

INVESTMENT GRADE AND UNCERTAINTY IN THE EMERGING MARKETS

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Resumo

Esse artigo avalia o impacto que a concessão do primeiro grau de investimento produz sobre a volatilidade das bolsas de valores. A partir de dados de um conjunto de países que receberam essa classificação nos últimos anos, é utilizado o modelo de mudança de regime markoviano para evidenciar as mudanças estruturais na volatilidade. Os resultados apontam evidências de redução no risco nos mercados acionários locais mas, com diferenças ao longo do tempo. No Chile e na África do Sul, a resposta é mais imediata. Na Índia, há uma defasagem de cerca de três meses até que ocorra uma queda na volatilidade. Por outro lado, no México e na Rússia, esse resultado só é verificado após um ano da concessão do grau de investimento. As formulações não indicam existência de assimetria na resposta da volatilidade a retornos positivos, um aspecto que difere de outros estudos. Os resultados são úteis para caracterizar os movimentos futuros de outras economias, como o Brasil.

Palavras Chave: Grau de investimento, volatilidade, mudança de regime markoviano

Abstract

This paper evaluates the impact of the first investment grade in the volatility of the stocks exchange in emerging markets. With data from five countries, using deterministic volatility and markov switching models in volatility, we see evidence in structural breaks at second moment. But, apart from risk reduction in local stock markets, there is differences along the time. In Chile and in South Africa, the answer is more immediate. In India, there is a lag of about three months until that happens a fall in the volatility. On the other hand, in Mexico and in Russia, that structural break is only verified after a year of the concession of the investment grade. The formulations don't indicate asymmetry existence in the answer of the volatility to positive returns, a different aspect of others studies. The results are useful to characterize the future movements of other countries like Brazil.

Key words: Investment grade, volatility, markov switching models.

JEL Codes: C22, G12

1. Introduction

The growth of the bond market in emerging countries, especially from the 1990s onwards, created several opportunities for investment diversification; see (Polwitoon *et al.*, 2008) for an approach to the development of this market. On the one hand, this growth allowed pension funds, investment banks, insurance companies and hedge funds to form new allocation portfolios, with immediate impacts on return and risk. However, in the same measure, it circumscribed the relations amongst markets and changed the contagion relationships; see (Rigobon, 2001) for an approach between Mexico and Argentina, and (Uribe *et al.*, 2004) who deal with the impacts of external shocks on sovereign spreads of emerging countries and on the business cycle.

The greater supply of assets stimulated the need for product differentiation and one of the best choices consists in rating it according to a certain level of risk. For many years, several independent agencies have operated in the international market by providing credit risk assessment services to investors, companies and governments. This measure is useful for both parties involved in the operation, i.e., the issuer and the purchaser of the bond. However, despite the possibility that there might be a conflict of interest between the parties in this process, these ratings are increasingly common and often required by investors and regulatory agencies.

From the viewpoint of companies and the governments, a good credit rating provides a good market window for raising funds at lower financial costs. Moreover, in view of the legal constraint

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to investment allocation by several public and private financial institutions in various parts of the world in bonds with lower credit ratings, a good risk rating might represent a higher demand, liquidity and longer debt maturity. (Kim and Wu, 2007) found evidence for a panel of 51 emerging markets that credit risk measures affect capital flow to these countries.

The impact of this rating on prices and asset volatility, and on a better risk diversification has been the subject of research by many authors. (Hand *et al.*, 1992) verified direct relationships between the disclosure of risk ratings upgrades and downgrades attributed by international agencies in both the bond and stock markets. There is also evidence of differences in long-term returns for periods before the disclosure of changes in risk ratings, as pointed out by (Holthausen *et al.*, 1986), who assessed a sample of 1,100 companies. (Impson *et al.*, 1992) assessed the impacts of changes in ratings in companies on their systematic risk. Results showed that improvements in bond risk rating are not associated with changes in the beta. On the other hand, downgrades of this rating are associated with an increase in systematic risk. Nevertheless, these events seem contradictory, as pointed out by the results in (Pinches *et al.*, 1978), (Glascock *et al.*, 1987), (Loughran *et al.*, 1995) and (Micu *et al.*, 2006).

(Dichev *et al.*, 2001) analyzed the long-term response of stock returns to changes in bond rating and found that a downgrade of risk rating speeds up future yield losses. Evidence also indicates the existence of asymmetric responses of returns between risk upgrades and downgrades. (Fulop, 2006) analyzes a sample of U.S. companies which received a downgrade in risk rating for "junk bonds" and found evidence that such movement was hastened on bond returns and volatility. On the other hand, the results obtained by (Bheenick, 2004) do not allow us to assert that an improvement in risk rating might add information to the market.

In the analysis of impacts on sovereign bonds, the results obtained by (Kaminsky *et al.*, 2001), who found a direct association between an improvement in risk rating with decrease in the yields of sovereign debts, volatility reduction and a higher return in the stock market, should be highlighted. (Rigobon, 2001) assessed the impact of the upgrade of Mexico to an investment grade country on the decrease in correlation with the Argentine market using EMBI+ returns data from both countries. According to this author, particularly before the disclosure of the risk rating, it was possible to reject the hypothesis that shock propagation is initially stable, i.e., on returns. However, the detachment between both economies, which may be interpreted as a regime switching in the model's parameters, does not find any response in the second moment of data analysis.

The main purpose of the present paper was the recent risk rating score given to the Brazilian economy by an international agency, which put Brazilian sovereign debt bonds for the first time in the investment grade group. The repercussion on stock prices in the domestic market was straightforward, despite several months in a row of high returns, signaling investors' anticipation of this movement. This created an expectation that the volatility of several assets in the country would reflect a better risk assessment with positive impacts over time. In the econometrics literature, this movement can be characterized as a regime switching in the second moment of returns, i.e., in volatility. To investigate this hypothesis, the volatility of representative indices of five emerging markets, whose sovereign bonds were upgraded to an investment grade status, was assessed through a Markov regime-switching model as proposed by (Hamilton *et al.*, 1994).

The hypothesis of decrease in volatility is associated with the assumption that less risky assets show lesser risk over time. It should be noted that the estimation of asset price volatility, as well as of index numbers that might represent the whole market, is an important result for studies and applications in finances.

The present paper is organized as follows. In addition to the introduction, Section 2 provides a brief description of the regime switching methodology, focusing on the problem related to the modeling on the second conditional moment. Section 3 discusses and analyzes the data referring to stock indices and estimation results. Finally, Section 4 concludes and offers guidelines for future research in this area.

