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Adaptability in the Brazilian Capital Market: Aspects Associated with Efficiency Reported by Companies Listed in B3

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ABSTRACT

This article aims to verify the influence of political uncertainty, accounting elements, and the macroeconomic environment on the (in)efficiency of securities traded by Brazilian public companies. Between 2000 and 2019, we used 275 non-financial companies with shares traded in B3. We performed regression tests with panel data for two samples, one balanced and one unbalanced, totaling two models. For each model, we performed an additional analysis using the Stepwise method. The dependent variable comprises the inefficiency of daily stock data. The independent variables comprise political-economic uncertainty, the companies' accounting indicators, gross domestic product per capita, and interest rate. We used controls related to the size, liquidity of the shares, and sectors of the companies. According to the selected sample, the results show that higher rentability companies tend to increase efficiency while liquidity positively or negatively affects efficiency. In periods where interest rates are high, there is less efficiency in predicting securities. These results aim to contribute to the literature on adaptive markets by providing evidence on defining aspects of Brazilian securities' efficiency variability.

KEYWORDS

Adaptive Market, Market Efficiency, Financial Market, Political Uncertainty, Macroeconomic Environment

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1. INTRODUCTION

Market efficiency has been considered, over the last decades, a critical feature of capital markets. The market is efficient when the prices of traded assets reflect available information when the publication of new information tends to be rapidly incorporated by the capital market when pricing the assets (Beaver, 1998; Fama, 1991).

The idea that markets are efficient was challenged by Stigler (1967) when he pointed out the existence of imperfections of this system such as the presence of trading costs. Fama (1991) also challenged market efficiency by saying that, among other things, the limited rationality of economic agents makes false the extreme version of the efficient market hypothesis. Although there is evidence that bond returns follow the random walk, robust explanations that the market is continuously efficient are lacking (Hiremath & Kumari, 2014).

Considering that markets are not continuously efficient, the literature on behavioral finance indicates the limited rationality of agents and their imperfect information. That constitutes the real description of capital markets' functioning, resulting in greater risk in resource allocation transactions (Silva & Oliveira, 2011).

Thus emerges the idea that markets are not efficient but adaptive because market efficiency happens cyclically. It appears from time to time due to changes in market conditions, institutional factors, and behavioral aspects of market participants (Ghazani & Araghi, 2014; Hiremath & Kumari, 2014; Lim & Brooks, 2011; Noda, 2016; Urquhart & McGroarty, 2016). As Cutler, Poterba, and Summers (1988) point out, aspects related to market regulatory policies, financial information, macroeconomic environment, among others, influenced the prices of assets traded in capital markets.

This research adopts, as an aspect related to market policies, periods of political-economic uncertainty, which represent, according to Baker, Bloom, and Davis (2016), the influence that specific economic policies can have on the decisions of economic agents in capital markets.

Studies such as those by Arbatli, Davis, Ito, Miake, and Saito (2017), Arouri, Estay, Rault, and Roubaud (2016), and Baker et al. (2016) provide evidence that periods of high political and economic uncertainty affect the returns and volatility of securities traded in capital markets.

Regarding the accounting aspect, since the '60s, studies such as those by Ball and Brown (1968) and Beaver (1968) have found that accounting information is relevant to capital markets because it influences the stock prices that companies trade in the market. According to Urquhart and McGroarty (2016), the efficiency of securities traded in international capital markets, related to macroeconomic aspects. These factors, related to the economic environment, help explain the predictability of return on assets provided in an economy.

As explained above, we understand that the capital market is not fully efficient. According to the hypothesis that markets are adaptive, the efficiency of securities traded in capital markets varies according to aspects related to market changes and institutional factors. Thus, this research presents the following problem: **Do political-economic uncertainty, accounting information, and macroeconomic aspects influence the efficiency of securities traded by Brazilian listed companies in B3?**

Given the problem presented, this paper aims to verify the influence of political or economic uncertainty, accounting information, and macroeconomic aspects on the levels of efficiency observed in the securities traded by Brazilian listed companies belonging to B3. For this purpose, we selected 275 Brazilian listed companies. Employing regressions with panel data, we defined, as a dependent variable, the companies' efficiency level through the Hurst Exponent and selected as independent variables: political uncertainty, accounting indicators, and the macroeconomic environment. We used controls regarding the size, liquidity of the shares, and sectors of the companies.

The findings of empirical tests provide evidence that companies which report an increase in their rentability tend to increase efficiency levels; current liquidity affects, positively or negatively, the efficiency of the securities; and, in periods when the interest rate is high, companies tend to present less efficiency in their securities. Additionally, large companies with more liquid securities tend to report greater efficiency in their stocks. These results reinforce the idea that markets work cyclically, having their efficiency affected by aspects belonging to the market and companies inserted in this environment.

