CONNECTIONS BETWEEN INVESTMENTS, FINANCING, AND DIVIDEND POLICY IN BRAZIL: CONTROLLING ENDOGENEITIES

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ABSTRACT

The main business decisions involve the search for the best relationship between investments, financing, and dividends. Based on evidence of imperfections in capital markets, it is believed that these decisions occur jointly, generating endogeneity in econometric models. Therefore, the objective of this study was to empirically analyze these interrelationships in the Brazilian stock market, addressing endogeneity issues through simultaneous equations estimated by Two-Stage Least Squares (2SLS), Three-Stage Least Squares (3SLS), and Generalized Method of Moments (GMM). The results partially confirmed the hypothesis of interdependence between these variables. It was found that investments are positively influenced by financing decisions and dividend distribution. In contrast, financial leverage was negatively associated with investment and dividend policies. Dividend distribution showed dependence on the simultaneous decisions of investment and financing. The results were consistent in the 2SLS and 3SLS estimates, but sensitive to the GMM method.

Keywords: Investments. Financing. Dividends. Endogeneity.

CONEXÕES ENTRE INVESTIMENTOS, FINANCIAMENTO E POLÍTICA DE DIVIDENDOS NO BRASIL: CONTROLANDO AS ENDOGENEIDADES

RESUMO

As principais decisões empresariais envolvem a busca pela melhor relação entre investimentos, financiamentos e dividendos. A partir das evidências de imperfeições nos mercados de capitais, acredita-se que essas decisões aconteçam de forma conjunta, gerando endogeneidade nos modelos econométricos. Diante disso, o objetivo deste estudo foi analisar empiricamente essas inter-relações no mercado acionário brasileiro, contornando os problemas de endogeneidade por meio de equações simultâneas estimadas por Mínimos

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Quadrados em Dois Estágios (2SLS), Mínimos Quadrados em Três Estágios (3SLS) e Método dos Momentos Generalizados (GMM). Os resultados confirmaram parcialmente a hipótese de interdependência entre essas variáveis. Constatou-se que os investimentos são positivamente impactados pelas decisões de financiamento e pela distribuição de dividendos. Em contrapartida, a alavancagem financeira mostrou-se negativamente associada às políticas de investimentos e dividendos. A distribuição de dividendos apresentou dependência das decisões simultâneas de investimentos e financiamento. Os resultados foram consistentes nas estimativas por 2SLS e 3SLS, mas sensíveis ao método GMM.

Palavras-chave: Investimentos. Financiamentos. Dividendos. Endogeneidade.

1 INTRODUCTION

One of the pillars of modern corporate finance theory is the separation between a company's investment, financing, and dividend policies. Modigliani and Miller (hereafter MM) (1958) defined that, in perfect capital markets, the value of a firm is independent of the financing method of its assets. Investment decisions are not influenced by dividend decisions and these, in turn, remain unaffected by the firm's financing policy.

However, models considering the existence of imperfections in capital markets suggest a possible interaction between these elements. Dhrymes and Kurz (1967) observed a strong interdependence between investment and dividend decisions and verified that financing activities can be influenced by both investment policies and dividend distributions. This scenario allowed the categorization of empirical studies on this topic into two main groups.

The first group includes research supporting the irrelevance of dividend policy (Fama, 1974; McDonald et al., 1975; Morgan & Saint-Pierre, 1978). These studies highlight that MM's theorems do not assume total independence between investment, financing, and dividend decisions, but exclude interdependencies between investment and financing based on dividend policies (Peterson & Benesh, 1983). Thus, empirical interrelations between investment and financing decisions do not violate MM's theorems, provided that causality is observed from investment to financing (Pruitt & Gitman, 1991).

The second group comprises studies emphasizing market imperfections such as taxes, agency costs, and inflation, which undermine the independence between investment and financing decisions (AHMED et al., 2021; Dhrymes & Kurz, 1967; Gomes et al., 2023; Grabowski & Mueller, 1972; Lee & Lee, 2021; Lee et al., 2016). In emerging economies, such as Brazil, these imperfections become more evident due to distinct institutional structures. Supra et al. (2016) and Pamplona and Silva (2020) suggest that such peculiarities may intensify the interrelations between investment, financing, and dividend decisions in these markets.

