Analysis of Volatility and Contagion Effect of countries from Latin America

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ABSTRACT

The volatility comprehends a concern for investors and scholars, both try to understand and predict with a logical way the dispersion of returns for a given security or market index, but these movements have shown irregular, complex and increasingly less influence of individual factors. Then, we define the following research question: What is the behavior of the volatility of the stock exchanges of countries from Latin America? Thus, the research aim is to investigate the volatility of the returns and check out the co-movements and the contagion effects of countries from Latin America. The sample comprises daily data from January 2002 to December 2016 to measure the volatility of the stock exchanges of countries from Latin America. To measure the volatility, an Auto Regressive model with Conditional Heteroscedasticity, ARCH/GARCH models were used. To check the contagion effects on the stock exchanges we use volatility models, vector auto regression models (VAR). The results indicate that during the period of higher volatility the diversification benefits decrease. Moreover, contagion effect was observed in all countries, with two facts being relevant, the first one is the influence of the Brazilian stock exchange in all other countries in the sample and, lastly, the low representativeness of endogenous factors to explain the volatility behavior of the stock exchange from Mexico.

Keywords: Volatility; Co-movements; Contagion effect

1. INTRODUCTION

Studies in finance went through several changes over the understand of the relationship between risk and return since the seminal work of Markowitz – Portfolio Selection (1952) – which is based on the principle that investors should seek for assets with low and negative correlation over their returns. Recent researches have pointed out explanations for the volatility of stock exchanges from market co-movements aftershocks, which triggers the process of movement in exchange rates, stocks, sovereign bonds and capital flows (e.g., Forbes & Rigobon, 2002; Pericoli & Sbracia, 2003; Vartanian, 2012).

Diversification is a risk management technique that mixes a wide variety of investments within a portfolio, wherein aims to smooth out unsystematic risk in a portfolio so the positive performance of some investments neutralizes the negative performance of others. Markowitz (1952) argue the use of correlation and covariance to represent a measure of the movements between the assets. Even though these distinct assets yet have a directly effect on their volatilities, because they are driven for external correlated forces.

The volatility comprehends a concern for investors and scholars, both try to understand and predict with a logical way the dispersion of returns for a given security or market index, but these movements have shown irregular, complex and increasingly less influence of individual factors. As reported for Broto, Díaz-Cassou & Erce-Dominguez (2011), the country-specific factors have been reduced due to the forces of the globalization, wherein the volatility of the markets are driven for global factors, and these ones are beyond the control of emerging countries.

According to Harvey (1995), the market performance of emerging countries can be impressive and highly volatile. Besides that, the correlations of the assets return from the emerging countries are lower than the ones from developed countries. As a result, it may be

possible to lower portfolio risk by participating in emerging markets. Therefore, some scholars argue for the need to estimate the degree of correlation of the return of emerging markets, identifying, separately, those of developed countries.

The spillovers into countries economics caused for crisis around the world have been subject of research about contagion effect since the Tequila crisis of 1994-95, the Asian flu of 1997 and the Russian virus of 1998 (Kaminsky & Reinhart, 2000). The emerging markets in Latin America were awaken from the Tequila crisis and given the heterogeneity in macroeconomic fundamentals across countries, these co-movements could be interpreted as indications of herding behavior on the part of investors (Forbes & Rigobon, 2002).

Financial market volatility is central to the theory and practice of asset pricing, asset allocation and risk management (Andersen, Bollerslev, Diebold & Ebens, 2000) and a common belief is that there are asset classes with low-negative correlations in international markets, particularly in emerging or frontier markets and so most studies analyze such correlations among stock market return (Baumöhl & Lyócsa, 2014). In this context, this paper will investigate the volatility of the returns for check out the co-movements and the contagion effects of countries from Latin America.

The sample comprises daily data from January 2002 to December 2016 to measure the volatility of the stock exchanges of countries from Latin America. To measure the volatility, an Auto Regressive model with Conditional Heteroscedasticity, ARCH/GARCH models were used. To check the contagion effects on the stock exchanges we use volatility models, vector auto regression models (VAR). The results indicate that during the period of higher volatility the diversification benefits decrease. Moreover, contagion effect was observed in all countries, with two facts being relevant, the first is the influence of the Brazilian stock exchange in all the other countries in the sample and, lastly, the low representativeness of endogenous factors to explain the volatility behavior of the stock exchange from Mexico.

