

Evaluating stock exchange volatility in Brazil after its upgrade to investment grade

Abstract: International evidence show that emerging countries upgraded to investment grade (IG) presented stock exchange volatility mitigation. This article evaluates volatility path of Ibovespa after Brazil's upgrade to IG to confront with international evidence. It's utilized TGARCH and EGARCH models to estimate conditional volatility of Ibovespa and MSCI Emerging Markets, this selected as benchmark. Results obtained are compatible with international evidence: it was observed considerable decrease of absolute and relative volatility of Ibovespa in the period of six years after investment grade was granted to Brazil. On the other hand, from 2012 on it was observed a reversal path of Ibovespa's volatility mitigation process while macroeconomic fundamentals started to deteriorate in Brazil driving to IG loss by two agencies in 2015.

Keywords: Investment Grade; Ibovespa; Volatility.

JEL: G1

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1. Introduction

On April 2008 Standard & Poor's upgraded Brazil's sovereign debt evaluated in foreign currency to investment grade. Right after, on May of the same year, Fitch Ratings followed the same direction and also granted the stamp of secure country for investment to Brazil. It is intuitive to think that such event has as one of the consequences volatility mitigation on stock exchange. It is common that long run investors like pension funds have as statutory rule the restriction of investing only in investment grade countries. Those institutions are long run investors with stable investments and its presence on a specific market tend to mitigate volatility of financial assets.

International empirical evidences show that emerging economies upgrade to investment grade (IG) had as consequence stock exchange volatility mitigation, as shown by Moraes & Portugal (2009) and Cavalcante (2009). According to Castro and Brandão (2008), investment grade status improves investment environment attracting long run investors and reduces risk premium demanded by the market. As mentioned by Canuto & Santos (2003), sovereign risk influences assets issued in a country, including private assets. Castro & Brandão (2008) reinforce this view by highlighting that investment grade granted to a country influences positively risk perception of companies in general. According to Polwitoon & Tawatnuntachai (2008), investments in emerging markets can rise portfolio return without relevant risk increase. This finding can apply better to emerging countries with investment grade offering better risk-return relation, with greater attractiveness for global portfolio allocations.

The objective of this paper is to assess stock exchange volatility evolution in Brazil after its upgrade to investment grade, confronting with international empirical evidence. It's utilized GARCH family models to estimate conditional volatility of São Paulo stock exchange index (Ibovespa) and MSCI Emerging Markets index (MSCI EM) returns, the last one used as benchmark. Results obtained in this paper confirmed international empirical evidence. It is observed considerable volatility mitigation of Ibovespa on absolute term and relative to the benchmark after Brazil's upgrade to IG. On the other hand, it is also observed that from the second semester of 2012 on it started a reversal path of the volatility mitigation process. During that period macroeconomic fundamentals in Brazil deteriorate culminating with one level downgrade of sovereign rating by Standard & Poor's on March 2014 and by Moody's on August 2015, followed by IG rating loss by the first agency on September 2015 and by Fitch in December of the same year.

The subject proposed assesses implications of sovereign rating to Brazil's stock exchange, bringing to the light the importance of IG rating in determining domestic variable income assets behavior. Capital market is a relevant source of long run capital to finance companies, its development is linked with how investors perceive sovereign risk. This research brings a relevant contribution for the literature by offering robust empirical evidences for Brazil, confronting and enriching international empirical evidences about the subject.

This paper is divided as follows: section 2 describes methodology and data, bringing also a brief initial discussion about sovereign risk, rating assessment and important stylized facts; section 3 show model estimation and selection, also presenting results with assessment of Ibovespa's volatility evolution after Brazil's upgrade to investment grade.

2. Metodology

2.1. Sovereign risk, rating assessment and stylized facts

Before assess Ibovespa's volatility evolution after Brazil's upgrade to investment

grade, it's appropriate to make a brief discussion about the concept of sovereign risk, about some basic inputs utilized by rating agencies to evaluate sovereign credit risk, and about relevant stylized facts for financial series.

The sovereign risk classification refers to the potential and willingness of a government to honor its debts according to terms and conditions agreed. According to Canuto & Santos (2003) the result of sovereign risk assessment is synthesized in classifications that reflect the estimated probability of a government to default, what means that not only profit and principal payment is suspended but also debt involuntary restructuring.

