Revista UNEMAT de Contabilidade

v. 12, n. 24, 2023

TAXATION ON DIVIDENDS AND ITS IMPACT ON COMPANIES IN THE ELECTRICITY SECTOR IN BRAZIL, THE UNITED STATES AND GERMANY

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RESUMO

O objetivo deste trabalho é analisar, por meio do pagamento de dividendos de empresas do setor elétrico do Brasil, Estados Unidos e Alemanha, a possível influência das suas respectivas legislações tributárias sobre a política de dividendos e também sobre o preço dos ativos. Metodologia: foram coletados dados de pagamentos de dividendos e de valores diários de ações de empresas do setor elétrico do Brasil, Estados Unidos e Alemanha, respectivamente negociados nas Bolsas de valores de São Paulo, New York e Frankfurt. Foi compreendido o período de 01 de janeiro de 2000 até 31 de dezembro de 2022. Resultados: as empresas brasileiras do setor elétrico pagam mais dividendos que as empresas do mesmo setor listadas na bolsa de valores de New York e de Frankfurt. O preço da ação é influenciado negativamente pelos dividendos nas empresas dos Estados Unidos e da Alemanha, mas não houve nenhuma correlação entre variação de preços de ativos e pagamento de dividendos no caso do Brasil.

Palavras-chave: finanças corporativas. Políticas de dividendos. Setor elétrico

ABSTRACT

The objective of this work is to analyze, through the payment of dividends from companies in the electricity sector in Brazil, the United States and Germany, the possible influence of their respective tax legislation on dividend policy and also on the price of assets. Methodology: data on dividend payments and daily value of shares of companies in the electricity sector in Brazil, the United States and Germany, respectively traded on the São Paulo, New York and Frankfurt stock exchanges, were collected. The period was covered from January 1, 2000 to December 31, 2022. Results: Brazilian companies in the electricity sector pay more dividends than companies in the same sector listed on the New York and Frankfurt stock exchanges. The share price is negatively influenced by dividends in companies in the United States and Germany, but there was no correlation between changes in asset prices and dividend payments in the case of Brazil.

Keywords: Corporate finance. Dividend policies. Electrical sector

1 INTRODUCTION

Among the theories that seek to explain the dividend distribution policy, it can be said that there has not yet been a consensus on its importance in valuing the firm (BLACK, 1976; ALLEN; MICHAELY, 2002). According to Vancin and Procianoy (2016), the dividend is a portion of a company's net profit that is distributed to investors, as a form of remuneration for invested capital. The amount to be paid and the form of distribution are complex decisions that have generated countless research on the subject.

In Brazil, the law that regulates the payment of dividends is law 6,404/1976, known as the Brazilian Corporation Law (LSA). This establishes that shareholders have the right to receive as a mandatory dividend, each year, a certain portion of the company's profits (VANCIN; PROCIANOY, 2016). According to Guerra (2020), tax legislation in Brazil differs from numerous other countries by ensuring tax exemption for the payment of dividends to shareholders of companies listed on the stock exchange. According to Guerra (2020), one of the most developed markets in the world, the USA, has an average distribution rate of 35%. However, according to the author, capital gains are taxed at 15% and there is no minimum legal distribution percentage. It is preferable, therefore, for companies to retain capital for new investments rather than distributing them. In Germany, in turn, there is a 25% tax on dividends, known as “Abgeltungssteuer”, plus a 5.5% solidarity tax on the tax on dividends (TAXATION IN GERMANY, 2023).

A characteristic of companies in the electricity sector is that they pay high dividends (BRIGHMAN et al, 2001), in some cases with a payout greater than 100%, a fact that is also present in companies in the electricity sector in Brazil (RODRIGUES et al, 2016) . High profitability, associated with low profit volatility, according to Myers (1984), also ends up serving as a motivation for the payment of high dividends.

The objective of this work is to analyze, through the payment of dividends from companies in the electricity sector in Brazil, the United States and Germany, the possible influence of their respective tax legislation on dividend policy and even the price of assets.

The article is divided as follows: this introduction, the theoretical framework, where the themes of dividend taxation and dividend policy in the electricity sector are explored in depth and the hypotheses to be tested are formulated. The methodology and results follow, where the statistical analysis of the collected data and its discussion in light of the literature are demonstrated. The article ends with final considerations, where the results achieved and perspectives for future work are reviewed.

2 THEORETICAL REFERENCE

Modigliani and Miller (1961), in their classic article, suggested that dividend policy is irrelevant in relation to the value of the company. Under the assumption of perfect markets, by separating investment and financing decisions, the authors concluded that value was determined solely and exclusively by the return on investments made. However, when considering market imperfections or frictions, the hypothesis of irrelevance of dividend policy often ends up being refuted.

Among the theories that seek to explain the dividend distribution policy, it can be said that there has not yet been a consensus on its importance in valuing the firm (BLACK, 1976; ALLEN; MICHAELY, 2002). They could be divided into four groups: in the first, some studies defend a high rate of dividend distribution, as they believe that this would be a way to reduce the company's available cash flow (EASTERBROOK, 1984; JENSEN, 1986) and an expectation of the existence of future profits (ALLEN; MICHAELY, 2002). The second group is characterized by defending the idea that dividend policy is irrelevant to investors. Miller and Modigliani (1961) state that, in the absence of taxes and transaction costs, dividend policy has no effect on share prices. A third group argues that, in countries where dividends are highly taxed, when compared to capital gains, this payment represents a real loss for investors and should therefore be avoided (ROSS et al, 1999). A fourth group places dividend policy as a residual decision after making investments that would maximize shareholder wealth (DONALDSON, 1961).

