

ARTÍCULO ORIGINAL

Financial contagion: The impact of the volatility of global stock exchanges on the Lima-Peru Stock Exchange

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ABSTRACT

What happens in the international financial markets in terms of volatility, have an impact on the results of the local stock market financial markets, as a result of the spread and transmission of larger stock market volatility to smaller markets such as the Peruvian, assertion that goes in accordance with the results obtained in the study in reference. The statistical evaluation of econometric models, suggest that the model obtained can be used for forecasting volatility expected in the very short term, very important estimates for agents involved, because these models can contribute to properly align the attitude to be adopted in certain circumstances of high volatility, for example in the input, output, refuge or permanence in the markets and also in the selection of best steps and in the structuring of the portfolio of investment with equity and additionally you can view through the correlation on which markets is can or not act and consequently the best results of profitability in the equity markets. This work comprises four well-defined sections; a brief history of the financial volatility of the last 15 years, a tight summary of the background and a dense summary of the methodology used in the process of the study, exposure of the results obtained and the declaration of the main conclusions which led us mention research, which allows writing, evidence of transmission and spread of the larger stock markets toward the Peruvian stock market volatility, as in the case of the American market to the market Peruvian stock market with the coefficient of dynamic correlation of 0.32, followed by the Spanish market and the market of China. Additionally, the coefficient of interrelation found by means of the model dcc mgarch is a very important indicator in the structure of portfolios of investment with instruments that they quote on the financial global markets.

Key words: Contagion and dynamic correlation, risk, transmission, volatility.

INTRODUCTION

There are in the literature, studies of the estimation of contagion and transmission of volatility in the global financial markets to local financial markets and small, among them, Valls (2014), Bejarano (2014), using the time series with autoregressive models, heteroskedasticity, conditional and dynamic evident in the phenomenon of financial contagion from the financial markets great to other small markets in Asia and Oceania. The present work, unlike what is described in the previous paragraph, in the first place characterizes the type of volatility that presents the historical series of quote of the Stock exchange of Lima in the historical period (2000-2016). In the second term, describes the characteristics of the volatility of the profitability of the Lima Stock exchange, and finally determines the contagion of volatility in the global financial markets to the peruvian market, estimating their impact on the volatility of the profitability of the Lima Stock exchange.

From 2002 onward the global financial markets, as can be seen in the figure 1, as were movements of high volatility, until since the year 2007 until 2016, the behaviour of the global markets that have pegged their volatility to the local market, consequently impacting on the volatility of the profitability. The economic context in which frames the present study, is the one that is described in the following lines: For the year 2007, international markets were already several years into a sustained boom, with investors, entrepreneurs,

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governments, and american consumers benefiting from a growth of wealth that seemed to have no end, with companies increasingly large, rich and powerful, this festival of prosperity came to an end in mid-2007, when some banks and financial institutions in the united States and England began to experience serious liquidity problems. In Peru, the Lima Stock exchange, showed a sustained growth and exponential that takes place in the period 2000 until the year 2007, as can be seen in figure 1. For the stock market to fulfill its role successfully, it is necessary that you can know and even to anticipate this information. In this regard, the changes in prices are random and are not predictable to the extent that they incorporate the expectations and information of all market participants. This variation in the performance of the asset is known as volatility.

Modelling and measurement of risks is a complicated task. The risk is a slippery concept, that refuses to be enclosed in formal models. The difficulty exists behind both the movements of the prices of financial assets, as the solvency of the economic agents (companies or individuals). The financial risk is associated with factors-economic, political factors and social factors. In globalized markets, the occurring shock is negative or positive, that cause changes to a greater or lesser volatility, as the case may be, given the behavior of the asymmetric volatility. Studies, such as Engle (1982) and Engle (2003), indicate that the volatility can be captured in models of variance conditioned as well as the models of the family ARCH, with which it is possible to predict the variance of future of an asset is risky. The main objective of this study, it is without doubt, improve the processes of identification and estimation of volatility in International Markets, measurement of the volatility joint and measure how they affect each other the returns of these markets and, in addition, to model the impact of news on the Stock exchange of Peru, and the attitude of the agents who take an active part in the market.

On the other hand, Enders (2015) on page 155 of his book *Applied Econometric Time Series*, deals with the TARARCH model, citing as the model that best welcomes the impact of the news that have occurrence in the financial markets on the behaviour of the local stock markets. The study of the historical volatility of the stock market of Perú and its relationship with other markets, it is of vital importance for the management of risks in the structuring of investment portfolios by investors. Likewise, knowledge of the historical volatility allows investors to make decisions on entry, stay or departure, and on the other hand, the taking of precautions and assurances that the portfolios required in the process of financial risk management. The volatility that present themselves in the markets of global values has impact on the behavior of the bidders and demanders of financial assets in the stock market. As well as the impact of news on the profitability of the stock markets and the dynamic relationship that manifest. The volatility in the financial markets has been measuring the value of the variance of the asset price. This variable, the variance, becomes explanatory of the evolution of the price itself in terms of information available at t, t_1 . At each moment in time, the volatility is known up to the moment immediately before becomes an important mechanism to know the progress of the asset as it is a "stylized" sufficiently proven that the financial markets suffer from "contagion": periods are very volatile, are followed by periods of the same feature, and, once you "calm down", the tendency remains in the observations.

