REVISTA ESPACIOS

A Comparative Performance Review of the Venezuelan, Latin-American and Emerging Markets Stock Indexes with the North-American Ones Using a Gaussian Two-Regime Markov-Switching Model

Comparación de los Índices Accionarios Venezolano, de Economías Emergentes y Latinoamericano con los Mercados Norteamericanos, Utilizando un Modelo Markoviano de dos Regímenes con Verosimilitud Gaussiana

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Abstract

In the present paper we use a two-regime Markov-switching model to characterize the weekly performance of the MSCI Latin America, MSCI Emerging markets, MSCI North America and the Venezuelan IBC stock indexes. Our results show that the Latin American portfolio (ex Venezuela) is the bets investment option in normal and distress periods than the North American and Emerging markets ones. The Venezuelan index shows an atypical high profitability and mean-variance efficiency in distress periods that needs further review.

Key words

Portfolio selection, Markov-Switching models, Emerging markets, Investment performance in Venezuela.

Resumen

En el presente artículo se utiliza un modelo markoviano de cambio de régimen con dos estados para medir el desempeño semanal de los índices MSCI Latinoamérica, MSCI mercados emergentes, MSCI Norteamerica e IBC venezolano. Nuestros resultados demuestran que el portafolio latinoamericano (sin Venezuela) es la mejor opción, en comparación al caso norteamericano y de economías emergentes. En nuestros resultados el índice venezolano presenta rendimientos y una eficiencia media-varianza atípicamente altos en periodos de crisis, resultado que requiere una mayor revisión.

Palabras clave

Selección de portafolios, modelos markovianos de cambio de régimen, mercados emergentes, desempeño de inversiones en Venezuela.

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1. Introduction: the Use of Markov-Switching Models in Stock Markets

Markov-switching models in the rationale of Hamilton's (1990; 1989) filter is a novel proposal that even though it is not recent, its use allows us to discriminate the performance of a given time series in $s=\{1,2,\cdots,S\}$ different regimes or states of nature[4]. That is, given a time series $\mathbf{x}=[x_t]$, with Hamiltons filter we can determine if a realization $x_t \in \mathbf{x}$ at t comes (for the purpose of this paper) from a "normal" or "good-performing" regime ($s=1$) or from a "distress" or "bad-performing"[5] one ($s=2$). That is, to determine either if $\xi_{s=1,t}$ or $\xi_{s=2,t}$ at t. This issue is of interest for investment management purposes, because the portfolio manager could determine if the performance of a given security or portfolio at t and at $t+n$ is proper from one of the aforementioned time periods (normal or distress). If the portfolio manager can determine this, she can sell the portfolio holdings in the studied asset in distress periods and buy it back in normal ones. This as Brooks and Persand (2001) primarily suggest and as Alexander and Dimitru (2005), Ang and Bekaert (2002, 2004), Kritzmman et. al. (2012) and Hauptmann et. al. (2014) study for the practical usefulness of this trading rule for active portfolio management applications.

Hamilton's filter is a time series analysis model that express $\xi_{s=i,t}$, given the probability $\xi_{s=i,t}$ of being in the $s=i$ regime and a transition probabilities matrix $\mathbf{P}$, that is part of a parameter vector $\hat{\theta}=\left[\mu_{s=1},\mu_{s=2},\sigma_{s=1},\sigma_{s=2},\xi_{s=1,t},\xi_{s=2,t},\mathbf{P}\right]$ of the Gaussian multi-modal or multi-state probability density function given in (2) in the next section:

$$\mathbf{P}=\begin{bmatrix} \pi_{1,1} & \pi_{2,1} \\ \pi_{1,2} & \pi_{2,2} \end{bmatrix},\ \pi_{i,j}=P\left(s_t=i\,|\,s_{t-1}=j;\mathbf{x};\hat{\theta}\right) \tag{1}$$

The smoothed probability $\xi_{s=i,t}$ in the parameter vector is the key factor that allows the portfolio manager to determine if the studied time series at t or $t+n$[6] is performing in a determined regime ($s=1,2$). Also, as outputs of interest in the parameter vector $\hat{\theta}$, Markov-switching models infer the levels of mean ($\mu_{s=i}$) and standard deviation ($\sigma_{s=i}$) applied to each regime. These last outputs are useful for risk measurement and management purposes such as the calculation of Value at Risk (VaR)

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[4] We will use the term "regime" that is proper to determine the actual state of nature at. The term "state" is proper of Natural Sciences. These two terms are synonyms but, for the given reasons, we will use the former term.

