Modeling stock index of Colombia, Peru, Mexico, Chile and United States between 2001 and 2011: Evidence against of informal efficiency.

NIEVA- Jefferson*†

Universidad Autonoma de Occidente. Calle 25 No. 115-85 Km. 2 Vía Cali – Jamundí. Cali – Colombia

Received August 22, 2012; Accepted February 28, 2013

This article presents estimations of the conditional mean and variance of stock returns of the following indexes: IGBC (Colombia), IPC (México), IPSA (Chile), IGBVL (Perú) and S&P 500 (USA) between 2001 and 2011. With the goal of establishing the dependence of these financial time series and categorize stock markets using informational efficiency findings. The methodology was based in the estimation of ARIMA and APARCH models using assumptions of probability distribution in the tails like t student and asymmetric GED. The findings show United States as the most informational efficient market and the least efficient were México, Chile, Colombia and Peru.

Information and Market Efficiency. International Financial Markets. Forecasting Models and Simulation Models. Financial risk.

Citation: Nieva J. Modeling stock index of colombia, peru, méxico, chile and united states between 2001 and 2011: Evidence against of informal efficiency. ECORFAN Journal-Mexico 2013,4-9: 745-757

*Correspondence to Author (email: jeffer_rojas@yahoo.com.mx)
† Researcher contributing first author.

Introduction

The capital market is an instrument through which savings becomes investment. It is composed of intermediate and non intermediate capital market. In the first one there is an institution which works as an intermediary savers and borrowers such as banks, financial corporations and other agents in the market. In the latter one the relation among savers units and saving lacking units is direct through stock markets which are trading equities, bonds, forex and financial derivates.

Given the relevancy of this mechanism to the economy, the efficiency in these markets will have a positive effect over economic growth (King and Levine, 1993; Levine and Zervos; 1998; Wurgler, 2000; Levine, 2004).
In that way, the financial markets had a good effect on the allocation of capital and this is possible through price mechanism. In economies with advanced financial development, the prices allow a better allocation of resources shifting investment to more productive sectors and reducing in the worst (Wurgler, 2000).

Nonetheless, after the last financial crisis, once more the hypothesis of efficient market (EMH) has been put in question, especially in the more developed economies such as the United States where EMH is suppose to be valid.

The proposition of Fama(1970) that prices in the financial markets always reflect the available information is not true because during last crisis in United States the prices overreacted and this is one of the reasons which explains the deep recession in US, the worst from Great Depression in 1929.

When prices do not reflect available information in the market, then someone who knows a relevant fact can get an extraordinary profit thanks to that informational advantage. Likewise this situation shift to an allocation of resources where valuations of assets are not based in the fundamentals of the economy and indeed is just speculation, as a consequence the price of assets increase and it helps growth of speculative burbbles.

In less developed economies such as in Latin-American the problem of informational efficiency (in the Fama´s sense) is a reality. However, during last decades level of financial development in Latin American countries has improved and also its financial systems have become more modern, integrated and bigger. At least this can be concluded after comparing findings about size of Wurgler(2000) and Uribe(2007). For instance, Colombia had a ratio of capitalization over nominal IBP of 3% in 1997 according to Wurgler(2000) and after ten years that measure has change to 41.61% according to estimations of Uribe(2007). The same exercise was made for México, Chile and Perú with similar conclusions.

In recent days, some Latin American countries have taken another important step toward regional integration of stock markets of Chile, Colombia and Perú with the launch of MILA (Mercado Integrado Latinoamericano). México wants become a member of this group and is expected to do so in the near future.

In this sense is important to make a new revision of EMH of Fama (1970) in the markets which are part of the MILA adding to México and US during a time where took place international financial crisis.

ISSN-Print: 2007-1582- ISSN-On line: 2007-3682
ECORFAN® All rights reserved.

In that context, the main goal of this paper is to find the equations of conditional mean and variance of equities returns of the market in the MILA moreover México and US between 2001-2011 and classifies the markets from less to more efficient in Fama´s sense.

The organization of the document is the following. In the next section will present the theory framework which is an explanation of the conditional media models (ARIMA) and conditional variance models (APARCH: GARCH, TARCH and GJR GARCH) moreover a short comment about the informational efficiency concept. Then methodology is discussed and stylized facts of financial time series, findings and finally conclusions and recommendations.

Theory Framework Informational efficiency.

In the correlations analysis with the past of financial time series, like this one, is impossible to separate the findings of the discussion about informational efficiency. Then will make a short exposition of the concept.

Fama (1970) said "A market in which prices always fully reflect available information is called efficient". Malkiel(1987, 120, quote by Uribe and Ulloa(2011), 130) said something similar "A capital market is said to be efficient if it fully and correctly reflect all relevant information in determining security prices. Formally, the market is said to be efficient with respect some information set, φ, if security prices would be unaffected by relevant information to all participants. Moreover efficiency with respect to an information set, φ, implies that it is impossible to make economic profits by trading on basis of φ."

