Mercados y Negocios
ISSN: 1665-7039
ISSN: 2594-0163
revistamercadosynegocios@cucea.udg.mx
Universidad de Guadalajara
México

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Mercados y Negocios, no. 42, 2020, June-, pp. 5-26
Universidad de Guadalajara
México

Mercados y Negocios
1665-7039 printed
2594-0163 on line
Year 21, N. 42, July-December (2020)

Benefits of an Emerging countries overweighted portfolio versus a globally diversified one

Beneficios de un portafolio sobreponderado en países emergentes versus globalmente diversificado

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Received: January 19th, 2020
Accepted: May 6th, 2020

ABSTRACT

In the present paper, we test the benefit of overweighting a Global stock portfolio in Emerging markets. This, against a globally full-diversified one. By using a Gaussian two-regime Markov-Switching model, we tested the benefit of global diversification. From a U.S. dollar based investor perspective, we found in our results that is preferable to invest in a portfolio with only U.S. and Emerging markets stocks, instead of a global broad diversified portfolio. By the fact that a less diversified portfolio has a better mean-variance efficiency in a global diversification context, this result seems challenge the main assumptions of the classical portfolio theory.

Keywords: portfolio selection; Emerging markets; Diversification; Markov-Switching models.

Jel Code: C24; G11; G15

RESUMEN

En el presente trabajo se prueba el beneficio de sobreinvertir un portafolio global de acciones en países emergentes. Esto en comparación a un portafolio globalmente diversificado. Al emplear un modelo markoviano con cambios de régimen, en un contexto de dos regímenes y una función de verosimilitud gaussiana, se encontró que es preferible tener un portafolio sobreinvertido en acciones de países emergentes y de Estados Unidos. Lo anterior en comparación a un portafolio globalmente diversificado. El resultado sugiere que los postulados de la teoría clásica de portafolios no siempre se sostienen en materia de diversificación global.

Palabras clave: Selección de portafolios; Mercados emergentes; Diversificación; Modelos markovianos de cambio de régimen

Código Jel: G11; G15; C24.

INTRODUCTION

The Markovian models of regime change[1] are analysis models in which a time series is characterized $x = [x_t]$ by two or more *behavior regimes* or *natural states*. It is assumed that the time series is not modeled by means of one single stochastic process$x_t \sim P(x_t, \theta)$, generating its performances or values but rather by $s = 1,2, \dots, S$ different stochastic processes. Stochastic processes that are combined to form a single one, through a combined and multi-modal likelihood function, based on a vector of parameters θ:

$$P(x_t, \theta) = \sum_{s=1}^{S} \omega_{s=i} \cdot P(x_t, \theta_{s=i}) \quad (1)$$

In the expression above, $\omega_{s=i}$ is the combination law that determines the proportion of data that belong to the regime $s = i$ and $P(x_t, \theta)$ its corresponding probability sub-function. In this specific case, subject of interest in present study, it is not assumed that the stochastic process generating the performances of a time series corresponds to an unimodal Gaussian probability function with one single localization parameter (μ) and one scale parameter (σ), but rather s parameters, corresponding to each regime or natural state ($\mu_{s=i}, \sigma_{s=i}$).

Based on the general way of a multi-modal probability function given in , the performances or observations of a time series are cataloged or characterized in sub-groups or sub-samples with their own sub-functions of probability and parameters. These lead to the general probability function, inherent to the stochastic process of time series x:

$$P(x_t, \theta) = \sum_{s=1}^{S} \omega_{s=i} \cdot P(x_t, \theta_{s=i}) = \sum_{s=1}^{S} \omega_{s=i} \cdot \left[\frac{1}{\sqrt{2\pi}\sigma} e^{-\frac{1}{2}\left(\frac{x_t - \mu_{s=i}}{\sigma_{s=i}}\right)^2} \right] \quad (2)$$

The given function in corresponds to that of a "*Gaussian mixture"* because $\omega_{s=i}$ represents the proportion or weight that the data of the regime have in the sample and in the general probability function. However, the Gaussian Mixture model presupposes that the belonging to one of the sub-functions$P(x_t, \theta_{s=i})$ is fixed throughout t and, for that matter static for all data in the time series. For this reason no interference can be made such as: the probability that the observer in t finds itself in a period characterized by the regime $s = i$ and its corresponding probability sub-function $P(x_t, \theta)$, as well as the probability $\pi_{s=j,s=i} = P(s = i | s = j, x, \theta)$ to transition from that *ith* state to another. To this regard, Hamilton´s (1989, 1990, 1994) proposal suggests that the change from one regime to another is modeled

[1] Better known in literature specialized in time series analysis as the Hamilton (1989, 1990) filter.

by means of a hidden Markovian chain of s states. A chain that is not visible in the analysis but can be inferred from the data.

Therefore, it may be re-expressed, not as fixed over the course of time but as a changing probability function for each state $P(x_t, \theta)$ over time. Based on the above, the "smoothed" probabilities" $P(x_t, \theta) = \xi_{s=i,t}$ are generated as additional output parameters that indicate the probability of each observation coming from some of the analyzed regimes as well as the localization and scale parameters (corresponding to each regime) and a matrix of probabilities of transition from one regime to another, given the nature of the Markovian chain of the stochastic process that models the regime changes.

$$\mathbf{P} = \begin{matrix} \pi_{s=1,s=1} & \pi_{s=2,s=1} & \cdots & \pi_{s=S,s=S} \\ \pi_{s=1,s=2} & \pi_{s=2,s=2} & \cdots & \pi_{s=S,s=S} \\ \vdots & \vdots & \ddots & \vdots \\ \pi_{s=1,s=S} & \pi_{s=2,s=S} & \cdots & \pi_{s=S,s=S} \end{matrix} \quad (3)$$