The biggest argument against paying dividends is that, in most countries studied (MILLER; SCHOLES, 1978), dividends are taxed at a higher rate than capital gains. Therefore, it would be more appropriate for the investor to sell part of his shares to generate funds, and create his own dividend. In this case, many managers could choose to distribute their profits through share buybacks, which would be more interesting for shareholders from a tax point of view, given the high taxation on dividends earned (MILLER; SCHOLES, 1978). To the extent that investors can be taxed at different tax rates, depending on their individual tax rates, the hypothesis of the “Client Effect” arises, in which investors who pay high taxes on dividends would be interested in acquiring shares with a reduced dividend yield. On the other hand, investors who are taxed at a low tax rate on dividends would be interested in purchasing shares with a high yield (MILLER; MODIGLIANI, 1961).

Elton and Gruber (1970) studied and tested the existence of the clientele effect in the North American market and recommend that, in the absence of taxes, the market should value shares, among other things, based on the value of dividends paid. The variation in the share price between the last day on which the paper is traded with the right to dividends and the 1st ex-dividend day must be equal to the amount received by the holder of the share. Therefore, the variation in the share price should correspond to the value of the dividend minus the amount of taxes. The authors found that the difference in share price with and without the right to dividends was smaller than the dividend paid. This finding signaled that, since there are investors with different taxation for income from dividends, the market considers this information to evaluate the share price, strengthening the clientele effect theory.

According to the theory of dividend relevance attributed to Gordon (1963) and Lintner (1962), there is a close affinity between dividend policy and share price. It is then assumed that the heterodoxy of the calculation basis of the Brazilian asset pricing model is unusual in the world (GUERRA, 2020). Brazil has another particularity: since 1976, in case of statutory omission, publicly traded companies have the duty to distribute at least 50% of net profit.

In Brazil, in the period before 1976, company directors had free will to determine the amount to be paid to shareholders in the form of dividends. This is because the legislation determined that if the amount to be paid was not foreseen in the statute, the decision would be made at a general meeting based on the board's proposal. In this context, legislators saw the need to create mechanisms that aimed to protect non-controlling shareholders, in a scenario in which the country sought to expand its capital market. In this sense, the Joint Stock Company Law was created - Law No. 6404/76, which brought articles that proposed mandatory amounts for distribution (GELBCKE et al, 2018).

The Corporations Law (LSA), Law no. 6404, 1976, establishes in its article 202 that shareholders have the right to receive as a mandatory dividend, in each year, the portion of profits established in the statute, or if this is omitted, the amount will be half of the accounting net profit for the year reduced or plus the following values: a) Quota allocated to the constitution of the legal reserve; b) Amount allocated to the formation of reserves for contingencies and reversal of the same reserves formed in previous years; and, c) Unrealized profits transferred to the respective reserve and profits previously recorded in this reserve, which were realized in the year. In the second section of the same article, it is established that, if the statute is not silent in relation to its distribution, the minimum mandatory dividend cannot be less than 25% of the adjusted net profit (GELBCKE et al., 2018).

The objective of establishing a minimum mandatory dividend would be to protect the minority shareholder, by preventing the possibility of the controller retaining all profits (LA PORTA et al, 2000; COELHO, 2002). At the same time, it would also have the function of strengthening the capital market by guaranteeing investors a minimum return on their capital. Procianoy (2006) highlights the importance of this mechanism when verifying that, in Brazil, there is a tendency for companies to retain the largest possible portion of profits, as a form of self-financing due to the scarcity of resources for long-term financing of companies at that time.

According to Guerra (2020), tax legislation in Brazil differs from numerous other countries by ensuring tax exemption for the payment of dividends to shareholders of companies listed on the stock exchange. The rule was established in 1996. In short, dividends are included in the company's profit, leaving shareholders free from any charges. This procedure is seen as inhibiting the economic double taxation of income generated by firms, enabling profits to be distributed in an accounting-fair manner. Furthermore, partners can be remunerated without having to dispose of their shares.

It is important to clarify that the USA – the country where most of the theories and studies on this topic originate – has tax legislation that is different from Brazil's regarding dividend policy. The main heterogeneities in Brazilian legislation on this matter are: (a) the receipt of dividends by shareholders does not constitute a tax-generating event; (b) there are mandatory minimum dividends; (c) there is an additional form of distribution of resources called interest on equity, which is deductible from the tax calculation base on

the profit of the company that distributes them, but consists of a tax-generating event for the shareholder who receives them (FORTI et al, 2015).

Furthermore, Law No. 11,638/07 began the process of convergence of internationally standardized accounting standards, thus meeting the demand of the International Accounting Standards Board (IASB), however without monitoring tax policies. In summary, the text prohibits the retention of profits in the profit account accumulated by Brazilian corporations, in addition to changing other institutional provisions. Thus, critics of the current format claim that the incompatibility with the international financial model makes new investments by external agents difficult, which tends to reduce market liquidity. Furthermore, this is a disincentive for companies to reinvest their profits in productive capital, making it preferable for managers to pass on a large part of the net profit to shareholders (GUERRA, 2020).

According to Guerra (2020), it was during the second half of the 1990s that Brazil created the bases for the current model of taxation on profits and dividends, with Law No. 9,249/1995 exempting shareholders from their payment. Furthermore, unlike other times, the prerogative was extended to individuals and legal entities domiciled abroad and to legal entities taxed based on real, arbitrated or presumed profit. The biggest news of the period, according to the author, was the inauguration of a new tax model for distributing dividends, called Interest on Equity (JCP). The rate was set at 15% per year, at source, for the shareholder, allowing the Legal Entity (PJ) to deduct the financial expenses associated with the respective payment from its revenues. Fagnani and Rossi (2018) showed that in this way the company would be free from paying Corporate Income Tax (IRPJ) and Social Contribution on Net Profit (CSLL). The motivation for creating such a tool was as a form of economic compensation for the end of accounting monetary corrections after the Real Plan (CARVALHO et al, 2015). However, today the JCP is used mainly for the purpose of tax benefits and financial optimization in the distribution of profits by companies. Unlike the distribution of dividends, the JCP is a benefit to the PJ at the expense of the shareholder because, if the dividends are exempt, their distribution does not give the same benefit to the distributing company. On the other hand, according to Guerra (2020), the JCP allows deduction for the purpose of determining the company's real profit in exchange for the payment of income tax on the distributed part made by the shareholder. Dividends are taxed in advance and then distributed, that is, for the shareholder to receive the same amount relative to the JCP distribution, the company will pay an even higher amount of taxes.

