TESTING THE EMPIRICS OF WEAK FORM OF EFFICIENT MARKET HYPOTHESIS: EVIDENCE FROM LAC REGION MARKETS

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Abstract*: The new coronavirus disease (Covid-19) evolved quickly from a regional health outbreak to a global collapse, stopping the global economy in a unprecedented way, creating uncertainty and chaos in the financial markets. Based on these events, it is intended in this paper to test the persistence of profitability in the financial markets of Argentina, Brazil, Chile, Colombia, Peru and Mexico, in the period between January 2018 to July 2020. In order to perform this analysis where undertaken different approaches in order to analyze if: (i) the financial markets of Latin America are efficient in their weak-form during the global pandemic (Covid-19)? ii) If so, the persistent long memories cause risks between these regional markets? The results suggest that the returns don't follow the i.i.d. hypothesis, from dimension 2, reinforcing the idea that returns of stock indexes have a non-linear nature or a significant non-linear component, exception made to the Argentina market, which was expected in virtue of the Ljung-Box (with the return squares) test results, and ARCH-LM. Corroborating the exponents Detrended Fluctuation Analysis (DFA), indicate the presence of persistent long memories, namely into the following markets: Colombia (0.72), Chile (0.66), Brazil (0.58) and Peru (0.57). The Argentina market does not reject the random walk hypothesis, while the Mexican market suggests some anti-persistence (0.41). This situation has implications for investors, once that some returns can be expected, creating arbitration opportunities and abnormal income, contrary to the supposed from the random walk hypothesis and information efficiency. The t-test results of the heteroscedasticity form the two samples suggest that there is no risk transmission between these regional markets, with the exception to the BOVESPA / BOLSAA MX markets, that is, the existence of persistent long memories in the returns does not imply the risk transmission between markets. These finds allow the creation of strategies of diversification inefficient portfolios. These conclusions also open space for the market regulators to implement measures that guarantee a better informational information of these regional markets.*

Keywords: *Covid-19, LAC region, Long memories, Arbitration.*

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1. INTRODUCTION

The Covid-19 global pandemic affects negatively global trade, as well as social and cultural life, namely the tourism, trade in goods, production and sectors like transportation. The fast spread of the coronavirus (COVID-19) has dramatic impacts in the financial markets all over their world, causing significant loses to the investors in a very short period. Aligned with all this negative effects, it seems inevitable that the stock exchanges, economic growth and exchange rates have also been affected in equal matter (Liu, Manzoor, Wang, Zhang and Manzoor, 2020).

The subject of hypothesis of efficiency in the markets, shows if the actual price of the active reflects all the available information, in a certain moment, and price adjusts quickly, as new and unforeseen information gets to the market. The mean reversion hypothesis, also known as negative series correlation, has been interpreted; it has an efficient correlation mechanism in developed markets, and, a sign of speculative bubble in the financial emerging markets (Summers, 1986; Fama and French, 1988).

This investigation will test the persistence and risk of the financial markets of Argentina, Brazil, Chile, Colombia, Peru and Mexico, in the period between January 2018 to July 2020. The results suggest that the returns don't follow the i.i.d. hypothesis, from dimension 2, reinforcing the idea that returns of stock indexes have a non-linear nature or a significant non-linear component, exception made to the Argentina market. In order to validate the persistence, the exponents *Detrended Fluctuation Analysis* (*DFA*), indicate the presence of persistent long memories, namely in the following markets: Colombia (0.72), Chile (0.66), Brazil (0.58) and Peru (0.57). The Argentina market does not reject the *random walk* hypothesis, while the Mexican markets suggest some anti-persistence (0.41). This situation has implications for investors, once that some returns can be expected, creating arbitration opportunities and abnormal income, contrary to the supposed from the *random walk* hypothesis and information efficiency. The t-test results of the heteroscedasticity from the two samples suggest that there is no risk transmission between these regional markets, except for the BOVESPA / BOLSAA MX markets, that is, the existence of persistent long memories in the returns does not imply the risk transmission between markets.