Therefore, they can be filtered and smoothed over time, generating a broader vector of output parameters with the smoothed probabilities $\xi_{s=i,t}$ that each data belongs to a determined regime in t and the corresponding matrix of transition probabilities P:

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$$\theta = \left[\mu_{s=i}, \sigma_{s=i}, \xi_{s=i,t}, \mathbf{P}\right] \quad (4)$$

With the abovementioned vector of parameters, the likelihood function of the Hamilton filter can be expressed as followed:

$$P(x_t, \theta) = \sum_{s=1}^{S} \omega_{s=i} \cdot P(x_t, \theta_{s=i}) = \sum_{s=1}^{S} \omega_{s=i} \cdot \left[\frac{1}{\sqrt{2\pi}\sigma} e^{-\frac{1}{2}\left(\frac{x_t - \mu_{s=i}}{\sigma_{s=i}}\right)^2}\right] = \sum_{s=1}^{S} \omega_{s=i} \cdot \xi_{s=i,t} \quad (5)$$

The parameters $\mu_{s=i}$ and $\sigma_{s=i}$ in y are data of interest in financial matters. Specifically, for the valuation of financial assets, market transactions or risk quantification to mention some of the most common applications.

Based on this brief introduction into the logics of the Markovian models of regime changes as well as its practical application to financial matter, the objective of present study is defined: to use the given Hamilton filter "en" to determine, in first instance, whether it is appropriate to model the time series of the stock indexes of financial markets belonging to countries considered as being emerging economies by the company Standard & Poors indexes. After the abovementioned objective, it is established to characterize the statistic

behavior and the average-variance efficiency [2] of each step in order to arrive to the corresponding conclusions and benefit of said filter in the professional financial practice.

In the following paragraph a brief revision is carried out of the studies that apply in financial matter in order to continue with the corresponding analysis of data and results, as well as the conclusions and guidelines for future research studies.

REVIEW OF REFERENCE WORKS

Among the works that implement the Hamilton filter (1989, 1990) to characterize the behavior of economic and financial time series, reference is made to the abovementioned case of Hamilton (1989, 1990, 1994) himself , who uses his proposal to model the probability that the United States economy is in a period of economic recession. ($\xi_{s=i,t} > 0.5$)[3]. Hamilton (1989, 1990, 1994) characterizes the gross national product with his model. His results show that the identification of $\xi_{s=i,t} > 0.5$ is consistent with the periods marked as recession on behalf of the *National Bureau of Economic Research* (NBER) on a high level of statistical significance.

In a similar study of Latin-America, Mejía-Reyes (2000) studies the GNP *per capita* of economies in Latin-American countries such as Argentina, Bolivia, Brazil, Chile, Colombia, Mexico, Peru and Venezuela. In the results, evidence is found in favor of the use of two model regimes, as well as elements to corroborate that established in previous studies (Bollerslev *et al*., 1988; Engle, Ng & Rotschild, 1990; Ang & Chen, 2002; Hass & Mitnik, 2009; Engle, Ghysels & Sohn, 2013). Studies that demonstrated that the behavior of profits in high volatility periods or regimes are asymmetric. This means, in a period of recession or "crisis"[4] the negative profits[5] tend to be proportionately higher than the positive profits in the period of crisis, as well as larger in magnitude than the negative profits in periods considered as "normal". In a complementary way, Mejia-Reyes (2000) finds evidence against the existence of a Latin-American macroeconomic cycle and certain consistency between the behavior of the crisis periods for the pairs United States-Chile and Brazil-Peru.

[2] Efficiency in the risk-profit ratio as established in financial theory and the classic portfolio theory.

[3] In present study and aligned with many of the abovementioned works, regime 1 shall be understood as the expansion period or "normal" behavior in the economy and financial markets and the second regime as the state of "recession" or crisis in the financial markets for presentation purposes.

[4] An important methodological note for this study regarding the term "crisis". This is a very broad concept in terms of economic theory. This goes from the Karl Marx´s crisis theory to John Mill´s or the definition of crisis in financial terms. However, to create an acceptable level of consistency in terms and without arguing the definition itself, in this study "crisis" shall be understood as the periods of high volatility (standard deviation) in the variation of prices and their generalized fall.

[5] Or percentage variations %Pt.

Another work closely related to the topic of present study is Canarella and Pollard (2007) who studied the performance of Latin-American stock exchange indexes such as those of Argentina, Chile, Mexico, Peru and Venezuela with the relevant models from present study. From their results it can be observed that the Hamilton filter (1989) applied in monthly periodicities is appropriate to determine the periods of financial crisis, these being consistent with financial or political crises in the analyzed countries.

Additionally, it is important to note that the periods of high volatility or $s = 2$ are relatively short (from 2 to 4 months). Besides, Mejía- Reyes (2000) carries out a study similar to Hamilton´s (1994), modeling the GNP per capita of Argentina, Bolivia, Brazil, Chile, Colombia, Mexico, Peru, the United States and Venezuela with a two-regime Hamilton filter. Its results lead to the conclusion that there is no Latin-American expansion and contraction cycle and that only some country pairs show a certain level of consistency: Brazil-Peru and United States-Chile (Mejía-Reyes, 2000).

In line with the perspective of analysis in Mejía-Reyes (2000), Cabrera and others (2017) apply the Hamilton (1989) filter to the stock exchange indexes of Latin-American countries such as Argentina, Bolivia, Brazil, Colombia, Mexico, the United States and Peru. Their conclusions lead to the fact that a 3 regime model is appropriate to model these markets and that there isn´t a very clear Latin-American cycle of expansion and contraction in these markets either. Only one level of consistency stands out between the United States, Mexico and Chile.