2. Methods

Suppose that the returns of an asset are given by an AR model (1), as in 1:

$$y_t = \alpha_0 + \alpha_1 y_{t-1} + \varepsilon_t \quad (1)$$

and that the conditional variance is given by 2:

$$\varepsilon_t = \sqrt{g_t} \tilde{\varepsilon}_t \quad (2)$$

where $\tilde{\varepsilon}_t = h_t v_t$ is an *ARCH-L*(q) process, with $v_t \sim IID(0,1)$ and:

$$h_t = \alpha_0 + \alpha_1 \tilde{\varepsilon}_{t-1}^2 + \alpha_2 \tilde{\varepsilon}_{t-2}^2 + \dots + \alpha_q \tilde{\varepsilon}_{t-q}^2 + \xi d_{t-1} \tilde{\varepsilon}_{t-1}^2 \quad (3)$$

Note that the leverage effect, whose purpose is to capture asymmetries in volatility, is given by parameter ξ , where a dummy variable will determine these impacts:

$$d_{t-1} = \begin{cases} 1 & \text{if } \tilde{\varepsilon}_{t-1} \leq 0 \\ 0 & \text{if } \tilde{\varepsilon}_{t-1} > 0 \end{cases}$$

Model (1 to 3) was originally proposed by Engle (1982) and later extended to allow identifying several characteristics of the second conditional moment[1] of the dataset (Engle, 2002). However, a single formulation for the entire dataset causes the current volatility to have an impact on future estimates. One of the new research avenues in this area seeks to model a dataset considering that the data are under the influence of an unknown parameter, which will determine the various states of the dataset. Such possibility minimizes the influence the choice of the sampling period exerts on the results.

Therefore, by making the variance of an asset have values that are conditional on the present and past regimes, we can write 2 as follows:

$$\varepsilon_t = \sqrt{g_{s_t}} \tilde{\varepsilon}_t \quad (4)$$

where constant $\sqrt{g_{s_t}}$ varies according[2] to regime $s_t = 1, 2, \dots, k$. Volatility is normalized to the first regime such that one assumes that $g_1 = 1$. In the presence of the leverage effect, one has the *SWARCH-L*(k, q) model, originally proposed by (Hamilton *et al.*, 1994). This class of models is described by a first-order Markov chain, where data are governed by transition probabilities between k states, which may be represented by a transition probability matrix $P = [p_{ij}] \in M(k \times k)$ such as:

$$P = \begin{bmatrix} p_{11} & p_{12} & \dots & p_{1k} \\ p_{21} & p_{22} & \dots & p_{2k} \\ \vdots & \vdots & \ddots & \vdots \\ p_{k1} & p_{k2} & \dots & p_{kk} \end{bmatrix} \quad (5)$$

where: $\sum_{j=1}^k p_{ij} = 1$ for $i=1, 2, \dots, k$, $p_{ij} \geq 0$ for $i, j=1, 2, \dots, k$.

Conditional heteroskedasticity models of the GARCH family with Markov regime switching are called nonlinear volatility models and are useful for characterizing the periods in which regime switching occurs in the second moment of the data series. The difficulty in estimating models with this characteristic is discussed in (Gray, 1996) and (Klaassen, 2002). (Haas *et al.*, 2004) propose that the conditional variance in a given regime should be only a function of the conditional variance in that same regime. The model described herein as 1, 4 and 5, called *SWARCH-L*(k, q), will be applied to find the probabilities for a change in state valid for the second moment of returns across stock markets of countries which had a positive investment grade rating.

3. Database and statistical results

This section analyzes stock market behavior in five emerging countries whose sovereign bonds obtained an investment grade rating: Chile, Mexico, South Africa, Russia and India. The main goal is to verify whether there is an association between the best rating score and a reduction in risk in the respective stock markets. To achieve that, we used daily data on the major local stock index for a period of two years before and two years after the risk rating date. In what follows, we

calculate the returns using the log difference and estimate several deterministic volatility models of the GARCH family with and without regime switching.

A preliminary investigation reveals differences in behavior among these markets, as illustrated in Table 3.1. The Chilean, and to a lesser extent, the Indian stock markets are the only ones that made gains after the investment grade rating equivalent to those shown in the previous two years. In Russia, the gains were significantly lower, while in Mexico and in South Africa there was also a reduction in returns. Nonetheless, since this analysis comprises different time periods, from the early 1990s to the mid-2000s, the conditioning circumstances of the external scenario might be affecting these results. In this case, it is important to contextualize these events individually.

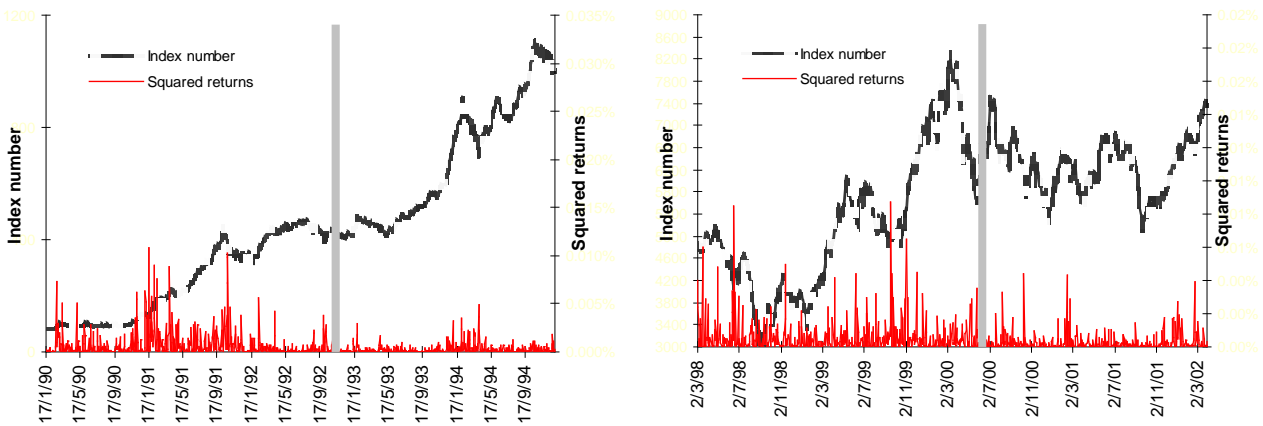
Table 3.1 – Stock market characteristics by country

	Chile	Mexico	South Africa	Russia	India
Date of 1 st IG	December 1992	March 2000	June 2000	October 2003	January 2004
Stock market returns					
2 years before	228%	66%	27%	220%	69%
1 year before	25%	64%	-6.8%	97%	66%
1 year after	58%	-26%	13%	4.2%	14%
2 years after	151%	-7.2%	-2.6%	25%	71%

In the analyzed group, Chile was the first country to obtain an investment grade rating by an international agency. Since the mid-1980s, Chile showed good performance indicators as a result of various structural and market policy reforms that produced significant impacts on the country's financing ability and changed the economy's productivity (Barro, 1999; Bergoening et al., 2001). Economic reforms continued in subsequent years, with privatization of companies, liberalization of the capital market and intensification of economic openness. In this period, most of the growth was due to exports, and foreign debt restructuring implemented by the government in such period yielded positive results on the credibility of local and foreign investors. Therefore, both before the upgrade of risk ratings and in the subsequent two years, the Chilean economy did not face external shocks sufficiently large so as to change the macroeconomic scenario described herein, and the asset returns in the country's capital market reflected this.