Rating agencies evaluate credit risk for an issuer and for a specific debt issue. As mentioned by Canuto & Santos (2003), it can happen that a specific debt issue has a superior rating – less risk – than the issuer itself in the case high quality collateral is offered. Agencies also differentiate debt issues according to maturity – short and long run – and according to the currency – domestic and foreign. Short run debt issues would be that ones with less than one year of maturity.

An important concept differentiation to consider is between country risk and sovereign risk. The first is a broader definition compared to the second. Sovereign risk refers to government default, and country risk refers to all financial assets of a country what demand a compensatory yield premium. Nonetheless, both risks are related as a sovereign default might have a negative impact on capital flow to the country affecting also external private debt. (Canuto & Santos, p. 16, 2003)

EMBI+ is an example of indicator that captures risk premium of emerging countries bonds. The index is composed by a basket of government bonds of several emerging economies. EMBI+ can be decomposed for each country as sovereign spreads. Each sovereign spread corresponds to the spread of the emerging country bond yield over US treasury yield. This sovereign spread is usually known as country risk but it is not the most appropriate terminology as it considers only government debt issues, sovereign risk is a better terminology for that. In other words, the yield spread of a emerging bond over US treasury reflects sovereign spread that represents part of the country risk that is a broader concept.

As highlighted by Canuto & Santos (2003), as the sovereign spread is calculated considering only central government bonds it corresponds to a sovereign risk indicator and it's inaccurate the usual classification of country risk.

Sovereign spreads fluctuations reflect market risk perception that is highly influenced by short run changes on relevant macroeconomic variables. But do these short run effects have long run relation with sovereign rating classification made by agencies? Canuto & Santos (2003) argument that, considering moments of economic normality, the use of market risk perception – reflected in the sovereign spread – as input for rating assessment would make sovereign rating classification unstable. Thus such short run variables are usually not considered as input by rating agencies to evaluate sovereign credit risk. But in moments with high volatility in the markets the use of sovereign spreads as input for rating classification might be important, as in such unstable moments the access to the domestic financial market is restrictive what might impact government funding. Rating classification must be stable reflecting macroeconomic fundamentals of an economy, not short run fluctuations.

[...] we have shown the close relation between sovereign classification and sovereign spread of EMBI+, this utilized as sovereign risk premium in the secondary bond markets of emerging economies, that usually have being identified as country risk measure. Indexes like EMBI+ have intense short run fluctuation, while sovereign classifications tend to reflect long run movements as well as events with broad and deep consequences. In the long run, it is expected convergence of sovereign risk and country risk. (Canuto

& Santos, 2003, p.5).

Sovereign rating evaluation is a broader analysis compared to an evaluation of central government payment capacity, it is also demanded to assess the willingness of the government to honor its financial obligations in the future. This second part of analysis is not that easy to estimate and involves much more subjective factors than quantitative variables.

The final rating decision by agencies is made in committees through vote. Several analysts bring quantitative and qualitative information to make a prognostic of central government's payment potential and willingness. Usually analysts visit countries to have local meetings with government representatives; economists; academics; journalists; among others. Information obtained *in loco* are submitted to the committees and are part of the subjective rating analysis.

Some macroeconomic variables forecasts are usually considered by rating agencies for analysis purpose, as: per capita nominal GDP in US dollars; real per capita GDP growth; nominal general government result / GDP; general or consolidated government net debt / GDP; gross interest spending; inflation measured by consumer price index; required gross external financing / international reserves; public sector net external debt / current account revenues from balance of payment; and net external debt of non-financing private sector / current account revenue from balance of payment, Canuto & Santos (2003).

Before exploring econometric modeling utilized in this paper it is convenient to make a brief summary of relevant stylized facts for financial series observed empirically and largely known. The first is the kurtosis observed in probability distribution of financial assets that usually follow a leptokurtic probability distribution, in other words with heavy tails and higher probability for outliers observation occurrence. According to Ziegelmann (2002), the presence of heavy tails is linked to the autocorrelation between squared returns.

Another important stylized fact is known as volatility cluster. Intense fluctuation of financial assets returns are usually followed by return movement in the same direction for the coming periods, these volatility clusters tend to dissipate during time. There is also correlation among volatility of assets negotiated in different markets, what is another stylized fact that can be explained by financial globalization where contagious effects influence volatility in representative markets over others.