This study is motivated by the use of variables applicable to analyzing markets at the company level. Thus, understanding capital markets' functioning with the predictability of return of the most traded securities in the Brazilian environment motivated this study's realization. The findings of this study aim to contribute to market agents by providing evidence on aspects that influence securities' efficiency, which contributes to several agents on decisions of resource allocation in capital markets. The approach used aims at contributing to the corporate finance literature by interacting with previously untested variables.

Another contribution of this study is to provide results that advance and corroborate the literature in adaptive markets, evidencing these empirical results on aspects that help explain the cyclical functioning of markets concerning periods of high and low securities efficiency.

2. LITERATURE REVIEW

2.1. Market efficiency and its implications

Markets are continually changing, and these changes in market conditions can arise in several ways. Cutler et al. (1988) observed that the literature on event studies, up to their research, demonstrated that the prices of assets traded in financial markets react to different aspects: announcements about corporate control, regulatory policies, accounting, and financial information, as well as macroeconomic market conditions, affecting the foundations of the entities concerning the pricing of their assets. Several market aspects can affect the pricing of securities and how they predicted them, which affects the efficiency of returns.

Since the markets work cyclically, the predictability of stocks' returns appears in specific periods, according to institutional factors, market changes, and market agents (Lo, 2004). In turn, general aspects such as economic policies, accounting information, and macroeconomic environment (Cutler et al., 1988) influence the pricing of assets traded in the market.

The next subsection briefly addresses aspects representing market changes that may influence the returns' predictability on traded assets.

2.2. Political uncertainty, accounting information, and macroeconomic environment

From the adaptability of markets, some factors can generate periods in which the level of predictability of stock returns increase, because markets are not efficient at all times (Lim & Brooks, 2011). According to Ghazani and Araghi (2014), market efficiency may vary periodically due to changes in certain market conditions and the institutional factors of both companies and the environments in which they are inserted.

This study uses periods of political and economic uncertainty in a given economy as an approach that represents changes in market conditions. Baker et al. (2016) define economic policy uncertainty as to the non-zero probability of specific changes in economic policies affecting the way economic agents make their decisions. Political, economic uncertainty affects how economic agents make decisions and, consequently, affects capital markets (Brogaard & Detzel, 2015).

The index provided by the Economic Policy Uncertainty (EPU) database is scaled by grossing the terms related to the index divided by the total of terms in these newspapers. The monthly series of counts is staggered and standardized, averaged among newspapers, obtaining the monthly EPU index (Caggiano, Castelnuovo & Figueres, 2017).

According to Arbatli et al. (2017), periods of high political and economic uncertainty compromise the economy's performance, affecting various entities' market operations, affecting the securities traded by these companies.

Studies on the effect of political-economic uncertainty on stock markets have focused on the effects of political uncertainty shocks on stock exchanges (Arouri et al., 2016), emphasizing their impact on the companies' stocks' return and volatility to these exchanges. Then, the variation in the levels of economic-political uncertainty in a country can affect the pricing of assets traded in capital markets. Our first research hypothesis is:

- **H1:** Levels of political and economic uncertainty affect the efficiency levels of stocks traded on the Brazilian capital markets.

Several studies attested to the fact that accounting information influences the pricing of assets in capital markets. For example, the results reported by Ball and Brown´s (1968) seminal work indicate that accounting profits are reflected in stock prices; that the market observes accounting information, and that this information is reflected in stock prices.

Ball and Brown (1968) and Beaver (1968) discussed the relevance of accounting information. Both studies aimed to relate accounting components to companies' market value and provide evidence that accounting values influence the share prices of the companies that provide them.

If the information reported by the accounting impacts the stock price, this information is considered relevant because it reflects, at some level, the price of the companies' assets (Barth, Beaver & Landsman, 2001). Our second research hypothesis is as follows:

- **H2:** The information reported by accounting affects the efficiency levels of stocks traded in the Brazilian capital market.

As pointed out by Cutler et al. (1988), macroeconomic market conditions influence the prices of securities traded in international capital markets. The variables that represent the macroeconomic environment relate to aspects of the economic, monetary, and development structure in a given country or territory (Santos, 2018). In his study, Santos (2018) used variables representing the macroeconomic environment, the average tax rate, average inflation, and GDP growth.

In the study conducted by Urquhart and McGroarty (2016), the authors related the degree of efficiency in international capital markets with macroeconomic aspects; these aspects help explain the levels of information efficiency in international capital markets. They understood that these aspects, related to a company's macroeconomic environment, could significantly influence how the market was pricing its assets, affecting its efficiency levels. Thus, our third research hypothesis is:

- **H3:** Macroeconomic aspects of an economy affect the efficiency levels of stocks traded on the Brazilian capital market.