Valls (2014), *Volatility in financial Markets: The impact of The global financial crisis*. doctoral thesis developed in Spain, that deals with the study of the volatility of the global markets using the models of the family ARCH (1) and GARCH (1,1), makes estimates of contagion from the volatility of global markets such as the United States toward smaller Markets as those of Latin America. Serna (2001), a Study of the volatility of the Stock market IBEX 35 in Madrid Spain 1991 – 2000, doctoral thesis, developed by Gregorio Serna Calvo, in the Graduate School of the University Carlos III of Madrid – Spain. Study of the determinants of the volatility of the profitability of the Bag under the model of Black and Scholes. Rodriguez (2004), doctoral thesis entitled the Influence of the Impact of the News is not expected on the volatility of the technology stocks in Spain, developed in the Graduate School of the University of Vigo in Spain. The main objective of the work in question focuses on the measurement of the effect of the new information derived from the occurrence of unexpected developments in macroeconomic indicators or internal data from the companies themselves on the volatility through the curves of impact of news. We also verify the influence of the risk premium on the actual return of the shares, based on the postulates of the traditional theory of portfolios, for companies tied to the New Economy. This work is part of the modelling of the conditional variance for the companies in the New Market through the GARCH models, which are used to contrast the existence of a dynamic relationship in the volatility, capturing the effects of asymmetric of the innovations on it.

Blanco (2000), a study developed in Bank of Spain by Dr. Robert Blanco, under the title Effects on the volatility of the stock market of Introduction of the Futures Contracts and Options on IBEX 35. The study focuses on the

evaluation of the volatility under the model by GARCH. Cargo (2007), doctoral thesis developed by the Esau Cargo Gave in Mexico, under the title Setting of the qualification of the Market Risk of the most active companies listed on the Mexican Stock exchange, with the implementation of an Artificial Neural Network Classifier. This work focuses on the actions more active, that is to say, that is bought and sold on a larger sum each quarter by the economic agents in Mexico, whose sensitivity to the risk of the mexican market is represented by the beta of the Index of Prices and Quotations (IPyC), calculated on statistical methods such as regression analysis and traditional techniques such as fundamental analysis and technical analysis. Engle (1982), Autoregressive Conditional Heteroskedasticity with Estimates of the variance of United Kingdom Inflation, published in the Journal of Econometrics, volume 50, number 4. In this work introduce the modeling, ARCH and GARCH for the evaluation of the behavior of the inflation at the time.

Chou (1992), Arch Modeling in Finance, published in the Journal of Econometrics, volume 52, number 1-2. In this work we model GARCH for volatility in the options Market. Analysis of GARCH multivariate introduced by Jorge Ludlov and Beatriz Mota in the Autonomous Metropolitan University of Mexico (2006), for the study of the volatility of joint stock markets of NASDAQ and S&P500. Enders (2015), in his text Applied Econometric Times Series, discusses on the use of models of asymmetric TARCh and EGARCH for modeling of the impact of news on the expected volatility of the markets, that is called Leverage effect. He says, that the bad news apparently have a greater effect on stock market volatility than good news, and on the other side, it makes note that there was a strong negative correlation between return and expected volatility (p. 155-156). Chambi (2017), the characterization of the volatility of the exchange of Values of Lima, as a series of time autoregresivo and heteroskedasticity conditioned using the model Garch. Chirinos (2013), in the article Measuring Contagion and Interdependence in Financial by Copulations and extreme events in the countries of Latin America, analyzes the interrelationship and transmission of shocks between financial markets in Latin America.

Piffaut & King (2016), in the article Integration, financial contagion and risk on stock markets, examines the problem of financial contagion to global markets by the coefficient of correlation dynamics. Morales (2015), in the study of financial contagion and interdependence in Latin America: analysis of transmission of shocks financial of Brazil to the rest of Latin american countries, is performed by using the correlation coefficient and dynamic conditional. Bejarano (2015), in their study of financial contagion in Latin American markets: an application of correlation dynamics, examines the financial contagion and the transmission of volatility. Medina (2017), in his PhD thesis entitled Financial Contagion international in the emerging countries of Asia and Latin America, models, and analyzes the problem of financial contagion with the model mgarch dcc. Villarino (2016), in financial mathematics volatility is a measure of the frequency and intensity of changes in the price of an asset of a type that is defined as the standard deviation of the change in a specific time frame. It is frequently used to quantify the risk of the instrument. The annualised volatility σ is proportional to the standard deviation σ_{SD} of the returns on the instrument divided by the square root of the temporary period of the returns:

The hypothesis that delineates the present work is strictly related to the identification of the influence of the volatility in the behavior of the stock exchange of Perú and in the volatility of its profitability, which statement is expressed in the following form:

The global financial markets spread volatility to the local market peruvian and consequently impact on the volatility of its profitability

METHODOLOGY

The analytical framework of this study is described below:

A first component is formed by the concepts related to the measurement of the descriptive statistics concerning the concept of risk.

A first concept in use, is the profitability of the Lima Stock exchange, whose description of the model is presented in the following lines. Return model The variations in the closing price of the index are the cause of profitability that this generates. From the daily prices (closing rates) are calculated by the profitability daily as a random variable to the volatility of the returns.

The problem that now arises is to identify the statistical model that best represents the behavior of prices and profitability. If we define the Return value as the quotient of the difference of prices between period t and period t-

1, and the price in period t-1 and we have the model:

$$Y_t = \frac{(P_t - P_{t-1})}{P_{t-1}}$$

You use the profitability logarithmic, that for small values of Profitability, Price turns P_t out to be a good approximation of the real yield, and allows the sum of the payoffs.

$$Y_t = \ln\left(\frac{P_t}{P_{t-1}}\right)$$

it is assumed the assumption that the logarithm of the price verifies the equation:

$$\ln P_t = r_o + \ln P_{t-1} + at$$

Where r_o es a constant and at is a normal random variable with mean zero and variance σ^2 , ε is the white noise, and that is distributed identically and independently over time. We can then write the Payoff logarithmic as:

$$Y_t = r_o + at + \varepsilon$$

A second concept is the risk that is developed in the following lines

The risk

$$\sigma = \frac{\sigma_{SD}}{\sqrt{P}}$$

Where P is the period in years of returns. The volatility generalized σ_T for time horizon T is expressed as:

$$\sigma_t = \sigma\sqrt{T}$$

If we apply the hypothesis that the random variables are independent, we can assume that the profitability of today has no influence on the profitability of tomorrow (Pérez, 2010, p.405).