These investigations present two contributions to the existing literature. The first contribution is regarding the study of efficiency, in its weak form, and risk transmission in the financial markets of Latin America, in the context of global pandemic (Covid-19). As far as we know some studies analyze the impact of the global pandemic in the financial markets (Ali, Alam, and Rizvi, 2020; Corbet, Larkin, and Lucey, 2020; He, Liu, Wang, and Yu, 2020; Sansa, 2020), however the approach was essentially distinct from the followed in this paper. The second contribution is related to the preference in these regional emerging markets; after the financial crisis of 2008 these regional markets became an important investment destination. In this context and having in mind that the large capital inflows are of a great importance to understand the persistence of returns and risk transmission between Latin-American markets, in order to provide international investors knowledge, they can implement efficient diversification strategies.

In terms of structure this paper is organized into 5 sections. In Section 2 is presented the literature review in concern of articles about the efficiency of market, in its weak form. Section 3 describes methodology and data. Section 4 presents the results. Section 5 concludes.

2.   LITERATURE REVIEW

Several works have been approaching the matter of efficiency of the markets, analyzing the profitability predictability hypothesis through the analysis of average reversal patterns, inspired in the semi-final works of Poterba and Summers (1988) and Fama and French (1988), in which they documented reversion to the average in the stock markets, in periods above one year. According to the authors Malafeyev, Awasthi, S.Kambekar, and Kupinskaya (2019) when the random walk hypothesis and informational efficiency are rejected it cause extreme movements in stock prices. The occurrence of these phenomena can, eventually, decrease the implementation of diversification strategies of efficient portfolios.

The authors Nisar and Hanif (2012) analyzed the stock markets of India, Pakistan, Bangladesh and Sri Lanka, and evidence (in) market efficiency, in its weak form. Mehla and Goyal (2013) suggest that the Indian market does not show the characteristics of *random walk* and as such is not efficient in its weak form. El Khamlichi et al. (2014) show that Islamic indices have the same level of (in) efficiency as benchmarks, but MSCI and FTSE indices are less inefficient.

Righi and Ceretta (2011), Sierra Suárez, Duarte Duarte and Mascareñas Pérez-Iñigo (2013), Worthington and Higgs (2013), Duarte and Mascareñas Pérez-Iñigo (2014), Ruiz-Porras and Ruiz-Robles (2015) tested market efficiency in its weak form in Latin America. Righi and Ceretta (2011) analyzed the S&P500, Ibovespa, Merval and IPC indexes, showing that these regional markets are efficient in their weak form, except for the U.S. market. Sierra Suárez, Duarte Duarte and Mascareñas Pérez-Iñigo (2013) studied the Colombian market, showing hybrid results, that is, the assets show signs of chaotic behavior in ascending periods and random in descending periods. While the authors Worthington and Higgs (2013) examined the financial markets of Argentina, Brazil, Chile, Colombia, México, Peru, e Venezuela, suggesting that the efficient market hypothesis is rejected. Duarte and Mascareñas Pérez-Iñigo (2014) analyzed the main financial markets in Latin America. The authors show that the five main Latin American economies have undergone a change from non-efficiency to efficiency in recent years, according to, the following chronological order: México (2007), Brazil (2008), Colombia (2008), Chile (2011) e Peru (2012). Ruiz-Porras and Ruiz-Robles (2015) analyzed the Mexican stock market, suggesting that the stock market is (in) efficient in its weak form, and this efficiency has declined since 2007.

Andrianto and Mirza (2016), Hamid, Suleman, Ali Shah, and Imdad Akash (2017), Singh and Kumar (2018) examined efficiency of markets, in their weak form, in Asian markets. Andrianto and Mirza (2016) show that Indonesia´s stock market is efficient in its weak form, suggesting that the daily movement of the stock prince is random, and does not present autocorrelation. Hamid, Suleman, Ali Shah, and Imdad Akash (2017) analyzed the markets of Pakistan, India, Sri Lanka, China, Korea, Hong Kong, Indonesia, Malaysia, Philippines, Singapore, Thailand, Taiwan, Japan, e Australia. The authors show that prices do not follow the random walk hypothesis. Singh and Kumar (2018) show that the Kuala Lumpur Stock Exchange shows signs of (in) efficiency in its weak form. Given this evidence, investors can benefit from the arbitration process by achieving anomalous profitability without incurring additional risk.