Valera and Lee (2016) carry out unit-root tests to the indexes of Asian countries such as: China, the Philippines, Hong Kong, Indonesia, Malaysia and Singapore. Their conclusions are that the null hypothesis of co-integration, using the Dickey-Fuller (1979) test, is maintained for monthly time series from January 1995 to June 2015.

Previously to present study, Wu (2015) conducted a similar one to model the currency exchange of the dollar against the currencies of China, South Korea, Hong Kong, Japan, Singapore and Taiwan.

Wu (2015) uses the Hamilton filter and its version with varying matrices of transition probabilities over time for the abovementioned currencies. As regressors, the implemented model uses the level of money supply, the industrial production and the short-term and long-term interest rate. The results obtained suggest that there are two regimes of volatility in the studied pairs and a strong relationship between the levels of volatility of the pairs and the variables such as the industrial production.

In the case of emerging African countries, reference is made to the work of Balcilar and others (2017) who studied the influence of the oil price on the real growth rate of South Africa´s economy. When applying the Hamilton filter to a two-regime Autoregressive Vector model (VAR), it is found that the price of the abovementioned goods has a strong influence on the growth rate of the South African economy during the expansion phase or regime. As for the case of the Middle East, Balcilar, Demirer and Hammoudeh (2013) analyze the case of the financial markets of the Arabian Gulf. Saudi Arabia, Qatar, Dubai and Kuwait with a daily time interval from September 7, 2006 to September, 28 of 2011.

Their evidence proves that these markets are characterized by three volatility regimes (low, high and extreme-or bankruptcy) and they highlighted the fact that there is a herd behavior or collective nervousness between Saudi Arabia, Dubai and Kuwait in the bankruptcy period or extreme volatility and in the high volatility period for Qatar. They also state that, as opposed to the markets of developed countries, these four cases transition from the low volatility period, going over to the extreme or bankruptcy period and ending up in the high volatility period (Balcilar, Demirer & Hammoudeh, 2013).

For that matter, using the Hamilton (1989) filter to model the behavior of stock exchange time series is not a new subject but it is of interest for investment purposes. Despite this interest, there are no references or precedents of studies where the market behavior of emerging economies is characterized as a whole and in blocks: Latin-America, Asia, Eastern Europe, Middle East, Africa and BRIC (Brazil, Russia, India and China). This in order to compare the description of each case in particular against the block of emerging countries and the behavior of the North American block (the United States and Canada) as well as against the performance of a global stock index that includes the characterization of the performance of developed and emerging countries.

Faced with this necessity, the objective of present study emerges: to describe the performance of the indexes included in Table 1 with a two-regime volatility model. As can be observed in the abovementioned chart, the performance of the markets in countries considered as developed and emerging is modeled by means of the market capitalization indexes BMI calculated by the company Standard & Poors-Dow Jones LLC Indexes. The latter is one of the most renowned qualifying and financial analysis companies in the world. Furthermore, it is one of the most accepted ones for the calculation of performance indexes in the investment administration industry (portfolios), to calculate and publish performance indexes of different types of financial assets, markets, investment styles and institutional portfolio strategies. To mention some examples, the renowned S&P500 index of the United States, the IPC of Mexican Stock Exchange, the S&P BMI global equity index and others are some of the most commonly used indexes to measure the performance of the respective markets they analyze.

Table 1
List of indexes, ticker symbol (identification code)

INDEX	*COUNTRY*	*TICKER*	*INITIAL*	*FINAL*
S&P GLOBAL 100	Global	GLOBAL	26/12/2000	30/03/2018
S&P 500	USA	SP500	30/12/1994	30/03/2018
S&P BMI EMERGING MARKETS INDEX	Emerging Countries	EMERGING	30/12/1994	30/03/2018
S&P BMI LATIN AMERICA EMERGING MARKETS INDEX	Latin America	LATAM	30/12/1994	30/03/2018
S&P BMI ASIA/PACIFIC EMERGING MARKETS INDEX	Asia	ASIAPAC	30/12/1994	30/03/2018
S&P BMI EUROPEAN EMERGING MARKETS INDEX	East Europe	EMEURO	30/12/1994	30/03/2018
S&P BMI MIDDLE EAST & AFRICA	Meadle Eastern and Africa	MOAFRICA	30/12/1994	30/03/2018
S&P BMI BRIC INDEX	Brazil, Russia, India y China	BRIC	15/08/2006	30/03/2018

Source: S&P Dow Jones indices LLC (2018).

For more specific purposes, the global and regional S&P Broad Market Index (BMI) capitalization indexes are used, calculation methodology of which is described in S&P Dow Jones LLC indexes (2018).

Table 2
The criteria to rate a financial market as developed, emerging or border

Type	*Classification criteria*
Developed Markets	Those needed to cover by an emerging market plus a per capita GDP greater than or equal to USD $ 15,000.00 in its host country.
Emerging Markets	Those necessary to cover for a frontier market plus the following: • A market capitalization greater than USD 15,000 million. • A settlement period for operations of maximum 3 business days. • A credit rating of your country's sovereign debt greater than or equal to BB + (S&P and Fitch) or Baa (Moody's). • No restrictions to allow control or majority ownership of foreign investors in companies listed in that country. • • There should be no restriction on foreign capital flows both in and out.
Border Markets	• A market capitalization greater than USD 2.5 billion. • • An average trading level (total amount of the value of all operations) of at least USD 1,000 million. • The division of the capitalization value of the stock market by the value of its nominal GDP must give a value greater than or equal to 5%

Source: S&P Dow Jones Indices (2016).

Having said this and before we proceed, there is one more question to be resolved in present study before continuing with the revision of data and results. What is understood by an emerging country? In a strict sense, it is a term that has been developing over time since the World Bank and the International Money Fund have sought to categorize countries in terms of their economic growth, stability and social development as well as being a political and financial term. Even the term "emerging economy" or "emerging country" is the result of an evolution process of the rating of first, second and third world countries that was used during the periods of the cold war.