Stationarity

Montenegro (2010), a stochastic process X_t is strictly stationary if its statistical properties or probabilities do not change with time: that is, if its cumulative distribution function is time-independent (p. 23). A way to perform the test of stationarity of a time series is the test of Dickey-Fuller.

Contrast Augmented Dickey-Fuller (ADF Test).

To perform the test of Dickey-Fuller augmented (ADF) to a time series X_t we run the ordinary least squares OLS, whose model is the following:

$$\Delta X_t = c + \varphi X_{t-1} + \sum \gamma_i \Delta X_{t-1} + \varepsilon_t,$$

Where the number of lags of ΔX_t may be chosen by running the model expressed in the lines above, ε_t is the white noise, Montenegro(2010).

Heteroskedasticity

Peña (2010), the heteroskedasticity is the existence of a variance not constant in the random distortions of an econometric model. The basic model of linear regression requires that the conditional variance of the random distortions to the values of the regressors X to be constant:

$$Var(u_i / X_i) = \sigma^2$$

Although, usually the hypothesis is formulated without mentioning the conditional nature of the variance, simply as:

$$Var(u_i) = \sigma^2$$

To understand intuitively this restriction we can reason in the following way. Equal variances “or” for the various values of “x” necessarily implies equal dispersion (variances) of “and” for different values of “x”, which necessarily implies that the regression line will represent with equal accuracy the relationship between “x” and “y” regardless of the values of “x”. This is very important because it must be remembered that the regression analysis is regression analysis conditional “and” on “x” which means, logically, that if you want to obtain a parameter of a stable relationship and useful between the two variables, the values of sample “and” should be equally dispersed with variations of “x”. In other words, and in terms of the error, although the error will be greater for higher values of “x” (do not force the error to have a size equal to the travel of “x”) the dispersion of the error around the regression line will be the same. This allows to consider also all valid data sample of the regressors “x” to determine the conditional relationship of “and” to the values of “x” without having to ponder a more or less u-values other than “x” in function of the greater or lesser dispersion of “and” in the different cases (p. 435).

The autoregressive Model of the time series

$$X_t = c + \alpha X_{t-1} + \varepsilon_t$$

X_t : result today

X_{t-1} : resultado of yesterday

α : ratio of the result of yesterday

ε : noise White

A third concept used is: The modeling Garch for the estimation of the volatility of the profitability of the Lima Stock Exchange

The ARCH(1) Model

The process ARCH(1), proposed by Engle(1982) is defined by the following expression quantifies the volatility of an index representative of a stock market in terms of variance.

$$\sigma^2_t = \partial_0 + \partial_1 \varepsilon^2_{t-1}$$

The GARCH(1,1) Model

The model GARCH(1,1) was proposed for cases of a series of financial which have excess of kurtosis and the clustering of the volatility around its mean. The model provides an adequate way to forecast the variances and covariances of the returns of the assets. The GARCH has application in the treatment of risk management, in the management of investment portfolio, asset allocation, options, price, exchange rate, interest rate, equity markets.

$$\sigma^2_t = \partial_0 + \partial_1 \varepsilon^2_{t-1} + \theta_1 \sigma^2_{t-1} \text{ where}$$

$$\partial_0 > 0, \partial_1 \geq 0, \theta_1 \geq 0 \text{ y } 0 \leq (\partial_1 + \theta_1) < 1.$$

DCC Mgarch Model

Bollerslev (1986): Model CCC, Engle (2002) Model DCC; Tse & Tsui (2002), Model DCC Mgarch.

The model DCC Mgarch The model assumes that you have the returns α_t of n actions with expected value zero and covariance matrix H_t , where the model is defined as:

$$\begin{aligned} r_t &= u_t + \alpha_t \\ \alpha_t &= \sqrt{H_t} * z_t \\ H_t &= D_t R_t D_t \end{aligned}$$

Where:

r_t : vector n*1, logarithm of returns of n stocks at time t.

α_t : vector of n*1, the average of returns of n stocks at time t.

u_t : vector of n*1 of the expected value of r_t

H_t : Matrix n*n conditional variance to α_t at time t.

z_t : vector 1*n of the error.

D_t : diagonal Matrix n*n of the standard deviation.

R_t : the correlation matrix conditional.

Arch Processes

To carry out the study, through the repositories collects the historical data of the indices of the various countries: the General Index of the Lima Stock exchange (IGBVL), IBEX 35 of Madrid, Spain. S&P500 the United States, Bovespa of Brazil, NIKKEI225 of Japan and Shanghai of China, between the period 2000 to 2016, a period which includes the time of the international financial crisis, as can be seen in the table that follows, which includes each series, the amount of 4412 data of daily exchange rate and the profitability daily

Table 1. *Financial markets studied*

Continent	Index Stock	Country
American	S&P500	United States
Europe	IBEX 35	Spain
South America	BOVESPA	Brazil
	BVL	Perú
Asia/Pacific	Shanghai	China
	Nikkei	Japan

Source: Repository of Investing.com

Through the indices have data for daily exchange rate at the close of the markets, which makes them a descriptive analysis and it becomes a profitability daily, using the equation of $Y = 100 * \ln\left(\frac{P_1}{P_0}\right)$ to later submit to statistical evaluation. The series of returns, they perform the test of stationarity with the object of selecting the model to estimate the volatility of the series, and thus to assess the character autoregressive of the same. After the statistical evaluations of the series, you select the model Garch(1,1) for the modeling of the volatility of the profitability. And finally with the model DCC Mgarch evaluates the correlation and dynamic conditional of the series of the indices of the bags in study.