An efficient market, according to Fama (1970) and Malkiel(1987), incorporates all available the information in the price, every player in the stock market gets the information and in this way is impossible make huge profits.

For example, when a relevant fact affects the price of one asset, it ups or down and after a short time the markets come back to equilibrium because if it would up (or down) indefinitely, one of the parties would not be able to trade with the other one. If it happens and exist relevant profits, this market is not efficient. When it happens the speculative burbbles take place.

That kind of efficiency is called informational efficiency or weak efficiency hypothesis. Campbell, Lo y Mackinlay (1997) did a classification of efficiency:

- Weak efficiency. Historical information is part of the financial time series. The best forecast he price for tomorrow is the actual price.
- Stronger efficiency. The price of the assets reflects all public available information.
- Strongest efficiency. In the market is known all the information even prívate information.

Using auto correlations analysis, especially ARIMA models, is possible to find out if one stock market is efficient or not (weak hypothesis). When autocorrelation coefficients are different of zero, is valid to say that stock market is not efficient in the Fama´s sense. This is the main goal of the present research.

In the next section will be present some theories about conditional media and variance models.

ISSN-Print: 2007-1582- ISSN-On line: 2007-3682
ECORFAN® All rights reserved.

Conditional mean. The conditional mean of a time series is a combination of auto regressive process which order *p* and a moving average with order *q* (Box and Jenkins, 1978). It is called an ARMA process (*p, q):*

$$r_t = \mu + \sum_{i=1}^{p} a_i r_{t-1} + \sum_{j=1}^{q} b_j e_{t-1} + e_t$$
$$\mathrm{E}\,(e_t, e_{t-1}) = 0$$

Where is expected that $a_i > 0$ and $b_j > 0$. r_t, is a daily return of the financial times series in the time t. If it is a stationary process, $\sum_{i=1}^{p} a_i + \sum_{j=1}^{q} b_j$, one shock over the mean has decreasing effect until it goes toward zero. When alpha plus beta are bigger than one, ($\sum_{i=1}^{p} a_i + \sum_{j=1}^{q} b_j > 1$), it is said that process does not toward to zero and its frenzied growth. If alpha plus beta are equal to one, any shock over the mean has a persistent effect.

When a time series needs to be differentiated respect to its lags to be forecast it, it is called integrated with order *d* and the literal means number of times that series have been differentiated. In this case, ARMA model (*p, q)* becomes in ARIMA model (*p, d, q).*

Conditional variance. The concept is illustrated in the equation (1), e_t is the stochastic term which is uncorrelated with the square innovations. The phenomena was analyzed by Engle(1982) who propose the ARCH models *(p, q) (*Autoregressive Conditional Heteroskedastic). He defines ARCH process as follow:

$$e_t = z\sigma_t$$

Where z is an idd process (zero mean and unit variance) and σ_t is not constant over the time showing volatility clusters (high volatility times are preceding by high volatility times). The conditional variance is explained by ARCH terms:

$$\sigma_t^2 = \vartheta_0 + \sum_{i=1}^{Q} \alpha_i \, e_{t-i}^2$$

Where $0 < \alpha_i < 1$, to ensure a non conditional variance finite Bollerslev (1986) proposed the generalization of ARCH models which him called GARCH (*p, q*), and the principal difference respect to ARCH process was add a new term in the equation: volatility of the past. Next, it will be show:

$$\sigma_t^2 = \vartheta_0 + \sum_{i=1}^{Q} \alpha_i \, e_{t-i}^2 + \sum_{j=1}^{P} \beta_j \sigma_{t-j}^2$$

$\sum_{i=1}^{Q} \alpha_i + \sum_{j=1}^{P} \beta_j$ (persistence) must be less than one to ensure the process toward zero. Otherwise any chock over variance would growth indefinitely.

After GARCH models new specifications have been proposed as such TARCH, GJR-GARCH, EGARCH, GARCH-M, among others. In this research will use GARCH, TARCH and GJR-GARCH models. The last ones have additional variables to capture the effect of positive and negative news over conditional mean (leverage effect).

GJR-GARCH models. The model proposed by Glosten, Jagannathan y Runkel (1993) adding a new term in the equation to capture leverage effects. The equation is:

$$\sigma_t = \omega + \sum_{i=1}^{q} [\alpha_i e_{t-i}^2 + \gamma_i (\max(0, e_{t-i}))^2] + \sum_{i=1}^{P} \beta_i \, \sigma_{t-i}$$

Gamma (γ_i) is a term to capture leverage effect. If it is different to zero, is valid to affirm that variance is sensible to negative news more than positive ones. Negative news increase the volatility.

ISSN-Print: 2007-1582- ISSN-On line: 2007-3682
ECORFAN® All rights reserved.

A similar model, EGARCH, was present by Nelson (1991) which specification is as follow:

$$\log(\sigma_t) = \omega + \sum_{j=1}^{P} \beta_j \log(\sigma_{t-j}) + \sum_{j=1}^{Q} (\alpha_i \frac{e_{t-j}}{\sigma_{t-j}} + \gamma_i \left| \frac{e_{t-j}}{\sqrt{\sigma_{t-j}}} \right|)$$

If γ_i is siginificative the variance presents asimetry.