Although evidence indicates that these decisions are often co-determined (Brav et al., 2005), analyzing them with traditional methods, such as OLS and panel data regression using Random Effects (RE) or Fixed Effects (FE), may lead to

inconsistencies. According to Barros et al. (2020), these inconsistencies arise from endogeneity caused by omitted variables that correlate with the error term, measurement errors in the variables, or bidirectional causality between the dependent and explanatory variables (Lee et al., 2016).

Violations of the assumption of independence between regressors and error terms are common in empirical data (Lee et al., 2016), especially when dealing with interrelated variables such as investments, dividends, and financing (Lambrecht & Myers, 2012; Lee et al., 2016). In this context, the use of Instrumental Variables (IV) is an appropriate approach to mitigate the endogeneity problems associated with these variables. Nonetheless, there is a methodological gap in studies on companies in the Brazilian stock market, which may compromise the analysis of interdependencies between these three corporate decisions, particularly due to the endogeneity issues that frequently affect these models (2020; Lee et al., 2016).

In this sense, this study seeks to answer the following research question: **"What are the structural interdependencies between investment, financing, and dividend policy decisions of companies trading in the Brazilian market?"** The objective was to empirically analyze these interrelations, addressing endogeneity problems through a simultaneous equations model, estimated using Two-Stage Least Squares (2SLS), Three-Stage Least Squares (3SLS), and Generalized Method of Moments (GMM).

The results partially confirm the existence of interrelations between these variables. It was observed that investments are positively impacted by financing decisions and dividend distributions. Conversely, financial leverage is negatively associated with investment and dividend policies. Dividend distribution was found to depend on the simultaneous decisions of investment and financing. The results were consistent in the estimates using 2SLS and 3SLS but were sensitive to the GMM method, which weakened the estimates, possibly due to the use of Investments in first differences as an instrument that did not strongly fit the model.

Based on these findings, this article contributes to the Corporate Finance literature by expanding the evidence from Gomes et al. (2023) through the application of simultaneous equations to control for endogeneity issues in empirical studies. Additionally, it offers practical contributions by highlighting the interrelations between investments, dividends, and financing, providing evidence for investors, analysts, and regulators to better understand the financial dynamics of the Brazilian capital market. Thus, the study positions itself within a growing field in Corporate Finance literature, addressing the endogeneity problem, which remains underexplored in Brazil.

The study continues with the presentation of empirical specifications, grounded in the literature. In the third section, methodological aspects are discussed, with an emphasis on data collection and processing, as well as the econometric techniques employed. The fourth section presents the results and theoretical discussion. The fifth section concludes with final considerations, including limitations and suggestions for future studies.

2 THEORETICAL FRAMEWORK

The debate on the interdependence of strategic financial decisions in the finance literature has been frequent since Modigliani and Miller (1958) posited that, in a perfect market, there are no interdependencies between financial decisions, so that companies' financing and dividend policies are independent. Thus, internal and external financing are perfect substitutes, and financing and dividend choices are irrelevant to the firm's value.

However, these assumptions are challenged by Jensen and Meckling (1976), who point out that conflicts of interest and high monitoring costs lead external financiers to demand higher returns to compensate for risks and costs. Myers and Majluf (1984) highlighted problems of information asymmetry in capital markets. Bernanke and Gertler (1989, 1990) and Gertler (1992) demonstrated that agency costs increase the premium on external financing, especially when the borrower's equity decreases.

In this regard, Wang (2010) argues that capital structure can be relevant for corporate investment decisions in imperfect or incomplete capital markets, where the cost of external capital exceeds that of internal financing. Thus, given the violation of the perfect market assumption, firms should consider funding decisions alongside decisions on resource allocation (Maqbool et al., 2024).

As these decisions are essential to corporate management and directly influence performance (Lee & Lee, 2021; Lee et al., 2016), they tend to be interconnected: investments allocate resources to projects or assets, financing defines the optimal proportion of debt and equity, and dividend policy distributes profits to shareholders. Understanding their interactions is crucial for effective financial planning and value creation for shareholders (Maqbool et al., 2024).

Although some authors (Fama, 1974; Higgins, 1972; McDonald et al., 1975; Switzer, 1984) support MM's argument, suggesting that capital market imperfections are insufficient to establish a joint relationship between dividend and investment decisions (Fama, 1974), several studies document how these decisions influence each other (Dhrymes & Kurz, 1967; McDonald et al., 1975; Myers & Majluf, 1984; Pruitt & Gitman, 1991; Switzer, 1984).