For benchmarking and practical purposes in the presentation, a financial market rating criteria is applied in the professional practice of investments, parting from the liquidity, accessibility, flexibility and size of the financial markets of a determined country as well as its stability of growth and social development.

The latter differentiates the markets with investment grade (subject of interest in present study) from those that are not fit for said activity by investors foreign to the country analyzed. Within the countries with investment grade, the levels and rating criteria presented in Table 2 apply as established by the country classification methodology of Standard & Poors (S&P Dow Jones LLC indexes (2016).

With this classification in mind that allows us to define "an emerging market economy" or simply "emerging market" and for the exclusive purposes of present study, the data and their processing method can be described in order to move on to the revision of the results obtained.

TIME SERIES ANALYSIS WITH THE HAMILTON FILTER IN THE INDEXES OF INTEREST

Data processing

The analysis or characterization in two regimes or natural states is carried out for the indexes described in Table 1 in the initial and final periods also mentioned in this chart with weekly data extracted from the database of *Reuters*.

For the levels of indexes P_t observed the paid or obtained profit was calculated for the index of each week with the percentage variation method in continuous time:

$$\Delta\%P_t = \ln(P_t) - \ln(P_{t-1}) \tag{6}$$

The Hamilton (1989) filter was applied to the variables of the $\Delta\%P_t$ using the likelihood function given in order to achieve the average parameters for each regime $\mu_{s=i}$, standard deviation $\sigma_{s=i}$, the smoothed probabilities of being in a determined regime $\xi_{s=i,t}$and the matrix P of specified transition probabilities in y.

Within the output parameters that were achieved, the vectors of transition probabilities were used and each vector of transition probabilities was characterized as part of the crisis regime or high volatility ($s = 2$) if the following conditions were complied with:

$$\xi_{s=i,t}, \mu_{s=i} \in s = 2 \Leftrightarrow \sigma_{s=i} = \max\left(\sigma_{s=i}, \sigma_{s=j}\right) \tag{7}$$

Of the two vectors of smoothed probabilities, achieved with the Hamilton filter, one belongs to regime 2, if its corresponding standard deviation is the highest on the vector of standard deviations delivered by the application of this filter. For example, when using the Hamilton filter it applies each one of the Gaussian probability functions of each regime that generate a vector of $T \times S$, to each one of the time series , as suggested by Hamilton (1989, 1994):

$$\left[\left[\xi_{s=1,t}\right] \quad \left[\xi_{s=2,t}\right]\right] = \left[\left[\frac{1}{\sqrt{2\pi}\sigma} e^{-\frac{1}{2}\left(\frac{x_t-\mu_{s=1}}{\sigma_{s=1}}\right)^2}\right] \quad \left[\frac{1}{\sqrt{2\pi}\sigma} e^{-\frac{1}{2}\left(\frac{x_t-\mu_{s=2}}{\sigma_{s=2}}\right)^2}\right]\right] \tag{8}$$

Each column in Table 1 has its corresponding average and standard deviation. In general, if the data do not represent any irregularities in their measuring, or if the time series studied is based on a phenomenon or variable that is not affected by any distortion (social, political, technological) then the regime that has the smallest standard deviation (this means, of a "normal" period or a period of low volatility) corresponds to the column on the left. However, as it occurred in the work of Balcilar, Demirer and Hammoudeh (2013), this may change given the nature of the Arabian markets at being border markets, according to the criteria established in Table 1.

Due to low market liquidity and operability this leads to behavior that is more atypical than that of an emerging or developed market. Based on the latter and the application of the Quasi-maximum likelihood method suggested by Hamilton (1994), it may result that in reality the regime corresponds to the smoothed probability vector of the in right, and not the one on the left as usually expected. For that matter, the given in rule is applied to distinguish which probability vector corresponds to each one of the regimes.

It is important to highlight that this is done to determine the average and the column in the matrix of transition probabilities. For example, if the left column "en" corresponds to the regime $s = 1$, it is understood that the average, the standard deviation and the first column of the matrix P of transition probabilities also corresponds to that regime.

Once the output parameters in each regime are characterized, the same ones (especially the smoothed probabilities of each regime $\xi_{s=1,t}$) are used to determine what executions of the time series correspond to the normal regime or $s = 1$ and which ones to the crisis regime or high volatility regime ($s = 2$). This can be accomplished by applying the following selection rule:

$$x_t \in s = 2 \Leftrightarrow \xi_{s=2,t} > 0.5 \quad (9)$$

The executions that do not comply with said criteria are considered part of the "normal" or low volatility regime.

Once this selection of data is carried out and the parameters of interest are established, first the averages and deviations are used to calculate an approximation of the Sharpe (1963) index. This index measures the level of nominal profit obtained, given the level of exposure to risk. This is applied for each regime or natural state. The same occurs for the following

expression, being $\underline{rf}$ the average weekly yield of the treasury bills rate (*treasury bills*) of the United States with a three-month term and a week of maturity[6]:

$$Sharpe_{s=i} = \frac{\mu_{s=i} - \overline{rf}}{\mu_{s=i}} \tag{10}$$

The goal of this analysis is to characterize and contrast the financial performance on emerging markets, whether in its totality and geographical diversification or regionally segmented or by blocks (BRIC for example).

These observed results contrast with the joint performance of all stock exchange markets, members of the S&P global 100 index (emerging and developed countries) and the performance of the United States stock markets at being the main stock exchange in the world and having the base currency in which the studied indexes are calculated.

