Rating Shock and Regime Shift: How Brazil's 2016 Rating Cut Altered the Dynamics of the Ibovespa (1994-2023)[a]

Choque de rating e mudança de regime: como o rebaixamento do Brasil em 2016 alterou a dinâmica do Ibovespa (1994-2023)

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Abstract: This paper examines the impact of Brazil's the impact of Brazil's sovereign downgrade within speculative territory in February 2016 on the dynamics of the Ibovespa index using daily data from 1994 to 2023. A Vector Autoregression (VAR) model combined with a Chow structural break test is employed to disentangle the effects of global shocks (Dow Jones, CRB Index) and domestic factors (SELIC, exchange rate), as well as anticipatory market behavior captured through a pre-announcement dummy. The results reveal strong financial integration, with a 1% increase in the Dow Jones associated with a cumulative rise of approximately 0.63% in the Ibovespa. Domestic monetary tightening exerts a delayed negative effect, while commodity price increases support equity valuations. Evidence of pre-event adjustment suggests that investors partially anticipated the downgrade. Overall, the findings indicate that the 2016 downgrade triggered a persistent regime shift in risk pricing, with long-lasting implications for sovereign credibility and portfolio allocation in emerging markets.

Keywords: Sovereign Downgrade. Ibovespa. VAR. Structural Break. Macroeconomics.

Resumo: Este estudo investiga os efeitos do rebaixamento soberano do Brasil, em fevereiro de 2016, sobre o comportamento do índice Bovespa, utilizando dados diários de 1994 a 2023. Um modelo Vetorial Autorregressivo (VAR) com múltiplas defasagens e o teste de Chow são empregados para avaliar o impacto de choques externos (Dow

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Jones, CRB Index), variáveis domésticas (SELIC, taxa de câmbio) e uma dummy de pré-anúncio de 15 dias. Os resultados mostram que um aumento de 1% no Dow Jones eleva o Ibovespa em aproximadamente 0,63%, indicando forte contágio financeiro. No âmbito doméstico, elevações na taxa SELIC afetam negativamente o índice com uma defasagem de nove dias, enquanto a alta nos preços das commodities favorece a valorização das ações, especialmente nos setores voltados à exportação. Evidências de comportamento antecipatório antes do anúncio do rebaixamento sugerem que os participantes do mercado ajustaram suas carteiras previamente ao evento. Em conjunto, o estudo revela que o rebaixamento do Brasil desencadeou não apenas volatilidade de curto prazo, mas também uma mudança de regime na precificação do risco, com implicações duradouras para a credibilidade soberana e as decisões de portfólio em economias emergentes.

Palavras-chave: Rebaixamento soberano. Ibovespa. VAR. Quebra estrutural. Macroeconomia.

JEL: G14. G24.

1. Introduction

Recent events have reignited the debate over the role of credit rating agencies in the pricing of financial assets. In August 2023, Fitch downgraded the United States from AAA to AA+; less than two years later, in May 2025, Moody's followed by lowering its rating to Aa1. Although these downgrades triggered only mild reactions in U.S. stock markets, they catalyzed academic discussions on market resilience when the issuer holds the privilege of issuing the global reserve currency (Azmi *et al*., 2023; Nicholson, 2023; Eichengreen, 2011).

The contrast is striking when considering Brazil's downgrade on February 17, 2016, by Standard & Poor's (S&P), from BB+ to BB. The announcement occurred amid the 2014-2016 recession, during which GDP contracted by 3.5% in 2015 and 3.3% in 2016, consolidating a cycle of deterioration and instability in capital markets (World Bank, 2025). The asymmetric market response suggests that the magnitude of the effects from a sovereign downgrade within speculative territory is conditional not only on the country's fiscal soundness but also on its level of economic development. The literature emphasizes that such events typically have asymmetric effects: downgrades tend to provoke more intense and persistent reactions than upgrades, particularly in emerging markets (Freitas; Minardi, 2013; Cruz de Souza; Borba, 2013). This asymmetry is not only linked to fiscal and institutional fragilities but also to market liquidity and the composition of the investor base. Han *et al*. (2009) show that, in emerging markets, the impact is more pronounced on American Depositary Receipts (ADRs) traded abroad than on local exchanges, indicating that market sophistication influences sensitivity to rating announcements. Similarly, Ismailescu and Kazemi (2010) find that sovereign spreads in emerging markets react significantly and persistently to downgrades, unlike the patterns observed in developed economies. The authors attribute this asymmetry to the greater presence of foreign investors in emerging markets and the heightened perception of risk, which amplifies the response to negative news.