The variables that constitute the hypotheses of this paper, now outlined, will be explained in more detail in the next section, which provides information regarding the methodological procedures adopted.

3. METHODOLOGICAL ASPECTS

3.1. Sample selection and data collection

According to this research's purpose, companies were selected that trade their shares in the Brazilian capital market. Thus, for this research, we used publicly traded companies in B3 in a time series with daily data from 2000 to 2019.

Table 1 presents the total number of companies in this sample, according to the exclusion criteria, evidencing the number of companies removed from the final sample and the exclusion reason.

Table 1
Criteria for the exclusion of companies from the sample

Total Companies with Shares Traded in B3 in 2020	354
(-) Companies without data available in the Economática database	(45)
(-) Companies belonging to the financial sector [1]	(29)
(-) Company with data only from the year 2020 onwards	(5)
(=) Final number of companies in the sample	275

Source: Research data.

We obtained the data regarding the time series of the stock price values and those regarding these companies' accounting data through the Economática platform.

It is worth mentioning that this number of companies in the sample is not repeated throughout the years, as many B3 companies were incorporated after 2000. Therefore, initially, an analysis was made through the Unbalanced Panel. Additionally, we analyzed using only the companies that repeated themselves throughout the years, through the Balanced Panel. For this purpose,

[1] These financial companies were excluded by some particularities of the sector that caused distortions in some calculated indices, because some groups and accounts did not follow the same pattern as non-financial companies.

we excluded 199 companies that did not have data in all periods of the sample, resulting in 76 companies with data referring to the twenty years of the research.

We extracted the information regarding periods of economic uncertainty in Brazil from the Economic Policy Uncertainty (EPU)[2]. That provides data that includes media coverage on the country's policy (Baker, et al., 2016). Lastly, we obtained information on macroeconomic variables through the Brazilian Institute of Geography and Statistics (IBGE) website[3] and Brazil's Central Bank (BACEN) website[4].

3.2. Market efficiency proxy

The Hurst Exponent, initially created to calculate the predictability of floods on the River Nile, is now used to measure the efficiency and predictability of return on securities traded in stock markets (Tzouras et al., 2015). This exponent provides information on long-term correlations in a time series, and the series that present long-term dependence tend to present a lower degree of efficiency (Couillard & Davison, 2005; Santos, 2018).

We obtained the Hurst Exponent through a calculation performed in nine stages, as presented by Tzouras et al. (2015, p. 54), which comprise:

1. Calculation of the logarithmic return of the price series for the moment $t = ln\frac{P_t}{P_{t-1}}$;
2. Assume a series of return times $X : X_1, X_2, X_3, X_4, \ldots, X_N$;
3. Calculate the series average: $\mu = \frac{1}{N}\sum_{i=1}^{N} X_i$;
4. Calculate the adjusted average of the series (Y): $Y_t = X_t - \mu$;
5. Calculate the accumulated deviation of the series (Z): $Z_t = \sum_{i=1}^{t} Y_t$;
6. Calculate the range of the series (R): $R = \max(Z_1, Z_2 \ldots, Z_{N)} - min(Z_1, Z_2 \ldots, Z_{N)}$;
7. Calculate the standard deviation of the series (S): $S = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(X_i - \mu)^2}$;
8. Lastly, calculation of the Rescaled Range: $(R/S)_t = \frac{R_t}{S_t}$.

After the procedure of these eight steps to obtain the Rescaled Range, we obtain the Hurst Exponent the ninth procedure:

$$H = \frac{\log(R/S)}{\log(N)} \quad (1)$$

[2] Available in: https://www.policyuncertainty.com/brazilmonthly.html

[3] Available in: https://www.ibge.gov.br/explica/pib.php

[4] Available in: https://www.bcb.gov.br/controleinflacao/historicotaxasjuros

Where:

N = total number of observations; S = standard deviation of the daily price variation; R = amplitude of the price variation, that is, the difference between the highest and lowest value of this variation; and log = natural logarithm.

The Hurst Exponent analysis was initially formalized by Mandelbrot and Wallis (1969), who presented the Rescaled Range (R/S) analysis as primordial in determining time series memories. In their study, Mandelbrot and Wallis (1969) determined that the Hurst Exponent has a range of 0 to 1, where values between 0 and 0.5 represent the no pervasiveness or anti relation of the series; values between 0.5 and 1 represent persistence or long-term memory, and values close to 0.5 denote the absence of dependence in series.

However, this study used the variation between -0.5 and 0.5 because, for Santos (2018), the titer's return is more efficient when close to zero. The further away it is, either positively or negatively, we assume that the predictability of this titer's return is less efficient. The creation of the variable occurs through the use of a module of the value obtained. In this case, the higher the index, the less efficient the period in question.