The remainder of this paper is organized as follows. The next section presents the theoretical framework; after that, the methods, data and sample are presented; the results and discussions are shown on topic 4; at the last one it is presented the conclusion remarks of this paper, its limitations and some suggestions for future ones.

2. THEORETICAL FRAMEWORK

According Markowitz (1952), the process of selecting a portfolio should be guided for the diversification, even though to be sensible, but a rule of a behavior which does not imply the superiority of diversification must be rejected both as a hypothesis and as a maxim.

The definition of contagion is still under discussion in the literature, and according to Pericoli & Scrabia (2003) at least 5 definitions have been adopted. Consensus is the qualitative and quantitative impact, causing structural breaks in the data, being estimated the regime changes described as Markov processes or testing significant changes in the correlation of asset returns. They also raise the lack of a possible and testable theoretical model to evaluate the empirical relevance of the contagion channels.

Bollerslev, Chou & Kroner (1992), portray volatility as a main variable that transits most of the financial instruments and acts as the main driver in several areas of economics and finance. For Gaio, Pessanha, de Oliveira & de Ázara (2007), volatility can be understood as one of the most significant variables for financial agents, due to its importance to the observation of direction and speed of movement of the securities.

Examining the relationship between stock returns and stock market volatility French, Schwert & Stambaugh (1987) found indirect evidence of a positive relationship between expected risk premiums and volatility. This finding is associated to the stock market returns are negatively related to the unexpected change in volatility of stock returns.

Schwert (1988) analyzed the relationship of stock volatility with real and nominal macroeconomic volatility, financial leverage, stock trading, default risk and company performance. He found mainly that leverage has insignificant effect on stock volatility and that fluctuations in aggregate stock volatility are difficult to explain using stock valuation models.

Using a modified model GARCH-M, Glosten, Jagannathan & Runkle (1993) showed a counterpoint to the belief that monthly volatility would be persistent, in which case positive unplanned returns seem to result in a downward revision of conditional volatility, while unanticipated negative returns result in an upward revision of conditional volatility.

Studying the dynamic behavior of stocks and volatility in emerging financial markets, De Santis (1997) found that there is strong evidence of volatility that is variable over time, with highly persistent changes, and can be predictable in almost all countries. In addition, in its statistical analysis, the fat-tailed distribution fits better than the normal distribution, and investors are not rewarded by the risk assumed in the stock market.

Ahmed & Sarfraz (2013) in their study measured volatility and examined the relative volatility of emerging and developed markets. These authors linked volatility with global stock market index and found, in the case of emerging markets, indexes with a higher ratio of non-normality and peaks of return distribution. For the developed markets, they found a greater volatility relation than in the emerging stock markets.

Emerging countries have structures for the distribution of securities returns usually most unstable, and local and global influence constantly vary from country to country as the stock markets of these countries are more integrated, the information at global levels is relatively more important and correlated in volatility behavior of the indexes of the stock exchanges of those countries (Harvey, 1995).

In recent decades, the study of the stock market linkages has increased, mainly the impacts in emergent markets. Baumöhl & Lyócsa (2014), found in their study that asymmetry in volatility is not a common phenomenon in emerging and frontier markets, and the relationship between volatility and correlations is positive and significant in most countries. Thus, diversification benefits decrease during periods of higher volatility.

Forbes & Rigobon (2002) analyzed the three main crises of the time (Asian crisis, 1997, Mexican devaluation, 1994, fall in the North American market, 1987) and showed that the coefficients that explain the market's correlation are conditioned by market volatility. In this sense, the authors showed that during these crises there was no increase in the correlation coefficients, thus refuting the existence of the contagious effect, there is only interdependence among the markets. Opposing Corsetti, Pericoli & Sbracia (2002) developed a contagion test study based on bivariate correlation analysis, generalizing existing tests and applying them to the international effects of the Hong Kong crisis of 1997. The authors found evidence of contagion effect in 5 countries of their sample of 17.

Correlations between international equity market returns tend to increase in highly volatile bear markets, which has led some to doubt the benefits of international diversification. Regime changes and currency hedging are still valuable in international diversification. The costs of ignoring the regimes are small for all-equity portfolios but increase when a conditionally risk-free asset can be held (Ang & Bekaert, 2002). Longin & Solnik (2001) found that correlation is not related only for the market volatility but also for the market trend. They also found that correlations increase in bear markets, but not in bull markets.