[5] For the sake of simplicity we will use indistinctly the terms "normal" and "good performing" for the good financial performance time periods. We do this by the fact that we don't want to engage in theoretical discussions proper from Economic Theory and Macroeconomics that the term "normal" and "crisis" periods. We will focus in the financial markets behavior, related to social, political financial and macroeconomic issues. The same note applies to the terms "distress" and "bad-performing".

[6] With $\mathbf{P}$ it is easy to determine $\xi_{s=i,t+n}$ as: $\xi_{s=i,t+n}=\xi'_{s=i,t}\times\mathbf{P}^n$.

or Conditional Value at Risk (CVaR), among several risk measures that incorporate the change of regime or state of nature in the financial asset or market.

Departing from this brief introduction of Hamilton's (1990; 1989) filter or Markov-switching models, we want to briefly mention the literature that use this time series model or similar ones (such as Normal-mixture) in the Latin-American case. As a first study, we found the work of Mejía-Reyes (2000) who use a Gaussian two-regime Markov-Switching model to study the GDP *per cápita* of Latin American countries. His results show that the recession time periods (or regimes) are deeper and more volatile than the expansion ones and also show that there is no common expansion-contraction economic cycle. The only countries that show similar regime switching behavior are Brazil with Peru and the United States and Chile, leading him to conclude that there is no common Latin American economic cycle. Following him, we found the work of Canarella and Pollard (2007) who study the stock index performance of Argentina, Brazil, Chile, México, Peru and Venezuela and find evidence in favor of using two-regime Markov-switching models. They also find that the high-volatility regimes ($S_{s=2}$) are concordant to the financial and/or political crises that each country suffered in different time periods such as 1994 or 1998. Finally, we mention the paper of Cabrera et. al. (2017) who use also two-regime Gaussian Markov-switching models to study the performance of some American stock indexes of countries such as Argentina, Bolivia, Brazil, Colombia, Chile and the United States. By applying the model to daily returns of these countries' indexes and by using the Bayes' factor to determine the proper number of regimes, they found that a 3 regime Markov-Switching model (a low, mid or high volatility regime) is appropriate to model them. They also found (by using Harding and Pagan's index of concordance) that the Chilean, Mexican and U.S. markets show some signs of concordance in their regime behavior but still there is no common Latin-American financial cycle, as Mejía-Reyes (2000) concluded for the GDP *per cápita*.

With this brief literature review and by noting that up to the moment of writing this paper we only found only one paper that studies the Venezuelan case from January, 1994 to April, 2005 in daily periods, we want to point out that there is no mean-variance and investment performance test in a regime-switching scenario for the Latin-American markets (as a hole in a single portfolio or index), in comparison to the general regime-switching mean-variance performance of the Emerging markets (also as a hole portfolio) and the North-American markets (U.S. and Canada). Departing from this, we will test the performance, in a Gaussian two-regime scenario, of the MSCI Latin-American index (ex Venezuela)[7] stock markets, the Venezuelan IBC index, the MSCI emerging markets and the North America stock index (U.S. and Canada).

With this in mind, we structured the paper as follows: In the next section we briefly describe the rationale of the Markov-Switching models and the data that we used in our test. In the third section

[7] The included countries in the index are Brazil, Chile, Colombia, Mexico and Peru. Argentina is considered a frontier market and Venezuela is not included in this index. Please refer to MSCI (2018a, 2018b) for further details.

we describe the main results that we found in our analysis and finally we present our main findings, conclusions, and suggestions for further research in the fourth one.