Dhrymes and Kurz (1967) highlighted managers' challenges in allocating resources to investments or dividends due to cash flow constraints. Grabowski and Mueller (1972) suggested that changes in investment, dividend, and R&D policies affect one another. Later studies, such as McCabe (1979), Peterson and Benesh (1983), and DeAngelo and DeAngelo (2006), indicated that market imperfections require joint decisions between investment and financing.

Ding and Murinde (2010) reinforced those decisions on investment, financing, dividends, and capital structure are interdependent, interconnected by accounting identities (Gatchev et al., 2010). Hence, simple equation structures fail to capture the simultaneous and opposing effects of financial decisions, limiting economic interpretations (Gatchev et al., 2010). However, evidence on these interconnections is mixed. Sadaf et al. (2019) found no interdependence, while Ahmed et al. (2021) identified a direct relationship between dividends and investments.

Maqbool et al. (2024), analyzing firms in Pakistan, observed that financing positively influences dividends and investments, while dividends and investments compete for available resources. In Brazil, Loss and Sarlo Neto (2006) concluded that there is no relationship between such policies and that imperfections in the Brazilian market are not effective justifications to explain evidence of a relationship between dividend and investment policies.

In the Brazilian market, David et al. (2009) showed that payout is negatively related to investment opportunities, while dividends remain stable in the short term to accommodate investments, as suggested by the pecking order theory (1984). Santos et al. (2021) demonstrated that asset growth is associated with reduced indebtedness, indicating a preference for equity. They emphasized the importance of integrating these decisions to evaluate financial performance. Gomes et al. (2023), based on the Payout Policy Theory (2012), concluded that investment (Capex) and leverage positively influence payout, reinforcing the need to analyze financing, investment, and payout collectively.

The empirical scenario with contradictory evidence can be explained, according to Wang (2010), by methodological problems that hinder effective analysis. Barros et al. (2020) highlight inconsistencies in traditional estimators, such as OLS, Fixed Effects, and Random Effects, due to endogeneity, a common problem in corporate finance. Ullah et al. (2021) comment that endogeneity occurs when an explanatory variable is correlated with the error term, violating a fundamental OLS assumption. Without adequate techniques to control for it, spurious correlations may arise, resulting in misleading recommendations and ambiguous research.

Barros et al. (2020) identify three common sources of endogeneity: (a) omission of variables correlated with both regressors and the response variable; (b) measurement errors due to data recording failures or misalignment between the desired construct and the available proxy; and (c) simultaneous determination of variables. Ullah et al. (2021) suggest the use of Instrumental Variables (IV) and highlight approaches like GMM, 2SLS, and 3SLS, widely applied to mitigate endogeneity problems, as proposed in this study.

2.1 Brazilian context and hypothesis development

To investigate the structural interdependencies between investment, financing, and dividend policies of companies listed on the Brazilian market, it is crucial to consider the specifics of this market. Assaf Neto (1997) emphasizes that financial decisions in developing economies face greater complexity and risk due to interest rate imbalances, lack of long-term savings, and frequent interventions in economic rules. He notes that, although there is a clear need to integrate investment, financing, and dividend decisions, the perfect market hypothesis often separates these analyses. In Brazil, this debate is exacerbated by differentiated interest rates determined by funding sources, such as BNDES resources, which create discontinuities in the capital cost line (Assaf Neto, 1997).

Additionally, factors such as the low degree of informational efficiency and legal protection (Gomes et al., 2023), as well as tax peculiarities—such as tax exemptions on dividends, mandatory minimum dividends, and the use of interest

on equity—distinguish Brazil from markets like the United States (Forti et al., 2015). These characteristics shape managerial decisions aimed at improving payout rates and directly influence financial policies.

In this context, considering the interrelated nature of these decisions, the study assumes that endogeneity issues exist in traditional analyses, which may lead to inconsistent results. The simultaneity of investment, financing, and dividend decisions, along with omitted variable bias and measurement errors, may generate spurious correlations and bias conclusions (Barros et al., 2020). Thus, addressing endogeneity problems can enhance the consistency of results and reveal more robust evidence on joint decisions in these policies within the Brazilian market.

Given this context and considering capital market imperfections and Brazil's tax peculiarities, the following research hypothesis is proposed: **The investment, financing, and dividend policies of companies listed on the Brazilian stock market are interdependent and influenced by endogenous relationships, where changes in one area directly impact the others**.