Aggarwal (2018), Rehman, Chhapra, Kashif, and Rehan (2018), Karasiński (2020) tested the persistence of profitability in various financial markets. Aggarwal (2018) analyzed the efficiency and market and the persistence of the South Korean stock market (KOSPI), and suggests that the time series do not follow a process of *random walk*. Rehman, Chhapra, Kashif, and Rehan (2018) show that the stock indexes of Pakistan, India and Bangladesh are not

efficient in their weak form. While author Karasiński (2020) examined efficiency in its weak form in European markets and shows that overall efficiency tended to improve after the global financial crisis of 2008.

In summary, this work aims to contribute to the provision of information to investors and regulators in Latin American stock markets, where individual and institutional investors seek diversification benefits, as well as to help promote the implementation of policies that contribute to the efficiency of these markets in this period of global pandemic (Covid-19).

3. METHODOLOGY

DATA

Data on the closing prices of the financial markets in Argentina, Brazil, Chile, Colombia, Peru, and Mexico were obtained from the *Thomson Reuters* platform. The quotations are daily and between the period from January2, 2018 to July 21, 2020, having been partitioned into two sub periods before and during Covid-19. Quotes are in local currency to mitigate distortions in exchange rates.

Table 1. The name of countries and their indices used in this paper

| Index	Country
BOLSAA MX	Mexico
BVLAC	Peru
COLCAP	Colombia
IBOVESPA	Brazil
IPSA	Chile
MERVAL	Argentina

Source: Own elaboration

METHODOLOGY

The development of the research took place along several stages. The characterization of the sample used was performed through descriptive statistics, the Adherence Test of Jarque and Bera (1980). To answer the first question of investigation, we tested the persistence of profitability through the tests: Ljung-Box (with the squares of profitability); ARCH-LM (Engle, 1982) and BDS (Brock and De Lima, 1996). In order to validate the results of the persistence of profitability we will use the *Detrended Fluctuation Analysis (DFA). DFA* is an analysis method that examines temporal dependence on non-stationary data series. This technique by assuming that time series are non-stationary avoids spurious results when the analysis focuses on the relationships of data series in the long term. The *DFA* model allows to examine the behavior of financial series, having the following interpretation: anti persistent series; series features $0 < \alpha < 0.5$ $\alpha = 0.5$ *random walk;* $0.5 < \alpha < 1$ persistent series. To answer the second question of investigation, that is, if the generalized increase in correlations had statistical significance, the heteroscedasticity t-test of two samples from Forbes and Rigobon (2002) will be applied. This type of correlations requires transformation through fisher's method. This test will show the results on the existence or not of risk transmission among the financial markets of the LAC Region, in the context of global pandemic (Covid-19).

4. RESULTS

Figure 1 shows the evolution of the markets, at levels of the financial markets of Latin America, in the period from January 2, 2018 to July 21, 2020, being the same as the period of great complexity, due to the global pandemic outbreak (Covid-19). Index prices index clearly reveal the instability experienced in these markets in January, February, March and April 2020.