2. Methodology

2.1. Markov-Switching Model Output Parameters and its Rationale for this Paper

As previously told, Markov-Switching models are a type of filter that allows us to split a time series $\mathbf{x}$ in several ($s = 1,2,\cdots,S$) number of subsets that correspond to different states of nature or regimes. With this filter, several phenomena, such as the economic or financial ones, can be modeled in several regimes such as the aforementioned ones of “normal” or “distress” times (for the purpose of the present paper). In his original practical example, Hamilton (1989; 1994), modeled the behavior of the historical time series of the U.S. GDP and filtered (characterized) the data in two regimes of “expansion” and “contraction”. His result showed a good fit of his two-regime model to forecast contraction periods, compared to the historical recession time periods of the National Bureau of Economic Research (NBER). Since then, several practical applications such as the aforementioned ones in the previous section have ben made.

Markov-switching models are an extension of Normal-Mixture models with which we can determine a mean $m_{s=i}$ and a standard deviation $s_{s=i}$ for each regime s, given a multimodal mixed stochastic process as the next one:

$$
\begin{aligned}
f(\mathbf{r};\theta) &= \left[\pi_{s=1} \frac{1}{\sqrt{2\pi\sigma_{s=1}}} e^{-\frac{1}{2}\left(\frac{r_t-\mu_{s=1}}{\sigma_{s=1}}\right)^2} + \pi_{s=2} \frac{1}{\sqrt{2\pi\sigma_{s=2}}} e^{-\frac{1}{2}\left(\frac{r_t-\mu_{s=2}}{\sigma_{s=2}}\right)^2} \right] \\
&= \left[\pi_{s=1} \cdot P\left(s=1 \mid \mathbf{x},\hat{\theta}\right)_t + \pi_{s=2} \cdot P\left(s=2 \mid \mathbf{x},\hat{\theta}\right)_t \right] \\
&= \left[\pi_{s=1} \cdot \xi_{s=1,t} + \pi_{s=2} \cdot \xi_{s=2,t} \right]
\end{aligned}
\qquad (2)
$$

Where $\hat{\theta}$ is, as told in the previous section, the estimated parameter vector in which $m_{s=i}$ and $s_{s=i}$ are the filtered location and scale parameters (mean and standard deviation) corresponding to each regime. Also in $\hat{\theta}$, $p_{s=i}$ are the mixing proportions (similar to the ones of a Normal-mixture model) of the multi-modal probability density function and $\mathbf{P}$ is a transition probability matrix, as defined in (1), that determines the likelihood of changing from one regime to another. The interesting feature of (2) is that we can split the time series in several regimes, and infer $\hat{\theta}$ through a Bayesian algorithm such as the Quassi-Maximum likelihood suggested by Hamilton (James Douglas Hamilton, 1994).

Given these outputs, we will use in this paper a Gaussian two-regime Markov-switching model to characterize the performance by quantify $x_{s=i,t}$ and the corresponding location $m_{s=i}$ and scale $s_{s=i}$ parameters of the weekly continuous returns of the MSCI emerging markets (MSIEMF), the MSCI Latin America (MSCILATAM), the MSCI North America (MSCINAMERICA) and Venezuelan Caracas (IBC) stock indexes (measured in local currency). With this location and scale parameters we will compare the performance of these market groups (or indexes) and we will determine if the two-regime Markov switching model is appropriate to model the stochastic process of their time series against a single regime time series case. This last issue will be determined through the fitness of the model to the data, given the Akaike (1974) or AIC , Schwarz (1978) or BIC and Hannan-Quinn (1979) or H-Q information criterions that depart from the log likelihood function of the single (3) and two-regime (4) cases respectively:

$$f(\mathbf{r};\boldsymbol{\theta}) = -\sum_{t=1}^{T}\left[\ln\left(\pi_{s=1}\frac{1}{\sqrt{2\pi\sigma}}e^{-\frac{1}{2}\left(\frac{r_t-\mu}{\sigma}\right)^2}\right)\right] \quad (3)$$

$$f(\mathbf{r};\boldsymbol{\theta}) = -\sum_{t=1}^{T}\left[\ln\left(\pi_{s=1}\cdot\xi_{s=1,t}+\pi_{s=2}\cdot\xi_{s=2,t}\right)\right] \quad (4)$$