In the Brazilian case, empirical studies support this pattern. Cruz de Souza and Borba (2013) document that sovereign downgrades generate statistically significant negative abnormal returns for domestic firms, whereas upgrades do not elicit notable effects. Markoski and Moreira (2010) find impacts restricted to the first two trading days following the announcement, with no evidence of persistence. Espíndola (2017) identifies signs of market anticipation through the behavior of variables such as the EMBI+, the exchange rate, and interest rate futures, although no structural break is detected in the Ibovespa on the announcement date.

Despite the abundance of international evidence, few studies have examined the effect of sovereign downgrades on Brazil's main stock market index using high-frequency data over a long time horizon. Moreover, there is a notable lack of studies that combine formal structural break tests with multivariate VAR models capable of isolating external shocks (Dow Jones, CRB Index) and domestic variables (SELIC, exchange rate) using extensive daily time series.

In this context, this article investigates how Brazil's February 2016 sovereign downgrade, altered the dynamics of the Bovespa index. The study quantifies the impact of the downgrade while controlling for external shocks (Dow Jones, CRB Index), domestic monetary conditions (SELIC, exchange rate, EMBI+), and ultra-short-term endogenous adjustments. It also tests for the presence of a structural break on the event date and assesses the speed of market adjustment and the degree of investor anticipation through extended lags and a 15-day pre-announcement dummy. To this end, a six-variable daily VAR is estimated using 7,287 observations spanning from 1994 to 2023. The model includes a 15-day pre-event dummy and applies the Chow test on February 17, 2016, to detect potential structural breaks. By combining high-frequency data, extended lags, and formal regime shift tests, the study contributes to the literature on asset pricing in emerging markets and on how quickly the Brazilian market internalizes sovereign risk shocks.

The central hypothesis of this study is that the sovereign downgrade of Brazil's investment-grade status represented a significant structural turning point in financial markets, reflected in a measurable change in the correlation between the downgrade event and fluctuations in the Bovespa index, which serves as the main benchmark for equity performance in Brazil.

The paper is structured into four sections in addition to this introduction. The next section reviews the literature on credit rating impacts in emerging markets, highlighting transmission channels and evidence of asymmetry. Section 2 presents the methodology, describing the six-variable VAR model, the construction of the pre-announcement dummies, and the daily dataset covering

1994-2023. Section 3 discusses the results, with emphasis on the magnitude, duration, and potential persistence of the 2016 shock. Finally, Section 4 offers concluding remarks.

2. Investiment grade status: theory and evidence on sovereign downgrades

Although often regarded as mere reflections of a country's fiscal solvency, sovereign credit ratings carry profound implications for the dynamics of financial markets. By synthesizing both public and private information regarding a government's ability and willingness to honor its debt obligations, these ratings act as catalysts for asset repricing, portfolio reallocation, and, in many cases, liquidity shocks. Unsurprisingly, the global credit rating industry remains highly concentrated among three major agencies – Standard & Poor's (S&P), Moody's, and Fitch Ratings – which together issue more than 95% of all sovereign and corporate credit ratings in circulation (White, 2010). While each agency employs its own rating scale, all of them emphasize the threshold separating investment-grade (BBB-/Baa3 and above) from speculative-grade (high-yield) debt. Ratings summarize a relative assessment of the debtor's capacity and willingness to service senior unsecured obligations, based on publicly available information as well as confidential data voluntarily disclosed by the issuer (Cantor; Packer, 1996).

When new developments emerge that may alter perceived credit risk, agencies rely on two short-term tools. The "CreditWatch" list signals an imminent likelihood of rating change, whereas "Outlooks" (positive, stable, or negative) indicate trends that do not yet warrant immediate action but may materialize within a one- to two-year horizon (S&P Global Ratings, 2022).

From a legal standpoint, sovereign default occurs when a debt payment is not made after the contractual grace period. Unlike corporations, sovereigns do not undergo formal bankruptcy proceedings; instead, defaults are typically followed by voluntary restructurings or debt exchanges involving principal haircuts, reduced coupon payments, and extended maturities (Sturzenegger; Zettelmeyer, 2008). While such arrangements reduce the present value of debt service, they also entail reputational costs, risk of asset seizure, tighter regulatory scrutiny, constraints on access to international financing, and trade disruptions (Borensztein; Panizza, 2010).

Protection against these risks is traded in the form of credit default swaps (CDSs). Standardized CDS contracts for emerging markets consider sovereign restructuring a credit event trigger (Packer; Suthiphongchai, 2003; Packer; Zhu, 2005). Depending on the terms, settlement may occur physically or financially – the latter involving a cash payment by the protection seller to cover the difference between face value and the market price of the defaulted bond. The amount paid reflects the effective loss incurred due to the credit event (Bolton; Oehmke, 2013). Thus, credit ratings issued by agencies (CRAs) directly influence borrowing costs and portfolio allocation. In particular, a downward revision below investment grade can trigger contractual restrictions, drive capital outflows, and ultimately affect asset pricing – a core mechanism explored in the empirical analysis of this study.