ZAGONEL et al (2018) identified changes in tax legislation in Brazil in the period 1986-2011 and verified their effect on corporate dividend policies for preferred and common shares. The authors used Probit and Tobit estimation from panel data to check the probability of companies paying dividends under different tax regimes. The final sample consists of 672 companies, 1,159 traded shares and 30,134 observations. The authors' results suggest that changes in tax legislation have a significant influence on dividend payments. Furthermore, companies do not follow target payout ratios, but dividends are moderately dependent on previous payments. Dividend payments are affected by share

voting rights, privatizations and deductible dividends. Regulatory changes that reduce agency problems among shareholders positively affect payout rates. Another relevant aspect, according to Zagonel (2018), is the legal framework of corporate law in Brazil, which allows a company to issue up to two thirds of its total equity in preferred shares without voting rights. Therefore, to have complete control over a public company in Brazil, the controlling shareholder can only have 16.7% of the company's total capital. Such disproportionate power raises obvious agency problems between majority and minority shareholders.

Vancin and Kirch (2020) analyzed a sample of 1,654 dividend distributions between 2008 and 2015, using investment and company value regressions. Their results indicate that companies that pay only the minimum dividend have a greater value attributed to an additional unit of cash, corroborating the authors' view that these companies will likely use these resources to finance future profitable investments. The authors also concluded that the mandatory dividend has a negative impact on investment, but only for companies that pay dividends above the minimum.

Vancin and Procianoy (2016), when analyzing 1531 dividend distributions in the period from 2007 to 2013, demonstrated that the existence of companies that pay only the mandatory dividend influences the regression coefficients, causing important biases for the research of dividend determinants in the Brazil. This is because companies that pay above the legal and contractual obligation are the real makers of the decision to pay dividends, whereas companies that pay only the mandatory amount simply comply with the legislation. In the case of companies paying dividends above the legal requirement, the previous year's dividend had a positive relationship, while in the group of minimum payments, debt, ownership concentration and dividends paid in the previous year had significant factors; all related in a positive way.

According to Forti et al (2015), as the main factors determining the payment of dividends in Brazil, it was found that the significant and positive variables were: Size, ROA, Market to Book, Liquidity and Profit Growth. That is, it can be inferred that the greater the size of the company, its profitability, its market value, its liquidity and the growth of its profits, the greater this firm's propensity to distribute money to shareholders, which is in line with the theory of corporate finance. On the other hand, it was found that the significant and negative variables were: leverage, Liquidity squared, Capex, Beta and Tag Along 100%. It is inferred that more leveraged companies, which invest more in fixed assets, have very high liquidity, greater risk and less conflict between controlling shareholders and minority shareholders, will have a lower propensity to pay dividends to shareholders.

In 2003, President George W. Bush proposed eliminating the U.S. dividend tax, saying "double taxation is bad for our economy and hits retirees especially hard." He also argued that while “it is fair to tax a company's profits, it is not fair to double tax it by taxing the shareholder on the same profits.” (DIVIDEND TAX, 2023). Soon after, Congress passed the Jobs and Growth Tax Relief Reconciliation Act of 2003 (JGTRRA), which included some of the cuts requested by Bush and which he signed into law on May 28, 2003. Under

the new law, the Qualified dividends are taxed at the same rate as long-term capital gains, which is 15% for most individual taxpayers. Qualified dividends received by individuals in the 10% and 15% income tax brackets were taxed at 5% from 2003 to 2007. The tax rate on qualified dividends was set to expire on December 31, 2008; however, the Tax Increase Prevention and Reconciliation Act of 2005 (TIPRA) extended the lower tax rate through 2010 and further reduced the tax rate on qualified dividends to 0% for individuals in income tax brackets of 10% and 15%. On December 17, 2010, President Barack Obama signed into law the Tax Relief, Unemployment Insurance Reauthorization, and Job Creation Act of 2010. The legislation extends the changes enacted to the taxation of dividends in the JGTRRA and TIPRA for an additional two years. (DIVIDEND TAX, 2023).

Additionally, the American Taxpayer Relief Act of 2012 (HR 8) was passed by the United States Congress and signed into law by President Barack Obama in the early days of 2013. This legislation extended tax rates on capital gains and dividends from 0 and 15 percent for taxpayers whose income does not exceed the limits established for the highest income tax rate (39.6 percent). Those exceeding these limits ($400,000 for single filers; $425,000 for heads of household; $450,000 for joint filers; $11,950 for estates and trusts) were subject to a maximum 20% rate for capital gains and dividends (DIVIDEND TAX, 2023).

Selamat et al (2012) demonstrated stock price reactions to announced tax reduction policy announcements in the US and Malaysia. The chosen events concern the good news effects when (i) US policymakers reduced the tax on cash dividends and (ii) Malaysian policymakers decided to introduce a full single-tier tax regime in 2008 to replace the previous regime. dividend credit of 1958. The US provided about $200 billion in taxes to shareholders on the premise that such a cash injection as tax cuts during 2003-2006 (first event) would stimulate the US economy to recover; again, the law was extended in 2010 to expire in 2012. Events in both countries were good news because shareholders would benefit from higher cash dividends in the case of US taxpayers and the introduction of a single taxation regime that reduced the cost administration of tax declaration, as well as reducing the cost of tax collection. As for Malaysia, the official announcement date, as well as when the bill became law with royal assent, apart from the market reacted positively.