Note that Hurst Exponent was calculated annually for the series of data from the closing values of the securities traded by the companies. In a series of twenty years, the Hurst Exponent calculation was made year-by-year using each company's daily data. Thus, we obtained the research variables annually.

3.3. Dependent variable and independent variables

The independent variables, which aim to explain the levels of efficiency in the predictability of return on securities, are divided into three prisms: levels of political uncertainty, as represented by the variable Economic Policy Uncertainty (EPU); accounting indicators, represented by the variables Leverage (LEV), Profitability (PROF), Rentability (RENT) and Current Liquidity (CL); and macroeconomic environment, represented by the Gross Domestic Product (GDP) per capita and Basic Interest Rate, represented by the Special System of Settlement and Custody (SELIC). Additionally, we used control variables regarding Size (SZ), Stock Liquidity (SL), and the companies' sectors. The sectors used were: Industrial Goods (IG), Communications (COM), Cyclic Consumption (CC), Non-cyclic Consumption (NCC), Basic Materials (BM), Oil and Gas (OG), Health (HEA), Technology (TEC) and Public Utility (PU). For the other companies belonging to the "Others" sector, we no created a specific dummy.

We explained the dependent variable and the independent and control variables used in this survey below (Chart 1):

Chart 1
Definition of independent variables and dependent

Variable	Definition	Data collection
Dependent Variable		
Share Efficiency (SEF)	Measure of Efficiency and predictability of the stock market share that varies between -0.5 and + 0.5 (Tzouras et al., 2015).	Historical Data of Securities Traded in B3 (https://economatica.com/)
Independent Variables		
Economic Policy Uncertainty (EPU)	Frequency of information regarding the economic uncertainty of policies (Baker et al., 2016).	Annual Average of Monthly Historical Data of Brazil (https://policyuncertainty.com)
Leverage (LEV)	Index that represents the relationship between Equity and Total Assets (PL/AT).	Accounting Variables Data (https://economatica.com/)
Profitability (PROF)	Index that represents the relationship between Net Profit and Net Revenue (LL/RL).	Accounting Variables Data (https://economatica.com/)
Rentability (RENT)	Index that represents the relationship between Net Income and Total Assets (RL/AT).	Accounting Variables Data (https://economatica.com/)
Current Liquidity (CL)	Index that represents the relationship between Current Assets and Current Liabilities (AC/PC).	Accounting Variables Data (https://economatica.com/)
Gross Domestic Product per capita (GDP)	Represents the average GDP growth of Brazil in the study periods (Santos, 2018).	IBGE data (https://www.ibge.gov.br/explica/pib.php)
Basic Interest Rate (SELIC)	It represents the Brazilian economy's basic interest rate and is the primary monetary policy instrument used by the Central Bank to control inflation (BACEN, 2019).	BACEN data (https://www.bcb.gov.br/controleinflacao/historicotaxasjuros)
Control Variables		
Size (SZ)	Logarithm of Total Assets of Companies.	Accounting Variables Data (https://economatica.com/)
Stock Liquidity (SL)	Liquidity of shares traded in volume at B3.	Stock Data (https://economatica.com/)
Sectors (IG, COM, CC, NCC, BM, OG, HEA, TEC, PU)	Dummy receives 1 if the company belongs to one of the mentioned sectors: Industrial Goods, Communications, Cyclic Consumption, Non-cyclic Consumption, Basic Materials, Oil and Gas, Health, Technology, and Public Utilities; and 0 otherwise.	Platform Data (https://economatica.com/)

Source: Research data.

3.4. Quantitative methods used

The research has two distinct configurations. One which comprises 275 companies, over twenty years, but with companies that do not repeat themselves in all years of analysis, and another that has a total of 76 companies, over twenty years, with all companies included in all periods of analysis. Thus, this study uses the Regression Model with Panel Data, unbalanced for the first sample, and balanced for the second.

We performed panel diagnostic tests for all regression models with panel data - variance of waste, Breusch-Pagan, and Hausman. These tests intend to verify which panel effect is most appropriate for the data observed by the sample - fixed, random, or grouped panel effects.

For each of the sample sets, a regression was made. For each regression per sample, an additional analysis was done using the Stepwise method.

The general regression model used for the two data sets has, as a dependent variable, the traded securities' efficiency and as independent variables aspects of political uncertainty, accounting indicators, macroeconomic environment, and control variables. Therefore, Equation 2 represents the regression model:

$$|SEF|_{it} = \alpha_0 + \beta_1 EPU_t + \beta_2 LEV_{it} + \beta_3 PROF_{it} + \beta_4 RENT_{it} + \beta_5 CL_{it} + \beta_6 GDP_t + \beta_7 SELIC_t + \beta_8 SZ_{it} + \beta_9 LS_{it} + \beta_{10} IG_{it} + \beta_{11} COM_{it} + \beta_{12} CC_{it} + \beta_{13} NCC_{it} + \beta_{14} BM_{it} + \beta_{15} OG_{it} + \beta_{16} HEA_{it} + \beta_{17} TEC_{it} + \beta_{18} PU_{it} + \mu_{it} \quad (2)$$

It is essential to point out that the variable SEF is modulated for all the study models, varying from 0 to 0.5. Thus, the closer to 0, the more efficient the company is, and the closer to 0,5, the less efficient it is. We treated the data by employing Excel sheets, and, later, for the generation of results presented in the following section, we employed Stata.