The literature identifies three main channels through which sovereign rating changes affect asset prices. First, regulatory mandates and portfolio guidelines may force institutional investors to divest securities downgraded below investment grade, generating liquidity pressures (Ellul; Jotikasthira; Lundblad, 2011; Arezki; Candelon; Sy, 2011). Second, rating changes may convey private information about a country's future solvency, thereby altering the risk premium required by investors (Cantor; Packer, 1996). Third, rating announcements often trigger high-frequency news flows that amplify market volatility, particularly in emerging economies with elevated foreign investor participation (Kaminsky; Schmukler, 2002; Ismailescu; Kazemi, 2010). Evidence from Latin America also indicates that stock markets exhibit statistically significant negative abnormal returns for up to five trading days following a downgrade, while upgrades tend to generate weaker or insignificant reactions (Gande; Parsley, 2005; Ismailescu; Kazemi, 2010).

Empirical studies consistently document this asymmetric pattern: credit rating downgrades provoke statistically significant negative responses in asset prices, whereas upgrades often have muted or no discernible effects. In the fixed income market, research by Hite and Warga (1997), Steiner and Heinke (2001), and Gande and Parsley (2005) confirms that bond returns are negatively affected around downgrade announcements. Similar findings are observed in equity markets (Dichev; Piotroski, 2001; Vassalou; Xing, 2003), as well as in studies spanning both asset classes (Hand; Holthausen; Leftwich, 1992). Hand *et al*. further note that the impact is greater when the issuer is already rated below investment grade and, therefore, more susceptible to regulatory-driven forced selling.

Moreover, the issue of market anticipation has attracted increasing attention. Using high-frequency data, Norden and Weber (2004) show that CDS spreads and equity prices often incorporate negative information before the official downgrade announcement, whereas they tend not to react to positive news. Hull, Predescu, and White (2004) also find that CDS premiums begin to widen ahead of Moody's downgrades, providing valuable input for probabilistic estimates of rating changes. Studies of cross-market transmission reveal that CDS shocks can quickly spill over to the stock prices of firms with high credit risk (Acharya; Johnson, 2007), while information flows in the opposite direction in the case of moderate-risk issuers (Forte; Peña, 2009).

Long-run event studies further highlight the heterogeneous nature of these effects. Katz (1974) and Grier and Katz (1976) show that, within specific U.S. industrial sectors, bond yields and prices often anticipate downgrades by up to 12 months, although the speed of price adjustment varies by industry. Pinches; Singleton (1978), analyzing 207 firms between 1950 and 1972, conclude that investors tend to adjust prices well before agencies officially revise their ratings—especially in the case of downgrades preceded by identifiable adverse events.

The empirical literature on the effects of sovereign rating changes on equity markets remains mixed but consistently shows a stronger market response to downgrades than to upgrades. In the U.S. corporate sector, several classical studies report statistically significant negative abnormal returns only in the case of downgrades (Griffin; Sanvicente, 1982; Nayar; Rozeff, 1994; Hand; Holthausen; Leftwich, 1992), with upgrades generally lacking clear informational content. Jorion; Zhang (2007) reinforce this asymmetry, showing that both types of announcements can be relevant, but negative events tend to elicit stronger reactions.

For the Brazilian case, empirical evidence consistently points to an asymmetric response between upgrades and downgrades. Markoski; Moreira (2010), using daily data from 1994 to 2003, find that the Ibovespa index exhibits abnormal returns confined to a ±1 day window, with downgrades producing significantly larger impacts than upgrades – suggesting that negative news is incorporated more swiftly. Espíndola (2017), employing credit market indicators, shows that CDS spreads, forward SELIC rates, and the USD/BRL exchange rate all signaled the 2016 downgrade weeks in advance, indicating a process of "pre-event learning." More recent findings from 11-day event windows reveal that the 2008 upgrade to investment-grade status did not generate statistically significant abnormal returns, whereas the 2015 downgrade to speculative grade triggered significant losses – particularly in common stocks – thus reaffirming the predominance of negative market signals (Barros; Colauto, 2020).

Taken together, these empirical findings suggest that financial markets tend to absorb downgrades more rapidly and intensely than upgrades. Credit and exchange rate instruments often incorporate part of the shock ahead of the official announcement, and while the equity market response may be short-lived, it can also signal structural inflection points in the financial system—a gap that this study seeks to address by formally testing for a structural break on February 17, 2016, using more than 7,000 daily observations.