Goergen et al (2005) analyzed the decision to change the dividend for a panel of German companies from 1984 to 1994. Consistent with Lintner (1956), Goergen et al (2005) demonstrated that net profit is a key determinant of the dividend decision. change the dividend. However, their results also refine Lintner (1956) and confirm the anecdotal evidence that German companies have more flexible dividend policies. First, the authors found that the occurrence of a loss is a key determinant in addition to the level of net profit. It has been observed that 80 percent of German companies that incur losses, with at least five previous years of positive profits and dividends, omit the dividend in the year of the loss. They do this regardless of the size of the loss and the level of past and future gains. Secondly, the vast majority of German companies quickly revert to the initial dividend payment after omission or cut.

Goergen et al (2005) found that in both the case of dividend omissions and dividend cuts, most companies restart the dividend within two years to revert to the initial dividend payment level. This finding contradicts Lintner (1956) and Miller and Modigliani (1961), that managers will only change the dividend if they believe that the company's earnings performance will be permanently, and not just temporarily, affected. These results contrast sharply with those of DeAngelo et al (1992) for the USA. They conclude that companies are more likely to reduce their dividends if the problems reducing profits are permanent in nature. The fact that German companies often omit and cut their dividends and quickly return to their initial dividend payment policy suggests that dividends in Germany have a less signaling role than dividends in the US or UK. These results also contradict Bhattacharya's (1979) assumption that the costs of dividend changes are asymmetric, with dividend reductions being more costly for the firm than dividend increases.

In Germany there is a 25% tax on dividends, known as “Abgeltungssteuer”, plus a 5.5% solidarity tax on dividend tax. Effectively there is a tax of 26.375%. When dividends are paid to an individual, capital income tax is charged at a rate of 25%. Since January 1, 2009, this tax is definitive for individuals residing in Germany. The solidarity surcharge is also imposed on capital income tax (TAXATION IN GERMANY, 2023).

According to Amihud and Murgia (1997), the higher taxation of dividends in the United States gave rise to theories that explain why companies pay dividends. Tax-based signaling models propose that higher tax on dividends is a necessary condition for making them informative about firm values. In Germany, where dividends are not tax disadvantaged and in fact are taxed lower for most classes of investors, these models predict that dividends are uninformative. However, the authors (AMIHUD; MURGIA, 1997) demonstrated that the stock price reaction to dividend news in Germany is similar to that found in the United States. This suggests reasons other than taxation that make dividends informative.

A characteristic of companies in the electricity sector is that they pay high dividends (BRIGHMAN et al, 2001), in some cases with a payout greater than 100%, a fact that is also present in companies in the electricity sector in Brazil (RODRIGUES et al, 2016) . High profitability, associated with low profit volatility, according to Myers (1984), also ends up serving as a motivation for the payment of high dividends.

As described above, Brazilian legislation determines that Joint Stock Companies must distribute part of the net profit to shareholders in the form of mandatory dividends. In this context, there are companies that choose to pay investors above the mandatory amount. These companies are considered to be the ones that actually make decisions about the dividend policy to be adopted. In this sense, Santos (2020) sought to identify the characteristics of companies in the electricity sector that paid statutory dividends higher than mandatory dividends in the 2019 fiscal year. The sample included 46 companies in the electricity sector listed on the BMF&FBovespa and the technique used was regression by ordinary least squares, with variable selection using the Stepwise method (omission of

non-relevant variables). It was found that companies that paid above the mandatory amount had less variation in operating cash flow (FCO) and also paid higher dividends in the previous year. Decisions on dividend policy were determined by the previous year's policy and the variation in the FCO, while companies that tended to manage the calculation base for dividends less were those that presented greater revenue variation and those that participate in level 1 and 2 corporate governance. On the other hand, companies with greater variation in FCO tended to manage the calculation basis for dividends (SANTOS, 2020).

Silva (2022), in order to demonstrate the influence of ownership concentration and company size on the dividend policy of companies in the Brazilian electricity sector, collected data on share control of companies in the electricity sector and other sectors listed on B3 during 2019. Based In the results, the following conclusions were reached: 1) companies in the electrical sector have lower payouts than companies in other sectors; 2) there was no difference between companies in the electrical sector and others in terms of payout in relation to ownership concentration, both between companies considered large and smaller; 3) in relation to the size of the companies, there was no statistically significant difference between the payout paid by the electricity sector and the other companies; 4) the smaller size of the company was related to a greater occurrence of losses both in the electrical sector and in all other companies.

Silva and Kirch (2021) with the aim of demonstrating whether the payment of dividends can be related to the future gain in value of their respective shares in companies in the Brazilian electricity sector. The authors showed a positive variation in the value of assets one year after their acquisition in that group that had a positive variation in dividends in the previous year, compatible with the “Dogs of Dow” strategy, with this relationship not being found for longer periods of time, both for dividends and quotations. Thus, Silva and Kirch (2021) suggest that the strategy of seeking appreciation of assets based on their previous payment of dividends should stick to the period of one previous year of payment of dividends aiming for a horizon limited to one year after the purchase of the action of the respective company.

Aiming to evaluate the occurrence of high dividend payments (greater than 5%) on a single date in the Brazilian electricity sector, as well as looking for a relationship with ownership concentration and frequency of dividend payments, Silva (2019b) selected share prices and dividend payments on their respective dates during the period from January 1, 2010 to December 31, 2015. It was demonstrated that the occurrence of yield payments paid less frequently in the group of electrical utilities, which is in line with theories on volatility of profit and the greater frequency of dividend payments as a sign of the company's financial health. Furthermore, when comparing electrical utilities with non-electrical utilities listed on the IBOVESPA, it became clear that the highest shareholding concentration is associated with dividend payments with a yield greater than 5% paid on a single date.

Silva (2019a), using the chi-square test, found an inverse relationship between GDP variation above 3% with investment in companies in the electrical sector listed on Bovespa during the period from 1994 to 2007. Furthermore, in periods of growth (GDP variation greater than 3%), external financing tends to be negative, while dividend payments tend to increase in these periods. These results, according to the author, point to a management model dependent on credit for its expansion. Companies in the electricity sector may, therefore, despite the large cash flow, be resorting to external credit for their investment. In other words, GDP expansion is in direct proportion to the distribution of dividends. The fact that companies in the electricity sector can easily obtain resources in the market, without the need to retain profits, could explain these results. Companies, according to the authors, especially larger ones, because they have greater access to credit, often subsidized, can afford this higher payment of dividends. This greater payment of dividends, in turn, can be used as a sign of the company's good functioning (Signal Effect).