A natural question that rises from the previously described data processing is the question whether the time series should be characterized by a Markovian model of regime change such as the Hamilton (1989) filter or should the average and standard deviation simply be applied in a context of a unimodal probability function. Therefore, the information criteria of Akaike (1974), Schwarz (1978) and Hannan-Quinn (1979) are used that part from the likelihood function (LLF) logarithm presented in:

$$LLF = \sum_{t=0}^{T} \ln\big(P(x_t, \theta)\big) \tag{11}$$

Complementary to the previous analysis, violin plots are created to compare and contrast the observed performance in the profits $\Delta\%P_t$ of each index. This type of analysis is an extension of the conventional box plot where the average, median, 5% and 9% quintiles are plotted in a square or vertical box, as well as the maximum and minimum values on a line.

As opposed to the conventional box plot, the violin plot vertically divides a box in two. To the left it presents the box of the $s = 2$ regime and to the right the one of the other regime. In a complementary way it presents the points with the observation of all profits observed and plots a Gaussian kernel on each side. The kernel on the left is the empirical function of probability of the data from the regime $s = 2$ where the given selection rule "en" is complied with. The one on the right corresponds to the remaining data. Given the fact that the two

[6]Given the fact that the abovementioned United States treasury bills are considered "risk-free asset" in the practice of international portfolio management, no distinction shall be made between the average corresponding to the normal periods and those belonging to crisis periods due to the fact that it is considered to be a "risk-free" asset.

plotted kernels overlap at each side, the graphic representation takes a similar shape to that of a violin. This is the origin of its colloquial name. Once the matter of how the data have been processed and analyzed is described, the revision of the results obtained can proceed.

RESULT ANALYSIS

In Table 3 a summary of the average and standard deviation parameters is presented, calculated for the entire time series and each one of the regimes of interest. Additionally, the observed Sharpe index is presented. As can be observed in gray highlighting on this table, the stock exchange of the United States (SP500) are suggested to be the most profitable during their period of study, followed by the stock exchange of Latin-America (LATAM) and the countries in Eastern Europe (EMEURO).

Similarly, the observed results can be appreciated in the two regimes. When applying the Hamilton filter, the results change, the most profitable indexes are those of Eastern Europe and Latin-America in normal or low volatility periods and the United States and the block of countries known as BRIC in the high volatility period or crisis.

Thanks to the effects of the diversification and in accordance with that expected by the assumptions in the Classic Theory of Portfolios, the index with the lowest level of risk (standard deviation) can be seen to correspond to the United States, after the global index. Situation which is expected thanks to the broad diversification both indexes have and because of the fact that the majority of investors have securities in stock of said country, considered to be the safest and the United States dollar being a reserve currency.

One cause that may introduce bias in favor of the United States, in terms of profitability and risk in present study, is the fact that all the studied indexes are valuated in United States dollars. Based on the previous, the effect of the exchange risk and depreciation that some emerging currencies may face against the dollar is not being incorporated at being the same safe-haven currency in times of crisis. With this in mind, a suggestion for future studies would be to review the stock exchange indexes valuated in other currencies again to determine whether the exchange effect generates observable results.

Despite of this result, it is observed that when measuring the expected profit deflated by the risk level based on the Sharpe index, the perspective changes when the Hamilton filter is applied. Specifically, the index of the United States is no longer the most efficient one with regards to its risk-profit ratio but rather the index of emerging countries and that of the BRIC block in normal and crisis periods, respectively.

Table 3
Summary of expected average profit, standard deviation and Sharpe index of the indexes studied.

Ticker	***Average (The entire time series)***	***Average ("normal" S=1)***	***Average ("crisis" S=2)***
GLOBAL	0.0306	0.2122	-0.6272
SP500	*0.1416*	0.3327	**-0.1970**
EMERGING	0.0858	0.4584	-0.7453
LATAM	0.1105	*0.4796*	-1.9198
ASIAPAC	0.0027	0.1732	-1.2806
EMEURO	**0.1910**	**0.4864**	-0.7278
MOAFRICA	0.0780	0.3602	-0.9734
BRIC	0.0935	0.2133	*-0.3250*
Ticker	***Standard deviation (The entire time series)***	***Standard deviation ("normal time") S=1)***	***Standard deviation ("crisis time" S=2)***
GLOBAL	2.4307	*1.6237*	*4.1481*
SP500	**2.3538**	**1.4485**	**3.3911**
EMERGING	2.9269	1.8550	4.3709
LATAM	3.9892	2.8550	7.3685
ASIAPAC	*2.7817*	1.9742	6.0024
EMEURO	4.2550	2.7460	7.0546
MOAFRICA	3.1088	2.2831	4.9986
BRIC	3.8470	2.5778	6.6312
Ticker	***Sharpe (Total)***	***Sharpe ("normal" S=1)***	***Standar sharpe ("crisis" S=2)***
GLOBAL	-0.0094	0.0977	-0.1641
SP500	**0.0374**	*0.1927*	*-0.0739*
EMERGING	0.0110	**0.2183**	-0.1828
LATAM	0.0143	0.1492	-0.2678
ASIAPAC	-0.0183	0.0606	-0.2223
EMEURO	*0.0323*	0.1576	-0.1108
MOAFRICA	0.0079	0.1343	-0.2054
BRIC	0.0104	0.0620	**-0.0571**

The average weekly yield of the treasury bills rate (treasury bills) of the United States with a three-month term and a week of maturity
0.0535

Source: Own elaboration with data from Reuters.

Table 4
Information criteria to determine the goodness of fit of Hamilton in the indexes studied.