3. Data, Model and Identification

To quantify the impact of the sovereign downgrade of February 17, 2016, on the Ibovespa index, we estimate a Vector Autoregression (VAR) model following the classical formulation proposed by Sims (1980). The VAR framework captures dynamic interdependencies among multiple endogenous variables without imposing a priori causal structure, making it especially suitable for assessing market responses to non-structural shocks. It is particularly effective for analyzing multivariate time series in which variables are interrelated. One of the main advantages of the VAR model is its ability to track the dynamic evolution of a system over time, which is essential for forecasting and identifying shocks in the dependent variables. In its general form, the VAR model can be expressed as:

$$Y_t = \mathrm{c} + A_1\, Y_{t-1} + \cdots + A_\rho\, y_{\mathrm{t-p}} + \varepsilon_{\mathrm{t}} \qquad (1)$$

Where Y_t=(y_{1t}, y_{2t}, …,y_{kt},) is a vector of (non)stationary endogenous variables, c is a vector of constants, A_1,…, A_ρ are coefficient matrices, and ε_{t} is a white noise vector with covariance matrix Σ, ssumed to be symmetric and positive-definite (Krätzig; Lütkepohl, 2004).

Our daily-frequency VAR model includes six endogenous variables over the period 1994-2023, totaling 7,287 observations. The variables are: Ibovespa, Dow Jones, CRB Index, SELIC rate, spot exchange rate (USD/BRL), and the EMBI+ risk index. Additionally, a dummy variable ("D-15") is included, taking the value of 1 between t-15 and t-1, following Almeida (2011), to capture anticipatory effects. The choice of a fifteen-day window is grounded in the event study literature using high-frequency data, which suggests that financial markets tend to price in sovereign downgrades a few days prior to the official announcement, but rarely beyond a three-week horizon (Norden; Weber, 2004; Ismailescu; Kazemi, 2010). This window also helps to preserve the exogeneity of the dummy by minimizing the risk of contamination from unrelated macroeconomic events.

Lag length selection was based on the Akaike Information Criterion (AIC). The AIC and Hannan-Quinn (HQC) criteria suggested 13 lags, while the Bayesian Information Criterion (BIC) pointed to 4. Given our focus on medium-term dynamics, we adopt 13 lags, consistent with common practice in high-frequency studies analyzing rating shocks (Almeida, 2011). A detailed description of the lag selection criteria and results is provided in Appendix A. LM autocorrelation tests, White's test, and the Breusch-Pagan-Godfrey test showed no significant problems of serial correlation or heteroskedasticity in the residuals. Moreover, the Durbin-Watson statistic (close to 2.0) indicates the absence of first-order autocorrelation.

Regarding stationarity, Augmented Dickey–Fuller (ADF) and Phillips-Perron (PP) tests revealed the presence of unit roots in all variables in levels. Accordingly, all series were first-differenced prior to estimation, ensuring that they entered the model as integrated of order zero processes (I(0)), in line with recommendations by Gujarati and Porter (2011).

Although alternative autoregressive frameworks could be considered, the choice of a standard reduced-form VAR is deliberate and closely aligned with the objectives of this study. The primary goal is not to recover deep structural shocks or impose a fully specified causal ordering among macro-financial variables, but rather to assess whether the sovereign downgrade of Brazil's in February 2016 altered the reduced-form dynamics governing the Ibovespa and its interaction with key external and domestic variables. In high-frequency financial settings, identifying contemporaneous structural restrictions, as required in SVAR models, often relies on strong and potentially arbitrary assumptions, particularly when variables such as global equity indices, exchange rates, sovereign risk, and commodity prices respond almost simultaneously to common information shocks. As emphasized by Cooley and Leroy (1985), different structural representations may be observationally equivalent in reduced form, making structural identification contentious in the absence of a well-defined theoretical hierarchy. In this context, a reduced-form VAR combined with a formal Chow test offers a transparent and statistically rigorous framework to test parameter stability and regime shifts associated with a clearly dated exogenous event, without imposing restrictions that could bias inference.

It is important to note that, although the VAR is specified in a fully endogenous framework, the analysis focuses on the first difference of the Ibovespa (D_IBOV) as the variable of primary interest, while the remaining macro-financial variables – EMBI+, USD Spot, Dow Jones, SELIC, and CRB Index – are included to capture the broader system dynamics and transmission mechanisms.