Therefore, the simultaneity of these decisions and the influence of omitted variables and measurement errors reinforce the need to address this interdependence in an integrated manner to reveal how these choices contribute to optimizing corporate value.

3 METHODOLOGICAL PROCEDURES

The objective of this research was to empirically analyze the interrelationships between investment, financing, and dividend policy decisions, addressing endogeneity issues through simultaneous equations estimated by Two-Stage Least Squares (2SLS), Three-Stage Least Squares (3SLS), and Generalized Method of Moments (GMM). The following sections present the data and sample used, as well as the models analyzed and the estimation methods employed.

3.1 Data and sample

The database was constructed using the Economatica® platform, which provided the accounting variables from the annual consolidated financial statements, closing on December 31 of each year, for companies listed on the Brazil, Stock Exchange, and Over-the-Counter (B3). The analyzed period, from 2010 to 2023, was selected because, starting in 2010, Brazilian companies began to mandatorily adopt international accounting standards. However, companies from the financial sector were excluded from the sample (Fama & French, 2002), companies with negative equity (Silveira Galvão et al., 2019) and those whose accounting data were unavailable for the analyzed period were also excluded. Thus, the sample consisted of 2,380 observations (159 companies per year), and the variables were winsorized at 1%.

3.2 Model and econometric tests

The empirical model adopted was a system of simultaneous equations, where each equation had its dependent variable regressed against two endogenous variables, as defined by Lee et al. (2016) and presented in Equations (1) to (3).

$$Inv_{it} = \alpha_{1i} + \alpha_{2i}Div_{it} + \alpha_{3i}AlaFin_{it} + \alpha_{4i}Inv_{i,t-1} + \alpha_{5i}Q_{it} + \epsilon_{it} \quad (1)$$

$$Div_{it} = \beta_{1i} + \beta_{2i}Inv_{it} + \beta_{3i}AlaFin_{it} + \beta_{4i}Div_{i,t-1} + \beta_{5i}P_{it} + \eta_{it} \quad (2)$$

$$AlaFin_{it} = \gamma_{1i} + \gamma_{2i}Inv_{it} + \gamma_{3i}Div_{it} + \beta_{4i}AlaFin_{i,t-1} + \gamma_{5i}lnAt_{i,t-1} + \gamma_{6i}EbitAt_{i,t-1} + \gamma_{7i}Msetor_{i,t-1} + \xi_{it} \quad (3)$$

These equations had the following endogenous variables:

- Inv_{it}: Investment per share, represented by *Capex* (*Capital Expenditure*), which indicates the investment rate or the growth of the company's fixed assets (Forti et al., 2015), divided by the total shares outstanding. Regarding dividends, Lambrecht and Myers (2012) indicate a positive relationship (+). Higgins (1972), McCabe (1979), and Peterson and Benesh (1983) report a negative relationship (-). With leverage, Peterson and Benesh (1983) and Switzer (1984) report a positive coefficient (+).
- Div_{it}: Dividends per share (Fama, 1974), including, in the Brazilian case, Interest on Own Capital (JSCP) and dividends paid. McDonald et al. (1975) and Yoon and Starks (1995) indicated a positive relationship (+) with the company's investments, and McCabe (1979) and Peterson and Benesh (1983) found a negative relationship (-). With leverage, a positive (+) sign is found in the studies of McCabe (1979), Peterson and Benesh (1983), and a negative (-) relationship in the results of Switzer (1984) and Jensen et al. (1992).
- $AlaFin_{it}$: Company's indebtedness, measured by Total Liabilities divided by Shareholders' Equity. Regarding the expected sign, McDonald et al. (1975), McCabe (1979), and Peterson and Benesh (1983) indicated a positive relationship (+) with investments, while McCabe (1979), Peterson and Benesh (1983), and Switzer (1984) found a negative relationship (-) with dividends. Jensen et al. (1992) and Fama and French (2002) observed an inverse relationship (-) between leverage and dividends.

Exogenous variables were selected based on empirical evidence. For the instruments, the first lag of the three policies was adopted (Lee et al., 2016), i.e., Investments ($Inv_{i,t-1}$), Financing ($AlaFin_{i,t-1}$), and Dividends ($Div_{i,t-1}$) for the period $t-1$. The control variables were: Q_{it}, defined as the sum of Sales Revenue with Inventory Changes (Fama, 1974; Lee et al., 2016), and P_{it}, formed by Net Income

minus dividends paid to preferred shareholders, to incorporate the amount of resources available for dividend payments to common shareholders.