Silva and Kirch (2022), in order to seek a correlation between non-operating profits and the dividend distribution policy of companies in the Brazilian electricity sector through their respective payments, analyzed using the Student's t test and ordinary least squares and demonstrated that The electricity sector stood out from other sectors for presenting lower non-operating profit, higher yield and lower annual appreciation than other sectors, with no difference in payment. The intrasectoral analysis showed an inverse relationship between non-operating profit and payment, as well as non-operating profit and dividend harvest. Companies in the electricity sector with high non-operating profits are related to low market value, yield and payout, and this factor can be a bad prognosis metric for the asset. According to the authors, these findings showed how the electricity sector differs from other sectors, requiring different strategies for investors who wish to obtain greater profits, such as considering high non-operating profit as a factor of lower profitability and valuation.

Silva and Kirch (2019), in turn, when studying the shares of the electrical system belonging to the Bovespa index, through the CAPM model, showed that they are more likely to generate increases in share prices above 2% than companies in other sectors belonging to the Bovespa index after the payment of dividends. According to the authors, shares in the electricity sector showed their own behavior, different from other companies.

Silva and Kirch (2023) when studying the time series of three companies in the Brazilian electricity sector (Cemig, Eletrobras and Transmissão Paulista) looking for relationships between dividends and asset prices. The least squares test showed no significant relationship between yield and price, the latter being the dependent variable. The Granger test showed a positive causal relationship between dividend yield and asset price variation in ELET3 and CMIG4, but not in TRPL4. Another aspect to be better clarified is the “negative” effect of dividend yield on prices that occurred in the CMIG4 asset and that appeared in the ARIMA model and in the Choleski impulse response.

Silva and Kirch (2020), researched the developments of actions in Brazil regarding the electricity sector. The period covered was from January 1, 2009 to July 20, 2019. Among the conclusions, the authors performed linear regression that showed no statistical correlation between yield and share prices.

Based on the review carried out above, the following hypotheses were formulated:

H_A: due to the peculiarity of their legislation, companies in the electrical sector in Brazil pay more dividends (higher yield) than companies in the same sector based in the United States and Germany.

H_{A0}: there is no difference in dividend payments between countries.

H_B: yield influences share prices.

H_{B0}: there is no influence of yield on share price.

The following section describes the methodology used to test the hypotheses raised above.

3 METHODOLOGY

From the Yahoo Finance website (YAHOO FINANCE, 2023), data was collected on dividend payments and daily values of shares of companies in the electricity sector in Brazil, the United States and Germany, respectively traded on the São Paulo, New York and Frankfurt. The values corresponded to the closing of the daily trading session. The period from January 1, 2000 to December 31, 2022 was covered. Furthermore, data analysis also included data on the GDP of the countries under study and the main indexes of each exchange: in Brazil, the Ibovespa, in USA, the SP&500 and Germany, the GDAXI.

To test the hypotheses, the collected data were converted as follows: dividends were converted into yield, annual yield variation (hereinafter D_yield), annual dividend payment variation (hereinafter D_div) and the first yield difference between D1 and D0 (hereinafter Yi_D1-D0).

The prices were converted into annual price variation, where the closing value of the asset on the last day of the year was collected in relation to the previous year's value (hereinafter D_price) and also through the difference between D_price and the annual variation of the stock index. respective country (hereinafter PR_SP). Companies where there was only one year of data were excluded, which would make the conversion to the variables described above unfeasible.

Data were analyzed using Student's t-test between the three countries, to test H_A and using uni- and multivariate regressions using ordinary least squares to test H_B. The level of statistical significance was set at 0.1.

4 RESULTS

On the São Paulo Stock Exchange (B3), 17 companies were found, for a total of 159 company-years. The stock exchange From the New York Stock Exchange, 35 companies were found, but Eletrobras was discarded, as it is a company already traded on B3. Thus, through 34 companies, there were a total of 567 company-years. On the Frankfurt Stock Exchange, 3 publicly traded companies were found, representing 60 company-years.

The descriptive statistics of companies in the electricity sector in different countries are shown in tables 1, 2 and 3. Table 4 shows the analysis, using the Student's t test, of the variables between countries. The yield, D_yield and D_div of Brazilian companies were higher than the yield of companies in the electrical sector in the USA and Germany, which rejects the null hypothesis H_A. The price variation between the different groups did not have statistically significant differences, even discounting the difference in the indices. As the yield is made up of the dividend divided by the share price, it can be concluded that the higher yield on the Brazilian stock market is due to a larger payment of dividends, as well as an increasing payment of them, rather than due to a fall in the asset's price. It is also important to highlight the higher yield in the USA than in Germany, but with greater growth in D_yield and D_div in German companies, which could be considered at a time when German companies surpassed the yield of American companies.

Table 1 – Descriptive Statistics of the Brazil Group (n = 159)

Variable	Mean ± standard error	Median	Minimum	Maximum
D_price (%)	7.85±2.83	4.47	-80.3	233.43
PR_SP (%)	1.37±2.76	1.1	-80.52	245.57
Yield (%)	6.67±0.53	5.22	0	54.8
D_yield (%)	4598.97±4458	2.76	-100	708965.5
D_Div (%)	3206.58±3090	1.52	-100	491425.4
Yi_D1-D0	-0.13±0.59	0.09	-49	34.22

Abbreviations: D_price: annual variation in share price; PR_SP: difference between the annual variation of the share and the Bovespa index of the respective year; D_yield: annual yield variation; D_Div: annual variation in dividends paid; Yi_D1-D0: annual difference between yields.