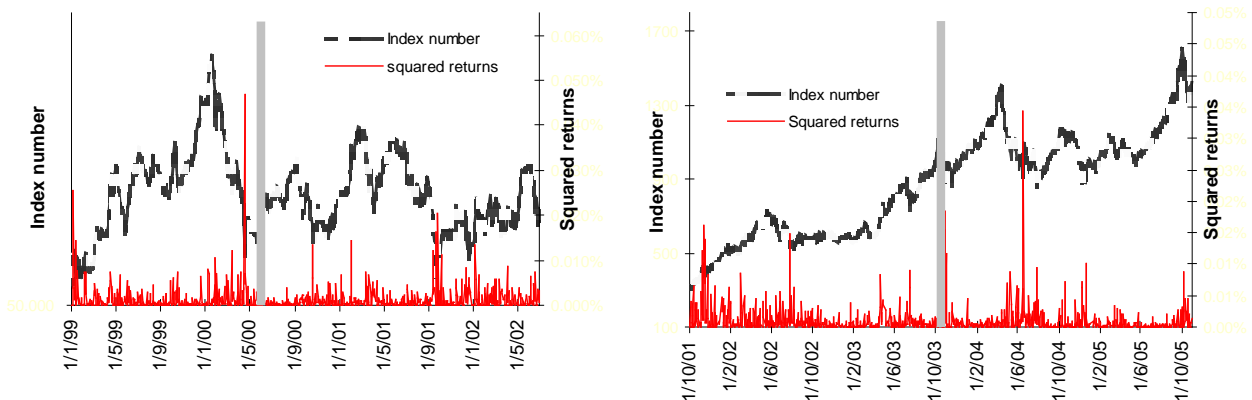
When the Mexican economy was granted the investment grade rating by Moody's on March 7, 2000, the country already experienced a cycle of positive growth with improvement of several macroeconomic indicators[3]. Several fundamentals are deemed crucial to this decision, such as the discipline in the conduct of the fiscal and monetary policies, better options for foreign debt payment with an increase in foreign currency reserves, greater transparency in strategic information and the process of economic openness in the wake of several trade agreements, particularly NAFTA (Rigobon, 2001; Blecker et al., 2007). However, the sampled period which includes two years before and two years after March 7th, 2000 contains four important external shocks: Russia's debt default, followed by the devaluation of the Real in Brazil, both before the upgrade, and the plunge in stock prices in the USA, particularly the NASDAQ index, and the Argentine crisis, both after the upgrade. Notwithstanding, the Mexican economy moved across the 1998-2002 period without any major disturbances[4].

Graph 3.1 Price and square of market index returns
Chile Mexico



In 2000, South Africa had its risk rating upgraded. In a historical analysis, we have two moments: the GDP increased on average (a) only 0.8% p.a. between 1985 and 1994 and (b) 3.1% p.a. between 1995 and 2004 (Plessis *et al.*, 2007). According to the author, the intensification of the democratization process, with the end of apartheid in 1994 and the country's greater economic openness, was decisive to create a positive environment for local and foreign investors; see also (Arora *et al.*, 2003) for an analysis of the total factor productivity. Nevertheless, the sampling period considered herein might have come under the influence of the same external scenario that assailed the Mexican economy, and it is important to consider these impacts on the analysis of returns and on volatility in the local stock market.

Graph 3.2 Price and square of market index returns
South Africa Russia

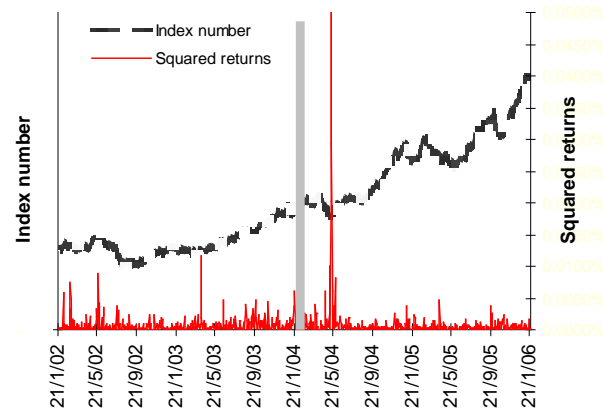


Russia is the fourth country analyzed. An array of positive events contributed to a better risk rating of its foreign debt. More than one decade of transition and microeconomic reforms had positive impacts; see (Bessonova *et al.*, 2003), who analyze the benefits of economic openness for local firms, and (Goriaev and Zobotkin, 2006) for an approach to macroeconomic, institutional and political aspects and the impacts on the stock market.

Shortly before obtaining an investment grade rating, the Russian economy was experiencing high growth rates, having positive impacts on the government's budget. Moreover, external accounts improved significantly, with current account surplus, increase in foreign reserves and reduction of foreign debt as a percentage of the GDP. The impact of this macroeconomic change was the market risk measured by EMBI+, which went from 6,000 basis points in early 1999 to approximately 230 basis points during the moments that preceded the investment grade rating[5].

The balance of payment crisis in India in the early 1990s was a decisive factor for the government to engage in a reform process, particularly a greater liberalization of capital control and trade liberalization (Virmani, 2006; Shah et al., 2007). Then, in 1997, with the advent of reforms in the financial market, portfolio capital flows increased. In the years prior to the investment grade rating, a strong accumulation of reserves was observed in the country, which already showed low exposure to public sector foreign debt. India was rated as investment grade by Moody's in January 2004, in a scenario of strong economic growth in the international market, which remained positive in the subsequent years.

Graph 3.3 Price and square of market index returns - India



In general, the grant of investment grade rating seems to follow the implementation of important reforms in local economies, with positive results on the growth rate, improvement in external accounts and fiscal balance. Despite the differences experienced in the periods after the rating upgrade, particularly with external shocks, it should be expected that the so-called "investment grade" represents a substantial change in risk perception by financial agents and this may be reflected in the behavior of the capital market, chiefly in asset volatility.