Ticker	*Akaike (The entire time series)*	*Akaike (Hamilton Filter)*	*Schwarz (The entire time series)*	*Schwarz (Hamilton Filter)*	*H-Q (The entire time series)*	*H-Q (Hamilton Filter)*
GLOBAL	-4135.5009	-4387.3414	-4130.6985	-4377.7366	-4133.6663	-4383.6723
SP500	-5815.1660	-6137.4079	-5810.0367	-6127.1493	-5813.2376	-6133.5511
EMERGING	-5123.4067	-5412.6235	-5118.3058	-5402.4218	-5121.4862	-5408.7826
LATAM	-4372.2094	-4629.5388	-4367.1085	-4619.3371	-4370.2889	-4625.6980
ASIAPAC	-2503.9400	-2704.8361	-2499.5787	-2696.1135	-2502.2396	-2701.4351
EMEURO	-4215.7163	-4541.8048	-4210.6154	-4531.6031	-4213.7959	-4537.9639
MOAFRICA	-4977.1470	-5180.8463	-4972.0461	-5170.6446	-4975.2265	-5177.0055
BRIC	-2227.7917	-2400.5585	-2223.3849	-2391.7448	-2226.0770	-2397.1290

Source: Own elaboration with data from Reuters.

Table 5
Transition and average duration probabilities of each regime in the indexes studied

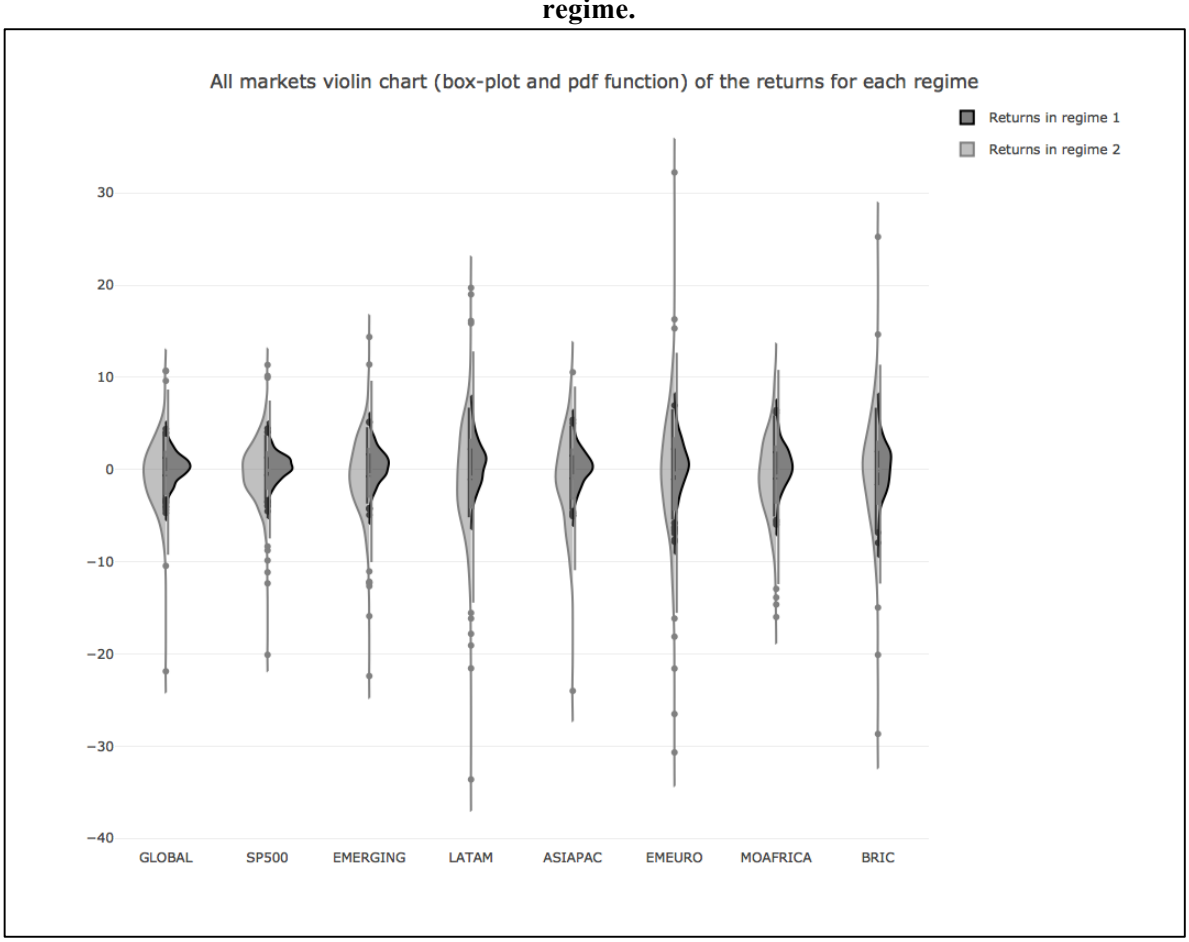
Ticker	$p_{S=1,S=1}$	$p_{S=1,S=2}$	$p_{S=2,S=1}$	$p_{S=2,S=2}$	*Periodo S=1*	*Periodo S=2*
GLOBAL	98.0452	1.9548	7.4974	92.5026	51.1557	13.3379
SP500	98.1863	1.8137	3.4441	96.5559	55.1354	29.0351
EMERGING	96.5974	3.4026	7.6348	92.3652	29.3892	13.0979
LATAM	95.3426	4.6574	26.1548	73.8452	21.4712	3.8234
ASIAPAC	99.1501	0.8499	6.9451	93.0549	117.6643	14.3987
EMEURO	96.8249	3.1751	9.8598	90.1402	31.4953	10.1421
MOAFRICA	97.6101	2.3899	9.1627	90.8373	41.8429	10.9138
BRIC	98.5533	1.4467	5.6187	94.3813	69.1212	17.7976

Source: Own elaboration with data from Reuters.