2.2. Data Sources and Processing

With the Gaussian Hamilton's (1989) filter or Markov-switching model given in (2), we will analyze the weekly time series of the four stock indexes (measured in local currency) summarized in table 1.

Table 1. The stock indexes studied, their geographical and time covering and the ticker used in this paper for each case

Name	***Countries included***	***Ticker***	***Start date in time series***	***End date in time series***
MSCI emerging markets net value index	Emerging markets worldwide	MSCIEMF	02/01/2002	22/03/2018
MSCI Americas net value index	U.S. & Canada	MSCINAMERICA	29/03/2000	22/03/2018
MSCI world Latin America equity index	Latin America ex. Venezuela	MSCILATAM	31/12/2001	22/03/2018
Caracas stock exchange Index	Venezuela	IBC	31/12/2093	22/03/2018

With their weekly historical levels, we calculated the continuous time returns and performed the quassi-Maximum likelihood algorithm suggested in Hamilton (1994) by using the R package of Perlin (2017). With the AIC, BIC and H-Q values of (3) or (4) we determined if the two-regime MS model is better than the location and scale parameters of a single regime time series and, with this result, we contrasted the location and scale parameters of each index to determine also their mean-variance performance.

As a visual inspection analysis, we made a historical return chart, compared with the observed probability of being in regime $s=2$ ($\xi_{s=2,t}$) and a 90% confidence estimation interval, given the expected mean ($\mu_{E,t}$) and expected standard deviation ($\sigma_{E,t}$) determined with the next three expressions:

$$\mu_{E,t} = \mu_{s=1}\cdot\xi_{s=1,t}+\mu_{s=2}\cdot\xi_{s=2,t} \quad (5)$$

$$\sigma_{E,t} = \sigma_{s=1}\cdot\xi_{s=1,t}+\sigma_{s=2}\cdot\xi_{s=2,t} \quad (6)$$

$$quantile_{5\%/95\%} = \mu_{E,t}+\left(Z_{5\%,/95\%}\cdot\sigma_{E,t}\right) \quad (7)$$

With this visual data processing we supported our quantitative results on the use of Gaussian two-regimes Markov-switching stochastic process to model the behavior of the Emerging, Latin American, North American and Venezuelan stock markets.

3. Results

In Table 2 we present the statistical resume of the four indexes of interest. Here we show the mean and standard deviation of the full time series and also the estimated ones for each regime. An interesting feature arrives when we calculated the Sharpe (1963) ratio by assuming a risk-free rate rf of zero[8]. That is, we compare how much nominal expected return (m or $m_{s=i}$) does each index or regional portfolio pays, given the exposure to risk (s or $s_{s=i}$):

$$\text{Sharpe ratio} = \frac{m}{s} \text{ or } \frac{m_{s=i}}{s_{s=i}} \qquad (8)$$

In Table 2 it is suggested that the Venezuelan index is the most profitable index but when its return is adjusted to risk with the Sharpe ratio, the picture changes in the full time series analysis and also in the two Gaussian regimes. An interesting feature, as we signaled in the bold Sharpe ratio values, is that either in the full time series analysis or in both regimes of volatility, the Latin-American markets (ex Venezuela) are the most mean-variance efficient investment option. That is, the Latin-American stock markets are a better investment even than the North American ones and even than the Emerging markets index that is diversified with other geographical areas such as Asia or Eurasia.