Figure 1. Evolution, in levels, of the 6 financial markets, in the full period
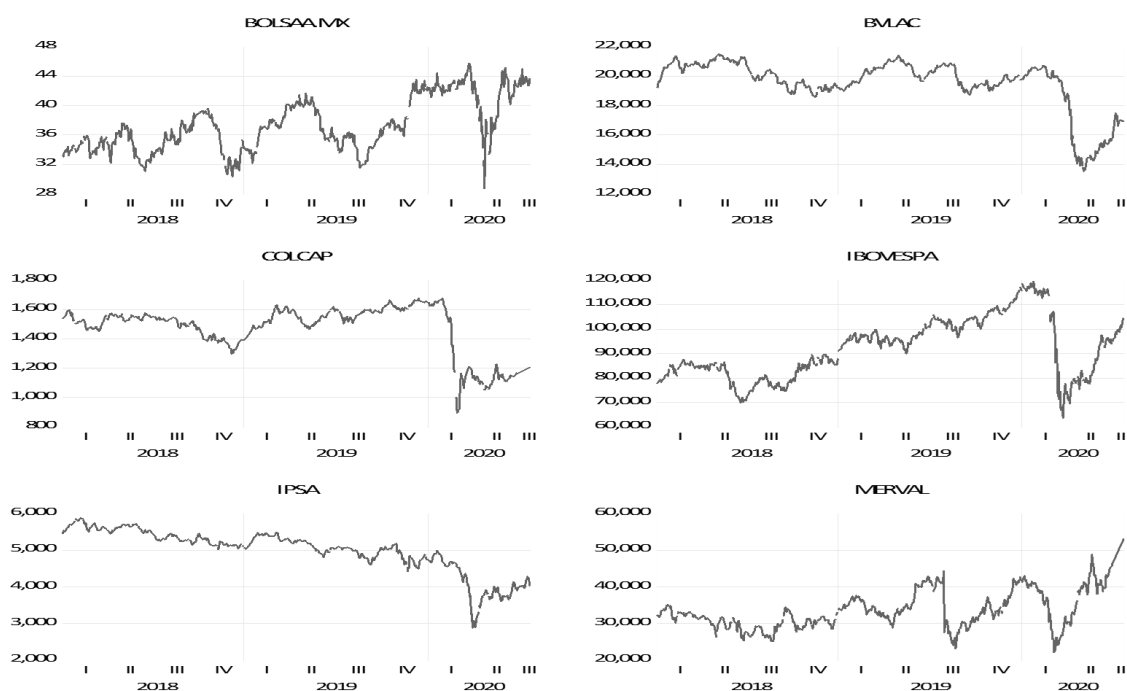
Source: Own elaboration

Table 2 shows the main descriptive statistics of the six financial markets in Latin America, referring to the full sample period. The average is positive in the stock indexes of Mexico (BOLSAA MX), Brazil, (IBOVESPA), and Argentina (MERVAL), except in the markets of Peru (BVLAC), Colombia (COLCAP), and Chile (IPSA). The Argentina market has the highest standard deviation (0.0351). The results obtained show that the series of profitability propose removals from the hypothesis of normality. This result arises through the Jarque and Bera test (1980) that allowed to reject the null hypothesis of normality (H_0) in favor of the alternative (H_1 - non-normality), for a significance level of 1%. Additionally, the coefficients of asymmetry and kurtosis are statistically different from those of a normal distribution, being the same leptokurtic and asymmetric.

Table 2. Descriptive statistics, in profitability, of the 6 financial markets in Latin America in the full period

	BOLSAA MX	BVLAC	COLCAP	IBOVESPA	IPSA	MERVAL
Mean	0.000437	-0.000202	-0.000387	0.000463	-0.000478	0.000795
Std. Dev.	0.022153	0.010505	0.015441	0.020328	0.014879	0.035148
Skewness	0.922157	-2.418776	-2.190409	-1.587049	-2.287239	-4.231528
Kurtosis	16.68369	26.17456	42.93431	20.61187	31.90027	57.53034
Jarque-Bera	5012.373***	14735.48***	42433.19***	8419.984***	22509.65***	80062.89***
Observations	631	631	631	631	631	631

Source: Own elaboration

Table 3 shows the results of unit root tests, with structure breaks, by Clemente et al. (1998), suggesting marked structural breakdowns in January, February and April 2020, in a complex period of the global pandemic (covid-19). The Argentina market shows that the most significant structural collapse occurred in July 2019. This model identifies the most significant structure breakdown, which means that there may be smaller, structure breaks in the period January 2018 to July 2020. The results are in line with the findings of the authors Lahmiri and Bekiros (2020), Sansa (2020), He, Liu, Wang, and Yu (2020), which show sharp declines in financial markets resulting from the global pandemic (Covid-19).

Table 3. Unit root tests, with structural breakdowns, referring to the financial markets of Latin America, in the full period

Index	t-stat	Break Date
BOLSAA MX	-29.09(0) ***	27/04/2020
BVLAC	-26.50(0) ***	03/04/2020
COLCAP	-21.98(0) ***	22/01/2020
IBOVESPA	-31.21(0) ***	23/03/2020
IPSA	-26.67(0) ***	30/03/2020
MERVAL	-30.75(0) ***	31/07/2019

Note: Lag Length (Automatic Length based on SIC). Break Selection: Minimize Dickey-Fuller t-statistic. The lateral values in parentheses refer to lags. ***. **. *. represent significance at 1%. 5% and 10%. respectively.

Source: Own elaboration.