An analysis of the squared returns illustrated in Graphs 3.1 to 3.3 provides evidence of their conditional volatility, as well as of volatility clustering and lower incidence of atypical events[6]. The analysis of the second moment does not seem to reflect the "anticipatory" movement of the market in relation to the investment grade, but the average of returns does. First, three conditional volatility models of the GARCH family are estimated, whose results are shown in Table 3.2. The symmetric model proposed by (Bollerslev, 1986) indicates the existence of high persistence[7] in conditional volatility, with the exception of India.

The diagnostic test proposed by (Engle *et al.*, 1993) to identify the presence of asymmetry in the shocks of positive and negative returns indicates this characteristic only for the Indian stock market. However, when the exponential $EGARCH(p,q)$ model proposed by (Nelson, 1991) and the presence of the leverage effect[8] proposed in (Glosten *et al.*, 1993) are considered, this asymmetry is not statistically significant for the period under analysis. It should be noted that, in the exponential model, the estimate of volatility clustering is captured by parameter α , which is significant in all markets. On the other hand, asymmetry is given by γ in the $EGARCH(1,1)$ model and by ξ in the GARCH(1,1)-L model, and is not statistically significant for Chile and Russia.

Table 3.2 – Univariate Conditional Volatility Models – whole period

		Chile	Mexico	South Africa	Russia	India
GARCH(1,1)~N	α	0.171 (0.00)	0.091 (0.00)	0.075 (0.00)	0.134 (0.00)	0.152(0.00)
	β	0.816 (0.00)	0.87 (0.00)	0.863 (0.00)	0.843 (0.00)	0.721(0.00)
Negative Size		-0.62 (0.53)	-0.68(0.49)	-0.39 (0.69)	1.24 (0.21)	-2.00 (0.04)
Positive Size		0.39 (0.69)	-0.56(0.57)	-1.17 (0.24)	-1.28 (0.19)	-1.75 (0.08)
EGARCH(1,1)~N	α	0.363 (0.00)	0.134 (0.00)	0.108 (0.00)	0.252 (0.00)	0.228 (0.00)
	β	0.954 (0.00)	0.974 (0.00)	0.942 (0.00)	0.951 (0.00)	0.844 (0.00)

Negative Size	γ	-0.06 (0.25)	0.743 (0.00)	0.549 (0.00)	0.091 (0.24)	0.741 (0.00)
		-0.87 (0.38)	0.15 (0.88)	-0.29 (0.76)	1.19 (0.23)	-1.26 (0.21)
Positive Size		0.10 (0.92)	-0.17 (0.86)	-0.42 (0.66)	-0.98 (0.32)	-1.09 (0.27)
GARCH-L(1,1)	α	0.18 (0.00)	-0.005 (0.72)	0.019 (0.23)	0.117 (0.00)	0.008 (0.72)
	β	0.815 (0.00)	0.895 (0.00)	0.878 (0.00)	0.839 (0.00)	0.697 (0.00)
	ξ	-0.017 (0.59)	0.15 (0.00)	0.078 (0.00)	0.033 (0.25)	0.247 (0.00)
Negative Size		-0.75 (0.45)	0.21 (0.82)	-0.084 (0.93)	1.38 (0.16)	-0.22 (0.82)
Positive Size		0.25 (0.80)	-0.22 (0.82)	-0.657 (0.511)	-1.10 (0.27)	-0.89 (0.37)

Note: The significance level is shown in parentheses.

The estimate of the GARCH model for subperiods whose results are shown in Table 3.3 indicates that the conditional volatility of the stock markets showed distinct persistence before and after the investment grade rating. This may signal a volatility regime switching, which should be taken into account to avoid spurious results in the models.

Table 3.3 – Univariate Conditional Volatility Models – subperiods

		Chile	Mexico	South Africa	Russia	India
Before investment grade						
GARCH(1,1)~N	α	0.346 (0.00)	0.113(0.00)	0.139 (0.00)	0.105(0.00)	0.161(0.00)
	β	0.605 (0.00)	0.820(0.00)	0.689 (0.00)	0.854(0.00)	0.603(0.00)
	$\alpha+\beta$	0.951	0.933	0.828	0.959	0.764
After investment grade						
GARCH(1,1)~N	α	0.160 (0.00)	0.055(0.00)	0.072 (0.00)	0.144(0.00)	0.138(0.00)
	β	0.814 (0.00)	0.922(0.00)	0.862 (0.00)	0.838(0.00)	0.770(0.00)
	$\alpha+\beta$	0.974	0.977	0.934	0.982	0.908

Note: The significance level is shown in parentheses.

3.1. Volatility regime switching

With the purpose of identifying and characterizing the presence of regime switching in the second moment, several formulations were estimated. Table 3.4 shows the best models, among which a convergence was observed. A SWARCH-L(3,2) model, i.e. with three possible volatility states and two lags for the ARCH equation, was selected for Chile. The leverage effect was nonsignificant, as well as in the formulation without regime switching. Variance in regime 2, captured by g_2 , is up to 5.4 times higher than in regime 1, but decreases to twice in g_3 . Thus, volatility is low in regime 1, high in regime 2, and average in regime 3.

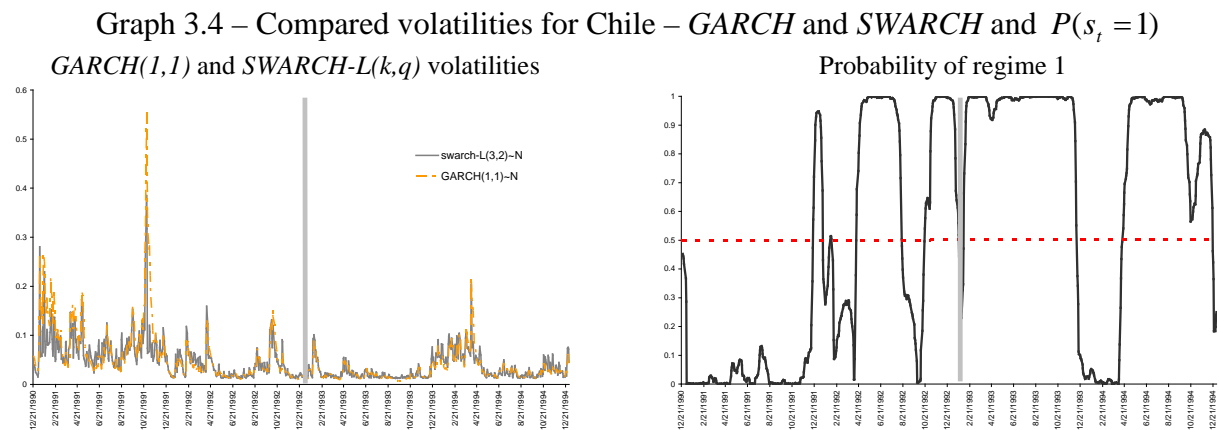
Table 3.4 – Results for the SWARCH-L(k,q) model