In summary the methodological process followed is the following:

- In the first place, the analysis of stationarity: it is performed with the test of Dickey Fuller.
- Secondly: the condition of autoregressive of the series: with the test AR(1).
- Third: select the model, with which to run the modeling, in our case, we select the GARCH(1,1) Model.
- Fourth: test of heteroskedasticity conditional: it is performed by squaring the residual of the Model Garch obtaining, and illustrating in graphical form, the series of the return with the $Resid^2$.

- Gets the model Garch for the profitability of the Lima Stock exchange (2000-2016).
- The problem of financial contagion is obtained by modeling DCC Mgarch, the correlation and dynamic conditional between the different markets under study.

DATA AND RESULTS

The descriptive statistics of the bags considered for the study are shown in table 2. Looking at the kurtosis is quite low for each of the entities, except for the BOVESPA, on the other hand, the figure 1, allows us to observe the typical behavior of time series is not stationary, and so effectively, by performing the test of single root is verified that all the series are non-stationary, therefore, it is not possible to submit to modeling stationary. The behavior of the trends of the time series, figure 1, figure 2, it is observed through the curve, the behavior, describing the background of the american stock exchange, japanese and chinese, a fact that already tells us that there is the presence of a phenomenon of transmission and/or contagion from the volatility.

Table 2. Descriptive Statistics of the series daily from the markets

INDICADOR	BOVESPA	IBEX 35	IGBVL	NIKKEI 225	SHANGHAI	S&P 500
Mean	41 311.57	9 799.97	10 054.81	13 054.81	2 108.47	1 372.02
Median	47 022.28	9 624.15	12 591.37	12 782.07	2 058.54	1 289.65
Maximun	382 784.10	15 945.70	24 051.62	20 868.85	5 166.35	2 298.37
Minimun	8 370.88	5 364.50	1 109.89	0.00	712.36	676.53
Std. Dev.	20 062.14	2 161.95	7 321.53	3 412.52	865.65	364.45
Skewness	0.87	0.60	0.00	0.28	0.80	0.79
Kurtosis	20.46	3.12	1.56	1.96	3.78	2.77
Jarque Bera	56 590.56	264.12	380.24	257.63	581.26	467.38
Probability	0.00	0.00	0.00	0.00	0.00	0.00

Source: Repository of Investing.com

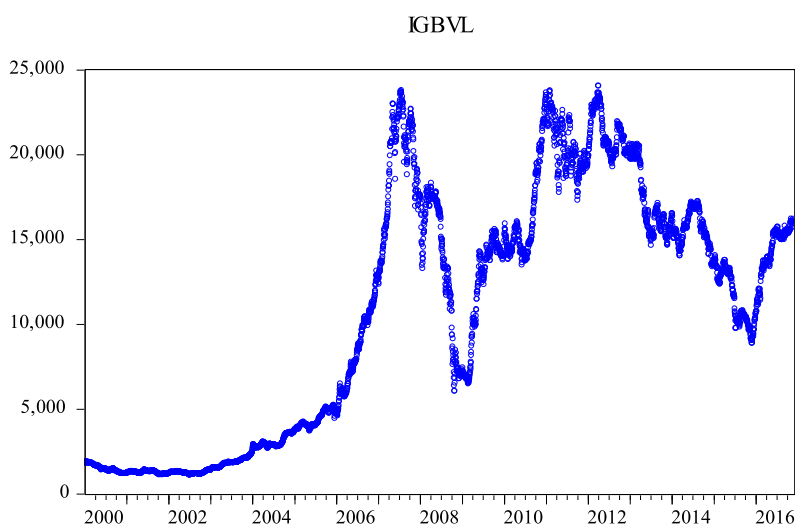


Figure 1. Evolution of IGBVL (2000-2016)

Figure 1 shows the evolution in time of the price of the sotck market of Lima – Peru, noticing a behavior steady between the years 2000 to 2002, but that grows dynamically from 2002 to 2007, then, a depression strong from 2007 to 2008, and 2008 and forward behavior of high and low, circumstances of behavior of high volatility. Figure 2 represents the evolution of the different stock market indices in the period 2000 to 2016, in which we can see a trend almost similar in all the financial markets large and small as the peruvian, as has happened with the historical evolution of IGBVL, we observe an evolution stationary in the periods 2000 to 2002 and for subsequent periods up to 2016 can be guessed that there are a behavior of time series non-stationary, whose

behavior that describes phenomena of comovimiento and graphically summarized you can visualize the phenomenon of contagion, as can be seen in the figure 3.