Table 2. Statistical summary of each index in a full time series analysis and in a Gaussian Two-regime context

Index	*MSCIEMF*	*MSCINAMERICA*	*MSCILATAM*	*IBC*
Full time series mean	0.1989	0.161	0.2489	1.2359
Full time series Standard dev.	2.4139	2.9411	2.8319	6.1784
Sharpe ratio	**0.0824**	0.0547	**0.0879**	0.2000
Mean in regime 1	0.4352	0.3198	0.4004	0.1863
Mean in regime 2	-0.6389	-0.7072	-0.3733	3.318
Standard dev. In regime 1	1.6358	2.1636	2.0951	2.1716
Standard dev. In regime 2	4.018	5.4491	4.7802	9.9287
Sharpe ratio in regime 1	**0.266047194**	0.147809207	**0.191112596**	0.08578928
Sharpe ratio in regime 2	-0.159009457	-0.1297829	**-0.078092967**	**0.334182723**

Source: Own elaboration with our Statistical analysis and with data from Reuters Datalink.

A notable exception is the Venezuelan case in the second regime but, as we will see next, the second regime of this index is determined not by several extreme downward returns (as is the case of the other indexes), but for several extreme "atypical" upward ones that are related to the actual economic and finance situation in the country.

[8] We did this because the indexes are in measured local currency and there is no well-accepted multi-currency risk-free asset.

In table 3 we present the goodness of fit of each index. As noted in all the information criterions, the two-regime representation is proper to model de stochastic process or performance of each index and finally, in table 4, we show the transition probabilities of each regime, along with the average time duration of each. As noted for the Venezuelan index, the probabilities of changing from one regime to another ($p_{1,2}$, $p_{2,1}$) are very high, suggesting a very unstable time series that is constantly changing from one regime to another.

For the Latin American case, it is of interest to note that the average time period in the normal times is longer than the Emerging markets and almost as equal as the North American ones. This result suggests that the Latin-American markets, as a hole, are as stable as the North American ones, with the benefit that the former are more mean-variance efficient (and profitable) than the Emerging and the North American portfolios.

Table 3. Goodness of fit of the two-regime Markov-Switching model against the full time series analysis with one regime

Index	*AIC (not filtered)*	*AIC (2 regimes filter)*	*BIC (not filtered)*	*BIC (2 regimes filter)*	*H-Q (not filtered)*	*H-Q (2 regimes filter)*
MSCIEMF	-3899.0198	-4097.2209	-3894.2793	-4087.7398	-3897.2035	-4093.5883
MSCINAMERICA	-3952.5478	-4170.2953	-3947.704	-4160.6078	-3950.7011	-4166.602
MSCILATAM	-3628.8407	-3789.1721	-3624.1002	-3779.691	-3627.0245	-3785.5395
IBC	-3431.0472	-4294.9483	-3425.9107	-4284.6753	-3429.1168	-4291.0874

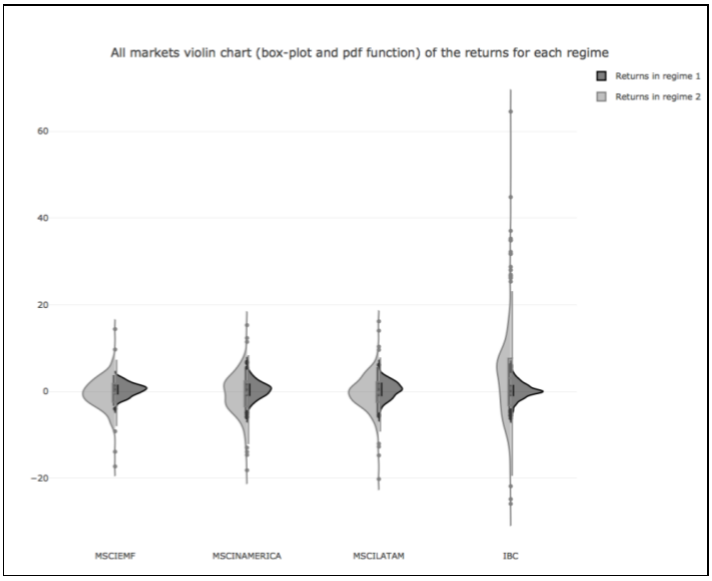
Source: Own elaboration with our Statistical analysis and with data from Reuters Datalink.