Corsetti et al. (2003) argue that many studies associate the idea of correlation in growing or high level of volatility with the presence of contagion. Such an idea may lead to erroneous evaluations under certain circumstances. The existence of interdependence is also consistent with upward correlation or volatility. Thus, the authors propose that the notion of contagion is associated with an increase in correlation beyond that expected by some pattern of

interdependence. Contagion would be associated with the excessive increase of correlations between the country generating the crisis and the others.

Perobelli, Vidal & Securato (2013) following the model of Corsetti et al. (2003), found that the Asian crisis of 1997 had the most contagion effect on the other markets, followed by the terrorist attacks of September 11, Brazilian crisis of 1999, internet bubble of 2000 and subprime crisis, other events had only restricted shocks on the origin countries.

Longstaff (2010) investigate the effects of collateralized debt obligations (CDOs) on the other markets during the subprime crisis. The results indicate that financial contagion was propagated primarily through liquidity and risk-premium channels, rather than through a correlated-information channel, which provided evidences from financial contagion spillover markets as development of the subprime crisis.

Patton (2004) compared the performance of a portfolio based on a normal distribution model with a portfolio based on a more flexible distribution model. The findings are that for investors with no short-sales constraints the gains are limited, and the knowledge of higher moments and asymmetric dependence leads to gain that are economically significant and statistically significant in some cases.

Pais & Stork (2010) investigate which are the sectors most dependent with the banking sector, they found that the property sector shows the highest level of extremal dependence. Further, the credit crisis has significantly increased the probability of a bank or property firm crashing. Moreover, contagion risks have increased significantly not only within the banking and property sectors, but also between them.

Aloui, Ben Aïssa & Nguyen (2011) in their study about the correlations of the BRIC and the US markets found strong evidence of time-varying dependence between these markets, and the dependency is stronger for commodity-price than for finished-product export-oriented. They also showed that the dependence of these markets is still the same during both bullish and bearish markets.

Implications of the literature of the contagion effect to Latin America countries are to better understand how to reduce a country's vulnerability to external shocks. According Forbes & Rigobon (2002), when the crisis is originated on elsewhere in the world, the short-run isolation strategies can be highly effective in reducing the effects of a crisis. But when the crisis is worldwide, the short run strategies are not effective, they will only delay a country's adjustment to a shock, not prevent it. Chen, Firth & Rui (2000) suggest that the potential for diversifying risk by investing in different Latin American markets is limited.

Measuring the co-movements by the Pearson correlation, a conventional dependence way of measure, might lead to a significant underestimation of the risk from joint extreme events. Because this measure assumes a linear relationship and a multivariate Gaussian distribution without making any distinction between large and small returns, or between negative and positive returns (Poon, Rockinger & Tawn, 2004).

According Alou et al. (2011), the solutions for handling these problems include either the use of multivariate GARCH models with leptokurtic distributions which allow for both asymmetry and fat tails or the use of multivariate extreme value theory and copula functions. These two approaches deal essentially with the extreme dependence structure of large (negative or positive) stock market returns, all in multivariate frameworks.

3. METHODOLOGY

The data used for empirical analysis refer to the time series returns of the four stock exchanges from Latin America, which are BMF&Bovespa (BVSP), Mexbol (MXX), Bolsa de Comercio de Buenos Aires (MERVAL) and Bolsa de Comercio Santiago (IPSA). The frequency of data is daily, and the period runs from January 2002 to December 2016, this period

was selected to portrait economic cycles of stability, credit expansion, external and internal crisis. The data source is the Yahoo Finance.

Table 1
Summary of sample information

Country	Ticker Stock Exchange	Turnover	Initial Period Analysis
Brazil	BVSP	60,227.29	01/02/2002
Mexico	MXX	45,642.89	01/02/2002
Argentina	MERVAL	16,917.86	01/02/2002
Chile	IPSA	4,151.39	01/02/2002

Note: BVSP = BMF&Bovespa; MXX = Mexbol; MERVAL = Bolsa de Comercio de Buenos Aires; IPSA = Bolsa de Comercio Santiago.

