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Estimating Emerging Stock Market Volatility Using Garch Family Models

KEYWORDS: GARCH models, BRIC emerging stock markets, volatility clustering, estimation, heteroscedasticity

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ABSTRACT *The main objective of this article is to estimate the volatility of the BRIC emerging stock markets, namely Brazil, Russia, India and China based on the analysis of their major stock indices. The econometric approach includes GARCH model which is performed in order to capture asymmetric volatility clustering and leptokurtosis. Outcomes suggest that open-end security markets follow focus strategy of speculative investing rather than directions of risk management. Empirical analysis reveals that short-term horizon trends and the term horizon trends are not similar, even contrary.*

INTRODUCTION

Volatility refers to ups and down in stock markets based on inflows and outflows of investments. It may be positive or negative but quite successful to attract investors. It is an important key factor which is the result of stock market's bulls and bears and also a major return generator. The last two decades have been a period of feverish research of this particular issue for both academics and practitioners. Nevertheless, empirical results were far from being conclusive and definitive. Moreover, great a variety of shades and motivational interpretations were provided in order to establish a theoretical direction. In recent past, accelerated progress in financial econometrics led to the possibility of predicting volatility, aspect that attracted even more investors and decision makers. Furthermore, emerging market volatility is a relatively unexplored area of interest especially in terms of extreme events such as the global financial crisis. Thus certain stylized facts such as : volatility clustering, leverage effect, leptokurtosis, skewness, heteroscedasticity characterized the dynamic behavior of emerging stock markets. Generally, a decrease in stock returns causes an increase in volatility higher compared with the case when volatility is generated by an increase in stock returns.

DATA ANALYSIS AND METHODOLOGY

Bollerslev (1986) has generalized ARCH model by including lagged valued of the conditional variance. The GARCH models permit a wider range of behavior and patterns more particularly for more persistent volatility. The most general form is GARCH (1, 1) where GARCH stands for Generalized Autoregressive Conditional Heteroscedasticity. The empirical analysis is focused on BRIC emerging markets. We have collected stock indices from its respective exchange and we use proxy index to represent the country i.e IBOVESPA, RTS, BSE-SENSEX and SSEC, for Brazil, Russia, India and China. Data time lag is from first transaction day of Jan, 2003 to last transaction day of Jan, 2013. We use GARCH (1, 1) model to estimating emerging stock market volatility by Bollerslev and Taylor (1986). GARCH stands for Generalize Autoregressive Conditional Heteroscedacity. We employ GARCH model with leg (1) and Order (1) under normal distribution errors. We have attempted to give brief specification of model as follows. The sample financial time series colected from first day transaction of Jan 2003 to last day transaction of Jan 2013 which is daily closing index prices. It was investigated the unit root problem in all series and hence the financial series have been transformed. The continuously-compounded daily returns are calculated using the log-difference of daily closing prices of stock markets selected indices :

$$R_t = \mathbf{h}\left(\frac{P_t}{P_{t-1}}\right) = \mathbf{h}\,(P_t) - \mathbf{h}\,(P_{t-1})$$

where Rt represents daily returns of indices and Pt stands for daily closing prices of indices.

$h_t = \omega + a_1 u_{t-1}^2 + b_1 h_{t-1}$

It is important to follow hypothesis of stationary covariance as unconditional variance and to exist that it processed by following :

$\sigma^2 = Var(u_t) = E(u_t^2) = E(\omega + \alpha_1 u_{t-1}^2 + \beta_1 h_{t-1}) = \omega + \alpha_1 E(u_{t-1}^2) + \beta E(h_{t-1}) = \omega + \alpha_1 \sigma^2 + \beta_1 \sigma^2$

It is formed the GARCH (1, 1) conditional variance equation $Var(u_t \mid h_{t-1}) = E(u_t^2 \mid h_{t-1}) = h_t$, And thus it can simply take form $h_t = \omega + \alpha_1 u_{t-1}^2 + \beta_1 h_{t-1}$.

there is presence of unconditional variance, it can be case where we employ the process to find $\alpha_1 + \beta_1 < 1$ and for converting it into generates positive result, we require that. Positive result will indicate good news for market. For the constant, conditional mean we followed $E(y_t|\square_{t-1})$, where E= $c + \phi\, y_{t-1} + 0$, and y_{t-1} is included in $|_{t-1}$ We would be able to conclude our result by $h_t = \omega + \alpha_1 u_{t-1}^2 + \beta_1 h_{t-1}$ Where, $\alpha_1 u_{t-1}^2$ represents ARCH component and $\beta_1 h_{t-1}$ GARCH component. Can be explored like this. The above formulation of GARCH (1,1) $h_t = \omega + \alpha_1 u_{t-1}^2 + \beta_1 h_{t-1}$ can be explored like this;