Table 2 – Descriptive Statistics of the USA Group (n = 567)

Variable	Mean ± standard error	Median	Minimum	Maximum
D_price (%)	5.08±0.82	6.55	-61.98	104.54
PR_SP (%)	-1.99±0.78	-1.8	-80.36	105.08
Yield (%)	4.25±0.07	3.91	0	17.89
D_yield (%)	-0.22±1.18	-2.45	-100	295.79
D_Div (%)	4.79±1.7	3.92	-100	682.14
Yi_D1-D0	-0.13±0.07	-0.11	-11.78	12.00

Abbreviations: D_price: annual variation in share price; PR_SP: difference between the annual variation of the share and the S&P500 index of the respective year; D_yield: annual yield variation; D_Div: annual variation in dividends paid; Yi_D1-D0: annual difference between yields.

Table 3 – Descriptive Statistics of the Germany Group (n = 60)

Variable	Mean ± standard error	Median	Minimum	Maximum
D_price (%)	3.53±3.62	3.04	-54.34	72.94
PR_SP (%)	-4.87±3.2	-3.47	-63.9	47.46
Yield (%)	3.83±0.29	3.62	0	9.27
D_yield (%)	14.16±13.49	0.51	-100	714.42
D_Div (%)	21.02±20.44	0	-100	1150
Yi_D1-D0	-0.08±0.25	0.01	-5.49	4.93

Abbreviations: D_price: annual variation in share price; PR_SP: difference between the annual variation of the share and the GDAXI index of the respective year; D_yield: annual yield variation; D_Div: annual variation in dividends paid; Yi_D1-D0: annual difference between yields.

Table 4 – Student's t test between countries

	Países		
Variable	Brazil vs USA	Brazil vs Germany	EUA vs Germany
D_price	NS	NS	NS
PR_SP	NS	NS	NS
Yield	Brazil > USA**	Brazil > Germany**	USA < Germany*
D_yield	Brazil > USA*	NS	USA < Germany*
D_Div	Brazil > USA*	NS	USA < Germany*
Yi_D1-D0	NS	NS	NS

Abbreviations: D_price: annual variation in share price; PR_SP: difference between the annual variation of the share and the index of the respective stock exchange for the respective year; D_yield: annual yield variation; D_Div: annual variation in dividends paid; Yi_D1-D0: annual difference between yields; *: $p < 0.1$; **: $p < 0.01$; NS: non-significant difference.

To test H_B, univariate and multivariate regressions were performed (tables 5 to 10). Within the univariate regression (tables 5 to 7), no statistically significant correlations were detected in the group of Brazilian companies between the dividend variables and the price variables. These results are in line with studies by Silva and Kirch (2020) and Silva and Kirch (2023). The only significant relationship was the correlation between GDP variation (D_GDP) with PR_SP, therefore accepting H_{B0} (table 5).

When using the dividend variables as dependent variables, a significant positive relationship was only found between yield and D_GDP, which is in accordance with Silva (2019a). Interestingly, an inverse relationship was found between D_GDP and the Ibovespa index (IBOV).

The univariate regression in the US group, as shown in table 6, showed that there was an inverse relationship between yield, D_yield and Yi_D1-D0 for D_price, rejecting HB0. Such correlations were not found when the dependent variable was PR_SP. In both D_price and PR_SP there was a significant positive correlation between D_GDP and the S&P500 index (SP&500).

When using the dividend variables as dependent variables, a negative relationship was found between SP&500 with yield, D_yield and Yi_D1-D0. D_GDP had a statistically

significant positive correlation with D_div, D_yield and Yi_D1-D0. A direct relationship was found between D_GDP and SP&500.

The univariate regression in the Germany group, as shown in table 7, showed that there was an inverse relationship between yield and D_price and PR_SP, rejecting H_{B0}. In both D_price and PR_SP there was a significant correlation between the GDAXI index (GDAXI), but without correlation with D_GDP. It is worth highlighting the fact that in D_price the correlation with GDAXI was positive and negative between PR_SP and GDAXI.

When using the dividend variables as dependent variables, a negative relationship was found with D_GDP. No significant correlations were found with the GDAXI index. Furthermore, no relationship was found between D_GDP and GDAXI.

Table 5 - Univariate Regression Brazil Group

Dependent variable	Independent variables						
	intercepto	D_Div	D_Yield	Yield	Yi_D1-D0	IBOV	D_PIB
D_price	0.058			0.08			
D_price	0.078**		8.58E-06				
D_price	0.078**	1.31E-05					
D_price	0.06*				-0.48		
D_price	0.056*						0.006
PR_SP	-0.036						0.022*
PR_SP	0.01	5.72E-05					
PR_SP	0.01		3.92E-05				
PR_SP	-0.03			0.39			
PR_SP	-0.009				-0.25		
D_div	25.22						6.38
D_div	45					-200	
D_yield	64.8					-290	
D_yield	36.18						9.15
Yield	0.063**					-0.036	
Yield	0.057**						0.002*
Yield	0.067**	-1.32E-05					
Yi_D1-D0	-0.001	1.26E-06					
Yi_D1-D0	0.004					-0.036	
Yi_D1-D0	-0.001						0.002
IBOV	0.088**						-0.016**

Abbreviations: D_price: annual variation in share price; PR_SP: difference between the annual variation of the share and the IBOV index of the respective year; D_yield: annual yield variation; D_Div: annual variation in dividends paid; Yi_D1-D0: annual difference between yields; IBOV: São Paulo Stock Exchange index; D_GDP: annual variation in Brazil's GDP; *: $p < 0.1$; **: $p < 0.01$.