Table 4. Transition probabilities and average duration (in time periods) of each regime

Index	*$\pi(S_t=1, S_{t-1}=1)$ in %*	*$\pi(S_t=2, S_{t-1}=1)$ in %*	*$\pi(S_t=1, S_{t-1}=2)$ in %*	*$\pi(S_t=2, S_{t-1}=2)$ in %*	*Periods in S=1*	*Periods in S=2*
MSCIEMF	96.8442	3.1558	12.3107	87.6893	31.6876	8.1229
MSCINAMERICA	98.5226	1.4774	7.6716	92.3284	67.6881	13.0350
MSCILATAM	98.2992	1.7008	7.2536	92.7464	58.7973	13.7863
IBC	9.7073	**90.2927**	**80.502**	19.498	10.3014	5.1287

Source: Own elaborations with data from Reuters Datalink.

Figure 1. Violin chart of the returns of each index, given the two-regime filtering

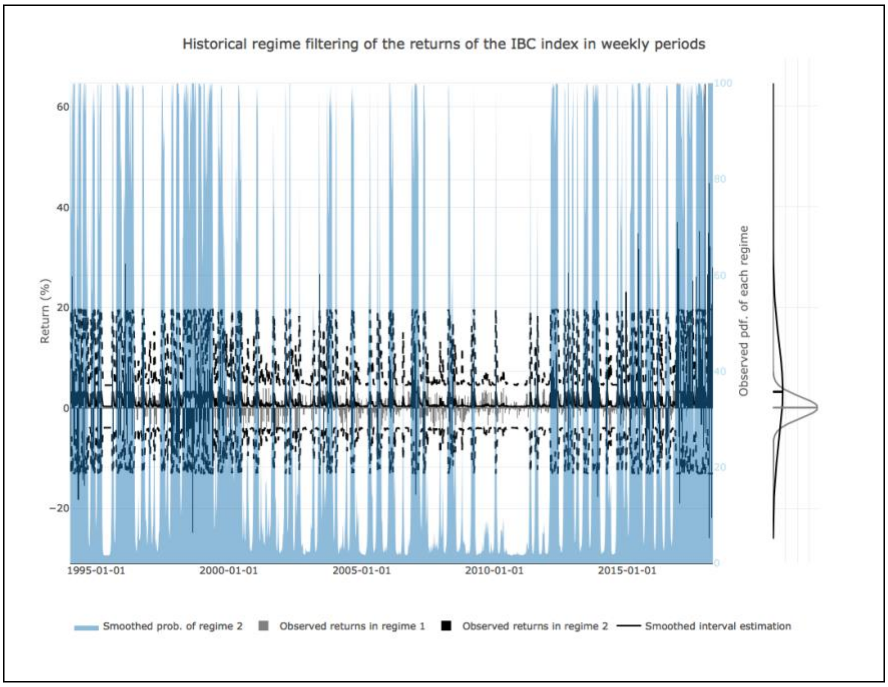


Source: Own elaboration with data from Reuters Datalink.

In order to confirm our results visually, we present a violin chart that is a variation of a box-plot one. This type of chart is composed of two box-plots. At the left side we show the box-plot of the returns when $\xi_{s=2,t} > 0.5$ and the right side presents the box plot of returns when $\xi_{s=2,t} \le 0.5$ or $\xi_{s=1,t} > 0.5$[9]. We complement this double boxplot with a Gaussian Kernel for each regime in their corresponding side for each regime.