4. RESEARCH RESULTS

We present below the results of this research obtained through panel diagnostic tests, validation tests, descriptive statistics, inferential statistics, and discussion of the results in the light of the literature.

4.1. Descriptive statistics

It is essential to highlight the descriptive statistics of the variables, which intend to inform the measures of position and dispersion of the data referring to the variables tested in the linear models.

In Table 2 below, information regarding the results of the descriptive statistics related to the following measures: Mean (MEAN), Median (MED), Minimum (MIN), Maximum (MAX), Standard Deviation (STD), and Variation Coefficient (VC) The results shown refer to the dependent variable and the independent variables of the research.

We may observe that the dependent variable, which represents the securities traded Market Efficiency (ME), has an average of 0.048352 for the largest sample and 0.049123 for the smallest sample. As can be seen, in the sample with 76 companies, there is a slight increase in average inefficiency compared to the sample with 275 companies. The minimum and maximum values of both samples are similar. The dispersion measures noted that both the standard deviation and the variation coefficient are relatively low, thus denoting no high variability in the dependent variable's values.

Both samples have similar means and medians regarding the independent variable representing the Economic Policy Uncertainty (EPU). We repeated the minimum and maximum values since both samples comprise the same period. The standard deviation is relatively high, but the variation coefficient is low, indicating no high variability of values around the mean.

Table 2
Results of the descriptive statistics of the variables

Variable	MEAN	MED	MIN	MAX	STD	VC
Sample with 275 companies - Unbalanced Panel - 3744 observations between 2000 and 2019						
EM	0,048352	0,040399	0,00013117	0,12838	0,036003	0,74460
EPU	163,79	137,89	91,099	346,49	73,937	0,45142
LEV	0,13797	0,38786	-34,644	0,62106	1,9698	14,278
PROF	0,77678	0,053957	-0,17398	59,440	6,0072	7,7334
RENT	0,64349	0,57983	0,00011017	1,5712	0,42682	0,66329
LIQ	1,6618	1,4498	0,21180	3,8447	0,97636	0,58751
PIB	4,0308	4,0410	3,9446	4,0789	0,039961	0,0099140
SELIC	11,584	11,180	5,4000	24,900	4,4038	0,38016
Sample with 76 companies - Balanced Panel - 1520 observations between 2000 and 2019						
EM	0,049123	0,038986	0,00013117	0,50000	0,045034	0,91677
EPU	151,91	127,56	91,099	346,49	68,474	0,45077
LEV	0,30687	0,38145	-11,675	0,99343	0,70963	2,3125
PROF	2,9890	0,062453	-389,79	563,51	38,782	12,975
RENT	0,70384	0,62863	0,00013117	5,8378	0,51577	0,73279
LIQ	1,8131	1,3216	0,00029166	49,819	2,5770	1,4213
PIB	4,0186	4,0349	3,9446	4,0789	0,045561	0,011338
SELIC	12,760	12,420	5,4000	24,900	4,8068	0,37671

Source: Research data.

For the accounting variables, a low standard deviation of the indexes is noted, in the smaller sample, thus providing evidence of low variability of these accounting variables. The coefficient of variation of all the indexes is similar, denoting that they have a normal variability around their mean. However, in the larger sample, a greater dispersion of the LEV variables is noted, and in the smaller PROF. These results indicate that companies with very distinct characteristics in the larger data set have reflexes in the dispersion.

The variables that represent the country's macroeconomic environment, throughout the sample, have similar means between the samples since both comprise the same period, and low variability if observed the coefficient of variation.

4.2. Diagnostic and validation tests of regression models

This research provides results for two regressions, which represent two different samples. We provided the results of the validation tests for these models. The Chow test compares Grouped MQO with Fixed Effects, the Breusch-Pagan test compares Grouped MQO with Random Effects, and the Hausman test compares Random Effects with Fixed Effects. Table 3 provides the statistical test results for the two regression models used in the study and the most appropriate panel diagnosis for each model.

