCH-LM tests), and are normally distributed (by Jarque-Bera tests). The satisfaction of various diagnostic checking promotes the fit of the ARMA(0,5)-GARCH(1,1) model for understanding the volatility clustering of Vietnam's stock market returns under the individual impact of macroeconomic variables.

### 4.3.2.2. Multivariate GARCH(1,1) Analysis

Based on the motivated results from the univariate GARCH analysis, the study proceeds the multivariate ARMA(0,5)-GARCH(1,1) process by adding six specified macroeconomic indicators to the variance equation. Given the same conditional mean equation (Eq. 3), the conditional variance equation is adjusted as follows:

$$h_t = \omega + \alpha_1 u_{t-1}^2 + \beta_1 h_{t-1} + \sum_{k=1}^{6} \varphi_{kt} X_{kt} \quad \text{(Eq. 6)}$$

The measured log likelihood (LL) and two other information criterions (AIC and SIC) all recommend the generalized error distribution (GED) for the ARMA(0,5)-GARCH(1,1) model based on the lowest values (Table 16).

**Table 16: Specification of Distribution Type for the ARMA(0,5)-GARCH(1,1) Model under the Impact of Macroeconomic Variables**

| | Normal | Student's t | GED |
|---|---|---|---|
| LL | 189.3787 | **192.3700** | 189.2709 |
| AIC | -2.1797 | **-2.2171** | -2.1784 |
| SIC | -1.8914 | **-1.9288** | -1.8901 |

*Source: Output of Estimated Log Likelihood and Information Criterions of different Distribution Type for ARMA (0,5) – GARCH(1,1) under Macroeconomic Impact by Eviews 8.0*

The estimation of the ARMA(0,5)-GARCH(1,1) model is presented in Table 17, including the conditional mean regression results (panel (a)) and the variance regression results (panel (b)). As provided by Panel (a) Table 17, the significant coefficients of moving average terms ordered 1, 2, and 4 at 5% conventional level indicate the role of previous shocks in explaining the current equity returns.

**Table 17: Estimates of ARMA(0,5)-GARCH(1,1) under Macroeconomic Impact**

| **Panel (a): The Conditional Mean Equation** | | | | |
|---|---|---|---|---|
| **Variable** | **Coefficient** | **Std. Error** | **z-Statistic** | **Prob.** |
| $\mu$ | 0.0059 | 0.0074 | 0.8057 | 0.4204 |
| *MA(1)* | 0.4214 | 0.0895 | 4.7085 | 0.0000 |
| *MA(2)* | 0.1770 | 0.0848 | 2.0874 | 0.0369 |
| *MA(3)* | 0.0408 | 0.0801 | 0.5100 | 0.6101 |
| *MA(4)* | -0.2342 | 0.0693 | -3.3793 | 0.0007 |
| *MA(5)* | 0.1340 | 0.0688 | 1.9489 | 0.0513 |
| Panel (b): The Conditional Variance Equation | | | | |
| $\omega$ | 0.0005 | 0.0005 | 1.0340 | 0.3011 |
| $u_{t-1}^2$ | 0.3684 | 0.1663 | 2.2150 | 0.0268 |
| $h_{t-1}$ | 0.5823 | 0.1237 | 4.7085 | 0.0000 |
| $\Delta LRGDP$ | -0.0113 | 0.0064 | -1.7628 | 0.0779 |
| $\Delta LCPI$ | 0.0835 | 0.0456 | 1.8316 | 0.0670 |
| $\Delta LRMS$ | 0.0165 | 0.0217 | 0.7630 | 0.4455 |
| $\Delta LRFR$ | -0.0110 | 0.0071 | -1.5599 | 0.1188 |
| $\Delta LREX$ | 0.0201 | 0.0203 | 0.9895 | 0.3224 |
| $\Delta LRFDI$ | -0.0005 | 0.0007 | -0.7348 | 0.4625 |

*Source: ARMA (0,5) – GARCH (1,1) under Macroeconomic Impact by Eviews 8.0*

The upper part of the Panel (b) Table 17 shows the estimated coefficients of the intercept, ARCH and GARCH terms. While the error term's coefficient is statistically non-significant, its value is very close to zero. In contrast, both the coefficients of ARCH and GARCH terms appear statistically significant and positive. Again, the condition of non-negative conditional variance is attained for the current specification of the GARCH model. Moreover, the value of ARCH coefficient ($\alpha_1 =$

$0.3684$) is smaller than that of GARCH coefficient ($\beta_1 = 0.5823$). It implies that the current stock return volatility is less influenced by the past shocks than its past volatility. Also, while ($\alpha_1 + \beta_1$) is nearly one (i.e. approximately 0.95), the variance of stock market returns remains highly persistent over time.

The lower section of Panel (b) in Table 17 demonstrates the estimation results for the influence of various explanatory variables on the volatility of Vietnam's stock market returns. Specifically, no macroeconomic variable under the research exposes its significant impact on Vietnam's stock market returns at the 5% significance level. However, if the significance level is assumed at 10%, the empirical results may recommend that the volatility of Vietnam stock returns statistically influenced by economic growth and movements in the consumer price index. Accordingly, any 1% increase of monthly change in GDP is expected to reduce stock market volatility by 1.1%, whilst a 1% rise of monthly change in CPI possibly leads to an increase in volatility up to 8.35%. These findings corroborate with the previous outcomes of the univariate analysis (Section 4.2.3.1.).