TARCH model (Threshold Autoregressive Heteroskedastic).

The TARCH model was introduced by Zakoïan(1994), the way as the model captures the asymmetry in variance is including dummies variable in the conditional variance equations:

$$\sigma_t = \omega + \sum_{1}^{Q} \alpha_j e_{t-j}^2 + \sum_{1}^{P} \beta\, \sigma_{t-i} + \phi_1 e_{t-1}^2 d_{t-1}$$

d_t=1 si $e_t < 0$ y d_t= 0, otherwise (positive news). If ϕ_1 is different to zero, the leverage effect is true.

APARCH model. The APARCH model (Assymetric Power ARCH Model) was proposed by Ding.

Granger and Engle (1993), it garners all the special cases of conditional variance in the models as GARCH, TARCH, EGARCH and GJR-GARCH.

$$\sigma^{\delta} = \omega + \sum_{j=1}^{q} \alpha_j (|e_{t-j}| - \gamma_j\, \varepsilon_{t-j})^{\delta} + \sum_{1}^{P} \beta_i (\sigma_{t-i})^{\delta}$$
$$\varepsilon_t = \sigma_t \mathrm{Z}_t\ , \mathrm{Z}_t \sim D(0,1)$$

Where,α_j ,γ_j, δ and β_i are terms to be estimated. If γ_i is positive and significative, variance is more sensible to negative news that positive ones.

The equation must to satisfy the follow conditions:

1. ω>0 , $\alpha_j \geq 0, j=1,2,\ldots q$, $\beta_i \geq 0,=1,2,\ldots p$, when $\alpha_j=0, j=1,2,\ldots q$, $\beta_i=0$, $i=1,2,\ldots p$, so $\sigma_t^2 = \omega$. It is because variances are positive, ω >0.
2. $\sum_1^Q \alpha_j \left(1-\gamma_j\right)^{\delta} - \sum_1^P \beta_i < 1$ guarantee non conditional variance exists.

Changing the value of the parametersω, α_i , γ_i, δ and β_i in (8) is possible to find especial cases of family GARCH models: "…

- When $\delta = 2, \beta_i = 0\ (i, = 1, \ldots p), \gamma_j = 0 (j = 1, \ldots q)$ APARCH model is an ARCH model.
- When $\delta = 2, \gamma_i = 0\ (i, = 1, \ldots p)$ APARCH model is a GARCH model.
- When$\delta = 2$, APARCH model becomes is a GJR-GARCH model.
- When$\delta = 1$, APARCH becomes is a TARCH …" (Ding-Ding, p. 7, 2011).

To estimate conditional variance model were running different specifications changing parameters.

Methodology

In the estimation of ARIMA models and different versions of GARCH was used maximum log likelihood method.

Considering the main goal of the present document is to find dependence respect to past of stock index´s returns only AR terms were specified in the mean equation and the identification of the process was carry out through Box and Jenkis methodology and analyzing the innovations with Box Pierce test to rule out serial auto correlation.

ISSN-Print: 2007-1582- ISSN-On line: 2007-3682
ECORFAN® All rights reserved.

Once selected no correlated models, the best models was chosen with information criteria[8].

Estimation of conditional mean needed to prove with different specifications, changing parameters in the APARCH model.

Eligible models were free of serial auto correlation and ARCH effects according to Lung Box test as single innovations as square innovations.

Finally, no correlated models and without ARCH effects were testing with Kolmogrov Smirnov test to prove if everyone follow a probability distribution t or asymmetric GED.

Once selected the best models according to desirable features of its errors, the model was chosen through information criteria.

Every index was run under assumptions of probability like t or asymmetric GED. The chosen had lower information criteria.

The information. All the information of the stock indexes corresponds to daily records of IGBC (Índice General de la Bolsa de Valores de Colombia), IGBVL (Índice General de la Bolsa de Valores de Lima), IGPA (Índice de la Bolsa de Comercio de Santiago), IPC (Índice General de la Bolsa de México) and S&P500 (Index of New York Stock Exchange) since 3 July of 2001 until 30 May of 2011 equal to 2419 observations. The information came from Banco de la República de Colombia, Banco Central de Chile, Banco Central del Perú, Bolsa de Comercio de Santiago and la Bolsa de Lima.

The estimation method was log likelihood to run ARIMA and GARCH models. In this research was use the econometric software R project i386 and packages like FGarch functions.

Findings

Stylized facts. In the graphic 1, see the daily prices of the stock index of Colombia, Chile, México, US and Peru.

Is evident the inexistence of constant mean, in other words these process are non stationary in mean.

To resolve this problem and to forecast every time series, the solution was become them stationeries. The new time series was continuously composed return equivalent to logarithmic difference respect to price (watch graphic 2) between t and t-1 periods.

In the graphic 2, the returns had a stable mean or they were stationary in mean albeit non in variance.