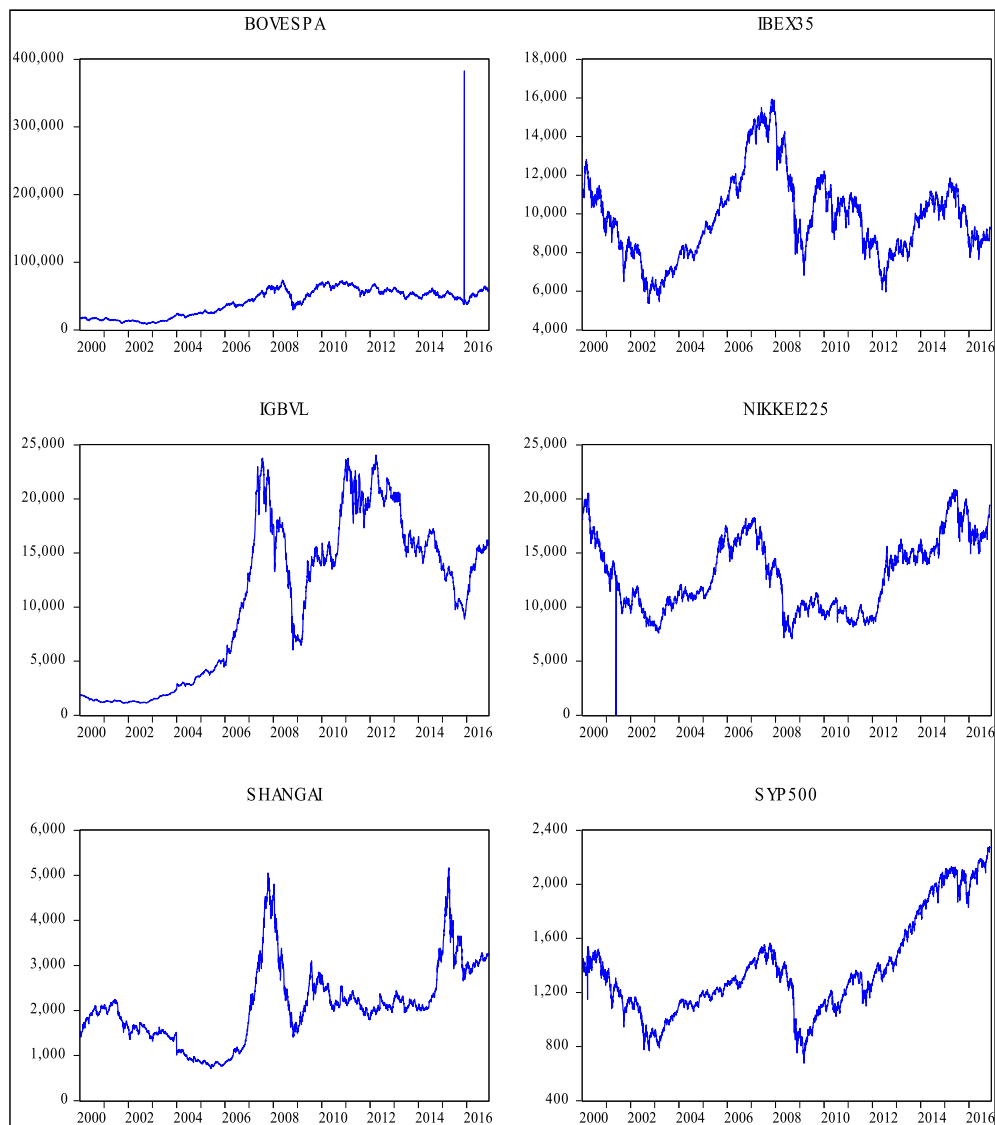


Figure 2. The historical Evolution of the stock indexes under study.

Figure background shows the historical behavior of the stock indices that are involved in the study, denoting the behavior of a time series of the type autoregresivo and not stationary, the relationships will be analyzed further on a previous characterization econometric.

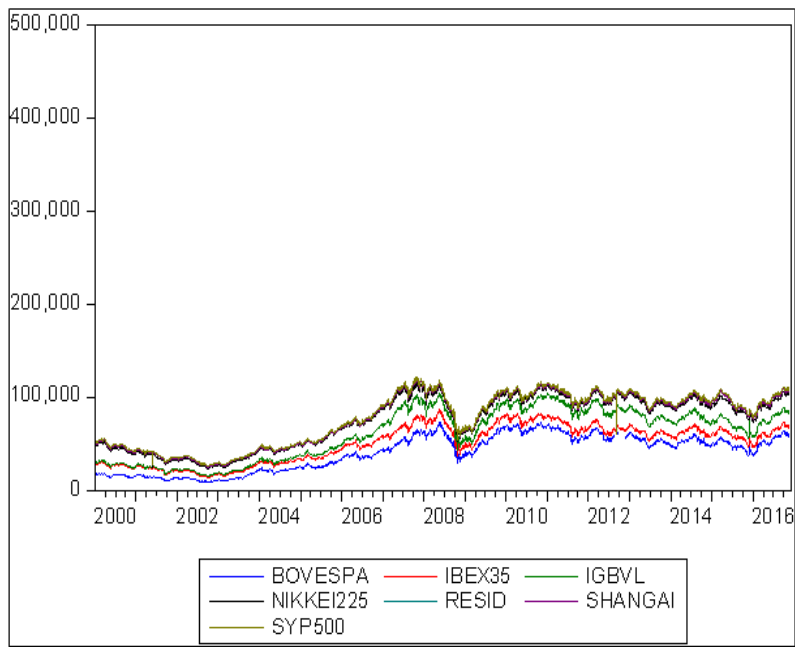
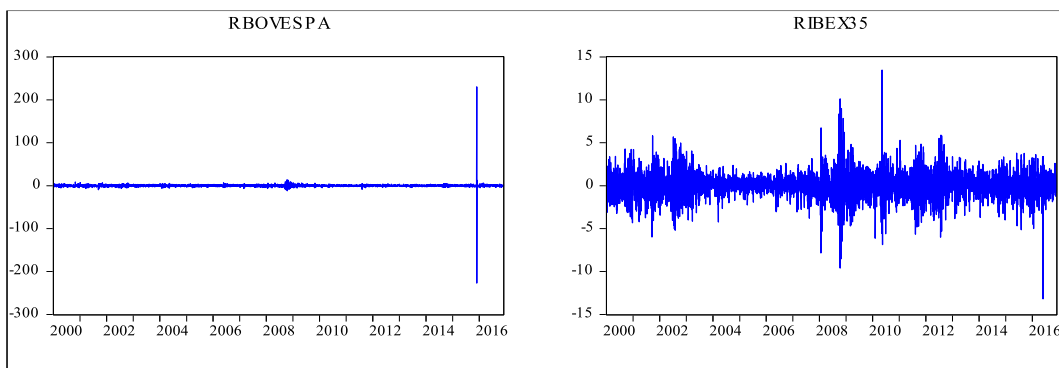


Figure 3. Historical Series of the daily quotations of the markets.