The natural logarithm of Total Assets ($lnAt_{it}$) was used to mitigate the effects of firm size. The variable $EbitAt_{it}$, representing the relationship between EBIT (Earnings Before Interest and Taxes) and Total Assets (Fama & French, 2002; Lee et al., 2016), was used to reflect each firm's ability to generate profits. Finally, to capture characteristics specific to the companies' capital structure, considering their industry sector, the average leverage value lagged by one year was adopted for each sector ($Msetor_{i,t-1}$).

Equations (1) to (3) were estimated using instrumental variables (IV) methods, considering that the use of OLS in simultaneous equations results in biased and inconsistent estimates due to the violation of the assumption of no correlation between the regressors and the error terms (Bound et al., 1995). Thus, to control for endogeneity, the 2SLS, 3SLS, and GMM estimation methods were employed, as proposed by Hansen (1982).

The 2SLS model was estimated in two stages (Lee et al., 2016; C. J. Wang, 2010). In the first stage, the endogenous variables were regressed against the exogenous variables and instruments to address the correlation between the endogenous explanatory variables and the error term. In the second stage, the adjusted values from this regression (predicted values) were used as substitutes for the original endogenous variables and were employed as regressors in the final model to ensure that the regression model was consistently estimated after addressing the endogeneity issue.

The 3SLS model, defined as an extension of 2SLS (Lee et al., 2016; C. J. Wang, 2010), it was developed in three stages. In the first stage, the endogenous variables of each equation were regressed against the exogenous variables and instruments, and the adjusted values from this regression were used as substitutes for the original endogenous variables. In the second stage, the covariance matrix of the errors was estimated from the residuals of the first stage, to capture the correlation between the error terms of the different equations in the system. Finally, in the third stage, the estimates from the first stage were adjusted using the estimated covariance matrix, resulting in more efficient estimators than those obtained by the 2SLS method.

For GMM estimation, three stages were followed (Greene, 2012). First, the moment conditions were considered to adjust the model parameters to the population parameters. Then, a weighting matrix was selected to assess the quality of the moment conditions. Finally, the GMM objective function was minimized to estimate the model parameters. The estimates were performed using the statistical software R, employing the *systemfit* package (Henningsen & Hamann, 2007) for the 2SLS and 3SLS methods, and the *gmm* package (Chausse, 2010) for the GMM method.

The use of these three approaches is justified by the complementary way they address endogeneity. Chen and Lee (2010) point out that, although 2SLS is widely used, it can be less efficient since it only uses information from the equation under analysis. On the other hand, 3SLS is more efficient as it makes use of additional information from the variance-covariance matrix of the simultaneous

equations system. GMM, in turn, generalizes instrumental variable estimators, allowing the use of a weighting matrix that takes into account factors such as temporal dependence, heteroscedasticity, and autocorrelation.

3.3 Instrument validity test

Finding a valid instrument suitable for the instrumental variables model is a common challenge in research (2021). Rossi (2014) warns that invalid instruments can lead to divergent estimates, even in the absence of endogeneity bias. When instruments are weak, the IV estimator loses its desired properties and may produce misleading results (Bound et al., 1995). Thus, following Wang (2010), the strength of the instruments was verified through the first-stage F-statistic of the regression, testing the hypothesis that the instruments are jointly equal to zero. Instruments with an F-statistic value below ten were considered weak (Lee et al., 2016; Rossi, 2014; C. J. Wang, 2010).

Moreover, since GMM provides more efficient estimators in the presence of heteroscedasticity compared to 2SLS or 3SLS (Lee et al., 2016), a heteroscedasticity test was conducted to decide which estimator to use. Pagan and Hall (1983) and Hashem and Taylor (1999) suggest that traditional tests like Breusch-Pagan or Cook-Weisberg are not the most suitable. Therefore, the alternative test proposed by Pagan and Hall (1983) was used, which relies on the estimates of the endogenous regressors from the first stage to avoid simultaneity issues. If the null hypothesis of homoscedasticity was rejected (as verified by the significance of the parameters, the F-statistic, and the R^2), the most efficient estimate would be the one obtained by GMM. Otherwise, the estimate from traditional IV would be preferred (Lee et al., 2016).