H_t represents volatility of BRIC stock markets. This is the only dependent variable and result as a combination of (1) ARCH term and (1) GARCH term. ω represents constant and it is independent variable of the model. $\alpha_1 u_t$-1^2 represents previous period's squared residual which we shall derive from mean equation. This is ARCH term of the model and it is completely independent variable. $\beta_1 h_t$-$_1$ represents previous day's residual variance, and this will represent us volatility of BRIC markets, hence this is actual GARCH term.

It was employed BRIC proxy indices from year Jan 03' to Jan 13' which represents daily closing stock market prices. First what we have noticed that there is large difference between min index and max index which has produced high standard deviation in regards of number of observation (2497). Log transformation has reduced degree with unchanged results. The informations highlighted in the following reveal that the mean is close to zero and positive for time series returns. It also indicates negative Skewness, (for all indices) which represents an asymmetric tail which exceeds towards negative

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values rather than positive. This negative tail also indicates that all indices are non-symmetric returns and are leptokurtic as well since its large kurtosis (table-1).

TABLE – 1 DESCRIPTIVE STATISTIC

Variance	BRAZIL-IBOVESPA	RUSSIA-RTS	INDIA-SENSEX	CHINA-SSEC
Basic Statistics				
Mean	0.0668424	0.0602754	0.0704324	0.0173870
Median	0.127544	0.175931	0.121207	0.00693064
Min	-12.0961	-21.1994	-11.8092	-9.25615
Max	13.6766	20.2039	15.9900	9.03425
Std.Dev	1.84202	2.25698	1.63371	1.65548
Skewness	-0.0945921	-0.542471	-0.0771899	-0.257509
Kurtosis	5.20287	11.1868	7.87480	3.66930
Unit Root Test (tested at 1%, 5% and 10% = -3.48, -2.89, and -2.57)				
test stat "tau"	-34.514	-45.0266	-42.3332	-48.9036

Source: Author's computation using stock indices

Generally all time series has unit root problems and it must be filtered and allowed for ARCH processes. For this purpose we have allowed trend for all indices by adding intercept to the model y_t (or Δy_t) on 1, y_{t-1}, Δy_{t-1},…, Δy_{t-p+1}, computing the t-statistic which can resulted in $\tau_\mu = \frac{\hat{\rho}-1}{se(\hat{\rho})}$ this process comparing its value to percentiles of DF τ_μ distribution. It has produced higher negative value than its critical value at 1%, 5% and 10% level which allows series for ARCH and proves no unit root problems. This is well enough to process for GARCH (1, 1) model to estimate volatility of BRIC (see table-2). We have given specification about GARCH (1, 1) model where conditional variance should not exceed 1, positively and thus $\alpha_1 + \beta_1 < 1$ proved successfully. It goes like;

For Brasil is $0.072719\ (\alpha_1 u_{t-1}^2) + 0.905065\ (h_{t-1}) = 0.977784 = <1$

For Russia is $0.119630\ (\alpha_1 u_{t-1}^2) + 0.854888\ (h_{t-1}) = 0.974518 = <1$

For India is $0.119038\ (\alpha_1 u_{t-1}^2) + 0.868409\ (h_{t-1}) = 0.987447 = <1$

For China is $0.049287\ (\alpha_1 u_{t-1}^2) + 0.942785\ (h_{t-1}) = 0.992072 = <1$