	Chile	Mexico	Russia	India	South Africa
α_0	0.013(0.005)	0.0057(0.006)	0.032(0.008)	0.026(0.007)	0.006(0.009)
α_1	0.335(0.03)	0.113(0.03)	0.065(0.03)	0.107(0.03)	0.106(0.03)
γ_0	0.011(0.001)	0.0135(0.001)	0.0354(0.006)	0.035(0.004)	0.075(0.009)
γ_1	0.161(0.08)	0.152(0.076)	0.0000(0.04)	0.0605(0.05)	0.012(0.067)
γ_2	0.158(0.06)	0.0403(0.04)	-	-	0.033(0.04)
γ_3	-	-	-	-	-
ξ	0.036(0.087)	0.168(0.107)	0.0434(0.06)	-	0.0828(0.08)
g_1	1	1	1	1	1
g_2	5.38(0.97)	1.600(0.59)	4.274(0.72)	10.34(6.14)	2.417(0.38)
g_3	2.18(1.13)	5.873(1.68)	1.981(0.67)	2.107(0.41)	0.039(0.02)
p_{11}	0.987	0.985	0.980	0.989	0.986
p_{22}	0.677	0.446	0.986	0.746	0.913
p_{33}	0.0006	0.223	0.939	0.957	0.329

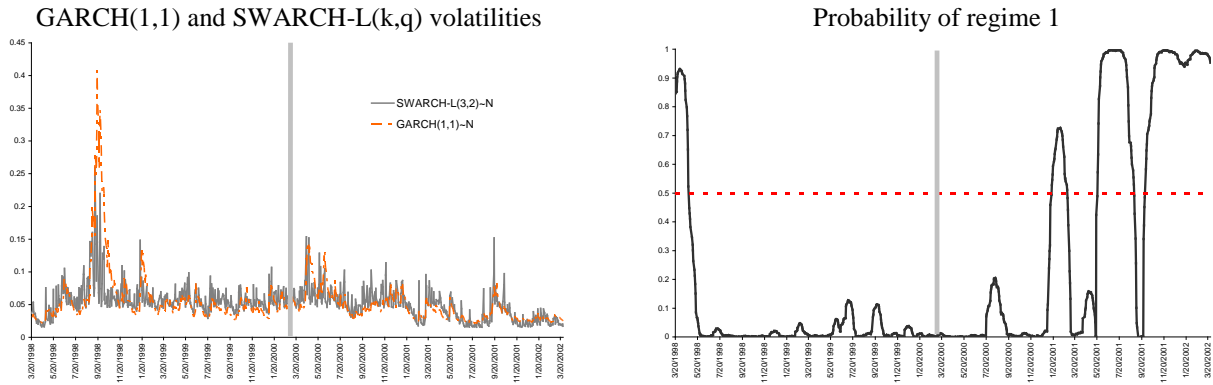
$t_{d.f}$	-	-	8.445(3.56)	-	10.63(5.11)
<i>LogLikelihood</i>	274.71	132.14	181.33	38.36	296.51
<i>AIC</i>	262.70	120.15	169.33	28.36	283.51
<i>Schwarz</i>	233.14	90.58	139.85	3.60	252.29

Note: comparison criteria are given by: $AIC = \log - k$ and $Schwarz = \log - (k/2) \ln(T)$, where k is the number of parameters of the model, \log is the result for the maximum likelihood function and T is the number of data used. Standard deviation is in parentheses.

The set of graphs 3.4 illustrates the volatility estimate obtained with the $GARCH(1,1)$ model comparatively with the volatility regime switching model for the data on Chile. As can be seen, there is a narrow relationship between these estimates, with a highlight only on the larger difference identified in October 1991. The following graph illustrates the moments where there is a higher probability of low volatility in the local stock market. The gray bar represents the date on which the country was awarded the investment grade. It is possible to see that $P(s_t = 1)$ remains more often above 50 after the rating upgrade. Two months before and one year after the investment grade, the Chilean stock market was in a low volatility regime. On average, this state is expected to last 76 days, given by $1/(1 - \hat{p}_{11})$. Results for the transition probability matrix reveal that there is a higher probability of being in a low volatility regime and remaining in it, given by $p_{11} = 0.98$, than of being in a high volatility regime and remaining in it, measured by $p_{22} = 0.677$.



Results for Mexico are a bit different. With the introduction of regime switching, the leverage effect, given by ξ , was not statistically significant when compared to the $GARCH(1,1)-L$ model. Volatility in regime 2 is approximately 1.6 times higher than that in regime 1, which is classified as having the lowest volatility. In regime 3, volatility is 5.8 times higher than the volatility found in regime 1. The difference between g_1 and g_3 is larger for Mexico than for Chile.

Graph 3.5 – Compared volatilities for Mexico – GARCH and SWARCH and $P(s_t = 1)$ 

The set of graphs 3.5 shows the comparison between the volatility estimates for both models. Except for the initial period, in September 1998, all other estimates were similar and yielded low values. The gray bar indicates when the country obtained the investment grade. Note that the Mexican stock market showed low volatility only almost one year after the rating, a result that persisted during the subsequent periods. The estimated transition probabilities indicate high values in case of being in a low volatility regime and remaining in it, $p_{11} = 0.985$, whose average in this regime amounts to 68 days, but also a high rate for $p_{33} = 0.22$, which measures the probability of being in a high volatility regime and remaining in it.

Results for South Africa also signal the need for using a model that captures a structural change in volatility. The leverage effect is nonsignificant, differently from the result found in the GARCH(1,1) model; however, the Student's t distribution with parameter at 10.6 and volatility estimates for regime 2 are important. The second regime is approximately 2.4 times higher than the first one, while the third regime, which would capture an intermediate volatility, is slightly higher than the first regime. The set of equations 6 illustrates how the model is shown in its general form.