Table 1 below summarizes the six model variables along with their definitions and sources:

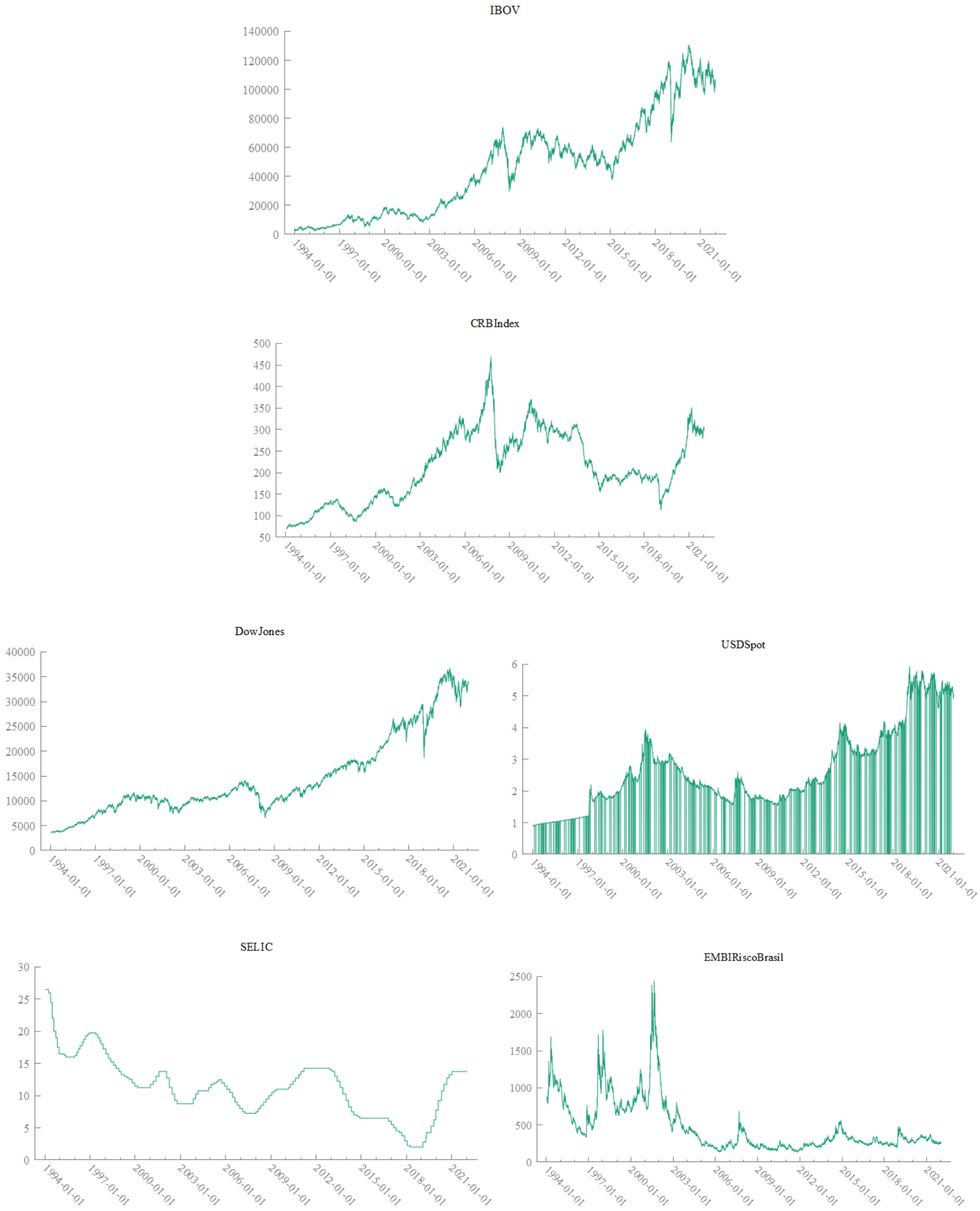
Table 1 – Variable description

Variable	code	Source	Series Description	Unit
EMBI+ Brazil	EMBI	IPEA	Emerging Markets Bond Index Plus for Brazil; measures daily sovereign bond spreads vs. U.S. Treasuries	Basis points
Spot Exchange Rate	USDSpot	FRED	Brazilian reais per U.S. dollar, not seasonally adjusted	BRL/USD
Dow Jones Index	DowJones	Nelogica l Profit Ultra	Dow Jones Industrial Average (DJIA); includes 30 major U.S. firms excluding transportation and utilities	Basis points
SELIC Rate	SELIC	BCB (Brazilian Central Bank)	Brazil's benchmark interest rate, affecting all other domestic rates	% per annum
CRB-Index	CRBIndex	Bloomberg Terminal	Thomson Reuters/Core Commodity CRB Total Return Index; based on futures prices for 19 commodities	Basis points
Ibovespa	IBOV	Nelogica l ProfitUltra	Main benchmark for Brazilian stock market performance, based on leading B3 companies	Basis points

Source: Research data.