On the other hand, the figure 4, is the description of the behavior of the profitability of the stock markets under study, in which there is a typical evolution of a time series stationary, with variances very focused towards its mean, kurtosis concentrated, in which it is displayed, periods of high volatility, in the years 2000 to 2002, of low volatility in the years 2004 and 2005, high volatility in the years 2007, 2008, a period that extends until 2016. The boundaries of volatility, in all market ranges between 10% to -10% in most of the markets studied, except in the bag brazilian. The illustrations of the volatility of the profitability of the markets, you can already appreciate the presence of the contagion and transmission of volatility in the larger markets to smaller markets such as peru, that are affected by volatility that occurs in other financial markets, as is described and analyzed, and concludes Valls(2014) in their analysis of stock markets american, european and asian and Bejarano(2014) in the study of market stock american and Latin american markets, occurrence that will confirm this later with the correlation and dynamic conditional, when describing the results of the modeling DCC Mgarch.



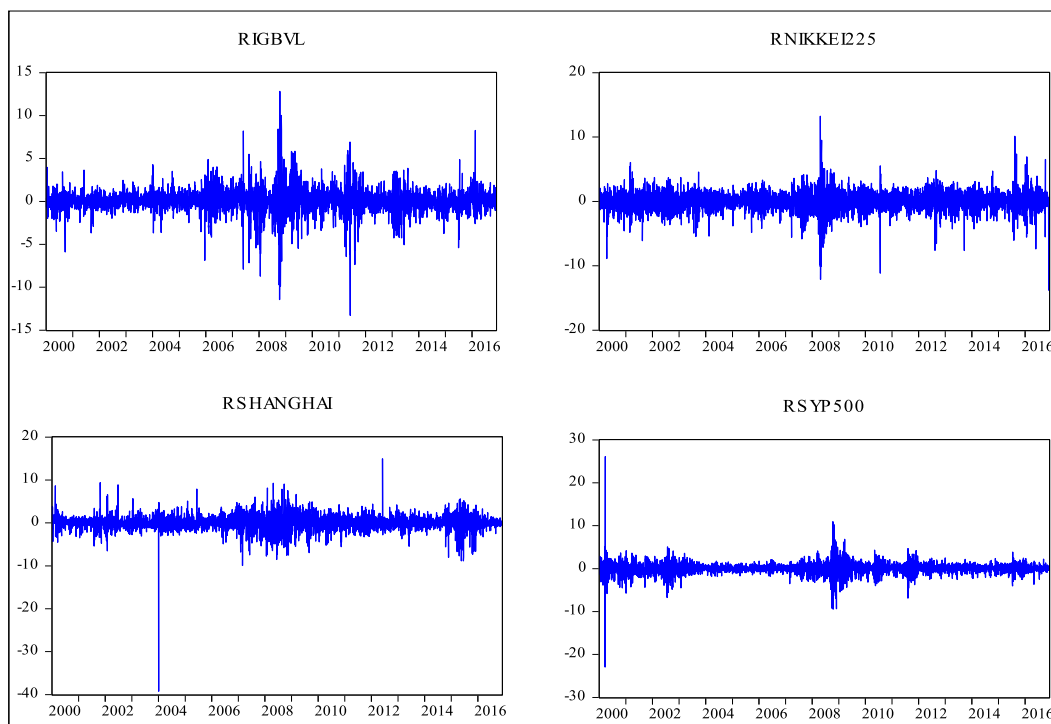


Figure 4. Profitability of daily stock market

Estimation of the model Garch for the profitability of the Lima Stock exchange. From the figure 4 displays the behavior seemingly stationary series of returns, which is verified with the test of single root of Dickey - Fuller, whose indicators are presented in the following table.

Table 3. *Test of Dickey – Fuller to the Series of the Profitability of the Daily BVL*

Null Hypothesis: RIGBVL has a unit root

Exogenous: Constant

Lag Length: 3 (Automatic – based on SIC, max lag=30)

Null Hypothesis: RIGBVL has a unit root		
Exogenous: Constant		
Lag Length: 3 (Automatic – based on SIC, max lag=30)		
	t-Statistic	Prob*
Augmented Dickey – Fuller test Statistic	-29.31993	0.00
Test critical values: 1% level	-3.43165	
5% level	-2.86200	
10% level	-2.56705	

*Mackinnon(1996) one-sided-values

As can be seen in table 3, the absolute value of the indicator ADF is greater at the three critical levels of Mackinnon and p-value lower to 0.05, it is inferred that the historic series of profitability of daily Stock market of Lima is stationary. This result is very important for the selection of a model for the estimation of the volatility of the profitability of the Lima Stock exchange. The verification of the character autoregressive of the historic series of profitability of the Lima Stock exchange is performed with the application of the model $Ar(p)$, table 4, that shows that indeed, the time series of the profitability of the Lima Stock exchange, included in the period 2000 to 2016, has a behavior-stationary, a result that leans to select a model autoregressive for the measurement of volatility, and use this model to test the prognosis.