One more stylized fact that is relevant is volatility asymmetric factor in response to price fluctuation. Negative price changes usually result in greater volatility compared to the one observed when price goes up. This occurs because economic agents tend to get more apprehensive in response to price decrease rather than to price increase. Asymmetric factor is an important point to be considered in volatility modeling choice for financial assets, as it will be further discussed.

2.2. Modeling

In this section it's performed a brief description of econometric models of GARCH family utilized in this research to model conditional volatility of indexes returns studied.

2.2.1. Threshold GARCH model (TGARCH)

Also known as GJR - Glosten, Jagannathan and Runkle - TGARCH model captures asymmetric effect of volatility, as highlighted by Ziegelmann (2002). Follows the analytic expression of a TGARCH (1,1):

$$\mu_t = \sigma_t v_t \quad \sigma_t^2 = \alpha_0 + \alpha_1 \mu_{t-1}^2 + \beta \sigma_{t-1}^2 + \gamma \mu_{t-1}^2 I_{t-1} \quad v_t \sim IID(0,1) \quad (1)$$

Where $I_{t-1} = 1$ if $\mu_{t-1} < 0$, $I_{t-1} = 0$, otherwise.

To incorporate the asymmetric effect it's expected that γ is greater than zero; so that for every negative error value more volatility is incorporated. Note that if $\gamma > \alpha_1$, supposing $\gamma > 0$, implies that negative shocks adds more marginal volatility compared to positive shocks, what is in line with stylized facts in financial series. "... when $\gamma > 0$ it is captured the leverage effect and with $\gamma = 0$, GJR(1,1) model is reduced to a GARCH(1,1). In this sense GARCH model is nestled with GJR model, as mentioned by Morais & Portugal (1999).

Non-negativity restriction for the model above is as follows:

$$\alpha_0 > 0; \alpha_1 > 0; \beta > 0; (\alpha_1 + \gamma) > 0$$

One of the weaknesses of GARCH model, that is not incorporating the asymmetric effect, is overcome by TGARCH model. On the other hand, it is possible that non-negativity restriction is violated using TGARCH. The model presented in the next section – EGARCH – incorporates the asymmetric effect and also solves the problem of violating the non-negativity restriction.

2.2.2. GARCH exponential models (EGARCH)

EGARCH model can be presented in a simplified format as follows:

$$\mu_t = \sigma_t v_t \quad (2)$$

$$\ln(\sigma_t^2) = \omega + \beta \ln(\sigma_{t-1}^2) + \gamma \frac{\mu_{t-1}}{\sqrt{\sigma_{t-1}^2}} + \alpha \left[\frac{|\mu_{t-1}|}{\sqrt{\sigma_{t-1}^2}} - \sqrt{\frac{2}{\pi}} \right] \quad (3)$$

Note the advantage of the model above compared to the prior one. Here the fact that it is applied a logarithm function to the conditional volatility guarantees that non-negativity restriction is not violated. The model also captures the asymmetric effect, as γ will be negative if the relation between return and volatility is inverse. As shown by Morais & Portugal (1999) the model is asymmetric due to the existence of coefficient γ , that captures the leverage effect.

2.3. Data

To estimate stock exchange volatility in Brazil it is utilized São Paulo stock exchange index (Ibovespa), as it is more largely known in the market and with the longest historical data available. Also it is estimated average stock exchange volatility for emerging countries to be utilized as benchmark. For that it is utilized Emerging Market Morgan Stanley Capital Internacional index (MSCI EM) as *proxy* of emerging markets stock exchange, due to its broad coverage and high credibility.

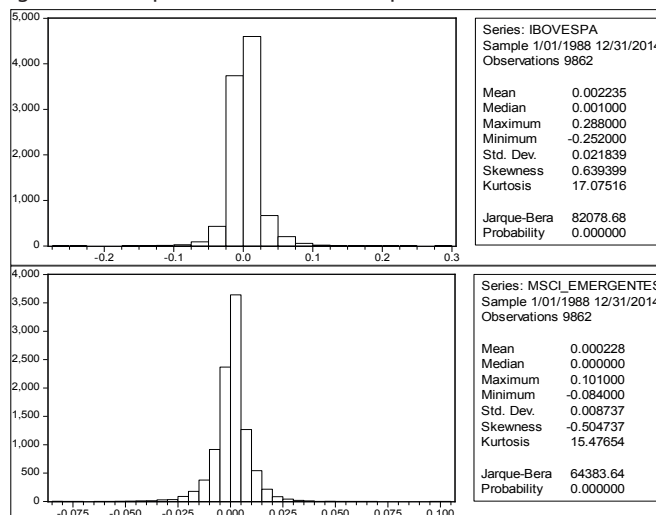
Historical data has CEIC Data as source, monthly frequency and correspond to closing market quotation. For the missing observation it is applied exponential interpolation technic. Due to the long run characteristic of this research, it was considered the longest historical data available as sample for both indexes - from first january 1988 to 31st december 2014 – to extend the historical analysis period the most and guarantee relevant ex-post empirical evidence findings.