[8] Information criteria:

Akaike $AIC = -2\ \frac{lnL}{T} + \frac{2k}{T}$

Bayesian: $BIC = 2\ \frac{lnL}{T} + \frac{klnT}{T}$

Schwarz: $SIC = T^{\frac{K}{T}}\, SCR/T$

Hann Quinn: $HQ = \ln(\sigma^2) + \frac{2k}{T}\ln((\ln(T))$

Where L is the likelihood, T is number of observations; K is number of parameter to be estimated in every model, SCR is the Square Residual Sum and σ^2 is residual variance. The election was done, looking for a model with the lower information criteria.

ISSN-Print: 2007-1582- ISSN-On line: 2007-3682
ECORFAN® All rights reserved.

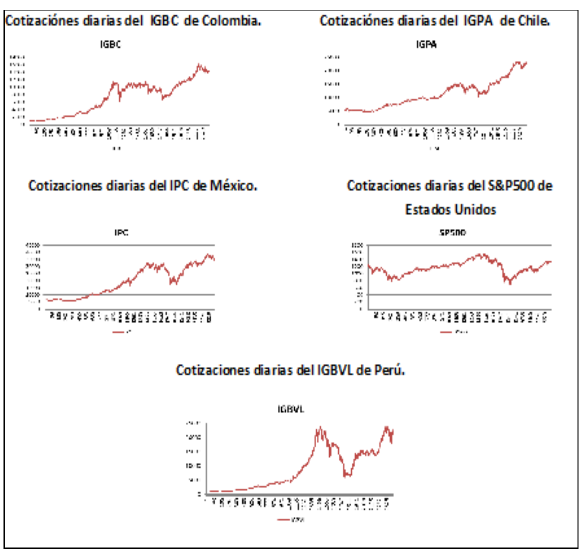
Article
ECORFAN Journal-Mexico
FINANCE
April 2013 Vol.4 No.9 745-757

In the other side, descript statistics of every stock return are shown in the picture 1. The mean of the returns was less than zero, Kurtosis was bigger than 3(leptokurtic) and returns presented negative asymmetry except for IGBC from Colombia. It means that in Colombian stock market had best daily opportunities to make profits respect others in the Region.

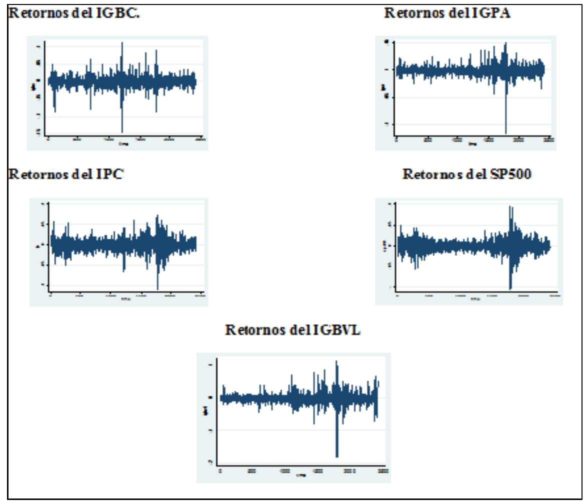
These facts bring to think about no normality of analyzed stock returns.

As a consequence was run Kolmogrov-Smirnov test. Null hypothesis of the test is that time series follow a normal distribution and the alternative is that the last affirmation is not true. Findings are shown in the picture 1.

After test the conclusion was rule out null hypothesis with significance level of 1%. The stock return did not follow a normal distribution.



Graphic 1



Graphic 2

	Indices				
Estadisticos	**igbc**	**igpa**	**igbvl**	**ipc**	**sp500**
mean	-0.0011054	-0.0005988	-0.0011414	-0.0006826	-0.0000312
max	0.11052	0.0501674	0.1144087	0.0726612	0.0946951
min	-0.1468805	-0.1170959	-0.183389	-0.1111152	-0.1042356
sd	0.0143103	0.0081887	0.0161555	0.0139897	0.013656
kurtosis	15.48874	24.20723	21.6585	8.588747	11.44006
skewness	0.2218972	-0.643981	-0.5203136	-0.1292254	0.1753769
mean	-0.0011054	-0.0005988	-0.0011414	-0.0006826	-0.0000312
Kol Sm	0.48	0.49	0.48	0.48	0.48
p- value	0	0	0	0	0

Table 1

IGBC

In the picture 2 are shown no correlated models under assumption of probability distribution of errors t- student. Conditional mean model with less information criteria was ARIMA (40, 0, 0), with 40 auto regressive terms (AR).

ISSN-Print: 2007-1582- ISSN-On line: 2007-3682
ECORFAN® All rights reserved.

In variance the GJR GARCH models (with probability distribution t student) were free of serial correlation, without ARCH effects and overcome KS test. Among these models, the best one was (1, 1).

Moreover was run a model with GED assumption of probability in tails (watch pictures 1 and 2). The best mean model was ARIMA (40, 0, 0) with variance GJR GARCH (1, 1) under GED distribution.