Table 4. The model $Ar(1)$ series of return daily of the BVL

Variable	Coefficient	Std.Error	t-Statistic	Prob.
Ar(1)	0.1431419	0.005813429	24.62262	1.53E -125
SIGMASQ	1.9015056	0.015570701	122.12075	0.00
R.squared	0.0192613	Mean dependent var		0.0494923
Adjusted R-squared	0.0190389	S.D.dependent var		1.3925839
S.E.regression	1.3792636	Akaike info criterion		3.4814344
Sum squared resid	8389.4428	Schwarz criterion		3.4843321
Log likelihood	-7678.044	Hannan –Quinn criter		3.4824564
Durbin-Watson stat	1.9935181			
Inverted AR Roots	0.14			

Source: IGBVL, elaboration: own.

The information provided by the model $Ar(1)$, table 4, it is inferred that the series in reference to have a behavior autoregresivo, being α the model $Ar(1)$ rather less than 1, and the indicator Inverted Ar Roots = 0.14, widely less than 1, that describes the range of profitability of the Lima Stock exchange as non-explosive, and that has a variation around the mean, a result that is consistent with the affirmation of Montenegro (2010). The character and behavior heterocedástico of the series of variance or volatility of the profitability of the Lima stock exchange, is illustrated by the following figure, that in a good way illustrates the effect of the news on the volatility of the exchange of Values of Lima.

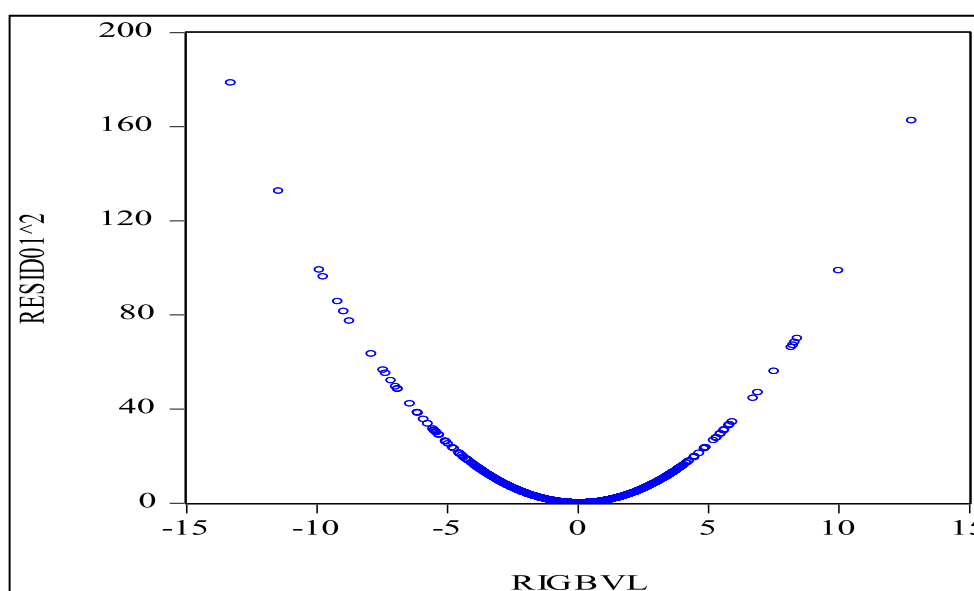


Figure 5. Heteroskedasticity of the profitability of the Lima Stock exchange.

Figure 5 in reference is the result of the series of volatility from 2000 to 2016, according to Montenegro (2010), the property statistics of heteroskedasticity is that in the time the volatility is different in each unit of time, is the reading that we confirm with the illustration of the figure 5. As equal as the other descriptive results obtained, it is useful to select the appropriate model to estimate the volatility of profitability. The conditioned behavior of volatility series of return of the Bag of Values of Lima can be seen in the following figure:

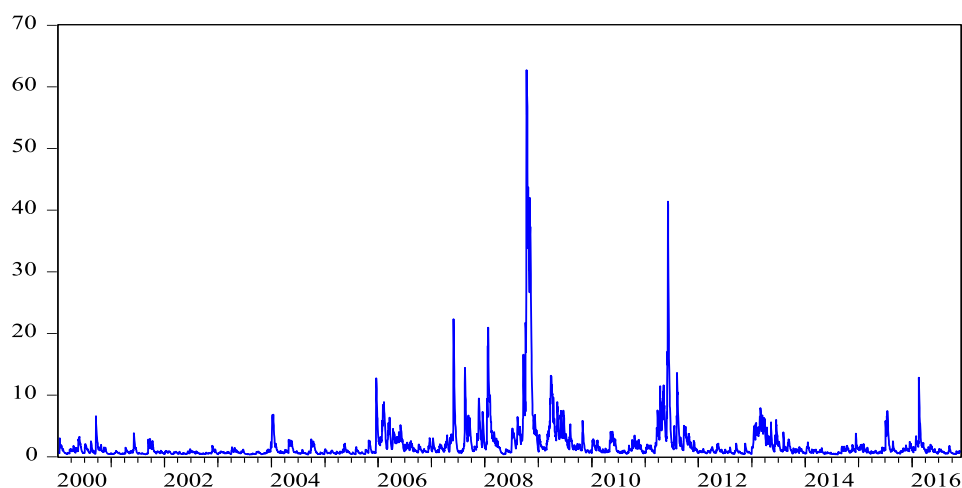


Figure 6. Character conditional volatility of the series RBVL.