To calculate indexes returns it was utilized the natural logarithm of the ration of indexes in "t" and "t-1", as suggested by Securato (2008). The index return is represented by Y_t : and $\frac{X_t}{X_{t-1}}$ is the index value in "t", so: $Y_t = \text{Log}\left(\frac{X_t}{X_{t-1}}\right)$.

Descriptive statistics of the historical data for Ibovespa and MSCI EM confirmed stylized facts of financial series, as summarized below (figure 01). Jarque-Bera test rejects the null hypothesis of normal distribution for data. Kurtosis measures confirm it with value greater than 3 what show that the distributions are leptokurtic with heavy

tails, what is common for financial series. The negative skewness coefficient for MSCI EM indicates that observation as concentrated on the right side of zero, thus positive returns are more frequent than negative. On the other hand for Ibovespa the coefficient is positive, being more frequent negative returns than positive.

Figure 1. Descriptive statistics of Ibovespa's and MSCI EM's returns.



Source: Self elaboration

Once the methodology discussion is done, the next section brings empirical results obtained through econometric models selected. It also brings an analysis of Ibovespa's volatility evolution compared to the benchmark after Brazil's upgrade to investment grade.

3. Results

3.1. Model estimation and selection

To model volatility of indexes return it was utilized GARCH family models, obtaining the generating volatility process and the conditional volatility estimation of series returns. It was considered only TGARCH and EGARCH models as both capture asymmetric effect, a relevant stylized fact for financial series as discussed previously. The model selection criteria, as well as identification, were based on statistical significance of estimated parameter and on Akaike e de Schwarz information criteria together. To model the mean of indexes returns it was utilized autoregressive models. The critical level of significance consider in this research is 2%.

Table 1. Significance and information criteria obtained from estimated models for Ibovespa and MSCI EM.

	Ibovespa		MSCI EM	
	CI Akaike	CI Schwarz	CI Akaike	CI Schwarz
TGARCH(1,1)	-5.296	-5.291	-7.047	-7.043
TGARCH(1,2)	-5.300	-5.295	-7.055	-7.050
TGARCH(1,3)	-5.314	-5.308	not significant	not significant
TGARCH(2,1)	-5.310	-5.305	-7.057	-7.052
TGARCH(2,2)	not significant	not significant	-7.058	-7.052
TGARCH(2,3)	-5.324	-5.318	-7.067	-7.060
TGARCH(3,1)	-5.311	-5.305	-7.058	-7.052
TGARCH(3,2)	not significant	not significant	not significant	not significant
TGARCH(3,3)	-5.328	-5.320	not significant	not significant
EGARCH(1,1)	-5.290	-5.286	-7.047	-7.043
EGARCH(1,2)	-5.297	-5.292	-7.057	-7.052
EGARCH(1,3)	-5.310	-5.304	-7.058	-7.052
EGARCH(2,1)	-5.307	-5.302	-6.839	-6.833
EGARCH(2,2)	not significant	not significant	-7.063	-7.057
EGARCH(2,3)	-5.397	-5.390	not significant	not significant

Source: Self elaboration

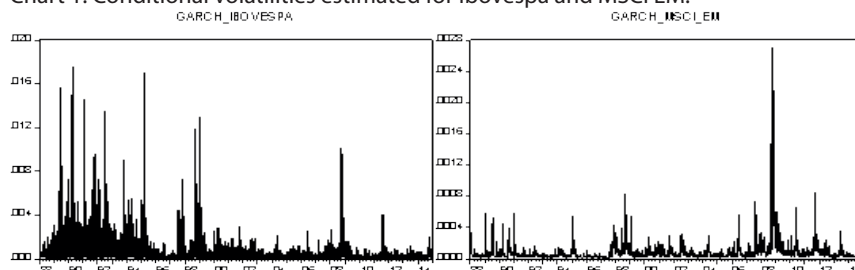
The models selected for series studied based on summarized information above (Table 1) and based on other criteria discussed, are:

AR(1) – EGARCH(3,3,1), for Ibovespa;

AR(1) – TGARCH(2,3,1), for MSCI Emergentes;

Conditional volatility estimated for indexes return can be viewed in the chart 1.