Modelos de media con distribución condicional t						Modelos de media con distribución GED			
ARIMA	**(40,0)**	(41,0)	(42,0)	(43,0)	(45,0)	(40,0)	**(41,0)**	(42,0)	(43,0)
AIC	**-6.1926**	-6.192112	-6.191512	-6.19085	-6.191775	-6.18E+00	**-6.184208**	-6.18E+00	-6.183086
BIC	**-6.080043**	-6.077161	-6.074166	-6.071109	-6.067244	-6.071994	**-6.069256**	-6.066409	-6.063344
SIC	**-6.193337**	-6.19288	-6.192312	-6.191683	-6.192674	-6.185287	**-6.184975**	-6.184556	-6.18E+00
HQIC	**-6.151667**	-6.150309	-6.148838	-6.147305	-6.146488	-6.143618	**-6.142404**	-6.141081	-6.13954

Table 2

Finally, the selected model was an ARIMA (40, 0, 0) and GJR GARCH (1,1) with conditional probability distribution t student. This finding is in the same direction of research as such Alonso and García (2008), Alonso and Serna (2009), and Uribe(2007). They found dependence in the returns of IGBC albeit using different methodologies and research fields.

IGPA

In this index, an ARIMA model (20, 0,0) with t distribution was chosen because models with higher lags had lower information criteria (watch picture 4). Selected models were least parsimonious.

In variance, the eligible models were GARCH (1, 1), GJR GARCH (1,1) and TARCH (2,1). Among them the best was TARCH (2, 1) (watch pictures 5, 6 and 7).

Then the same exercise was done with assumption of probability GED. The best model in mean was ARIMA (20, 0, 0) and eligible models of variance were GARCH (1,1) and GJR GARCH (1,1), the best was GJR GARCH (1,1). (See pictures 4 and 5)

Among models with t- student and GED assumptions, the best model according to information criteria was an ARIMA (20, 0, 0) with a TARCH (2, 1) model in variance under t student assumption.

	Modelos de media con distribución t								Modelos de media con distribución GED							
ARIMA	**(20,0)**	(25,0)	(30,0)	(35,0)	(38,0)	(40,0)	(41,0)	(45,0)	**(20,0)**	(25,0)	(30,0)	(35,0)	(38,0)	(40,0)	(41,0)	(45,0)
AIC	**-7.254264**	-7.253045	-7.255122	-7.264246	-7.267910	-7.268486	-7.267804	-7.267433	**-7.256727**	-7.255965	-7.259007	-7.269586	**-7.273057**	-7.273905	-7.273111	-7.275097
BIC	**-7.189604**	-7.17641	-7.166514	-7.163663	-7.160143	-7.155929	-7.152852	-7.142902	**-7.192067**	-7.179331	-7.170399	-7.169003	-7.165289	-7.161348	-7.158159	-7.150566
SIC	**-7.25451**	-7.253389	-7.255581	-7.264836	-7.268586	-7.269222	-7.268572	-7.268332	**-7.256973**	-7.25631	-7.259466	-7.270176	-7.273733	-7.274642	-7.273879	**-7.275996**
HQIC	**-7.23075**	-7.225176	-7.222899	-7.227668	-7.228719	-7.227553	-7.226	-7.222146	**-7.233212**	-7.228096	-7.226784	-7.233008	-7.233866	-7.232972	-7.231307	-7.229809

Table 4

	Modelos de GJR GARCH con distribución t				Modelos de GJR GARCH con distribución GED			
Criterios de información	**(1,1)**	(1,2)	(2,1)	(2,2)	(1,1)	(1,2)	(2,1)	(2,2)
AIC	**-7.254264**	-7.253589	-7.268065	-7.254187	**-7.256727**	-7.255956	-7.25661	-7.25648
BIC	**-7.189604**	-7.186534	-7.150719	-7.182342	**-7.192067**	-7.188901	-7.18716	-7.184635
SIC	**-7.25451**	-7.253853	-7.268865	-7.25449	**-7.256973**	-7.25622	-7.256893	-7.256783
HQIC	**-7.23075**	-7.229204	-7.225391	-7.22806	**-7.233212**	-7.23157	-7.231353	-7.230353

Table 5

	Modelos de GARCH con distribución t				Modelos de GARCH con distribución GED			
Criterios de información	**(1,1)**	(1,2)	(2,1)	**(2,2)**	(1,1)	(1,2)	(2,1)	(2,2)
AIC	**-7.248082**	-7.247313	-7.246511	-7.246657	**-7.250033**	-7.249158	-7.248436	-7.248494
BIC	**-7.185816**	-7.182653	-7.181851	-7.179602	**-7.187767**	-7.184498	-7.183776	-7.181439
SIC	**-7.24831**	-7.247559	-7.246757	-7.246922	**-7.250261**	-7.249404	-7.248682	-7.248759
HQIC	**-7.225438**	-7.223799	-7.222997	-7.222272	**-7.227389**	-7.225643	-7.224922	-7.224109

Table 6

Modelos TARCH con distribución t				
Criterios de información	(1,1)	(1,2)	**(2,1)**	(2,2)
AIC	-7.270992	-7.272294	**-7.272474**	-7.272266
BIC	-7.206332	-7.205239	**-7.203024**	-7.200422
SIC	-7.271238	-7.272559	**-7.272757**	-7.272569
HQIC	-7.247477	-7.247909	**-7.247217**	-7.246139

Table 7

ISSN-Print: 2007-1582- ISSN-On line: 2007-3682
ECORFAN® All rights reserved.