Figure 1 displays the evolution of the main variables in levels over the period 1994-2023, with a vertical line marking February 17, 2016. A visual inspection suggests changes in trend and volatility around the downgrade episode, particularly for the Ibovespa and sovereign risk indicators, reinforcing the motivation for the formal structural break tests conducted in the next section.

Figure 1 – Evolution of main financial and macroeconomic Variable (1994-2023)



Source: Research data.

Table 2 presents descriptive statistics for the six variables:

Table 2 – Descriptive statistics

Variable	Observations	Mean	Std. Dev.	Max	Min
EMBI +	7.287	477,40	350,81	2.443,00	136,00
USD-Spot	7.287	2,52	1,32	5,92	0,89
Dow Jones	7.287	14.493,08	8.084,84	36.797,36	3.598,71
SELIC	7.287	11,44	4,61	26,50	2,00
CRB-Index	7.287	212,24	81,94	469,70	69,42
IBOV	7.287	45.994,82	34.054,91	130.776,27	2.138,20

Source: Research data.

Figure 1 presents the evolution of the main variables in levels over the period 1994–2023, with a vertical line indicating February 17, 2016. Visual inspection suggests shifts in both trend and volatility around the downgrade episode, particularly for the Ibovespa and sovereign risk indicators, thereby supporting the use of formal structural break tests in the following section.

The next section presents and discusses the results of the econometric estimation.

4. Analysis of Results

Interpreting the lagged coefficients is the first step in assessing whether the VAR model realistically reproduces the transmission mechanisms that motivated its specification. Identifying which lags are statistically significant serves three purposes: (i) it validates the choice of 13 lags, ensuring that neither external shocks nor domestic feedbacks are truncated; (ii) it reveals the speed at which global information is incorporated into the Ibovespa; and (iii) it highlights potential windows for monetary or macroprudential intervention during which the effects of shocks have not yet dissipated.

As a preliminary diagnostic, static OLS regressions are estimated to assess the contemporaneous explanatory power of external (Dow Jones and CRB Index) and domestic (SELIC, Exchange rate, and EMBI+) variables on daily Ibovespa returns. Table 3 reports joint F-tests from preliminary static OLS regressions. Joint F-tests indicate that neither block is statistically significant at conventional levels, and the overall explanatory power remains modest. This result is consistent with the well-documented low predictability of high-frequency equity returns, which are largely driven by idiosyncratic news, market microstructure effects, and rapid information diffusion. Importantly, the absence of strong contemporaneous effects motivates the use of a dynamic VAR framework, where the relevance of global and domestic factors emerges through lagged transmission mechanisms, cumulative responses, and parameter instability rather than through static correlations.

Table 3 – Joint F-Tests: Preliminary ols diagnostics

Block of variables	Restrictions tested	F-statistic	p-value
External variables	Dow Jones, CRB Index	F(2, 7295) = 1.945	0.143
Domestic variables	SELIC, USD/BRL, EMBI+	F(3, 7295) = 1.205	0.306

Source: Research data.

Notes: Joint F-tests are based on a static OLS specification with daily Ibovespa returns (ΔIBOV) as the dependent variable. The tests evaluate the null hypothesis that the coefficients of each block of variables are jointly equal to zero.

Table 4 summarizes the estimated coefficients. Among the lagged variables, the significance of Dow Jones returns at lags -1, -5, -6, -8, -10, and -13 suggests that external shocks are transmitted to the Ibovespa in windows that coincide with the release calendar of key U.S. macroeconomic indicators (e.g., employment, inflation, FOMC meetings). This is consistent with the view that high-impact news propagates through global markets in weekly or biweekly waves, influenced by international liquidity flows to emerging economies.

For the Ibovespa's own lags (-1, -6, and -7), the results suggest short-term memory effects linked to recurring seasonal patterns. The intraday reversal documented by Chordia, Roll, and Subrahmanyam (2005) explains the immediate effect at lag -1, while day-of-the-week effects and portfolio rebalancing near the end of the week or month – well-documented by Lakonishok and Smidt (1988) and later updated by Marquering, Nisser, and Valla (2006) – justify the significance of lags -6 and -7.