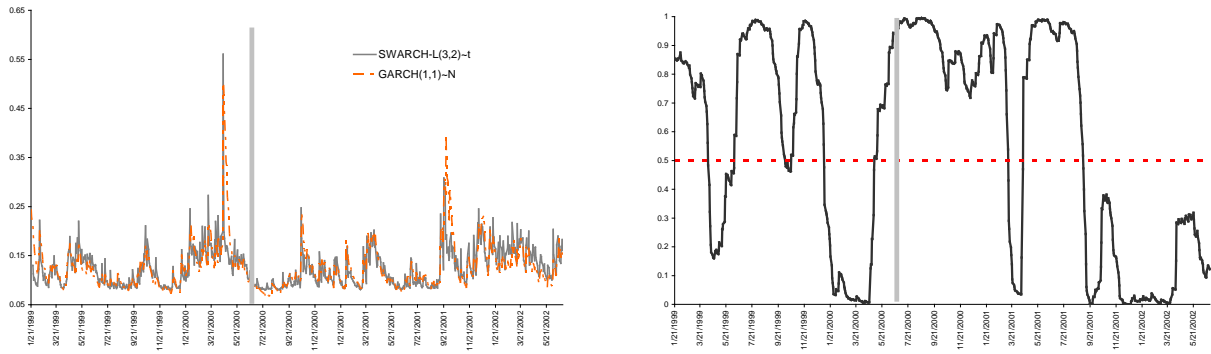
Note that the transition probability matrix indicates a high probability of being in the low volatility regime and remaining in it. It has an average duration of $1/(1 - \hat{p}_{11}) = 72$ days, and in regime 2, this average is lower, of only $1/(1 - \hat{p}_{22}) = 12$ days. The probability of being in a high volatility regime and moving to a low volatility one is $p_{21} = 0$, and that of being in regime 1 and moving to regime 3 is $p_{13} = 0$.

$$\begin{aligned}
 y_t &= 0.006 + 0.106y_{t-1} + \varepsilon_t \\
 v_t &\sim t - student(10.6)d.f \\
 h_t^2 &= 0.075 + 0.012\tilde{\varepsilon}_{t-1}^2 + 0.033\tilde{\varepsilon}_{t-2}^2 + 0.082d_{t-1}\tilde{\varepsilon}_{t-1}^2 \\
 g_1 &= 1, g_2 = 2.41, g_3 = 0.039 \tag{6} \\
 P &= \begin{bmatrix} 0.986 & 0 & 0.154 \\ 0.014 & 0.913 & 0.517 \\ 0 & 0.087 & 0.329 \end{bmatrix}
 \end{aligned}$$

The set of graphs 3.6 compares the volatility between the models with and without structural break in the second moment, and provides the results for the behavior of probability of regime 1, $P(s_t = 1)$. It should be highlighted that for six months before the investment grade rating, the South African market showed higher stress than in the following moments. This movement was also detected by the probability of being in a low volatility regime, which emerged after that date and so remained for eight months. In late 2001 and during the first half of 2002, the South African stock market showed higher volatility, with the highest probabilities associated with $P(s_t = 2)$. The

change in the foreign scenario, mainly deriving from the U.S. stock market, may have been decisive for this result.

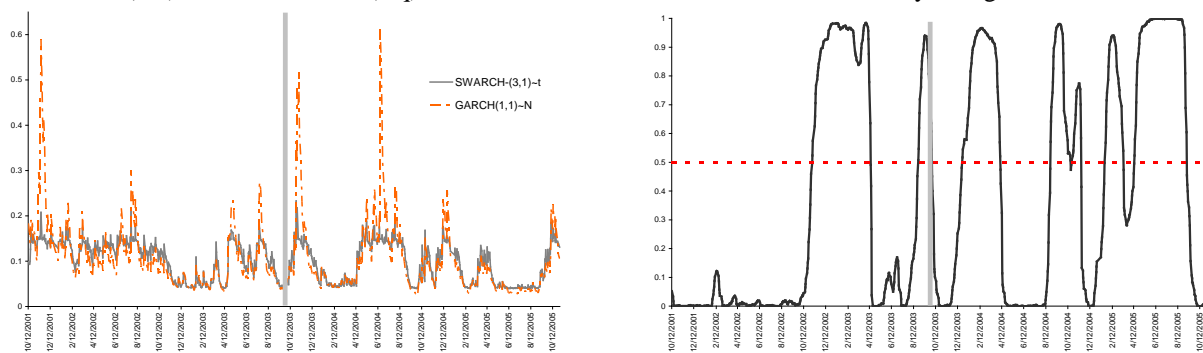
Graph 3.6 – Compared volatilities for South Africa – GARCH and SWARCH and $P(s_t = 1)$
GARCH(1,1) and SWARCH-L(k,q) volatilities



Estimates for data from Russia show lack of a leverage effect, as observed in the GARCH(1,1) model, but a Student's t distribution is accepted. The best formulation is that with three variance regimes, where volatility of the second regime is approximately 4.3 times higher than that of the first regime, and in the third regime, it is twice higher than in the first regime. The set of graphs 3.7 shows the comparison between volatility estimates in the case of the GARCH(1,1) and SWARCH-L(3,1) models for Russia. They differ more slightly between both formulations, particularly in moments of market stress, in which volatility rises to a peak. The gray bars show when the country obtained the investment grade.

It should be noted that Russia went through a period of relative calmness in the international scenario during the period analyzed herein and which might be signaling lower volatilities. However, the estimates of the low volatility regime did not show the same persistence than that seen in the Chilean and Mexican stock markets. Moreover, here they indicate an average of only 49 days. On the days that preceded the investment grade rating, the market was experiencing low volatility, which was reversed right afterwards. Only after one year did probability of regime 1 prove to be more persistent. An interesting aspect of the results for the Russian stock market is that estimates for the probabilities of remaining in each volatility regime are high, as can be seen for $p_{33} = 0.94$, $p_{22} = 0.986$ and $p_{33} = 0.94$.

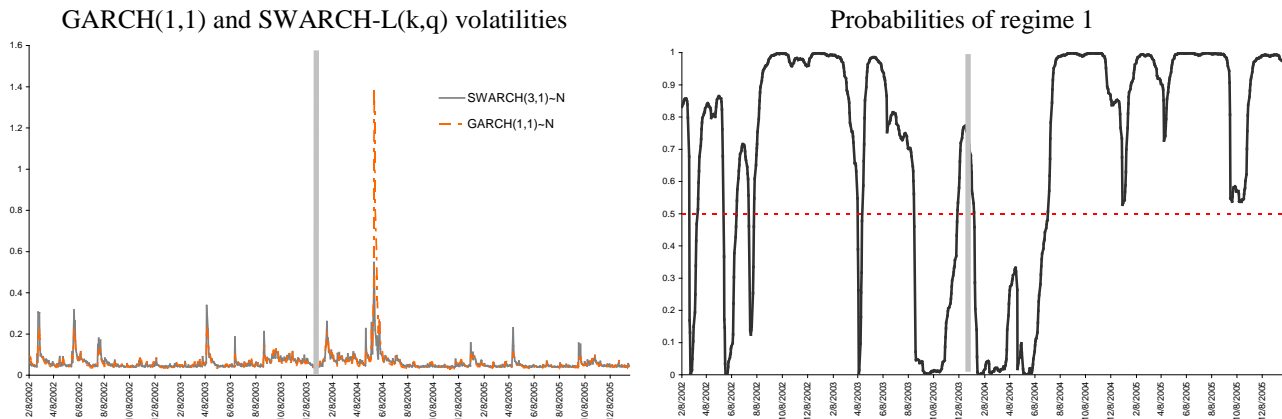
Graph 3.7 – Compared volatilities for Russia – GARCH and SWARCH and $P(s_t = 1)$
GARCH(1,1) and SWARCH-L(k,q) volatilities