With the violin chart we can distinguish in a better fashion the reason of why the Venezuelan IBC index looks more efficient in distress or bad-performing time periods: it is (as mentioned earlier) dominated by several extreme positive returns that skew the mean to the positive ground. Among several possible explanations is the fact that the country has been immersed in a deep inflationary process that pushed up the real returns in equities, leading to some "extraordinary" positive nominal returns in local currency.[10] Despite this result, subject to further research, we observed that the two-regime model is appropriate to characterize the time series of this and all the indexes studied in this paper. As a final visual analysis, we present in figures 2 to 4 the historical weekly returns paid by the indexes of Venezuela, Latin America and the emerging markets. As noted, the behavior of their returns and the potential risk measurement with the interval is appropriate if it is made with (7) by the fact that the two-regime model captures the change in regimes or markets conditions more properly and presents better expected mean and risk (standard deviation) levels.

Figure 2. Two-regime time series filtering of the Venezuelan IBC stock index (in local currency)



Source: Own elaboration with data from Reuters Datalink.

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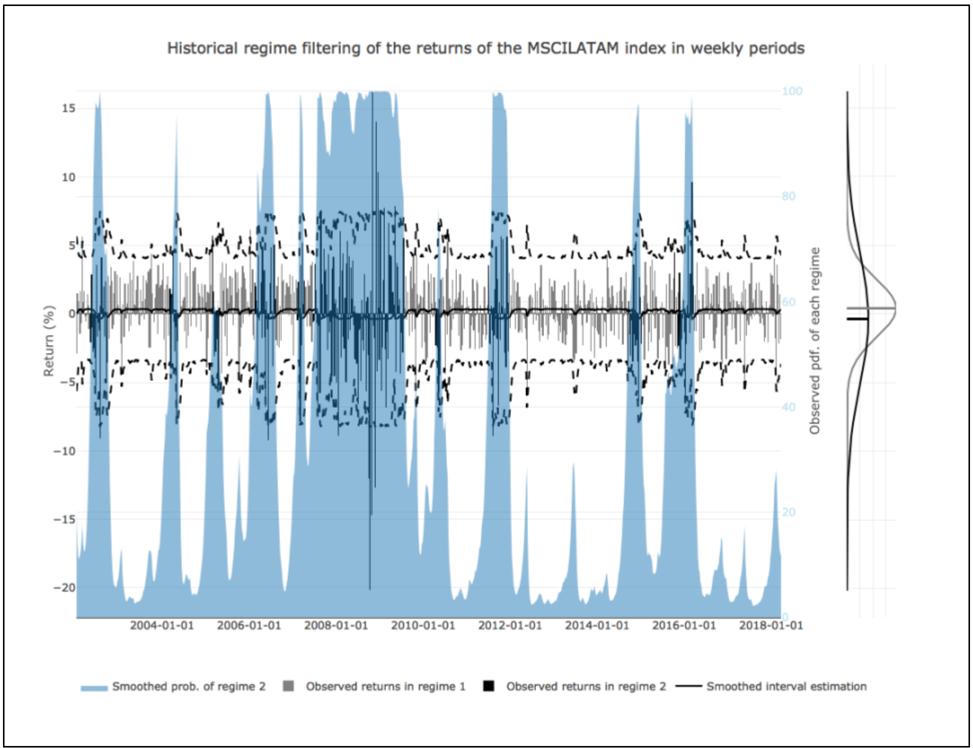
[9] A feature of the Markov-Switching models is that $\sum \xi_{s=i,t} = 1$.