Table 3
Results of the statistical test for panel diagnostics

Model 1 - Unbalanced Panel	Results	Panel Diagnostics
Chow Test	p-value = 0.0000	Fixed Effects
Hausman Test	p-value = 0.8263	Random Effects
Breusch-Pagan Test	p-value = 0.0000	Random Effects
Model 2 - Balanced Panel	Results	Panel Diagnostics
Chow Test	p-value = 0.0000	Fixed Effects
Hausman Test	p-value = 0.0580	Random Effects
Breusch-Pagan Test	p-value = 0.0000	Random Effects

Source: Research Data.

The results provided in Table 3 show which panel treatment is most appropriate for the data series reported in the model. We reject the test's null hypothesis in the results where the p-value is below 5% (p-value < 0.05).

In Models 1 and 2, as presented, it was pointed out in the diagnostic tests that the panel with random effects is adequate because, in the Hausman test, we do not reject the null hypothesis that the panel with random effects.

The regression models' validation tests were: the test for heteroscedasticity, the normality test, and the autocorrelation test. Table 4 provides the results for these tests, with their respective p-values. In the first test, the null hypothesis represents the absence of heteroscedasticity; in the second test, it indicates that the errors have a normal distribution. Finally, in the third, it represents the absence of the first-order autocorrelation. If the test's p-value is significant (p-value<0.05), we rejected the null hypothesis.

Table 4
Regression validation tests

Models	Heteroscedasticity Test	Normality Test	Autocorrelation Test
		p-value	
Model 1	0.0000	0.0000	0.0000
Model 2	0.0000	0.0000	0.0706

Source: Research Data.

Note: This table reportsthe results regarding the p-values of the tests referring to the heteroscedasticity, normality and autocorrelation of theresidues of the two regression models with panel data used in the study.

The test of heteroscedasticity of waste points out that in all models, we rejected the null hypothesis of non-heteroscedastic errors. Thus, to correct this problem, regressions with robust standard errors were used, using the HAC matrix.

Regarding the normality test, all six models pointed to the rejection of the null hypothesis of errors with a normal distribution (p-values < 0.05). However, given the number of observations in both sample sets (N = 3744 and 1520), it is assumed that the errors have a normal distribution. Additionally, in graphical analysis, the data provide central tendency evidence, reinforcing these residues' normal distribution.

Finally, in the autocorrelation test, in Model 1, the null hypothesis of first-order noncorrelation was rejected; in Model 2, we rejected this hypothesis. Thus, only in the second model is it that the residues are not related to each other. For the first model, it was necessary to use the HAC matrix for the correction of autocorrelation.

We used the Newey-West approach for the correction of problems related to heteroscedasticity and autocorrelation. Thus, when calculating standard errors using HAC (Heteroskedasticity and Autocorrelation Consistent) matrix, both validation problems are solved. Given the results reported in this subsection, it can be stated that the data provide qualities so that they can be considered as reliable estimates. Hence, the next subsection provides the results of the regression models.

4.3. Regression Results with Panel Data

Based on the premise that the Brazilian capital market is adaptive, as indicated by Dourado and Tabak (2014), we understood that the constant securities in the market could present levels of efficiency and inefficiency measured for each stock return over twenty years, in up to 275 companies that make up B3.

Two regression models were outlined. We applied these two models in two different sample sets. In the first one, the companies do not repeat themselves along the twenty years - unbalanced panel - while in the second one, the companies repeat themselves along the whole studied period - balanced panel.

However, Table 5 disposes of the results referring to the models applied in the two sample sets, in unbalanced and balanced panels by random effects, as pointed out by panel diagnostic tests.

Table 5
Regressions of the EM dependent variable for samples of 275 and 76 companies

Variable	Model 1	Model 2
Constant	0,180790	0,0818411
	(0,0437)**	(0,6578)
EPU	1,08827e-06	2,47374e-06
	(0,8895)	(0,8577)
LEV	0,000420409	0,00101266
	(0,2184)	(0,7252)
PROF	3,84644e-05	1,86367e-05
	(0,8049)	(0,6358)
RENT	-0,00154390	**-0,00802082**
	(0,4644)	**(0,0171)****
CL	**-0,00204999**	**0,000811249**
	(0,0100)***	**(0,0070)*****
PIB	-0,0266469	-0,00244201
	(0,2345)	(0,9579)
SELIC	**0,000679528**	**0,00138663**
	(0,0001)***	**(0,0001)*****
SZ	**-0,00448839**	**-0,00616743**
	(0,0169)**	**(0,0055)*****
SL	**-0,0149830**	**-0,00271072**
	(0,0090)***	**(0,0563)***

Table 5
Cont.