Finally, we have the results for the last country considered herein to obtain the investment grade. Results of the volatility regime-switching model for India indicate a well-defined relationship between the grant of investment grade and lower stock market risk. Volatility estimates between the GARCH(1,1) and SWARCH(3,1) models are very similar, except for the shock in June

2004, as shown in the set of graphs 3.8. The leverage effect was not significant and was removed from the model, and this result contrasts with the one found in the GARCH(1,1)-L model.

Graph 3.8 – Compared volatilities for India – GARCH and SWARCH and $P(s_t = 1)$



Volatility in regime 2 is approximately 10 times higher than that found in regime 1, captured on the same date on which volatility reached an all-time high, i.e., in June 2004. As this is an isolated event, its persistence is low, as confirmed by $1/(1 - \hat{p}_{22}) = 4$, i.e., an average of 4 days in the high volatility regime. The probability of being in a low volatility regime and remaining in it is high for the period analyzed herein, $p_{11} = 0.989$, indicating the highest average of days in this state, $1/(1 - \hat{p}_{11}) = 92$. Approximately three months after obtaining the investment grade, the stock market risk in India was low and remained so throughout the sampled period.

The results pointed above signal a difference in the frequency at which low volatility regimes occurred, given by $P_{s_t=1}$, for Chile, Mexico and Russia, when comparing the periods before and after the grant of the investment grade. In Chile, for example, it is possible to note that in 30% of the trading days alone market volatility was low before the risk rating upgrade (Table 3.5). Nevertheless, in the two years that followed the investment grade, the frequency reached nearly 80% of the trading days. On the other hand, there is no evidence of this change in the Indian and South African markets. Except for Russia, the persistence of regime 1 is high, ranging from 68 days in Mexico to 92 days in India.³

Table 3.5 – Frequency of $P_{s_t=1}$ – low volatility

	Chile	Mexico	South Africa	Russia	India
Before investment grade	29%	5%	63%	27%	73%
After investment grade	79%	44%	55%	51%	77%
Total	55%	25%	58%	39%	75%
$(1 - \hat{p}_{11})^{-1}$	76	68	72	49	92

4. Conclusions

The present paper investigated the conditional volatility of the major stock market index in five emerging countries that obtained the investment grade. The main contributions of this paper were in identifying the existence of a response pattern of this market to the best risk rating upgrade. 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. However, there are differences regarding the time at which the impact occurs. The anticipation of investment grade occurs in the first moment of the stock index returns series, but not in the second moment.

³ SWARCH-L(k,q) models were also estimated for each country, similarly to the deterministic models of Table 3.3, splitting the sample into before and after the investment grade; however, the results were not satisfactory. Formulations with $k=4$ did not converge either, probably because of the large number of parameters.

In the set analyzed herein there is evidence that investment grade produces a volatility regime switching, which is immediate in Chile and South Africa. In India, there is a lag of three months before a decrease in stock market risk, albeit with a longer duration. On the other hand, positive effects in Russia and Mexico occurred only after one year. In addition, volatility regime switching model can capture moments in which there is a greater stock market stress, represented by higher estimated volatility, but of shorter duration, as shown by $1/(1-\hat{p}_{22})^{-1}$. The formulations do not indicate asymmetric response of volatility to positive and negative returns, differently from other studies, especially (Hamilton *et al.*, 1994). It should be noted that these results are useful for characterizing future movements of other economies, such as Peru and Brazil, whose investment grade has been recently upgraded.

Some aspects are relevant for guiding future research. First, it is important to find support for this result in a wider set of countries and to broaden the period of analysis. It would also be interesting to use a simultaneous equation model in the presence of heteroskedasticity, as proposed by (Rigobon, 2001). It is also important to verify the existence or not of asymmetry in stock market returns or volatility between the upgrade and downgrade of risk ratings.

References

- ARORA, V.; BHUNDIA, A. (2003), Potential output and total factor productivity growth in Post-Apartheid South Africa, IMF Working Paper N° 178, Washington.
- BARRO, R.J. (1999), Determinants of Economic Growth: Implications of the Global Experience for Chile, Cuadernos de Economía, 36(107): pp. 443-478.
- BERGOEING, R.; KEHOE, P.; KEHOE, T.; SOTO, R. (2001), A decade Lost and Found: Mexico and Chile in the 1980s, Documento de Trabajo N° 107, Banco Central de Chile, Chile.
- BESSONOVA, E.; KOZLOV, K.; YUDAEVA, K. (2003) Trade Liberalization, Foreign Direct Investment, and Productivity of Russian Firms, Dynamic, Economic Growth, and International Trade, Conference Papers.
- BHEENICK, E. B. (2004), Rating timing differences between the two leading agencies: Standard and Poor's and Moody's, Emerging Markets Review, 5, pp. 361-378.
- BLECKER, R.A. (2007), External Shocks, Structural Change, and Economic Growth in Mexico, 1979-2006, Working Paper N° 157, Political Economy Research Institute, University of Massachusetts Amherst.
- BOLLERSLEV, T. (1986), Generalized Autoregressive Conditional Heteroskedasticity, Journal of Econometrics, v. 31, pp. 307-328.
- BOLLERSLEV, T.; CHOU, R.Y.; KRONER K.F. (1992), ARCH Modeling in Finance: A Review of the Theory and Empirical Evidence, Journal of Econometrics, v. 52, pp. 5-59.
- DICHEV, I.D.; PIOTROSKI, J.D. (2001), The Long-Run Stock Returns following Bond Ratings Changes, The Journal of Finance, vol.56, N° 1, pp.173-203.
- ENGLE, R.F. (1982), Autoregressive Conditional Heteroskedasticity with Estimates of the Variance of the United Kingdom Inflation, Econometrica, v.50, pp. 987-1007.
- ENGLE, R.F. (2002), New Frontiers for ARCH Models, Journal of Applied Econometrics, Vol.17, N° 5, Special Issue: Modelling and Forecasting Volatility, pp.425-446.
- ENGLE, R. F.; NG, VICTOR K. (1993), Measuring and Testing the Impact of News on Volatility, Journal of Finance, n.48/5, pp. 1749-78.
- FULOP, A. (2006), Feedback effects of rating downgrades, working paper, ESSEC Centre de Recherche.
- GLASCOCK, J.L.; DAVIDSON, W.N.; HENDERSON, G.V. (1987), Announcement effects of Moody's bond ratings changes on equity returns, Quarterly Journal of Business and Economics, Vol. 26, pp.67-78.
- GLOSTEN, L.R.; JAGANNATHAN, R.; RUNKLE, D. E. (1993), On the Relation Between Expected Value and the Volatility of the Nominal Excess Return on Stocks, Journal of Finance, v. 48, pp. 1779-1801.
- GORIAEV, A.; ZABOTKIN, A. (2006), Risks of investing in the Russian stock market: Lessons of the first decade, Emerging Markets Review, 7, pp. 380-397.
- GRAY, S.F.(1996), Modeling the conditional distribution of interest rates as a regime-switching process, Journal of Financial Economics, 42, pp.27-62.
- HAAS, M.; MITTNIK, S.; PAOLELLA, M.S. (2004), A new approach to Markov-switching GARCH models, Journal of Financial Econometrics, 4, pp.493-530.
- HAMILTON, J.D.; SUSMEL, R. (1994), Autoregressive conditional heteroskedasticity and changes in regime, Journal of Econometrics, 64, pp.307-333.
- HAND, J.R.M.; HOLTHAUSEN, R.W.; LEFTWICH, R.W. (1992), The effect of Bond Rating Agency Announcements on Bond and Stock Prices, The Journal of Finance, Vol.47, n° 2, pp.733-752.
- HOLTHAUSEN, R.W.; LEFTWICH, R.W. (1986), The effect of bond rating changes on common stock prices, Journal of Financial Economics, Vol.17, 57-89.