What all we learn from above equation provides sum of ARCH and GARCH which is denoted by $\alpha_1 + \beta_1$ which shows positively results for BRIC indices which is <1. Brasil-IBOVESPA index $\alpha_1 + \beta_1 = 0.977784$ which proves that model is stable and able to conclude estimated volatility results. This custom is further followed by rest indices which also stands merely i.e. Russia- RTS $\alpha_1 + \beta_1 = 0.974518$, for India-BSE SENSEX $\alpha_1 + \beta_1 = 0.987447$, and China – SSEC $\alpha_1 + \beta_1 = 0.9920723$. Decision makers and investors require noting here that integrated value for $\alpha_1 + \beta_1$ is very big, and very near to 1. This means that the reactive function of BRIC indices market volatility goes towards shock or collision, which is a relatively result of slow speed attenuation. It also may result that exterior shock will influence the return of BRIC emerging markets in a long term. In the above description the total of $\alpha_1 + \beta_1$ is near to zero, and gives positive sign of the market. Brazil represents $\alpha_1 + \beta_1 = 0.977784$, which is third nearest figure to 1 from entire study. We can rank Brazil to 3rd position comparing nearest to 1. It means that a result which is most near to one (1) will be given priority for the investment at first. The above equation proves that China would have the first priority for the investment as an emerging market from BRIC, $\alpha_1 + \beta_1 = 0.9920723$, followed by India as second best alternate, Brazil and Russia at third and forth. However, the other data support and outcomes gives further information about decision making. Basic statistics, series returns, log returns and stationary figures reveals that; Brazil and India market seems to represent normal degree of volatility among BRIC, where as Russia and China reflects very high degree of volatility of the series returns. It requires considering the overall statistics and outcomes for the right decision making. The GARCH (1, 1) estimation provides us following outcomes.

TABLE – 2 GARCH (1, 1) ESTIMATIONS

Variable		Coefficient	Std. error	Z - Stat	p-value
Brasil – IBOVESPA	π	0.096681	0.0304670	3.173	0.0015
	ω	0.065572	0.0214908	3.051	0.0023
	α	0.072719	0.0135481	5.368	0.0000
	β	0.905065	0.0174935	51.74	0.0000
Russia - RTS	π	0.196502	0.0354339	5.546	0.0012
	ω	0.121928	0.0339571	3.591	0.0003
	α	0.119630	0.0210871	5.673	0.0001
	β	0.854888	0.0204956	41.71	0.0000
India – BSE SENSEX	π	0.123616	0.0253384	4.879	0.0006
	ω	0.0401623	0.0147921	2.715	0.0066
	α	0.119038	0.0208531	5.708	0.0001
	β	0.868409	0.0223856	38.79	0.0000
China – SSEC	π	0.0185460	0.0298848	0.6206	0.0000
	ω	0.0214090	0.0087845	2.437	0.0048
	α	0.0492873	0.0092446	5.331	0.0002
	β	0.942785	0.0105207	89.61	0.0000

Source: Author's computation using stock indices

In the previous table regarding GARCH (1, 1) estimation value of mean covariance π provides all positive results for BRIC indices. The linkage of this parameter with entire result series may lead us to conclude that investors in BRIC indices generate more negative shocks rather than positive. Nevertheless positive shocks generate equal degree of volatility in BRIC markets.

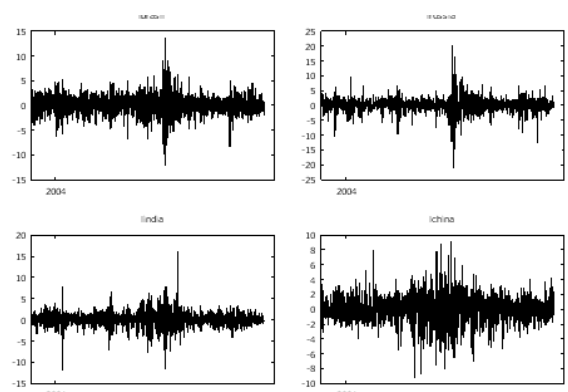

Figure 3 Log returns series of BRIC indices

Source: Author's computation using stock indices

CONCLUSIONS

The idea of estimating BRIC emerging stock market by GARCH (1, 1) has satisfied results and enclosed ideological outcomes. The BRIC emerging markets were characterized by volatility and risk. It ranks BRIC market as CIBR, China, India Brazil and Russia as an alternate to invest in emerging market on the basis of their $a_1 + b_1$ returns. The unit root test was applied to check for stationarity and BRIC indices found to be stationary after log returns. In respect to application of GARCH (1, 1) model which has explicit and simple coefficients of lagged squared error with conditional variance. Furthermore, BRIC indices are exploding very large change evident in the pattern of volatility during the sample period, particularly effects measurable in global financial crisis and post crisis period. All BRIC markets represent a certain degree of volatility and risk. It is an important factor for decision makers and investors for indicating high standard deviation ratio risk and return on investment and a chance for higher returns. Consequential, the impact of an extreme financial event is much more dramatic than in the case of a speculative bubble.

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