Chart 1. Conditional volatilities estimated for Ibovespa and MSCI EM.



Source: Self elaboration

3.2. Evaluating volatility evolution of Ibovespa

In this section it is made an absolute and relative assessment of Ibovespa's volatility evolution after Brazil's sovereign rating upgrade to investment grade. The relative evaluation is performed by comparing with the selected benchmark: MSCI EM.

International empirical evidence show that upgrade of emerging countries to investment grade has the effect of stock exchange volatility mitigation. According to Cavalcante (2009) it was observed considerable stock exchange volatility mitigation after the first rating upgrade to investment grade for a set of representative emerging countries: Mexico, Chile, India, Russia and South Korea. Cavalcante (2009) show that all five countries studied presented volatility mitigation in the medium run: for Mexico volatility reduced about 27%; for Chile 38%; for India 20%; for Russia 3%; and for South

Korea the reduction was 16%. Morais & Portugal (2009) reached similar empirical results: "Results point out that a higher grade awarded to sovereign debt bonds by an international agency leads to periods of lower volatility in the local stock market. This is associated with improved risk perception by the agents."

Brazil had its sovereign rating in foreign currency upgraded to investment grade on april 2008 by Standard & Poor's (S&P) and on may of the same year by Fitch Ratings. As illustrated on table 2 below, on average the conditional volatility of Ibovespa presented 22% decrease during the six years after the year Brazil's first upgrade to investment grade compared to the base period of six years prior to 2008. MSCI EM, on the other hand, presented 25% volatility increase for the same period and comparison base. Such results reinforces the argument that Brazil's upgrade to investment grade in 2008 promoted stock exchange volatility mitigation, confirming the international empirical evidence for Brazil, both on absolute and relative terms.

Table 2. Average change of conditional volatility for Ibovespa and MSCI EM during six years after Brazil's upgrade to investment grade – 2008 – compared to the base period.

Average Volatility Change	
Ibovespa	-22%
MSCI EM	25%

Source: Self elaboration

The chart 2 presents the evolution of 365 days moving average ratio of conditional volatility of Ibovespa and MSCI EM¹. For values less than 1 it means that average volatility for Ibovespa is lower than for MSCI EM compared to the base period. On the other hand, for values greather than 1 the average volatility for Ibovespa is greater than for MSCI EM in the same comparison base.

Analitically, considering $Vol(t) = \sigma_t^2$ the 365 days moving average of estimated conditional volatility for "t", it's defined:

$$I(Ibovespa_t, MSCI_EM_t) = \frac{Vol^{Ibovespa}(t)}{Vol^{MSCI_EM}(t)} \quad (4)$$

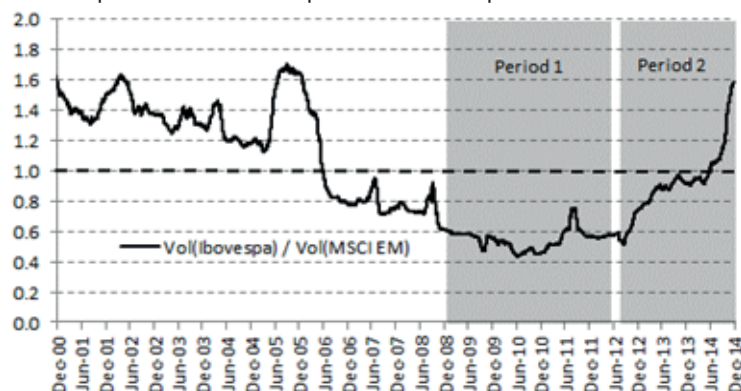
$$\text{If } I(Ibovespa_t, MSCI_EM_t) < 1 \rightarrow Vol^{Ibovespa}(t) < Vol^{MSCI_EM}(t)$$

$$\text{If } I(Ibovespa_t, MSCI_EM_t) > 1 \rightarrow Vol^{Ibovespa}(t) > Vol^{MSCI_EM}(t)$$