- IMPSON, C.M.; KARAFIATH, I.; GLASCOCK, J. (1992), Testing Beta Stationarity across Bond Rating Changes, *The Financial Review*, Vol. 27, N° 4, pp.607-618.
- KAMINSKY, G.; SCHMUKLER, S. (2001), Emerging markets instability: Do sovereign ratings affect country risk and stock returns? Working paper, George Washington University mimeo, Washington.
- KIM, SUK-JOONG, WU, E. (2008), Sovereign credit ratings, capital flows and financial sector development in emerging markets, *Emerging Markets Review*, 9, pp. 17-39.
- KLAASSEN, F. (2002), Improving GARCH volatility forecasts with regime-switching GARCH, *Empirical Economics*, 27, pp. 363-394.
- LANGE, M.; RAHBEK, A. (2007), An introduction to regime switching time series, in T.G. Andersen, R.A. Davis, J.-P. Kreiss and T. Mikosch (eds), *Handbook of Financial Time Series*, Springer, New York.
- LOUGHRAN, T.; RITTER, J.R. (1995), The new issues puzzle, *Journal of Finance*, Vol.50, pp.23-51.
- MICU, M.; REMOLONA, E.; WOOLDRIDGE, P. (2006), The price impact of rating announcements: which announcements matter?, BIS working papers N° 207.
- NELSON, D.B. (1991), Conditional Heteroskedasticity in Asset Returns: A New Approach, *Econometrica*, v.59, pp.347-70.
- PINCHES, G.E.; SINGLETON, J.C. (1978), The adjustment of stock prices to bond rating changes, *Journal of Finance*, Vol.33, pp.29-44.
- PLESSIS, S.D.; SMIT, B. (2007), South Africa's growth revival after 1994, Stellenbosch Economic Working Papers n° 01/06.
- POLWITON, S.; TAWATNUNTACHAI, O. (2008), Emerging Market Bond Funds: A Comprehensive Analysis, *The Financial Review* 43, pp.51-84.
- RIGOBON, R. (2001), The curse of non-investment grade countries, Working paper n° 8636, NBER.
- SELAIVE C.,J.; DÉLANO T.,V (2006), Premios soberanos : una aproximación factorial, *Economía Chilena*, Vol. 9, N° 1, pp.49-67.
- SHAH, A.; PATNAIK, I. (2007), India's experience with capital flows: The elusive quest for a sustainable current account deficit, In: S. Edwards (ed.) "Capital controls and capital flows in emerging economies: Policies, practices and consequences" Chapter 13, 609-643, The University of Chicago Press.
- URIBE, M.; YUE, V.Z. (2004), Country Spreads and Emerging Countries: Who drives whom? Proceedings, Federal Reserve Bank of San Francisco.
- VIRMANI, A. (2006), India's Economic Growth History: Fluctuations, Trends, Break Points and Phases, *Indian Economic Review*, Vol. 41 (1), pp.81-103.

Notes

- [1] The assumption that historical volatility is conditional over time was extensively investigated in the econometrics literature using models of the GARCH family; see Bollerslev et al. (1992) and Engle et al. (1993). The advantage of using these classes of models is to capture several stylized facts in finances, such as volatility clustering, asymmetry of returns and volatility, and volatility response to shocks, measured by persistence.
- [2] In this case, the log-likelihood function is given by $L_n(L) = \sum_{t=1}^n \ln[f(y_t / s_t)]$, and the number of parameters to be estimated increases considerably.
- [3] Moody's was the first agency to award investment grade to the country, upgrading its rating from Ba1 to Baa3 for the long-term debt in foreign currency. In the same month, S&P upgraded the risk rating for the same type of debt, from BB to BB+; however, the score was still below the investment grade level, based on the methodology used by this agency. Only in February 2002 did S&P rate Mexico as investment grade.
- [4] Data for Chile range from December 3, 1990 to December 30, 1994; from March 2, 1998 to March 27, 2002 for Mexico; from January 1, 1999 to June 28, 2002 for South Africa; from October 2, 2001 to October 31, 2005 for Russia; and from January 21, 2002 to January 23, 2006 for India.
- [5] In August 1998, Moody's awarded grade B3 to Russian sovereign bonds, i.e. six levels below the investment grade. At the end of April 2001, Russia obtained grade B2.
- [6] In each graph, gray bars indicate the date on which investment grade was obtained.
- [7] Persistence in GARCH(1,1) models is given by $\alpha + \beta$, where $h_t = w + \alpha \varepsilon_{t-1}^2 + \beta h_{t-1}$. In the GJR model, persistence is given by $\lambda = (\alpha_1 + \beta_1 + \xi / 2)$. It should be noted that this high persistence is characteristic of conditional volatility models that do not take into account regime switching; see Hamilton et al. (1994).
- [8] Engle et al. (1993) show that the model proposed by Glosten et al. (1993) is the one that best represents the leverage effect on volatility.