In order to verify the existence of persistent profitability in the financial markets of Latin America, we will estimate the following methodologies: Ljung-Box (with the squares of profitability); ARCH-LM (Engle, 1982) and BDS (Brock and De Lima, 1996). Table 4 shows the Ljung-Box test results, applied to index yield rates, as well as squared yields. We performed in a first phase, and for lags 4 and 12, the Ljung-Box test and we verify as we increase the lags the autocorrelation becomes more persistent. To validate results, we used the same model, with the profitability squared, also for lags 4 and 12, and we proved that the autocorrelation becomes more persistent; the exception to these results is verified in the Argentina market (MERVAL) that indicates balance or anti-persistence.

Table 4. Results of Ljung-Box tests applied to time series waste for Latin American markets in the full period

	BOLSAA MX	BVLAC	COLCAP	IBOVESPA	IPSA	MERVAL
LB (4)	15.889***	13.837***	67.198***	25.328***	31.968***	**5.7256**
LB (12)	74.395***	54.230***	82.955***	81.623***	49.439***	**16.115**
LB^2 (4)	149.60***	181.90***	166.99***	693.50***	216.03***	**2.2472**
LB^2 (12)	345.38***	225.81***	437.24***	951.86***	327.15***	**4.1862**

Note: The asterisk ***, ** represent significance at 1% and 5%, respectively.

Source: Own elaboration.

To analyze the presence of the phenomenon of conditional heteroscedasticity in financial series, it is customary to use the *Lagrange Multiplier* test (ARCH-LM test) (Engle, 1982). The ARCH-LM tests were applied to residues of first-order self-regressive processes and, for *lag* 10. Table 5 shows that the residues of the self-regressive processes of the financial markets under analysis exhibit conditioned heteroscedasticity, corroborating this characteristic frequently present in financial assets. The Ljung-Box tests, applied to the square of the profitability (table 4), for these lags 4 and 12, prove the evidence of the ARCH-LM test, reinforcing the evidence of the presence of ARCH effects in the time series. The markets of Brazil (IBOVESPA) and Mexico show more significant heteroscedasticity, while Colombia

(COLCAP) and Chile the signal is less pronounced. The Argentina market (MERVAL) shows that the data series has no ARCH effects.

Table 5. ARCH-LM test for waste applied to time waste series for Latin America markets in full period

	BOLSAA MX	BVLAC	COLCAP	IBOVESPA	IPSA	MERVAL
ARCH LM (10 lags)	126.1958***	36.26859***	14.24187***	306.5358***	5.409216**	**2.289060**

Note: The LM test was applied to the residues of a first-order self-regressive process of each series. Asterisk***, ** represent significance at 1% and 5%, respectively.

Source: Own elaboration.

Table 6 shows the BDS test results, and we can verify that the chances that the yields are i.i.d. is rejected, with statistical significance, from dimension 2, reinforcing the idea that the profitability of stock indices have a nonlinear nature or have a significant nonlinear component, except for the Argentina market, which was expected due to the results of the Ljung-Box (with the squares of profitability) and ARCH-LM tests. According to author Taylor (1986) the significant presence of greater autocorrelation between the squares of profitability than among the original values of profitability is also an indication of the presence of nonlinearity. Table 4 shows the results of the autocorrelation tests of the squares of the profitability, for lags 4 and 12 and all indexes reject the null hypothesis, identifying autocorrelation in series, except for the Argentina market. The results of the autocorrelation tests are totally coincident with those obtained by the BDS test. The rejection of the null hypothesis, i.i.d., can be explained, among other factors, by the existence of autocorrelation or by the existence of heteroscedasticity in the series of scholarship indices, cases in which the rejection of the null hypothesis is explained by nonlinear dependence on the data. These results are in line with studies by the authors Pernagallo and Torrisi (2019) that show the existence of persistence in the profitability of financial markets.