Table 6 - Univariate Regression USA Group

Dependent variable	Independent variables						
	intercept	D_Div	D_Yield	Yield	Yi_D1-D0	S&P500	D_PIB
D_price	0.051**	-0.019					
D_price	0.117**			-1.27**			
D_price	0.052**		-0.142**				
D_price	0.034**					0.48**	
D_price	0.059**				-2.48**		
D_price	0.01						0.027**
PR_SP	-0.018*	-0.024					
PR_SP	-0.019*		-0.029				
PR_SP	0.023			-0.582			
PR_SP	-0.01				-0.39		
PR_SP	0.034**					-0.519**	
PR_SP	-0.042**						0.02**
SP500	0.053**						0.007*
D_Div	0.014						0.017*
D_Div	0.045*					0.029	
D_yield	0.023*						-0.314**
D_yield	0.053**					-0.027**	
Yield	0.041**						-0.0007
Yield	0.04**					-0.009*	
Yi_D1-D0	0.0016*						-0.001**
Yi_D1-D0	0.0006					-0.014**	

Abbreviations: D_price: annual variation in share price; PR_SP: difference between the annual variation of the share and the S&P500 index of the respective year; D_yield: annual yield variation; D_Div: annual variation in dividends paid; Yi_D1-D0: annual difference between yields; S&P500: New York Stock Exchange index; D_GDP: annual variation in US GDP; *: $p < 0.1$; **: $p < 0.01$.

Table 7 - Univariate Regression Germany Group

Dependent variable	Independent variables						
	intercept	D_Div	D_Yield	Yield	Yi_D1-D0	GDAXI	D_PIB
D_price	0.172**			-3.5*			
D_price	0.034		0.005				
D_price	0.043				-1.33		
D_price	0.03	0.02					
D_price	0.004					0.621**	
D_price	0.045						-0.0006
PR_SP	-0.025				0.206		
PR_SP	-0.05		0.01				
PR_SP	-0.054*	0.026					
PR_SP	0.16**			-4.97**			
PR_SP	0.005					-0.378**	
PR_SP	-0.028						0.007
D_div	0.27						-0.052
D_div	0.237					-0.328	
D_yield	0.154					-0.152	
D_yield	0.259*						-0.102*
Yield	0.034**					0.019	
Yield	0.038**						-0.002*
Yi_D1-D0	0.002					-0.015	

Yi_D1-D0	0.002*						-0.003**
GDAXI	0.068*						-0.009

Abbreviations: D_price: annual variation in share price; PR_SP: difference between the annual variation of the share and the GDAXI index of the respective year; D_yield: annual yield variation; D_Div: annual variation in dividends paid; Yi_D1-D0: annual difference between yields; GDAXI: Frankfurt Stock Exchange index; D_GDP: annual variation in Germany's GDP; *: $p < 0.1$; **: $p < 0.01$.

The multivariate analysis is found in tables 8 to 10, where D_GDP and variations in indices were included. In the group of Brazilian companies (table 8), no relationships were found between the price variables and the dividend variables, accepting H_{B0}. The only significant correlations found were a direct relationship between D_price and IBOV and an inverse relationship between PR_SP and IBOV. D_GDP was directly correlated with D_price and PR_SP. When approaching the dividend variables as dependent, an inverse correlation with IBOV was found.

In the group of US companies (table 9), different in the univariate analysis, both in D_price and in PR_SP negative correlations were found with all dividend variables, which rejects H_{B0}.

When using the dividend variables as dependent variables, a negative relationship was found between SP&500 with yield, D_yield and Yi_D1-D0, equal to the univariate regression. D_GDP had a statistically significant negative correlation with D_yield and Yi_D1-D0 and a positive correlation with D_div. A negative relationship was found between SP&500 with yield, D_yield and Yi_D1-D0.

In the group of companies from Germany (table 10), there was an inverse relationship between yield and D_price and PR_SP, rejecting H_{B0}, similar to what was demonstrated in the univariate analysis. Also as in the univariate analysis, in both D_price and PR_SP there was a significant correlation between the GDAXI index, but without correlation with D_GDP. It is worth highlighting the fact that in D_price the correlation with GDAXI was positive and negative between PR_SP and GDAXI. When using the dividend variables as dependent variables, a negative relationship was found between Yi_D1-D0 in GDAXI and D_GDP. Yield and D_yield had a negative correlation with D_GDP, different from the univariate analysis.

Returning, Brazilian companies in the electricity sector pay more dividends than companies in the same sector listed on the New York and Frankfurt stock exchanges. The share price is negatively influenced by dividends in companies in the United States and Germany, but there was no correlation between changes in asset prices and dividend payments in the case of Brazil. This last statement could be justified by comparing the variability (in the form of standard error) of dividends and yields in different countries: the standard error of these attributes in Brazil is a few dozen times higher than in the USA and Germany.

Table 8 - Multivariate Regression Brazil Group

Dependent variable	Independent variables						
	intercept	D_Div	D_Yield	Yield	Yi_D1-D0	IBOV	D_PIB
D_price	-0.01			0.17		0.64**	0.015*
D_price	0.008			0.24		0.57**	
D_price	0.05			0.05			0.006
D_price	0.019	3.70E-05				0.69**	0.014
D_price	0.07*	1.19E-05					0.002
D_price	0.038	3.97E-05				0.6**	
D_price	-0.0003				-0.42	0.63**	0.017*
D_price	0.055**				-0.52		0.007
D_price	0.024				-0.357	0.55**	
D_price	0.02		2.52E-05			0.67**	0.014
D_price	0.038		2.71E-05			0.6**	
D_price	0.075*		7.8E-05				0.003
PR_SP	0.002			0.28		-0.41**	
PR_SP	-0.019			0.209		-0.33*	0.017*
PR_SP	-0.05			0.27			0.02*
PR_SP	0.019		2.52E-05			-0.33*	0.014
PR_SP	0.038		2.71E-05			-0.40**	
PR_SP	-0.008		3.39E-05				0.019*
PR_SP	-0.006				-0.42	-0.345*	0.018*
PR_SP	0.02				-0.35	-0.43*	
PR_SP	-0.036				-0.36		0.023**
PR_SP	0.019	3.7E-05				-0.33*	0.013
PR_SP	0.038	3.97E-05				-0.4**	
PR_SP	-0.008	4.94E-05					0.019*
D_div	40.49					-184	3.31
D_yield	58.3					-267	4.7
Yield	0.06**					-0.026	0.002
Yi_D1-D0	0.001					-0.026	0.002

Abbreviations: D_price: annual variation in share price; PR_SP: difference between the annual variation of the share and the IBOV index of the respective year; D_yield: annual yield variation; D_Div: annual variation in dividends paid; Yi_D1-D0: annual difference between yields; IBOV: São Paulo Stock Exchange index; D_GDP: annual variation in Brazil's GDP; *: $p < 0.1$; **: $p < 0.01$.