To measure volatility, we used auto regressive models with conditional heteroskedasticity (ARCH) and GARCH (Generalized ARCH). According to Morettin (2004), the basic idea is that the error term (X_t) of an auto model regression for a variable Y_t is not serially correlated, but the volatility (conditional variance) depends on past returns by means of a quadratic function. An ARCH/GARCH model can be represented according to equations one, two, three and four presented below:

$$Y_t = \beta_0 + \beta_1 \beta Y_{t-1} + \ldots + \beta_1 \beta Y_{t-p} + X_t \quad (1)$$

$$X_t = \sqrt{h_t \varepsilon_t} \quad (2)$$

$$h_t = \alpha_0 + \alpha_1 X_{t-1}^2 + \ldots + \alpha_r X_{t-r}^2 \quad (3)$$

h_t is the conditional variance; ε_t is an independent and identically distributed sequence of variables (i.i.d.) with zero mean and variance equal to one N ~ (0, 1); α_0 is the intercept; and α_1 is the coefficient of the auto-regressive component.

Considering an autoregressive model with that estimated in equation 1, the conditional variance in a GARCH (r,s) model can be given by:

$$h_t = \alpha_0 + \sum_{i=1}^{r} \alpha_1 X_{t-1}^2 + \sum_{i=1}^{r} \beta_j h_{t-j} \quad (4)$$

In that, βj represents the parameter of the autoregressive component of volatility and εt is a sequence of independent and identically distributed variables (i.i.d.) with zero mean and variance one N ~ (0, 1).

Following, after estimation of volatility models, auto regression vector models - VAR and vector with error corrections - VEC were tested to check the co-movements between the countries, the contagion effect.

The VAR model can be written as follows:

$$Z_t = A_1 Z_{t-1} + \ldots + A_k Z_{t-k} + \emptyset D_t + \mu_t \quad (5)$$

Where μ_t ~ IN (0, $\sum$), Z_t is a vector (n x1) and each element A_1 is an array of order parameters (n x n) and D_t represents deterministic terms, such as constant, linear trend and seasonality. For the study were used for the system of simultaneous regressions, explained by the equations:

$$\beta GarchBVSP = \beta GarchMXX + \beta GarchMERVAL + \beta GarchIPSA \quad (6)$$

$$\beta GarchMXX = \beta GarchBVSP + \beta GarchMERVAL + \beta GarchIPSA \quad (7)$$

$$\beta GarchMERVAL = \beta GarchBVSP + GarchMXX + \beta GarchIPSA \quad (8)$$

$$\beta GarchIPSA = \beta GarchBVSP + GarchMXX + \beta GarchMERVAL \quad (9)$$

To use the auto regressive vector (VAR) model, it was necessary to analyze the sample to identify whether the variables would be stationary or not. From the initial principle that the GARCH series are all originally stationary, the final model uses the auto regressive vector - VAR, and it is not necessary to use the vector with error corrections - VEC.

The unit root tests were developed for Phillips-Perron (PP), which confirm whether the series has a unit root or if the variable was generated by a stationary process and Augmented Dickey-Fuller (ADF) which is the extension of the Dickey-Fuller test that aims to delete any serial correlation. After the tests of unit root, it was necessary to verify if the series would be cointegrated, through Johansen cointegration test. In this case, if no cointegration is observed, the vectors auto regressive (VAR) is used. If the cointegration is observed, the vector with error corrections (VEC) is used.

For the development of the VAR it was necessary to identify the number of lags, according to the Akaike Information Criterion (AIC) and defining the ordering of the variables using the Granger and Block test.

4. RESULTS AND DISCUSSIONS

The descriptive statistics of the volatility stock exchanges analyzed are presented in Figure 1. As noticed all countries had high peaks of volatility during the period of the subprime crisis, as evidenced by Perobelli et al. (2013), this crisis occurred from September 26th, 2007 to March 17th, 2009, which caused subsequently effects on these markets afterwards.