Variable	Model 1	Model 2
IG	0,00170405	-0,00345932
	(0,6447)	(0,4690)
COM	-0,00314130	-0,00482581
	(0,3910)	(0,3037)
CC	0,00383234	**0,0113330**
	(0,2460)	**(0,0799)***
NCC	-0,00187161	0,000695795
	(0,5871)	(0,8906)
BM	0,00599833	0,00830142
	(0,1155)	(0,1075)
OG	0,00253728	**0,0260890**
	(0,5235)	**(0,0065)*****
HEA	-0,000479478	0,00678262
	(0,9212)	(0,5038)
TEC	-0,00527457	-
	(0,3891)	-
PU	0,00548813	0,00576892
	(0,1243)	(0,2720)
R^2	**0,0530303**	**0,0730622**
N	**3744**	**1520**
Panel Effect	**Random**	**Random**

EM = Market Efficiency; EPU = Economic Policy Uncertainty; LEV = Leverage; PROF = Profitability; RENT = Rentability; LIQ = Liquidity; PIB = Gross Domestic Product per capita; SELIC = Basic Interest Rate; SZ = Size; SL = Stock Liquidity; IG = Industrial Goods; COM = Communications; CC = Cyclical Consumption; NCC = Non-cyclical Consumption; BM = Basic Materials; OG = Oil and Gas; HEA = Health; TEC = Technology; PU = Public Utility.

Source: Research Data.

Note: Values contained outside parentheses representthe regression coefficients, values within parentheses represent p-value and ***, ** and ** correspond to statisticalsignificance at the levels of 1%, 5% and 10% respectively . All models were corrected by the HAC matrix.

The findings in Table 5 provide results about the levels of efficiency in predicting the return of the Brazilian listed companies in B3. For both data series, we noted that variables related to accounting indicators, macroeconomic environment, and control variables are positively or negatively related to the efficiency levels of the securities traded on the Brazilian capital market.

The complete sample shows that current liquidity, an attribute that represents companies' capacity to pay, is negatively associated with the securities' inefficiency. If the capacity is higher to pay in the short term, the greater its securities' efficiency in a given period. In the regression with the 76 companies, this attribute of payment capacity is positively associated with inefficiency, representing that the greater current liquidity reduces the period's securities' efficiency. This result is distinct in both sets of the sample. For companies that remain in the market throughout the sample period, the high payment capacity negatively influences their efficiency. In contrast, for

more "recent" companies, with data not constant throughout the sample period, this attribute is well seen as positively influencing market efficiency.

In the second model, companies with higher rentability in the period tend to have more efficient titles. In other words, the market perceives companies with higher rentability positively, thus resulting in more efficient securities in the period analyzed.

We understood that the market reacts positively only concerning the company's liquidity and profitability among the accounting indicators. This result reinforces the idea that the accounting information influences how the market was pricing the securities, causing reflexes in their efficiency levels, thus corroborating the H2 of this research.

The variable representing the Basic Interest Rate (SELIC), in both models, has a positive and significant relationship with the efficiency of the shares. This result shows that the higher the interest rate in Brazil also used to control inflation, the lower the efficiency of securities traded on the Brazilian capital market. This finding helps explain that, in periods of high-interest rates in the Brazilian market, securities traded in the capital market are more predictable. In this period of high-interest rates, investors can easily project future trends in return for securities traded in the capital market. This finding related to macroeconomic variables corroborates the H3 of this paper.

Control variables also showed statistical significance with the efficiency of the securities. Both Size (SZ) and Stock Liquidity (SL) contribute to the greater market efficiency. I.e., large companies and companies with more liquid stocks in the Brazilian market tend to have greater efficiency in their securities reported to the Brazilian capital market.

An analysis was also issued to select the most critical variables in the regression through the stepwise method. This procedure is based on an algorithm that includes or excludes independent variables from the model based on decision rules, using the best set of independent variables for the regression model. Thus, the results shown below in Table 6 use this method to select these variables in this research's two sample sets.

The use of this method for both models reinforces the results previously presented in Table 5, i.e., aspects such as payment capacity, rentability, interest rate, company size, and share liquidity are considered aspects that positively or negatively influence the efficiency levels of the securities traded by the Brazilian listed companies in B3.

Table 6
Regressions of the EM dependent variable for samples of 275 and 76 companies - Stepwise Method

Variables	Model 3	Model 4
Constant	0,0704322	0,0725322
	(0,0001)***	(0,0001)***
RENT	-	**-0,00790738**
	-	**(0,0294)****
CL	**-0,00190571**	**0,000864196**
	(0,0140)**	**(0,0085)*****
SELIC	**0,000835381**	**0,00141204**
	(0,0001)***	**(0,0001)*****
SZ	**-0,00435014**	**-0,00601902**
	(0,0162)**	**(0,0105)****
SL	**-0,0149979**	**-0,00267937**
	(0,0087)***	**(0,0407)****
IG	0,000841454	-0,00482968
	(0,8099)	(0,3721)
COM	-0,00348948	-0,00605989
	(0,3380)	(0,2534)
CC	0,00294642	0,0100106
	(0,3580)	(0,1470)
NCC	-0,00294954	-0,000822359
	(0,3567)	(0,8861)
BM	0,00521102	0,00690278
	(0,1432)	(0,2304)
OG	0,00160156	**0,0239087**
	(0,6730)	**(0,0053)****
HEA	-0,00153568	0,00553213
	(0,7421)	(0,5928)
TEC	-0,00639107	-
	(0,2875)	-
PU	0,00516240	0,00454626
	(0,1429)	(0,4360)
R^2	**0,0514615**	**0,0721303**
N	**3744**	**1520**
Panel Effect	**Random**	**Random**