A question that naturally rises from the previous analysis is whether the Hamilton filter is really appropriate for this analysis. This is, to determine more clearly if we must separate the time series in two regimes. In order to do this, the logarithm of the likelihood function (*LLF*) was used, presented in the information criteria of Akaike, Schwarz and Hannan-Quinn.

In chart 4 the values observed for each index in two scenarios are presented: the entire time series and their quantification with the Hamilton filter. Based on the results presented, there is evidence in favor of the use of the Hamilton filter to model the stochastic process of all the studied time series.

Figure 1
Violin plot with the statistic summary of the performance of each studied index, separated per regime.



Source: Own elaboration with data from Reuters.

Table 5 presents the matrices of transition probabilities of each regime in each index as well as the average amount of days the normal and crisis periods last for each studied case.

The indexes of the United States, the BRIC and Asia-Pacific are those that keep a prolonged duration of their "normal" period. In the crisis regime, the indexes that last the least are the indexes of Latin-America, the emerging countries of the European region, Africa and the Middle East. Once again this leads us to observe that the indexes are valuated in American dollars and that they must also be valuated in other currencies to see their exchange effect and to contrast the results observed so far.

In order to finalize this section, Figure 1 is presented as a violin plot of the data of the profits observed for each index, which are separated or filtered for each regime. In clear gray highlighting the kernel or empirical probability distribution of the regime or crisis period is

represented and in dark marking that of the normal or low volatility period. An interesting characteristic is that the stock exchange of the United States, Africa and the Middle East as well as the global index have the narrowest hood shapes during the crisis periods. Likewise, the global index, the United States and Asia-Pacific present this behavior in the normal periods.

This result adds an additional perspective since in normal periods that provided by the Classic Theory of Portfolios is upheld. The latter in the sense of the benefits of the diversification in order to reduce risk and variability. However, in crisis periods the global index suffers adverse downward fluctuations that are larger than those of the United States. On the other hand, the stock exchange markets of emerging countries do fulfill the expectations. In the case of the latter, the index presents a much compacter hood shape than when the performance of each one of its geographical blocks is quantified.

Based on the obtained results, it can be stated that the benefit of the diversification is maintained during crisis periods as well as normal periods for markets considered as emerging but it is lost in crisis periods when the performance of the indexes from emerging countries is combined with those of developed countries. This means that the benefit of diversification in a globally diversified portfolio organized per type of country is lost in periods of high volatility at valuating the observed performance in dollars.

CONCLUSIONS

In present study the time series of global stock exchange indexes of the United States, emerging economies and different geographical blocks of countries belonging to the emerging countries was characterized. The indexes studied are the so-called *broadmarketindex* or indexes of broad markets, calculated and published by the company Standard & Poors Dow Jones LLC, who quantify the performance of the capitalization value of the stock exchange markets of the member countries of each case.

Therefore, the company calculates a global index (S&P global 100) which is comprised by capitalization indexes of developed countries as well as emerging countries, according to the metrics established by the same company. For that matter the abovementioned index is a theoretical portfolio of reference that incorporates the benefit of the global diversification, the interaction (covariance) and diversification achieved among multiple emerging and developed countries.

It was observed that one of the benefits of investing in a diversified way is one of the principles of the so-called Portfolio Theory, which initiates with the seminal work of

Markowitz (1959; 1956) and in which he establishes that the higher the amount and diversification of financial assets in the portfolio, the more the specific risk and total risk are reduced considerably. This is known in large part thanks to Sharpe´s (1963; 1964) Capital Asset Pricing Model or *CAPM*. Based on the above, multiple studies have been conducted to study the benefits of investing in a diversified way in emerging economies to obtain negative covariance benefits and more attractive expected profits.

Based on that perspective, the present revision is elaborated with the aim of characterizing the performance of the global index 100, S&P 500 of the United States, S&P Emerging markets, S&P BRIC and the regional indexes of the S&P Emerging markets, applicable to the market of Latin-America, Asia-Pacific, Eastern Europe and Russia as well as Africa and the Middle East, in two volatility regimes.

In order to characterize in two regimes the Hamilton (1989, 1990) filter was used with the Gaussian likelihood function, applying the quasi- maximum likelihood function proposed by Hamilton (1994). By implementing the latter, the benefits of the global diversified investment can be observed to be low. This is so when separating by regimes or natural states (one regime for "normal" low volatility or stable periods and another for "crisis" high volatility or periods of instability of prices)

The result obtained is due to the fact that the S&P global 100 has lower levels of expected profit than the S&P of the United States and some indexes of emerging countries such as the Latin-American and Eastern European economies. It also presents lower levels of efficiency in its risk-profit ratio, measured by the index of Sharpe (1966) which leads to the observation that the global diversification is not as attractive as expected, given the principles of the Portfolio Theory.

Therefore, compared to the performance observed between the United States and the emerging economies, the global index that includes other developed economies does not present major benefits than these two. This suggests that it is better to have a portfolio with two components or groups: one for the United States and another for emerging economies, leaving aside the remaining developed economies.

A benefit can be observed when investing in emerging countries with added geographical diversification. This due to the fact that the geographical indexes of emerging economies (especially Eastern Europe and Latin-America) individually show a higher efficiency in their risk-profit ratio than the general index but when analyzing the performance of their empirical probability function or kernel on a violin plot, one may come to the conclusion that the individual indexes have an increased dispersion in normal periods as well as crisis periods than the S&P emerging markets it comprises.

Although it is true that when comparing the performance of emerging countries to the global index there are no significant differences; it is important to highlight that a diversification on a global level (including all developed and emerging markets in the same portfolio) does not lead to significant reductions of the risk dispersion levels. This leads to the observation or conclusion that the indexes of emerging economies may be part of a portfolio exclusively diversifying them with stock of the United States.