April 2013 Vol.4 No.9 745-757

IPC

The conditional mean of the IPC´s returns can be estimated using a ARIMA (30, 0,0) under assumption of probability distribution t student (see picture 8). In the conditional variance, eligible models were GJR GARCH (1, 1), GARCH (2, 1) and TARCH (1, 1), the best was last one (see pictures 9, 10 and 11).

Under assumption of conditional probability distribution GED was estimated an ARIMA (30, 0, 0) because it was only model without no serial correlation. In the side of variance were run GJR GARCH models because they were only ones without no serial correlation and ARCH effects. The best among GJR GARCH models were (1,1). (See picture 9)

The best model was an ARIMA (30, 0, 0) and TARCH (1,1) under assumption of probability t student in tails.

This finding is similar to findings like Lopez (2004) who found as best model to the TARCH (1, 1) too.

Criterios de información	Modelo de la media con Distribución t	Modelo de la media con Distribución GED
	(30,0)	**30,0**
AIC	**-6.067013**	**-6.068048**
BIC	**-5.978404**	**-5.979439**
SIC	**-6.067472**	**-6.068507**
HQIC	**-6.034789**	**-6.035824**

Table 8

Criterios de información	Modelos GJR GARCH con distribución t				Modelos GJR GARCH con distribución GED			
	(1,1)	(1,2)	(2,1)	(2,2)	(1,1)	(1,2)	(2,1)	(2,2)
AIC	**-6.067013**	-6.065542	-6.067607	-6.06678	-6.068048	-6.066615	-6.068174	-6.067347
BIC	**-5.978404**	-5.974538	-5.974209	-5.970987	-5.979439	-5.975612	-5.974776	-5.971554
SIC	**-6.067472**	-6.066026	-6.068116	-6.067315	-6.068507	-6.067099	-6.068684	-6.067883
HQIC	**-6.034789**	-6.032447	-6.033642	-6.031944	-6.035824	-6.033521	-6.034209	-6.032511

Table 9

Modelos GARCH con distribución t			
GARCH	**(1,2)**	**(2,1)**	**(2,2)**
AIC	-6.045625	**-6.048453**	-6.047588
BIC	**-5.957017**	-5.959844	-5.956584
SIC	-6.046084	**-6.048912**	-6.048071
HQIC	-6.013402	**-6.016229**	-6.014493

Table 10

Modelos TARCH con distribución t				
Criterios de información	**(1,1)**	(1,2)	(2,1)	(2,2)
AIC	**-6.096105**	-6.096603	-6.097553	-6.096733
BIC	**-6.007496**	-6.0056	-6.004155	-6.00094
SIC	**-6.096564**	-6.097087	-6.098062	-6.097269
HQIC	**-6.063881**	-6.063509	-6.063588	-6.061897

Table 11

IGVBL

Conditional mean of the IGBVL´s return was estimated under different specifications as shown in the picture 12. Using assumption of t student, the best model was an ARIMA (70, 0, 0) with conditional variance models as such GJR GARCH, GARCH and TARCH models.

Eligible models were GJR GARCH (1, 1), GARCH (1, 1) and TARCH (1,1) (see pictures 13,14 and 15). The selected model was a GJR GARCH.

When assumption of probability distribution changed to GED, the model with best behavior was an ARIMA (30, 0, 0) according to its parsimony. Meanwhile, conditional variance was calculated with GJR GARCH models because these specifications were no correlated and free of ARCH effects. The best model was GJR GARCH (1, 1).

In this sense, the decision was choose an ARIMA (70, 0, 0) and GJR GARCH (1,1) with assumption of conditional probability in fats t student.

ISSN-Print: 2007-1582- ISSN-On line: 2007-3682
ECORFAN® All rights reserved.

April 2013 Vol.4 No.9 745-757

Modelo de la media con Distribución t								Modelos de media con distribución GED	
ARIMA	(20,0)	(25,0)	(30,0)	40,0	50,0	60,0	70,0	(30,0)	40,0
AIC	-6.11979	-6.122613	-6.123793	-6.130806	6.209992	-6.267531	**-6.318965**	-6.123519	**-6.131879**
BIC	-6.05513	-6.045978	-6.035184	-6.018249	-6.073487	-6.107078	**-6.134563**	**-6.03491**	-6.019322
SIC	-6.120036	-6.122957	-6.124252	-6.131543	-6.21107	-6.269012	**-6.320911**	-6.123977	**-6.132616**
HQIC	-6.096275	-6.094743	-6.091569	-6.089873	-6.16035	-6.20918	**-6.251905**	**-6.091295**	-6.090946