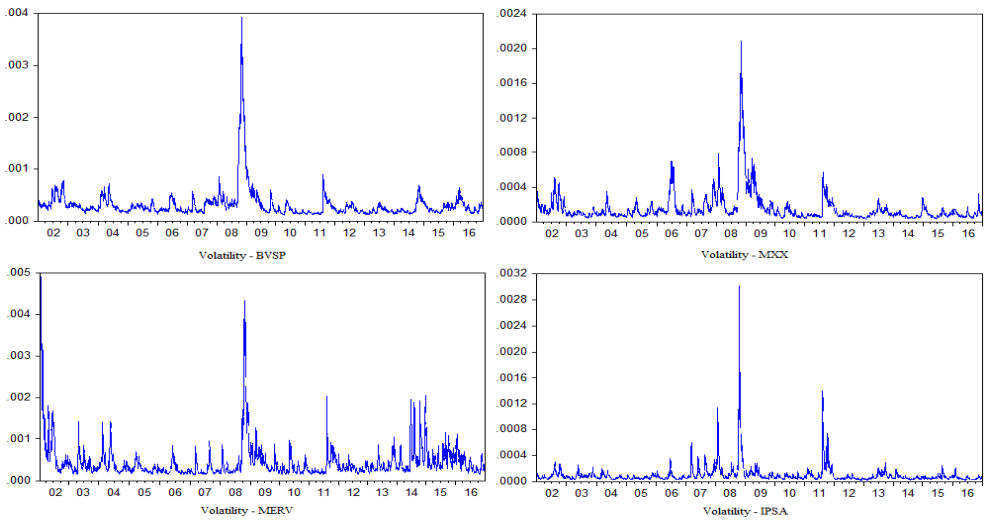

Fig. 1. Volatility of the stock exchanges.

The correlations of the markets on this paper during the period analyzed showed that all of them presented positive and high correlations between the markets due to the similarity of these markets, all developing economies. However, during the period of higher volatility, subprime crisis, the correlations displayed higher volatility between than during the other periods, these findings meet the results of Baumöhl & Lyócsa (2014), which demonstrated that diversification benefits decrease during more volatile periods.

Table 2
Correlations of the markets

Period	BVSP x MXX	BVSP x MERV	BVSP x IPSA	MXX x MERV	MMX x IPSA	MERV x IPSA
All	0.8998	0.5990	0.7081	0.5215	0.7185	0.4453
Before subprime crisis	0.5792	0.2637	0.4452	0.1665	0.4996	0.0578
During subprime crisis	0.9673	0.9370	0.7266	0.8982	0.7331	0.7269
After subprime crisis	0.6397	0.5012	0.4944	0.3173	0.5887	0.3441

Note: BVSP = Volatilidade BMF&Bovespa; MXX = Volatilidade Mexbol; MERV = Volatilidade Bolsa de Comercio de Buenos Aires; IPSA = Volatilidade Bolsa de Comercio Santiago.

The analyzes on the relationship between volatility of the stock exchange index of the countries reported (Brazil, Argentina, Chile and Mexico) and the contagion effect, it was necessary to identify if the series were stationary. For this analysis was performed the Augmented Dickey-Fuller - ADF test - where the trend level and constant were verified. For situations where the constant is not significant, the test is redone without constant and trend. If there is a significance of 1% the null hypothesis is rejected, and the series has a unit root, meaning that it is stationary.

Table 3
Unit Root Test - Augmented Dickey-Fuller

Period	**ADF**	**C and T**	**Stationary**
Brazil	-6.572658***	C	Stationary
Chile	-10.95179***	C	Stationary
Argentina	-7.346912***	C	Stationary
Mexico	-6.473240***	C	Stationary

Note: *** significance 1%. C and T indicate the presence of Constant and Trend, respectively.

The results of the unit root test for all the countries of the sample rejected the null hypothesis (H0) that the series has a unit root, that is, the series are stationary, presenting a level of significance of 1%, estimated with constancy.

In order to identify the number of lags for the VAR, a lag determination test was performed, presented in Table 4. The results of the test presented that should be used four lags.

Table 4
Determination of VAR lags

Lag	LogL	LR	FPE	AIC	SC	HQ
0	97830.45	NA	1.30e-30	-57.46047	-57.45326	-57.45789
1	114790.5	33870.29	6.21e-35	-67.41292	-67.37690	-67.94162
2	115488.8	1393.003	4.16e-35	-67.81371	-67.37690	-67.94162
3	115779.6	579.2958	3.54e-35	-67.97510	-67.88144	-67.94162
4	115921.1	281.5389*	3.29e-35*	-68.04880*	-67.92632*	-68.00503*

Note: LR: sequential modified LR statistical test (5% level); FPE: prediction of Final Error; AIC: Akaike Information Criterion; SC: Schwarz Information Criteria; HQ: Hannan-Quinn Information Criteria.

After the determination of the number of VAR lags, a series of variance decomposition analysis were developed, one for each country being studied with the main objective of identifying the possible influences from one market to the another, it means analyzing the correlations on the volatility behavior of the indexes of the stock exchanges studied.

Table 5 presents the variance decomposition of the Brazilian stock index (Ibovespa), and it is observed that the volatility of the Brazilian index is explained almost in its totality (92%) by endogenous variables, which in some way influence the volatility of the market. Following the Chilean stock exchange represents 6.57%. Finally, the Mexican and Argentine stock exchanges represent low influences on the volatility of the Brazilian stock index, respectively, 1.24% and 0.15%. As noticed, despite the geographic proximity, countries bordering Brazil have little influence on their stock market.