Table 4 – Var estimation results (dependente Variable: D_IBOV)

Variable	Coefficient	Std. Error	t-statistic	p-value	
const	4,96698	10,4016	[0,4775]	0,633	
d_DowJones_1	0,152873	0,0575407	[2,657]	0,0079	***
d_DowJones_5	0,171291	0,0578225	[2,962]	0,0031	***
d_DowJones_6	0,344665	0,0577233	[5,971]	<0,0001	***
d_DowJones_8	0,802874	0,0579263	[13,86]	<0,0001	***
d_DowJones_10	0,198096	0,0587951	[3,369]	0,0008	***
d_DowJones_13	0,168696	0,0584405	[2,887]	0,0039	***
d_SELIC_9	−249,992	114,01	[−2,193]	0,0284	**
d_CRBIndex_11	10,0956	4,02098	[2,511]	0,0121	**
d_IBOV_1	−0,0643104	0,01179	[−5,455]	<0,0001	***
d_IBOV_6	−0,0313602	0,0118248	[−2,652]	0,008	***
d_IBOV_7	0,0417961	0,0116523	[3,587]	0,0003	***
Dmenos15_7	2059,69	882,009	[2,335]	0,0196	**
Dmenos15_14	1261,09	730,189	[1,727]	0,0842	*
Mean of Dependent Δ	13,83535		Std. Dev. of Dependent Δ	905,281	
Sum of Squared Residuals	5,56E+09		Standard Error of Regression	879,724	
R²	0,068368		Adjusted R²	0,05567	
F (98, 7188)	5,38255		F-Statistic p-value	2,19E-57	

Source: Research data.

Notes: (*) , (**) and (***) denote significance at the 10%, 5%, and 1% levels, respectively.

To test for potential structural breaks, Chow tests were conducted following the procedure adopted by Almeida (2011), which examines different windows prior to the event – specifically 5, 7, and 15 days. The 15-day window was found to be particularly relevant, suggesting that financial agents were able to anticipate and react to the event in advance. The results of the Chow test are reported below (Table 5).

Table 5 – Chow test for structural breaks

Break Date	**Coefficient**	**F-statistic**	**t-statistic**	**p-value**
17/02/2016	4,96698	6,22118	0,4775	0,0000

Source: Research data.
Note: The Chow test evaluates the null hypothesis of parameter stability across the full sample. Rejection indicates a structural break at the specified date.

According to the results presented in Table 5, which reports the outcome of the Chow test, there is strong statistical evidence of a structural break in February 2016 ($F = 6.221$; $p < 0.001$). In other words, the null hypothesis of parameter stability is rejected, confirming that Brazil's sovereign downgrade led to a structural shift in the joint dynamics of the system composed of the Ibovespa, Dow Jones, CRB Index, SELIC rate, USD/BRL exchange rate, and the EMBI+ sovereign risk index. To capture the potential long-term effect of the downgrade, a post-break dummy variable was introduced, taking the value of 1 from February 17, 2016, onward. The positive coefficient associated with this intercept shift indicates that, after controlling for all other variables, the average daily trajectory of the Ibovespa shifted downward, consistent with a permanent repricing of sovereign risk. Specifically, the average daily return of the Ibovespa declined by approximately 0.05 percentage points after February 17, 2016 – equivalent to a loss of around 60 points per day when the index is trading near 120,000 points. This downward shift reveals a persistent deterioration in the market's risk perception toward Brazilian sovereign assets. The identified structural break suggests that the downgrade event significantly altered investor behavior with respect to the Ibovespa. This may reflect a reassessment of macroeconomic fundamentals, heightened perceptions of country risk, or adjustments in investor expectations in response to the downgrade announcement.

With respect to international factors, the Dow Jones Index (as shown in Table 4) is statistically significant at multiple lags – specifically, at days -1, -5, -6, -8, -10, and -13 – with all estimated coefficients being positive. This means that a one-unit increase in "d_DowJones_1," which represents the short-term return on the Dow Jones, is associated with a 0.1528 unit increase in the Ibovespa return (d_IBOV) on the same day. When the effects across all significant lags are aggregated, a 1% increase in the Dow Jones leads to an average cumulative rise of approximately 0.63% in the Ibovespa. This underscores the high degree of integration between Brazilian and global equity markets. The staggered impact pattern is consistent with the timing of U.S. macroeconomic data releases (such as payroll and inflation reports) and with the weekly portfolio rebalancing cycles commonly observed among institutional investors. The magnitude of these coefficients confirms the Brazilian stock market's strong sensitivity to Wall Street fluctuations, in line with the extensive literature on financial contagion in emerging markets (Andersen *et al*., 2007; Bekaert; Harvey, 1997).

Regarding domestic conditions, the SELIC rate (Table 4) exhibits a statistically significant negative effect with a nine-day lag, at the 5% confidence level. The results indicate that an unexpected 1 percentage point hike in the policy rate leads, nine trading sessions later, to an average decline of approximately 250 points in the Ibovespa. This result aligns with the cost-of-capital channel: higher interest rates discourage productive investment, increase borrowing costs, and enhance the attractiveness of fixed-income assets relative to equities, thereby triggering a portfolio reallocation away from stocks.