Table 12

MODELOS GJR GARCH con distribución t			MODELOS GJR GARCH con distribución GED			
Criterios de información	1,1	1,2	**1,1**	1,2	2,1	2,2
AIC	-6.318965	-6.312641	**-6.123519**	-6.121639	**-6.123663**	-6.122889
BIC	-6.134563	-6.125844	**-6.03491**	-6.030636	-6.030265	-6.027096
SIC	-6.320911	-6.314636	**-6.123977**	-6.122123	**-6.124172**	-6.123425
HQIC	-6.251905	-6.24471	**-6.091295**	-6.088545	-6.089698	-6.088053

Table 13

MODELOS GARCH con distribución t				
Criterios de información	**1,1**	1,2	2,1	2,2
AIC	**-6.121813**	-6.119909	-6.120379	-6.11968
BIC	**-6.035599**	-6.0313	-6.03177	-6.028676
SIC	**-6.122248**	-6.120368	-6.120838	-6.120164
HQIC	**-6.09046**	-6.087685	-6.088155	-6.086585

Table 14

MODELOS TARCH con distribución t				
Criterios de información	**1,1**	1,2	2,1	2,2
AIC	**-6.149813**	-6.149501	-6.149111	-6.148089
BIC	**-6.061205**	-6.058497	-6.055713	-6.052296
SIC	**-6.150272**	-6.149985	-6.14962	-6.148625
HQIC	**-6.11759**	-6.116406	-6.115146	-6.113253

Table 15

S&P500

S&P 500´s returns were forecast with ARIMA models of 10, 15, 16 and 17 lags in their conditional means. They were eligible models without auto correlation serial. In the conditional variance was estimated one model, GARCH (2, 1), it was only one without serial correlation and ARCH effects, moreover it overcame KS test. (See pictures 16 and 17).

Under assumption of conditional probability distribution GED only models with 10, 15 and 16 AR terms in the conditional mean were relevant. The ARIMA (10, 0, 0) was chosen because it was least parsimony.

The decision was chosen an ARIMA (10, 0, 0) in the conditional mean and GARCH (2, 1) with GED assumption of probability according to information criteria.

Modelo de la media utilizando distribución GED					Modelo de la media utilizando distribución t		
ARIMA	10,0	15,0	16,0	17,0	10,0	15,0	16,0
AIC	**-6.343999**	-6.338434	-6.338785	-6.338289	-6.321912	-6.324426	-6.324579
BIC	**-6.303287**	-6.288142	-6.286099	-6.283208	-6.283595	-6.274135	-6.271893
SIC	**-6.344097**	-6.338583	-6.338949	-6.338468	-6.321999	-6.324575	-6.324743
HQIC	**-6.329194**	-6.320144	-6.319625	-6.318258	-6.307978	-6.306137	-6.305419

Table 16

Modelo GARCH	
Criterios de información	2,1
AIC	**-6.343999**
BIC	**-6.303287**
SIC	**-6.344097**
HQIC	**-6.329194**

Table 17

Conclusions

In the present research was found that all analyzed stock returns indexes exhibits dependence from its past.

In other words they do not collect relevant information in the asset prices so quickly (inefficiency informational). It means that if one stochastic event increases (decrease) the prices of assets in the Latin American stock markets, its effect will take some time to be assimilated.

ISSN-Print: 2007-1582- ISSN-On line: 2007-3682
ECORFAN® All rights reserved.

As a consequence, it would be possible to forecast the price of one asset using models like ARIMA or GARCH and improve their behavior adding new variables to capture “day effect” and “hour effect”, it has been done by Montenegro (2007) and, Alonso and Garcia (2009) analyzing IGBC from Colombia, Bravo (2004) with his structural model to IGBVL from Peru, Garcés and Calle (2007) using ARCH models and different versions of GARCH models in Peru and Sanchez-Vinnelli(2008) with time series models to explain daily returns of a group of nine companies from Peru.

This finding has one important repercussion: growing of speculative burbles if it does not controlled on time[9].

The stock markets more efficient according to numbers of lags in the conditional mean equation are: United Stated and Chile. While México, Colombia and Peru are slower that first ones.

Especially Peru stock market is the slowest in the group because it is affected by events from two months ago.

To conclude that stock markets in Latin America and specially in the analyzed markets are inefficient in the informational sense is nothing new because the same argument has been found by researchers in Colombia by Alonso and García (2008 and 2009).

Montenegro (2007), Uribe (2007), Uribe and Ulloa (2001), in Peru Bravo (2004), Silapú and Calle (2007), and Sanchez and Vinelli(2008), in México López (2004) and to other Latin-American countries Espinosa (2005).

Findings of this paper could be useful to get new risk premiums (correlations term) in the CAPM model to MILA´s markets through vanguard methods like Copulas.

It could be a new topic for researching.

Also is important to talk about the existence of *leverage* effect in the mean equation of the regional index´s returns. In this sense is valid to affirm that all analyzed stock indexes are more sensible to negative news than positive ones with exception of US market which is the most efficient in the informational sense.