EM = Market Efficiency; EPU = Economic Policy Uncertainty; LEV = Leverage; PROF = Profitability; RENT = Rentability; LIQ = Liquidity; PIB = Gross Domestic Product per capita; SELIC = Basic Interest Rate; SZ = Size; SL = Stock Liquidity; IG = Industrial Goods; COM = Communications; CC = Cyclical Consumption; NCC = Non-cyclical Consumption; BM = Basic Materials; OG = Oil and Gas; HEA = Health; TEC = Technology; PU = Public Utility.

Source: Research Data.

Note: Note: Values contained outside parentheses representthe regression coefficients, values within parentheses represent p-value and ***, ** and ** correspond to statisticalsignificance at the levels of 1%, 5% and 10% respectively. All models were corrected by the HAC matrix.

In the analyses of the sectors, we noted that the Oil and Gas sector presents a strong statistical significance in one of the data sets. In other words, companies belonging to this sector tend to report securities with less efficient returns.

The results provided by both sets of samples provide evidence that the market does not present constant efficiency. Moreover, this efficiency is affected by market aspects, such as the interest rate, the income of the population, and the intrinsic factors of the companies constant in this market, represented, in this case, by the index coming from the financial statements: rentability.

These findings are essential for understanding the factors that contribute to the increase or reduction of the securities' predictability, according to the adaptability of the markets predicted in the Adaptive Markets Hypothesis of Lo (2004).

5. FINAL CONSIDERATIONS

According to the Adaptive Markets Hypothesis (AMH), the efficiency in predicting the return of securities traded in capital markets works cyclically when it appears, from time to time, being affected by institutional factors, behavioral aspects, and market changes conditions.

This study aimed to verify how aspects related to political uncertainty, accounting information, and macroeconomic aspects influenced the efficiency levels presented in the predictability of return on shares traded by Brazilian listed companies.

Thus, 275 Brazilian listed companies were selected, which provided data from 2000 to 2019 for 3744 observations. These companies do not have data for all years; therefore, besides obtaining balanced panel data, an additional analysis was made with only 76 public companies with data for all years between 2000 and 2019, for a total of 1520 observations.

The Hurst Exponent calculation for each of the daily series on each company's quotations, year by year, to obtain the level of efficiency in these companies' shareholder return for each reported period. Thus, this paper's variable dependent was obtained through this calculation and represented the Market Efficiency (ME).

The independent variables represented the following aspects: political uncertainty, accounting indicators; and macroeconomic environment. We used regression methods by panel data. Through grouped panels and random effects, results on accounting indicators and macroeconomic environment were provided on the efficiency of the securities reported by Brazilian public companies.

Regarding the importance of accounting information, the reported results provide evidence that the increase in current rentability and liquidity is seen positively by the market, through the negative relationship between this variable and low efficiency, showing that the increase in this index contributes to the increase in the efficiency of companies over time. Liquidity showed a positive relationship with inefficiency in the sample that comprised the balanced panel, thus showing that this attribute is influenced by the companies' characteristics selected in the sample. In this case, older companies, which have been trading since 2000.

These results attested that the accounting information is relevant for the capital markets because the information reported in accounting statements influences the shares' efficiency levels, as pointed out by Barth et al. (2001). These results corroborate the H2 of the study.

Finally, the variables that represent aspects of the macroeconomic environment were also significant in explaining the efficiency of the shares issued by Brazilian companies. SELIC is positively associated with the low efficiency of companies. In periods in which the interest rate is high, the securities traded in B3 are less efficient in predicting their returns.

According to Cutler et al. (1988), these results indicate that macroeconomic conditions influence the prices of securities traded in capital markets. The findings also corroborate the study by Urquhart and McGroarty (2016), who found strong evidence that the macroeconomic environment explains the levels of informational efficiency of the indices in international markets, thus confirming the H3 outlined in this article.

The study is limited by using only four accounting proxies for analysis and only two proxies representing the macroeconomic environment and by analyzing only Brazilian companies. It is suggested for future research the use of other proxies that represent market changes and institutional factors and the expansion of the sample using companies from other countries. Another suggestion is related to capturing market agents' behavior over time, bearing in mind that, according to the hypothesis of market adaptability, these agents' behavior may affect these securities' efficiency levels.

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