Table 5
Decomposition of Variance BVSP (Brazil)

Period	S.E.	BVSPVOL	IPSAVOL	MERVVOL	MXXVOL
1	4.92E-05	100.0000	0.000000	0.000000	0.000000
5	0.000112	95.43339	3.657844	0.058564	0.850202
10	0.000157	92.02883	6.570205	0.154965	1.245996

Note: LR: sequential modified LR statistical test (5% level); FPE: prediction of Final Error; AIC: Akaike Information Criterion; SC: Schwarz Information Criteria; HQ: Hannan-Quinn Information Criteria.

The analysis of the results of Table 6, which is the variance decomposition of the Argentina stock exchange (Merval), it is possible to observe that the volatility of the index is explained in 70% by internal variables, that is, domestic variables that in some way influence the behavior of volatility. The influence of the Brazilian stock exchange is observed in 24.79%, followed by Chilean with 3.7% and finally the Mexican stock exchange exerting only 1.47% influence on the behavior of the Argentine stock market volatility. Here it is interesting to note that, even without being strongly influenced by Argentina, Brazil has a considerable influence over the behavior of the Argentine stock market.

Table 6
Decomposition of Variance MERVAL (Argentina)

Period	S.E.	BVSPVOL	IPSAVOL	MERVVOL	MXXVOL
1	6.46E-05	16.42258	0.006173	83.57125	0.000000
5	0.000122	20.46334	2.813487	76.07099	0.652178
10	0.000147	24.79706	3.707610	70.01859	1.476735

Note: LR: sequential modified LR statistical test (5% level); FPE: prediction of Final Error; AIC: Akaike Information Criterion; SC: Schwarz Information Criteria; HQ: Hannan-Quinn Information Criteria.

The results shown in Table 7, which deals with the Mexican stock exchange variance (MXX), indicate the volatility of the Mexican index is explained by 29.16% by endogenous variables, which means that internal variables in some way influence the Behavior of volatility. In contrast, a large part of the Mexican stock market's volatility is influenced by the behavior of the Brazilian stock exchange (60.52%), in sequence the Chilean stock exchange showed an influence of 10.21% while the Argentine stock market only 0.98%.

Table 7
Decomposition of Variance MXX (Mexico)

Period	S.E.	BVSPVOL	IPSAVOL	MERVVOL	MXXVOL
1	9.53E-05	49.96469	3.002208	0.061028	46.97207
5	0.000292	58.00950	6.331729	0.130293	35.52848
10	0.000364	60.52517	10.21199	0.098663	29.16418

Note: LR: sequential modified LR statistical test (5% level); FPE: prediction of Final Error; AIC: Akaike Information Criterion; SC: Schwarz Information Criteria; HQ: Hannan-Quinn Information Criteria.

Analyzing Table 8, it is possible to notice that the Chilean index volatility is explained in 68.81% by internal variables, that is, endogenous variables that in some way influence the Behavior of volatility. Following, the Brazilian stock exchange exerts influence of 30.48%, followed by the stock exchanges of Argentina and Mexico with 0.46% and 0.23% respectively.

Table 8
Decomposition of Variance IPSA (Chile)

Period	S.E.	BVSPVOL	IPSAVOL	MERVVOL	MXXVOL
1	3.64E-05	32.48709	67.51291	0.000000	0.000000
5	7.02E-05	30.01700	69.48663	0.216573	0.279800
10	9.38E-05	30.48008	68.81837	0.469486	0.232069

Note: LR: sequential modified LR statistical test (5% level); FPE: prediction of Final Error; AIC: Akaike Information Criterion; SC: Schwarz Information Criteria; HQ: Hannan-Quinn Information Criteria.

The results show that the Brazilian market has a great influence in relation of some countries of the America Latina region, while the inverse influence does not happen. Moreover, it is noted that the Mexican stock market volatility is weakly influenced by its internal variables, as it was shown, and that, by order of greater influence from the Brazilian stock exchange to the smaller one is: Mexico, Chile and Argentina.

After the analysis of the co-movements of the markets, it was made the Generalized Response Impulse Function of Argentina (MERV), Chilean (IPSA) and Mexican (MXX) on the Brazilian stock exchange (BVSP). The stock exchanges were derived from a shock of two standard deviations and these response impulses are shown in Figures 2, 3 and 4. It was analyzed only the response of the other stock exchanges to the shock of two standard deviations of the variables that represent the Brazilian stock market, because in the analysis of variance decomposition this country was the only one to have a representative influence of the volatility behavior of the other stock exchanges.