Finally, in the present document was evident how important is to estimate financial time series models using assumptions of probability different to normal distribution like asymmetric t student or asymmetric GED to forecast or make VaR analyses.

The recommendations are as follows:

- Toward regulatory authorities and Central Banks: They should consider to take measures like proposed by Uribe and Ulloa (2011)to prevent speculative burbles which has terrible consequences over economies.

- In the same way should be important to design mechanism to improve the access PYME companies to regional stock markets. It requires a great effort to formalization of the companies.

- Is necessary to continue the integration process of the regional stock markets to increase trade volumes, investments options and deep of the market.

[9] This phenomenon has been studied by a recent work written by Uribe and Ulloa (2011) about informational efficiency using copulas.

ISSN-Print: 2007-1582- ISSN-On line: 2007-3682
ECORFAN® All rights reserved.

References

Alonso, J.C. y García J. C (2008). *¿Qué tan buenos son los patrones del IGBC para predecir su comportamiento?: Una aplicación con datos de alta frecuencia*. En Borradores de Economía y Finanzas- Universidad Icesi # 14.

Alonso, J.C. y Serna, M (2009). *Patrones del IGBC y Valor en Riesgo: Evaluación del desempeño de diferentes metodologías para datos intra- dia*. En Borradores de Economía y Finanzas- Universidad Icesi # 20.

Bravo Coronel, F. H (2004). *Determinantes de la Bolsa de Valores en el periodo enero de 1994 – octubre 2003.* Tesis de grado para optar por el titulo de economista en la Universidad de Trujillo del Perú.

Bollerslev, T. (1986). *Generalized autoregressive conditional heteroskedasticity*. Journal of Econometrics 31, 307-327.

Box. G. E.P. y Jenkins, G. M. (1976). *Time series analysis: Forecasting and Control.* Holden-Day, San Francisco.

Campbell, J., Lo, A. W., y Mackinglay, A. C. *The econometrics of the financial markets.* New Jersey, Princeton University Press.

Ding, D. (2011). *Modeling of market volatility with APARCH model.* Projet Report- Uppsala Universitet # 16.

Espinosa Mendez, C (2005). *Evidence of Chaotic Behavior in American Stock Market*. Universidad Diego Portales- MPRA # 2794.

Engle, R. F. (1982). *Autoregressive conditional heterocedasticity of the estimates of the variance of the United Kingdom Inflation*. Econometrica 50(4), 987-1006.

Fama, F. E. (1970*). Efficient capital Markets: II*. Journal of Finance 46(5) 1575-1617.

King, R. y Levine R.(1993). *Finance and growth: Schumpeter might be right*. Quarterly Journal of Economics. 108, 717-737.

Levine, R. y Zervos, S. (1998). *Stock market, Banks and economic growth*. American Economic Review 88 537-558.

Levine, R. (2004). *Finance and growth: Theory and evidence*. NBER working papers # 10766.

Lopez Herrera, F. (2004). *Modelado de la volatilidad y pronóstico del índice de precios y cotizaciones de la Bolsa Mexicana de Valores*. Revista Contaduría y Administración- Universidad Nacional Autónoma de México # 213.

Glosten, L., Jagannathan, R. y Runckle D. (1993). *On the relation between the expected value and volatility of the nominal excess return on the stocks*. Journal of Finance # 48, 1779-1801.

Malkiel, B. G. (1987). *Efficent markets hypothesis*. En *the New Palgrave*, J. Eatwell, M. Milgate y P. Newman (eds), Macmillan Press, 120-123.

Montenegro, Alvaro (2007). *El efecto día en la Bolsa de Valores de Colombia*. Departamento de Economía-Pontificia Universidad Javeriana Bogotá.

Sanchez, J. C., Vinelli Ruiz, M (2008). *Evidencia empírica del efecto fin de semana y de presencia del paseo aleatorio en la Bolsa de Valores de Lima*.

ISSN-Print: 2007-1582- ISSN-On line: 2007-3682
ECORFAN® All rights reserved.

Silapú Garcés, B. L, Calle Ruiz, S. A. (2007). *Análisis de la eficiencia en la Bolsa de Valores de Lima, periodo: 1999-2004*. Universidad Nacional de Piura- Facultad de Economía.

Uribe, J. M. (2007) *Caracterización del mercado accionario colombiano 2001-2006: Un análisis comparativo*. Banco de la Republica de Colombia-Borradores de economía # 456.

Uribe, Jorge Mario Y Ulloa Inés, María (2011). *Revisando la hipótesis de los mercados eficientes: Nuevos datos, nuevas crisis y nuevas estimaciones.* Cuadernos de economía 30(55),2011.

Wurgler, J (2000). *Financial markets and allocation of capital*. Journal of Financial Economics 58 187-214.

Zakoïan, J. (1994). *Threshold heteroskedastic models*. Journal of Economic Dynamics and Control 18, 931-955.

ECORFAN® All rights reserved.