The CRB commodity index also exerts a statistically significant influence, with a positive effect appearing at a lag of 11 trading days and significant at the 5% level (Table 4). A one-point increase in the CRB index raises the Ibovespa by approximately 10 points, suggesting that rising commodity prices benefit export-oriented firms listed on the B3, particularly in sectors such as energy, mining, and agribusiness. This finding highlights the importance of terms of trade in shaping the performance of the Brazilian equity market, given its structural reliance on global commodity cycles.

Additionally, the dummy variable corresponding to the 15 days preceding the downgrade event is statistically significant at the 1% level (Table 4). This indicates that the Brazilian stock market – proxied by the Ibovespa – anticipated the downgrade and began adjusting asset prices in response to the growing likelihood of a credit rating cut. It suggests that investors may have reacted to early signals or formed expectations about the downgrade before its official announcement.

In sum, the empirical results indicate that the Ibovespa is highly sensitive to both external and domestic shocks. Among international drivers, the cumulative effect of a 1% increase in the Dow Jones leads to an average increase of 0.63% in the Ibovespa, confirming strong financial integration. On the domestic front, a 1 percentage point hike in the SELIC rate results in a drop of about 250 index points nine days later, consistent with the cost-of-capital channel. The CRB Index points to the favorable role of improved terms of trade in supporting stock valuations. Furthermore, the Ibovespa exhibits ultra-short-term endogenous correction mechanisms: roughly 6.4% of a return shock is reversed on the following trading day, as indicated by the negative and significant coefficient of the first lag of d_IBOV. The additional significant lags (-6 and -7) reinforce the existence of a weekly rebalancing pattern, suggesting that a substantial portion of excessive movements dissipates within eight trading days. The pre-announcement dummy confirms that the market anticipated the downgrade and re-priced assets accordingly prior to the formal disclosure. Finally, the structural break identified in February 2016 signals a permanent repricing of sovereign risk, fundamentally altering the sensitivity of the Ibovespa to its underlying macro-financial fundamentals.

5. Final Remarks

Based on the estimation of a Vector Autoregression (VAR) model with 13 lags and six macro-financial variables, as well as the application of the Chow structural break test, the results provide strong evidence of a regime shift in the Brazilian equity market. This structural break, captured by a negative shift of approximately 0.05 percentage points in the daily average return of the Ibovespa (around -60 points per day when the index is near 120,000), reflects a permanent repricing of sovereign risk. Even years after the event, the market continued to demand a higher risk premium to hold Brazilian assets. This persistent effect reinforces the notion that sovereign credit downgrades are not limited to short-term volatility but also reshape the sensitivity of financial markets to macroeconomic fundamentals, with far-reaching implications for economic policy.

On the external front, the analysis highlights the strong correlation between the Ibovespa and the Dow Jones Industrial Average. A 1% increase in the U.S. stock market leads, on average, to a 0.63% rise in the Ibovespa over the distributed lags. This result illustrates the high degree of financial integration and suggests that local investors adjust their portfolios promptly in response to changes in global expectations, an effect consistent with the findings of Andersen *et al*. (2007) and Bekaert and Harvey (1997).

Regarding domestic variables, monetary policy has a statistically significant and economically meaningful effect on the equity market. A one-percentage-point increase in the SELIC rate generates a lagged decline of approximately 250 points in the Ibovespa after nine trading days. This effect reflects the classic cost-of-capital channel: tighter monetary conditions discourage equity investment by increasing the opportunity cost of capital and enhancing the relative appeal of fixed-income assets. Conversely, the appreciation of commodities, captured by the CRB Index, positively affects the stock market with an 11-day lag. This suggests that improvements in the terms of trade benefit export-oriented sectors, particularly energy, mining, and agribusiness firms listed on the B3.

The model also reveals robust endogenous correction mechanisms operating at very short horizons. Approximately 6.4% of a return shock is reversed the following day, and lags -6 and -7 suggest a weekly cycle of adjustments, likely driven by institutional rebalancing or calendar anomalies such as the day-of-the-week effect (Chordia *et al*., 2005; Lakonishok; Smidt, 1988). The significance of the 15-day pre-announcement dummy further confirms that investors anticipated the rating downgrade, with observable effects up to two weeks before the official event. This finding is in line with the notion of pre-event learning discussed by Espíndola (2017).

Taken together, the results show that the Brazilian equity market is highly responsive to both global and domestic shocks. More importantly, the downgrade event in 2016 marked the beginning of a lasting regime of heightened risk aversion. This regime shift persisted through 2023, indicating that credit rating announcements have long-term consequences, effectively reshaping market expectations and behavior. The findings contribute to the broader debate on sovereign credibility and portfolio allocation in emerging markets and underscore the importance of high-frequency monitoring of key financial variables. Future research could explore regime-switching models, such as Markov-switching VARs, to further investigate the persistence and transmission mechanisms associated with such structural changes.

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