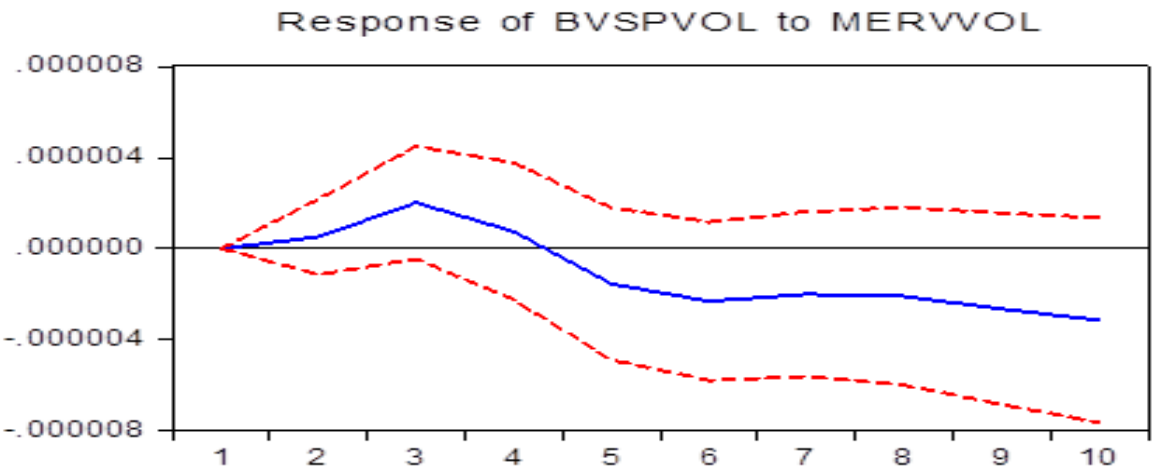

Fig. 2. Function Impulse Response (FIR) - BVSP shock over MERV

Figure 2 demonstrates the Argentine stock market volatility response to a shock of two standard deviations of the variable that represented the Brazilian stock exchange. An increase in the Argentine volatility index is observed in the face of a shock caused by the Brazilian stock exchange, represented after the third day, where after this effect the index shows a downward behavior, a slight improvement after the sixth day and again a behavior of fall to the end.

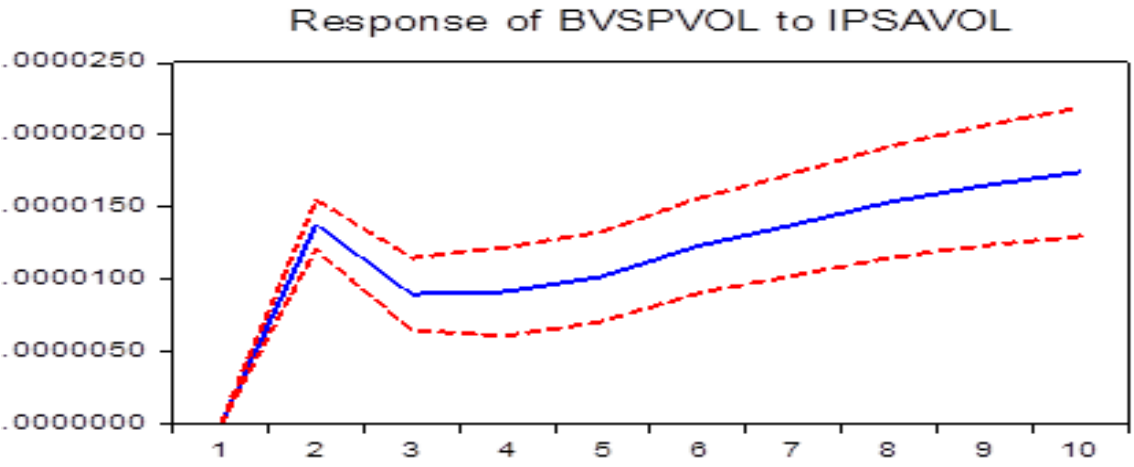

Fig. 3. Function Impulse Response (FIR) - BVSP shock over IPSA

With respect to the Chilean stock exchange, as shown in Figure 3, in the first few days an increase in the volatility index is observed until the second day, where after the effect of shocks the index shows a reduction of the index until the third day, where it once again growing, showing an opposite behavior to that caused to the Argentine stock exchange, which showed a constant fall behavior.