The chart 2 show that after Brazil's upgrade to IG volatility of Ibovespa moved systematically bellow volatility of MSCI EM until the first semester of 2014 compared to the base period. From january 2009 to june 2012 – period 1 highlighted in the chart 2 - Ibovespa presented on average 45% less volatility than the benchmark compared to the base period, confirming and reinforcing international empirical evidence. On the other hand drew attention the fact that from the second semester of 2012 on – period 2 highlighted in the chart – the volatility gap between the indexes narrowed, being observed reversal of the volatility mitigation process starting from the second semester of 2014, when the volatility of Ibovespa exceeded in a sharp way the volatility of the benchmark, compared to the base period. During this period Brazil's macroeconomic fundamentals deteriorate and on march 2014 Standard & Poor's downgraded in one level Brazil's sovereign rating, and also Moody's did the same on august 2015, followed by IG loss by the first agency on september 2015 and by Fitch on december of the same year.

¹ Series were transformed to index with base period corresponding to the average of the six years prior to Brazil's upgrade to IG (2008).

Chart 2. Evolution of 365 days of moving average ratio of conditional volatility estimated for Ibovespa and MSCI EM compared to the base period.



Source: Self elaboration

4. Conclusion

This paper assessed stock exchange volatility evolution in Brazil after its upgrade to investment grade, in 2008, to confront with the international empirical evidence that show – according to Morais & Portugal (2009) and Cavalcante (2009) – that the upgrade of emerging countries sovereign rating to investment grade has as one of the effects stock exchange volatility mitigation.

Data utilized were the returns of São Paulo stock exchange index (Ibovespa) and Emerging Markets MSCI index (MSCI EM), this selected as benchmark being a proxy for average emerging markets stock exchange behavior. For volatility modeling of indexes returns it was considered TGARCH and EGARCH models, and the selection process and model identification were based on Akaike e Schwarz informational criteria and statistical significance of estimated coefficient.

Results obtained were consistent with the international empirical evidence. On average Ibovespa's volatility was 22% lower during the six years after 2008 compared to the six years prior to Brazil's upgrade to investment grade, while MSCI EM volatility increased 25% on average for the same period and comparison base reinforcing empirical evidence. To evaluate the dynamics of Ibovespa's volatility it was calculated 365 days moving average ratio of conditional volatility of Ibovespa and MSCI EM. From January 2009 to the first semester of 2012 Ibovespa's volatility moving average was systematically lower than MSCI EM, 45% less on average. On the other hand, from the second semester of 2012 on it was observed that moving average gap between the indexes started do narrow and, in the second semester of 2014, the volatility mitigation process started to reverse and the volatility of Ibovespa exceeded in a sharp way the volatility of the benchmark. During this period Brazil's macroeconomic fundamentals started to deteriorate culminating with one step downgrade of Brazil's sovereign rating by Standard & Poor's on march 2014 and by Moody's on august 2015, followed by IG loss on september 2015 by the first agency and by Fitch on december of the same year.

International empirical evidence also shows that the stock market volatility mitigation process, on emerging countries upgraded to investment grade, can be reverted if there is no consistency in future rating classification. Cavalcante (2009) found that the volatility mitigation process was reverted for emerging countries that suffered investment grade loss. A suggestion for future research is to bring answers to the following question: what are the consequences for domestic financial assets after Brazil's IG loss?