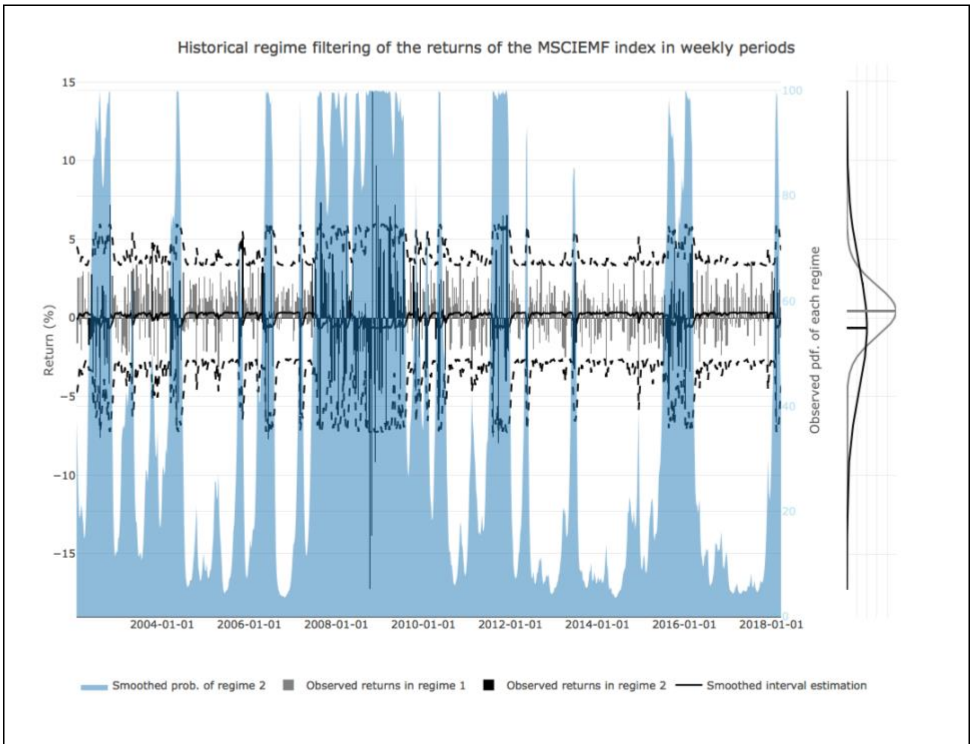
[10] This last issue is a subject recommended for further research.

Figure 3. Two-regime time series filtering of the MSCI Latin-America stock index (in local currency)



Source: Own elaboration with data from Reuters Datalink.

Figure 4. Two-regime time series filtering of the MSCI Latin-America stock index (in local currency).



Source: Own elaboration with data from Reuters Datalink.

4. Conclusions

In the present paper we characterized the performance of the main (local currency measured) Venezuelan stock market index along with the index of the main Latin American and emerging economies stock markets in contrast with the North American (U.S. and Canada). By using a Gaussian two-regime Markov-Switching model to filter the weekly historical data, we found that the Venezuelan, Latin-American, North-American and Emerging markets stock indexes have a better modeling with a two-regime stochastic process where the low volatility (high standard deviation) regime is considered the “normal” or “good-performing” time period in the analyzed financial market, and the high volatility one is proper of a “distress” of “bad-performing” state of nature.

An interesting feature that we found is the fact is that the behavior of the Venezuelan stock market in the bad-performing time periods is dominated by several positive extreme returns, a situation that we relate with the effect that the high inflation levels have in the real returns of this market. An issue that we suggest to review more deeply in future research, along with a performance review in a USD or other foreign non-Venezuelan currency basis.

Among the main findings of our paper is the risk-return profile (measured with the Sharpe ratio without risk-free asset) of the Latin-American stock index that has a better risk and return profile than the hole emerging markets case. We found valid this conclusion for normal and distress time periods (the model detected properly the influence of the financial crisis of 2007-2008 and the European debt crisis of 2011-2013).

Finally, we found that the risk-return profile of the Latin-American markets (modeled with the MSCI Latin America that excludes Venezuela) is almost similar to the North-American ones (U.S. and Canada).

Among the suggestions for future research we suggest to compare the performance of this indexes in a USD or EUR based investor perspective, along with another likelihood function for the Markov-Switching model, such as the Student-t case.

We hope this test is useful to determine the appropriateness of investing in Latin-American markets (as a hole in a single diversified portfolio), in comparison to the performance achieved in a portfolio diversified either in the main emerging economies or the North American ones. Also, we hope to give more insights about the actual Venezuelan stock markets and their economies, in order to find a sustainable long-term growth and prosperity for Venezuela and Latin America.

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