To confirm the validity of the ARMA (0,5)-GARCH model for this multivariate study, Table 17 provides the evidence from the Ljung-Box tests, ARCH-LM tests, and Normality tests. According to the Ljung-Box estimates, the Q-statistics and Q2-statistics respectively cannot reject the hypothesis about no serial correlation in standardized residuals and squared standardized residuals derived from the model, with up to 36 lags at the 5% level of significance (Panel (a) and (b) Table 17). Further, all of the ARCH effects on the residuals have been successfully removed, revealed by the rejection of the null hypothesis from the ARCH-LM tests up to 12 lags at 5% significance level. Besides, the Jarque-Bera value accepts the null of normality at 5% significance level, the series of residuals from the model remains normally distributed.

**Table 18: Diagnostic Tests for the ARMA(0,5)-GARCH(1,1) Model under the Impact of Macroeconomic Variables**

| **Panel (a): Ljung-Box Q-statistics** | | | **Panel (b): Ljung-Box $Q^2$-Statistics** | | |
|---|---|---|---|---|---|
| **Lag** | **Q-Stat** | **p-value** | **Lag** | **$Q^2$-Stat** | **p-value** |
| 6 | 3.0718 | 0.080 | 1 | 0.0102 | 0.919 |
| 12 | 7.0814 | 0.420 | 8 | 5.1501 | 0.741 |
| 16 | 8.4175 | 0.675 | 16 | 16.349 | 0.429 |
| 20 | 14.724 | 0.471 | 20 | 19.133 | 0.513 |
| 24 | 22.031 | 0.283 | 24 | 23.057 | 0.516 |
| 28 | 31.085 | 0.121 | 28 | 24.864 | 0.635 |
| 32 | 31.980 | 0.233 | 32 | 27.889 | 0.675 |
| 36 | 36.709 | 0.221 | 36 | 28.248 | 0.818 |
| Panel(c): ARCH-LM Test | | | Panel (d): Normality Test | | |
| Lag | F-statistic | p-value | | Skewness | 0.3114 |
| 1 | 0.0099 | 0.9211 | | Kurtosis | 3.1533 |
| 4 | 0.6656 | 0.6168 | | Jarque-Bera | 2.7427 |
| 8 | 0.5842 | 0.7897 | | p-value | 0.2538 |
| 12 | 0.9875 | 0.4641 | | | |

*Source: Output of Ljung Box Q-statistics, ARCH-LM, and Normality Tests for ARMA (0,5) – GARCH (1,1) under Macroeconomic Impact by Eviews 8.0*

## 5. CONCLUSION

To summarize, this paper employs a series of GARCH using three major types of distribution to model the volatility of Vietnam's equity returns over the time span from August 2000 to December 2013. While the generalized error distribution (GED) exposes its high power in most cases, the simplest form within the GARCH family (i.e. GARCH (1,1)) followed by a specification of ARMA orders (i.e. ARMA (0,5) were proven to be sufficient for the current research context. By successfully passing a variety of diagnostic checks, the ARMA (0,5)-GARCH (1,1) model is able to verify its adequacy in modeling stock market returns for the case of Vietnam, both in univariate and in multivariate analyses. Either ignoring or including exogenous macroeconomic variables, the residuals produced from all of the models appear with freedom of autocorrelation up to the 36th lag, no presence of ARCH effect up to the 12th lag, and attain normal distribution.

In the consideration of the macroeconomic impacts on the volatility of Vietnam's stock returns, a number of important findings can be drawn from this paper as follows. First, the volatility of Vietnam's stock market returns is highly persistent, suggesting a long memory of the volatility in response of a shock. Second, the current volatility of Vietnam's stock market is affected by the last previous shock more than by the last previous volatility itself. Third, a monthly change in consumer price index appears as the most essential indicator that help predicting the volatility of the Vietnam's stock market, since any 1% increase in CPI can explain an increase of the volatility by 5.3% under the univariate case (with the significance level of 5%) and correspondingly by 8.35% under the multivariate case (with the significance level of 10%). Forth, any news about economic growth can be considered as the second significant factor in explaining Vietnam stock return volatility as a 1% rise in real GDP is expected to be followed by a fall in volatility by 1.6% within the univariate study and by 1.1% within the multivariate study. Finally, a statistical significant evidence under the univariate analysis is uncovered for the impact of a change in the exchange rate (USD/VNA) on Vietnam's stock market volatility. These findings suggest that the prediction of Vietnam's stock market volatility could be better in consideration with selected macroeconomic impacts. It will benefit the investors and policy makers who intend to follow the movements of this emerging stock market in order to make financial and regulatory decisions.

Nonetheless, it is also a notice that a number of disadvantages of applied GARCH models still exists. Specifically, the simple GARCH model is not adequate to account for an asymmetry problem, which can generate inaccurate forecasts of volatility (Brooks and Persand, 2003). The asymmetry or leverage effect occurs when the underlying impact from bad news is beyond the impact from good news. Therefore, extensions of the GARCH models that incorporate with asymmetric volatility should be considered in further study to attain more precise estimations for this current paper, which can be the exponential GARCH (1,1) model (or EGARCH, introduced by Nelson, 1991) and threshold ARCH model (or TARCH, presented by Zakoian (1991) and Glosten et al. (1993)). While the EGARCH model modifies the standard GARCH by estimating the logarithm of the conditional variance process so that the asymmetry in volatility clustering can be captured, the TARCH model divides the innovations that influence on the conditional variance into good and bad intervals.

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