The evaluation of the conditional nature of the time series is very important in the selection of the model for the estimation of the volatility of the series, Enders (2015), therefore the result of this evaluation is conclusive in rank to the series as one that complies with the feature of conditionality. Finally, making a summary of the statistical evaluation of the time series of the profitability of the Lima Stock exchange, necessary to select the model to estimate the volatility of the series, with the results that are summarized in the table 5.

Table 5. Summary of the statistical rating of the series of return and the volatility of the Stock exchange of Lima

Rating of the series	Statistical instrument	Result
The character autoregresivo of range of profitability of the Lima Stock Exchange.	Model Ar(1)	Confirmed that it is autoregresivo the series, table 4.
The heteroskedasticity of the volatility of the profitability of the Lima Stock Exchange.	Residual square confirmed.	Confirmed, figure 5
Conditionality of the series of voaltility of the profitability of the Lima Stock Exchange.	Conditional variance confirmed	Confirmed, figure 6

Source: Result of statistical rating.

The results presented in table 5, that the indicators are necessary and sufficient to select the model, in which model the volatility of the series of the profitability of the Lima Stock exchange, it is concluded in using the model Garch, with the use of which is obtained the results in table 6 and the model 1 that describes the behavior of the volatility.

Table 6. Model Garch profitability of the Lima Stock Exchange

Dependent variable: RIGBVL
 Method MLARCH- Normal distribution (BFGS/Marquardt step s)
 Date: 09/07/17 Time: 21.41
 Sample: 1/04/2000 11/30/2016
 Included observatrions: 4412
 Convergence achieved after 25 iterations
 Coefficient covariance computed using outer product of gradients
 Presample variance: backcast(parameter = 0.7)
 GARCH=C(2)+C(3)*RESID(-1)^2+C(4)*GARCH(-1)

Variable	Coefficient	Std. Error	Z-Statistic	Prob.
C	0.0718862	0.0149694	4.8022254	1.57E-06
Variation Equation				
C	0.0511266	0.0043306	11.8057700	3.64E-32
RESID(-1)^2	0.1640764	0.0078129	21.0005800	6.48E-98
GARCH(-1)	0.8116956	0.0074681	108.6878500	0.00
R-squared	-0.0002590	Mean dependent var		0.0494923
Adjusted R-squared	-0.0002590	S.D.dependent var		1.3925839
S.E.of regression	1.3927640	Akaike info criterion		3.0235251
Sum squared resid	8556.4202	Schwarz criterion		3.0293203
Log likelihood	-6665.8960	Hannan-Quinn criter.		3.0255691
Durbin Watson	1.7153696			

Source: Repository of investing.com

The model GARCH(1,1) which describes the volatility of the profitability of the Lima Stock exchange, with the data of the table 6 will have the following model for the volatility.

$$\sigma_t^2 = 0.0511266 + 0.8116956\varepsilon_{t-1}^2 + 0.1640764\sigma_{t-1}^2, \text{ model (1).}$$

The sum of the coefficients of the model is close to one, which means that the volatility shown by the model, is persistent in time $(\alpha + \beta) = 0.975772$, Perez (2006). Already finally, with the statistical treatment followed, then you can model the phenomenon of financial contagion from the volatility of the markets globalized, large to the stock market in Perú.

Table 7

Conditional Correlation Mgarch model
 Dynamic conditional correlation MGARCH model
 Sample: 1-4412 Number of obs = 4411
 Distribution Gaussian Wald chi2(16) = 1.25e+08
 Log likelihood = -91095.19 Prob>chi2 = 0.0000

DCC Mgarch	Coef.	Std.	Err.	P> z	95% Conf. Interval	
Corr(IGBVL,SYP500)	0.32705	0.06521	5.01	0.00	0.19923	0.45487
Corr(IGBVL,IBEX35)	0.28388	0.06720	4.22	0.00	0.15218	0.41559
Corr(IGBVL,SHANGHAI)	0.10339	0.07004	1.48	0.140	-0.03388	0.24066
Corr(SYP500,IBEX35)	0.53969	0.05543	9.74	0.000	0.43104	0.64834
Corr(SYP500,SHANGHAI)	0.01482	0.06915	0.21	0.830	-1.20716	0.15036
Corr(IBEX35,SHANGHAI)	0.03183	0.06894	0.46	0.644	-0.12072	0.15036

Source: Repository of investing.com

The results obtained with the modeling DCC Mgarch, shown in table 7, it is inferred that the american market is the one that has the greatest impact on the transmission of volatility to the peruvian market, with a coefficient DCC (0.32705). The Spanish market in the second term with coefficient DCC(0.28388) and with less intensity than the market of Shanghai, with coefficient DCC(0.10339), where it is concluded that stock markets are larger spread and spread volatility to smaller markets such as the peruvian, in the same sense they have finished their studies, Bejarano(2014) and Valls(2014).

CONCLUSIONS

From the indicators obtained and presented in table 6, as a result of the modeling garch time series of the profitability of the Lima stock exchange, it is concluded that the behavior of the time series is autoregresiva and stationary with heteroskedasticity conditional, impacted by the volatility of other financial markets globalized.

Modeling Garch, model 1, it is concluded that the model obtained describes the behavior of the volatility of the profitability of the Lima Stock exchange, statistically significant, with ability to forecast for the short term.

The results of the modeling DCC Mgarch are obtained the coefficients of correlation dynamics summarized in table 7, which confirms our hypothesis of the existence of evidence of the phenomenon of the contagion of volatility from stock markets largest to the stock market in Peru, as is the case of the american stock exchange to the peruvian with a correlation dynamics of 0.32, of the spanish stock exchange and the peruvian with the coefficient of 0.28, and in third order of importance the influence of the China market to the stock peruvian with coefficient of 0.10.

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