Table 6. BDS test applied to time series waste, referring to Latin America markets in the full period

	BOLSAA MX	BVLAC	COLCAP	IBOVESPA	IPSA	MERVAL
Dimension (2)	6.5566***	6.0448***	3.9619***	9.0055***	8.3832***	**-0.04015**
Dimension (3)	6.9686***	7.7242***	6.8186***	9.4047***	11.5163***	**-0.05405**
Dimension (4)	7.0610***	8.7397***	8.9511***	9.2726***	13.3075***	**-0.06481**
Dimension (5)	7.1258***	9.3107***	10.3755***	9.3957***	14.6851***	**-0.07403**
Dimension (6)	7.1959***	9.6764***	11.3864***	9.9429***	15.9209***	**-0.08228**

Notes: The method considered in the BDS test was the pair fraction, for a value of 0. 7. The first column concerns the size of the dive (embedding dimension). The values shown in the table refer to the z-Statistic, ** represent significance at 1% and 5%, respectively.

Source: Own elaboration

Table 7 shows the results of the exponents α DFA, and we found that the Latin American markets indicate persistence in profitability, i.e. the presence of sharp long memories, particularly in the markets of Colombia (0.72), Chile (0.66), Brazil (0.58) and Peru (0.57). The Argentina market does not reject the *random walk* hypothesis, while the Mexican market suggests anti persistence (0.41). These findings show that prices do not fully reflect the information available and that price changes are not i.i.d. This situation has implications for investors, since some returns can be expected, creating opportunities for arbitrage and abnormal income, contrary to what is supposed by the assumptions of *random walk* and informational efficiency. These results are mostly corroborated by the Ljung-Box tests (with the squares of profitability); ARCH-LM (Engle, 1982) and BDS (Brock and De Lima, 1996) that show persistence in profitability.

Table 7. DFA exponent for return. The hypotheses are H_0: $\alpha = 0.5$ and H_1: $\alpha \neq 0.5$

Index	DFA exponent (Covid-19)
BOLSAA MX	$0.41 \cong 0.0238$
BVLAC	$0.57 \cong 0.0239$
COLCAP	$0.72 \cong 0.0014$
IBOVESPA	$0.58 \cong 0.0224$
IPSA	$0.66 \cong 0.0030$
MERVAL	$0.52 \cong 0.0052$

Note: The values of the linear adjustments for αDFA always had $R^2 > 0.99$

Source: Own elaboration.

In order to analyze the risk transmission among the financial markets of the LAC Region, non-conditional correlations were estimated, and the statistical significance was examined. One way to test the statistical significance of the correlation coefficient is to resort to t *statistics,* which follows the distribution t, with $n - 2$ degrees of freedom, in which r is the correlation coefficient between two series and n is the number of observations. To test whether the matrix of correlation coefficients is globally different from the identity matrix, we use the verisimilitude ratio test, suggested by Pindyck and Rotemberg (1990).

Table 8 shows the non-conditional correlation coefficients of the statistics for the Pre-Covid sub period, and we can verify the existence of non-significant correlation coefficients (BVLAC-IBOVESPA; BVLAC-MERVAL), negative correlation coefficients (BOLSAA MX-IPSA; IBOVESPA-IPSA; IPSA-MERVAL). Additionally, we can also verify that the positive correlation coefficients are not high.

Table 8. Non-conditional correlation coefficients, pre-covid-19 period

	BOLSAA MX	BVLAC	COLCAP	IBOVESPA	IPSA	MERVAL
BOLSAA MX	###					
BVLAC	0.134108***	###				
COLCAP	0.119942**	0.578708***	###			
IBOVESPA	0.234242***	0.021255	0.160407***	###		
IPSA	-0.100876**	0.439219***	0.132402***	-0.545241***	###	
MERVAL	0.165000***	-0.069380	0.144528***	0.583039***	-0.203724***	###

Note: Asterisks ***, ** represent significance at 1% and 5%, respectively.

Source: Own elaboration

Table 9 shows the non-conditional correlation coefficients in the Covid-19 period, and we can see that the market pairs BOLSAA MX-COLCAP, BOLSAA MX- IPSA, BVLAC- MERVAL, COLCAP- MERVAL, IPSA-MERVAL present negative correlation coefficients (in 15 possible). In addition, we can also see the increase in correlations when compared to the previous period.