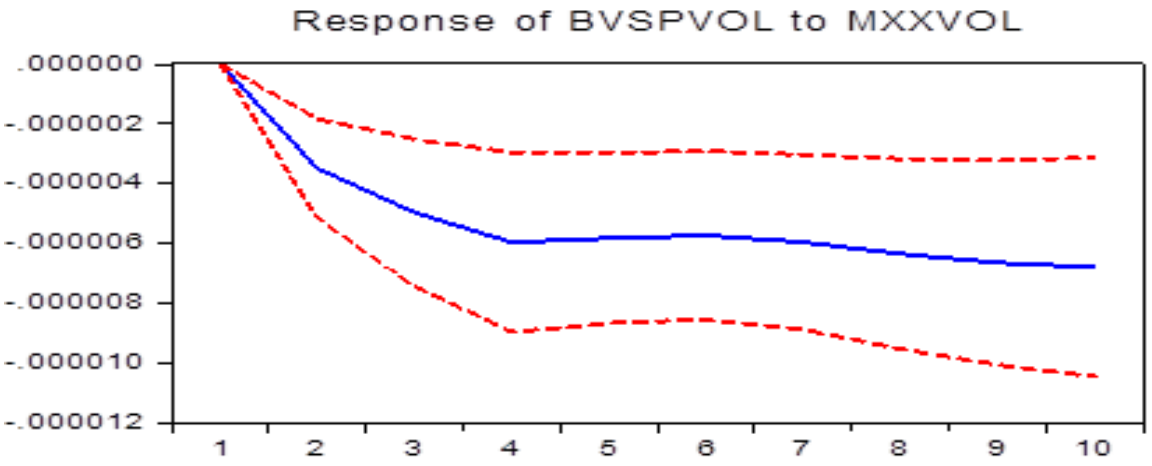

Fig. 4. Function Impulse Response (FIR) - BVSP shock over MXX

Figure 4, finally, presents the behavior of the Mexican stock exchange after the shocks of two standard deviations by the Brazilian stock exchange. It is possible to observe a behavior similar to that of the Argentine stock exchange after the shocks, where the volatility index shows a steady fall behavior, with small signs of recovery, but which do not remain.

In general, the stock exchanges analyzed (Argentina, Chile and Mexico) present some response when they receive shocks from the Brazilian stock exchange, generally occurring in the first days suggesting the occurrence of the contagion effect of volatility. This paper follows the results found by Edwards & Susmel (2001) and Fujii (2005), which evidenced robust evidence of co-movements of volatility among Latin America countries.

It is observed that the response of the other exchanges analyzed to the shock caused by the Brazilian stock exchange usually occurs, as already mentioned, in the first days after the stimulus and that an oscillation remains during the average period of four days and soon after, starts an equilibrium process that is observed until the end of the time series, in this case, the suggestive existence of a pattern between recovery behavior against shock is perceived. Figures 1, 2 and 3 show that after the average of 10 days, the average volatility index shows a linear behavior, tending to the same initial position of the index before the shock, which reinforces the contagion effect of volatility.

5. CONCLUSIONS

This paper aimed to investigate the volatility of the returns for check out the co-movements and the contagion effects of countries from Latin America countries. The results indicate evidence of a contagion effect was observed in all countries, with two facts being relevant, the first is the influence of the Brazilian stock exchange in all other countries in the sample and, lastly, the low representativeness of endogenous factors to explain the volatility behavior of the stock exchange from Mexico. These results following the findings of Edwards and Susmel (2001) and Fujii (2005), who found significant causal linkages within countries of Latin America region.

The results indicate that during the period of higher volatility, subprime crisis, the correlations displayed higher volatility between than during the other periods, these findings meet the results of Baumöhl & Lyócsa (2014), which demonstrated that diversification benefits decrease during more volatile periods, and was found that the Brazilian stock exchange has a great influence on Argentina, and the same influence is not observed when analyzing the strength of the Argentine stock exchange over the Brazilian stock market, following the found of Milken (2017).

The limitations of the study are the sample of Latin America stock exchanges, which were selected due to the availability of information in the consulted database. With this it is possible to suggest for futures researches to work with a larger sample of the countries of Latin America and review the analysis, even include in the sample the American stock exchange, the main world stock exchange, as well as the stock exchange of some strategic partner country for the Latin America countries.

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