Table 9 - Multivariate Regression USA Group

Dependent variable	Independent variables						
	intercept	D_Div	D_Yield	Yield	Yi_D1-D0	S&P500	D_PIB
D_price	0.02			-0.819*		0.45**	0.024**
D_price	0.07**			-0.94*		0.47**	
D_price	-0.017*		-0.064*			0.51**	0.017**
D_price	0.024**				-1.43*	0.5**	
D_price	-0.02*	-0.03*				0.54**	0.018**
D_price	0.006	-0.028					0.023**
D_price	0.012	-0.022				0.56**	
D_price	0.056*			-1.11*			0.027**
D_price	0.017				-2.11**		0.02**
D_price	-0.01				-1.15*	0.48**	0.018**
D_price	0.014*		-0.08**			0.53**	
D_price	0.01		-0.118**				0.02**
PR_SP	0.02			-0.82*		-0.54**	0.024**
PR_SP	0.07**			-0.94*		-0.528**	
PR_SP	-0.023			-0.46			0.02**
PR_SP	-0.02*	-0.029*				-0.45**	0.018**
PR_SP	0.012	-0.022				-0.43**	
PR_SP	-0.045**	-0.03					0.014**
PR_SP	-0.017*		-0.06			-0.48**	0.017**
PR_SP	0.014*		-0.08**			-0.47**	
PR_SP	-0.045**		-0.014				0.013**
PR_SP	-0.009				-1.15*	-0.51**	0.018**
PR_SP	0.024**				-1.43*	-0.5**	
PR_SP	-0.038**				-0.15		0.014**
D_Div	0.013					0.008	0.017*
D_yield	0.068**					-0.286**	-0.024**
Yield	0.042**					-0.009*	-0.0006
Yi_D1-D0	0.002**					-0.013**	-0.0008**

Abbreviations: D_price: annual variation in share price; PR_SP: difference between the annual variation of the share and the S&P500 index of the respective year; D_yield: annual yield variation; D_Div: annual variation in dividends paid; Yi_D1-D0: annual difference between yields; S&P500: New York Stock Exchange index; D_GDP: annual variation in US GDP; *: $p < 0.1$; **: $p < 0.01$.

Table 10 - Multivariate Regression Germany Group

Dependent variable	Independent variables						
	intercept	D_Div	D_Yield	Yield	Yi_D1-D0	GDAXI	D_PIB
D_price	0.173**			-4.6**		0.69**	-0.004
D_price	0.165**			-4.5**		0.127**	
D_price	-0.037	0.025				0.71**	0.006
D_price	0.03	0.02					-0.0003
D_price	-0.03	0.024				0.7**	
D_price	0.187**			-3.66*			-0.008
D_price	0.036		0.004				-0.001
D_price	-0.033		0.012			0.71**	0.006
D_price	-0.025		0.009			0.7**	
D_price	-0.002				-0.25	0.63**	0.002
D_price	0.0004				-0.36	0.63**	
D_price	0.05				-1.17		-0.008
PR_SP	0.17**			-4.6**		-0.308*	-0.004
PR_SP	0.165**			-4.51**		-0.306*	
PR_SP	0.166**			-5.02**			-0.002
PR_SP	-0.033		0.012			-0.29*	0.006
PR_SP	-0.02		0.008			-0.3*	
PR_SP	-0.06		0.015				0.009
PR_SP	-0.037	0.025				-0.28*	0.006
PR_SP	-0.029	0.024				-0.29*	
PR_SP	-0.065*	0.027					0.009
PR_SP	-0.002				-0.25	-0.37*	0.002
PR_SP	-0.034				0.59		0.008
PR_SP	0.0004				-0.36	-0.37*	
D_div	0.307					-0.394	-0.055
D_yield	0.286*					-0.276	-0.104*
Yield	0.037**					0.017	-0.002*
Yi_D1-D0	0.007*					-0.018*	-0.004**

Abbreviations: D_price: annual variation in share price; PR_SP: difference between the annual variation of the share and the GDAXI index of the respective year; D_yield: annual yield variation; D_Div: annual variation in dividends paid; Yi_D1-D0: annual difference between yields; GDAXI: Frankfurt Stock Exchange index; D_GDP: annual variation in Germany's GDP; *: $p < 0.1$; **: $p < 0.01$.

5 FINAL CONSIDERATIONS

This study aimed to look for differences in dividend policy in companies in the electricity sector in Brazil, the United States and Germany given that their tax legislation on the subject is different from each other. The findings found may be related to the Brazilian dividend taxation policy, which, by not taxing them, leads to an incentive for them to be paid. On the other hand, the negative correlation found between yield and share price in companies in the United States and Germany suggests a mismatch between the two and perhaps even a drop in the price of these assets when there is an increase in dividend payments.

Regarding the lack of correlation between yield and share price in Brazilian companies, although according to the studies by Silva and Kirch (2020 and 2023), when approaching

a different methodology, in the form of time series, the result was also different, showing direct relationship between the yield at a previous date in relation to the price (SILVA; KIRCH, 2021, SILVA; KIRCH, 2023).

Future perspectives include the study of other countries, especially those where the legislation on dividend taxation is different from that demonstrated by the countries described in this work. Furthermore, other aspects such as concentration of dividend payments and share splits can be very promising topics of study.

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