As notes for further research, it is necessary to carry out the analysis valuating the indexes in other currencies including the use of local currencies. This is suggested because some developed countries (such as the European countries and Japan) suffered significant depreciation in their currency against the United Sates Dollar during some of the studied periods (especially the crisis periods) and this may have an important repercussion on the measured performance and the conclusions.

Other likelihood functions and the study of more regimes in the stochastic process of the time series of the indexes may also be of interest to broaden the results obtained in the present.

REFERENCES

Akaike, H. (1974). A new look at the statistical model identification. *IEEE Transactions on Automatic Control*, *19*(6), 716–723. https://doi.org/10.1016/J.CUB.2017.09.001

Ang, A., & Chen, J. (2002). Asymmetric correlation of equity portfolios. *Journal of Financial Economics*, *63*(212), 443–494. https://doi.org/10.1016/S0304-405X(02)00068-5

Balcilar, M., Demirer, R. & Hammoudeh, S. (2013). Investor herds and regime-switching: Evidence from Gulf Arab stock markets. *Journal of International Financial Markets, Institutions & Money*, *23*, 295–321. https://doi.org/10.1016/j.intfin.2012.09.007

Balcilar, M., van Eyden, R., Uwilingiye, J., & Gupta, R. (2017). The Impact of Oil Price on South African GDP Growth: A Bayesian Markov Switching-VAR Analysis. *African Development Review*, *29*(2), 319–336. https://doi.org/10.1111/1467-8268.12259

Bollerslev, T., Engle, R. F., Wooldridge, J. M., Engle, F. & Wooldridge, M. (1988). A Capital Asset Pricing Model with time-varying Covariances, *Journal of Political Economy, 96*(1), 116–131.

Cabrera, G., Coronado, S., Rojas, O., & Venegas-Martínez, F. (2017). Synchronization and Changes in Volatilities in the Latin American'S Stock Exchange Markets. *International Journal of Pure and Applied Mathematics*, *114*(1). https://doi.org/10.12732/ijpam.v114i1.10

Canarella, G., & Pollard, S. K. (2007). A switching ARCH (SWARCH) model of stock market volatility: some evidence from Latin America. *International Review of Economics*, *54*(4), 445–462. https://doi.org/10.1007/s12232-007-0025-2

Dickey, D. A., & Fuller, W. A. (1979). Distribution of the Estimators for Autoregressive Time Series With a Unit Root. *Journal of the American Statistical Association*, *74*(366), 427–431.

Engle, R. F., Ghysels, E., & Sohn, B. (2013). Stock Market Volatility and Macroeconomic Fundamentals. *Review of Economics and Statistics*, *95*(July). https://doi.org/10.1162/REST_a_00300

Engle, R. F., Ng, V. K., & Rotschild, M. (1990). Asset pricing with Factor-ARCH covariance estructure. Empirical estimates for Treasury bills. *Journal of Econometrics*, (45), 213–237. https://doi.org/10.1016/0304-4076(90)90099-F

Haas, M., Mittnik, S., & Paolella, M. S. (2009). Asymmetric multivariate normal mixture GARCH. *Computational Statistics & Data Analysis*, *53*(6), 2129–2154. https://doi.org/10.1016/j.csda.2007.12.018

Hamilton, J. D. (1989). A New Approach to the Economic Analysis of Nonstationary Time Series and the Business Cycle. *Econometrica*, *57*(2), 357–384.

Hamilton, J. D. (1990). Analysis of time series subject to changes in regime. *Journal of Econometrics*, *45*(1–2), 39–70. https://doi.org/10.1016/0304-4076(90)90093-9

Hamilton, J. D. (1994). *Time Series Analysis*. Princeton: Princeton university press.

Hannan, E. J., & Quinn, B. G. (1979). The Determination of the Order of an Autoregression. *Journal of the Royal Statistical Society. Series B (Methodological)*, *41*, 190–195. https://doi.org/10.2307/2985032

Markowitz, H. (1959). *Portfolio selection. Efficient diversification of investments.* New Haven: Yale University Press.

Markowitz, H. (1952). Portfolio selection. *The Journal of Finance*, *7*(1), 77–91. https://doi.org/10.1111/j.1540-6261.1952.tb01525.x

Markowitz, H. (1956). The optimization of quadratic functions subject to linear constraints. *Naval Research Logistic Quarterly*, *3*(March-June), 1–113.

Mejía, P. (2000). Asymmetries and Common Cycles in Latin America: Evidence from Markov-Switching Models. *Economía Mexicana. Nueva Época*, *IX*(2), 189–225.

S&P Dow Jones Indices LLC. (2016). *Country clasification methodology*. S&P Dow Jones Indices LLC. Retrieved April 26, 2018, from https://us.spindices.com/documents/index-policies/methodology-country-classification.pdf?force_download=true

S&P Dow Jones Indices LLC. (2018). *S & P Global BMI , S & P / IFCI Methodology*.

Schwarz, G. (1978). Estimating the dimension of a model. *The Annals of Statistics*, *6*(2), 461–464.

Sharpe, W. (1963). A simplified model for portfolio analysis. *Management Science*, *9*(2), 277–293.

Sharpe, W. (1964). Capital asset prices: A theory of market equilibrium under conditions of risk. *The Journal of Finance*, *XIX*(3), 425–442.

Valera, H. G. A., & Lee, J. (2016). Do rice prices follow a random walk? Evidence from Markov switching unit root tests for Asian markets. *Agricultural Economics*, *47*(6), 683–695. https://doi.org/10.1111/agec.12265

Wu, J.-T. (2015). Markov regimes switching with monetary fundamental-based exchange rate model. *Asia Pacific Management Review*, *20*(2), 79–89. https://doi.org/10.1016/j.apmrv.2014.12.009