References

- BALL, C. A. & TOROUS, W. N. Stochastic Correlations Across International Sock Markets. *Journal of Empirical Finance*, 7: 373 – 388, 2000.
- BHEENICK, E. B. Rating timing differences between the two leading agencies: Standard and Poor's and Moody's, *Emerging Markets Review*, 5: 361-378, 2004.
- BOLLERSLEV, Tim & CHOU, Ray & KRONER, Keneth. ARCH Modeling in Finance: a Review of the Theory and Empirical Evidence. *Journal of Econometrics*, 52:5-59, 1992.
- BR00KS, Chris (2002). *Introductory Econometrics for Finance*. Cambridge, Cambridge.
- CANUTO, Otaviano & SANTOS, Pablo Fonseca. *Risco-Soberano e Prêmio de Risco em Economias Emergentes*. Brasília: Ministério da Fazenda – Secretaria de Assuntos Internacionais, 2003.
- CASTRO, Nivalde J. & BRANDÃO, Roberto. *Investment Grade: Impactos na Economia Brasileira e no Setor Elétrico Brasileiro*. Grupo de Estudos do Setor Elétrico, 2008.
- CAVALCANTE, Bruno Maia. *Grau de investimento em economias emergentes e suas consequências sobre a volatilidade em bolsa de valores: os casos do México, Chile, Rússia, Índia e Coréia do Sul*. Universidade Federal do Rio Grande do Sul, Porto Alegre. Dissertação de Mestrado, 2009.
- CHRISTOFI, A. & PERICLI, A. Correlation in Price Changes and Volatility of Major Latin America Stock Markets. *Journal of Multinational Finance Management*, 9: 79 – 93, 1999.
- ENDERS, W. *Applied Econometric Time Series*. John Wiley & Sons Inc., EUA, 2. ed., 1995.
- ENGLE, Robert F. & Ng, Victor K. Measuring and Testing the Impact of News on Volatility. *Journal of Finance*, 48(5): 1749-78, 1993.
- FAN, J. & YAO, Q. *Nonlinear Time Series Modelling and Prediction*. Springer-Verlag, New York, 2002.
- FULOP, Andras. Feedback effects of rating downgrades. ESSEC Working paper, 2006.
- GLASCOCK, J.L. & DAVIDSON, W.N.; HENDERSON, G.V. Announcement effects of Moody's bond rating changes of equity returns. *Quarterly Journal of Business & Economics*, 26: 67-78, 1987.
- HAND, J.R.M. & HOLTHAUSEN, R.W. & LEFTWICH, R.W. The effect of Bond Rating Agency Announcements on Bond and Stock Prices. *The Journal of Finance*, 47, nº 2: 733-52, 1992.
- KIM, Suk-Joong & WU, E. Sovereign credit ratings, capital flows and financial sector development in emerging markets. *Emerging Markets Review*, 9: 17-39, 2008.
- MORAIS, Igor A. & PORTUGAL, Marcelo S. Modelagem e previsão de volatilidade determinística e estocástica para a série do Ibovespa. *Estudos Econômicos*, 29, N. 3: 303 – 341, 1999.
- _____. Investment Grade and Uncertainty in the Stock Market: an Analysis for Chile, México, South África, Rússia and india. Disponível em: <http://virtualbib.fgv.br/ocs/index.php/ebf/9EBF/paper/viewFile/615/108>. Acesso em: 18/10/2014, 2009.
- NELSON, D. B. Conditional Heteroscedasticity in Asset Returns: a new approach. *Econométrica*, 59: 347-370, 1991.
- POLWITOON, Sirapat & TAWATNUNTACHAI, Oranee. Emerging Market Bond Funds: A Comprehensive Analysis. *The Financial Review*, 43: 51-84, 2008.
- POON, Ser-Huang & GRANGER, Clive. Forecasting Volatility In Financial Markets: A Review. *Journal of Economic Literature*, 41, N. 2: 478 – 539, 2003.
- RIGOBON, Roberto. *The Curse of Non-Investment Grade Countries*. Sloan School of Management, MIT and NBER, 2002.
- SECURATO, José Roberto. *Cálculo Financeiro das Tesourarias*. Bancos e Empresas. Saint-

Paul, São Paulo, 4. Ed, 2008.

TAYLOR, Stephen J. Asset Price Dynamics, Volatility, and Prediction. Princeton, London, 2007.

TSAY, R. S. Analysis of Financial Time Series. John Wiley & Sons Inc., EUA, 1. ed., 2002.

URIBE, Martin & YUE, Vivian Z. Country Spreads and Emerging Countries: Who drives whom? Available at: www.frbsf.org/publications/economics/papers/2004/wp04-32bk.pdf. Access date: 18/10/2014, 2004.

ZIEGELMANN, Flávio Augusto. Estimation of Volatility Functions: Non-parametric and Semi-Parametric Methods. 191p. Thesis submitted to the University of Kent of Canterbury for The Degree of Doctor in the Subject of Statistics, 2002.

ZIEGELMANN, F. A. & PEREIRA, P. L. V. Modelos de volatilidade estocástica com deformação temporal: um estudo empírico para o índice Ibovespa. P.P.E, v.27, n.2: 353-376, 1997.