Table 9. Non-conditional correlation coefficients, Covid-19 period

	BOLSAA MX	BVLAC	COLCAP	IBOVESPA	IPSA	MERVAL
BOLSAA MX	###					
BVLAC	0.179370***	###				
COLCAP	-0.216833***	0.697127***	###			
IBOVESPA	0.069303	0.672792***	0.746810***	###		
IPSA	-0.218262***	0.730612***	0.808306***	0.796805***	###	
MERVAL	0.271763***	-0.408585***	-0.079134	0.168842**	-0.167217**	###

Note: Asterisks ***, ** represent significance at 1% and 5%, respectively.

Source: Own elaboration

Table 10 shows the results of risk transmission between Latin American markets through the t-test of heteroscedasticity of two samples of Forbes and Rigobon (2002) between the Pre-Covid and Covid sub periods. The results suggest that there is no risk transmission between these regional markets, except for BOVESPA / BOLSAA MX markets, i.e. the existence of persistence of profitability, and long memories do not imply the transmission of risk between markets. These results open doors to the existence of possibilities for diversification of efficient portfolios.

Table 10. Results of risk transmission, between Pre / Covid-19 sub-period

Markets	t-Statistic	Results	Markets	t-Statistic	Results
MERVAL / BOVESPA	-0.34	Nonexistent	BOL.MX / BOVESPA	0.23	Nonexistent
MERVAL / IPSA	-1.25	Nonexistent	BOL.MX / IPSA	-0.90	Nonexistent
MERVAL / BVLAC	-2.59	Nonexistent	BOL.MX / BVLAC	-2.66	Nonexistent
MERVAL / COLCAP	-2.46	Nonexistent	BOL.MX / COLCAP	-2.64	Nonexistent
MERVAL / BOL.MX	-0.62	Nonexistent	BOL.MX / MERVAL	-0.09	Nonexistent
BOVESPA / MERVAL	1.21	Nonexistent	IPSA / MERVAL	0.96	Nonexistent
BOVESPA / IPSA	0.35	Nonexistent	IPSA / BOVESPA	1.06	Nonexistent
BOVESPA / BVLAC	-0.61	Nonexistent	IPSA / BVLAC	-0.67	Nonexistent
BOVESPA / COLCAP	-0.28	Nonexistent	IPSA / COLCAP	-0.38	Nonexistent
BOVESPA / BOL.MX	**1.42***	Existent	IPSA / BOL.MX	1.11	Nonexistent
BVLAC / MERVAL	1.14	Nonexistent	COLCAP / MERVAL	0.91	Nonexistent
BVLAC / BOVESPA	1.23	Nonexistent	COLCAP / BOVESPA	1.02	Nonexistent
BVLAC / IPSA	0.42	Nonexistent	COLCAP / BVLAC	-0.72	Nonexistent
BVLAC / COLCAP	-0.18	Nonexistent	COLCAP / IPSA	0.21	Nonexistent
BVLAC / BOL.MX	1.30	Nonexistent	COLCAP / BOL.MX	1.06	Nonexistent

Notes: Critical values correspond to a one-tailed significance on the right, 2.7638 (1%), 1.8125 (5%) and 1.3722 (10%). ***, **, * indicate significant results at 1%, 5% and 10%, respectively.

Source: Own elaboration

5. CONCLUSION

The general conclusion to be retained and, supported by the results obtained, through the tests carried out with econometric and econophysical models demonstrates that the global pandemic has a significant impact on the memory properties of the indices of the financial markets in Latin, America. We believe that the profitability does not follow the hypothesis i.i.d., from dimension 2, reinforcing the idea that the yields of stock indices have a nonlinear nature or have a significant nonlinear component, with the exception made to the Argentina market, which was expected due to the results of the Ljung-Box (with the squares of profitability) and ARCH-LM tests. Corroborating the exponents of *Detrended Fluctuation Analysis (DFA)*, it indicates the presence of long memories. These findings show that prices do not fully reflect the information available and that price changes are not i.i.d. This situation has implications for investors, since some returns can be expected, creating opportunities for arbitrage and abnormal income, contrary to what is supposed by the assumptions of *random walk* and informational efficiency. The results of the t-test of heteroscedasticity of two samples suggest that there is no risk transmission between these regional markets, except for BOVESPA / BOLSAA MX markets, i.e. the existence of persistence of profitability, and long memories do

not imply the transmission of risk between markets. These findings allow the implementation of strategies for diversification of efficient portfolios. These findings also make room for market regulators to take steps to ensure better informational information in these regional markets.

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