4 RESULTS ANALYSIS AND DISCUSSION

After defining the variables and the proposed methodology, the discussion of the results obtained through the different estimation methods (2SLS, 3SLS, and GMM) is presented. Initially, a descriptive analysis of the variables is conducted, highlighting their behavior over the sample period. Next, the "instrument strength" tests are presented. Finally, the results from the regressions estimated from the simultaneous equations are discussed.

4.1 Descriptive analysis of the variables

Table 1 presents the descriptive statistics for the endogenous variables Investments, Financing, and Dividends, as well as the control variables. With the exception of Q, all variables have 2380 observations, reflecting a complete and consistent dataset for the sample used. On average, companies invested R$ 0.08 per share, with a median of R$ 0.03. This difference suggests a positive skew, indicating that most companies made investments smaller than the mean. Untabulated data suggest that the health (Inv = 0.0995) and public utilities (Inv = 0.01002) sectors, related to the supply of electricity, natural gas, and water, were the largest investors during the period.

Table 1
Descriptive Statistics of the Variables

	N	Me	SD	Min	P25	Med	P75	Max
Inv	2380	0.08	0.16	0.00	0.01	0.03	0.07	1.09
Fin	2380	2.73	3.13	0.34	1.15	1.76	2.90	21.38
Div	2380	0.17	0.33	0.00	0.03	0.08	0.17	2.29
Q	2053	0.23	0.31	-0.38	0.01	0.17	0.36	1.56
P	2380	0.17	0.22	-0.38	0.07	0.13	0.22	1.20
AT	2380	21.55	1.80	16.94	20.39	21.54	22.72	25.92
EbitAT	2380	0.08	0.24	-1.19	0.02	0.08	0.14	1.00
MSetor	2380	2.91	1.93	1.19	1.86	2.21	2.85	9.59

Note: This table presents the descriptive statistics, including the number of observations (N), Mean (Me), standard deviation (SD), minimum value (Min), first quartile (P25), median (Med), third quartile (P75), and maximum value (Max) of each variable for the period from 2010 to 2023. Inv, Fin, and Div stand for Investments, Financing, and Dividends, respectively. Q is the sum of sales revenue and changes in inventory. P is the difference between net income and dividends paid to preferred shareholders. AT is the natural logarithm of Total Assets. EbitAt is the ratio of earnings before taxes and interest to total assets. MSetor is the average investment value in each sector. Except for AT, the variables were divided by the number of shares outstanding as of December 31 of each year.
Source: Elaborated by the authors.

For financing, the average was R$ 2.73 per share, with a positive skew, as the median was R$ 1.76. The variability was higher, with a standard deviation of 3.13. Some companies had financing levels much higher than the average (Max = 21.38), suggesting financial leverage strategies, surpassing the sector's average (MSetor), which was R$ 9.59 per share. The real estate sector had the highest percentage of financing (Fin = 6.87).

For dividends, the average was R$ 0.17 per share, with a standard deviation of 0.33 and a median of R$ 0.08. The moderate positive skew indicates that some companies distribute relatively high amounts to shareholders. The health sector was the highest dividend payer during the period, with an average of R$ 0.26 per share (non-tabulated data). Regarding the control variable P, which reflects the portion of net income retained by companies after paying dividends to preferred shareholders, the average was 0.17, indicating that, on average, companies retain about R$ 0.17 of net income per share for dividends or investments.

These results should be analyzed in the context of Brazilian economic crises, such as the 2008 subprime crisis and the 2016 crisis, which were marked by political instability, rising inflation, increased interest rates, and a decline in GDP, negatively affecting corporate investments (Franzotti & Valle, 2020). Contrary to the findings of Lee et al. (2016) and DeAngelo and Roll (2015), significant instability in companies' debt levels was observed, with highly heterogeneous financing levels, which may affect dividend payments to shareholders.

4.2 Instrument relevance test

As shown in Table 2, the tests indicated that the instruments used are valid. The coefficients for the endogenous variables ($Inv_{t-1} = 0.71(44.59)$; $Fin_{t-1} = 0.82\ (67.07)$; $Div_{t-1} = 0.79\ (80.69)$) were significant at the 1% level, confirming that

they are statistically different from zero. These results suggest a possible temporal dependence in the variables analyzed.

Table 2
Instrument Relevance Test

	Investments	Financing	Dividends
Coef	0.71***	0.82***	0.79***
tTest	(44.59)	(67.07)	(80.69)
R2	0.54	0.77	0.79
Ftest	1159.22***	1884.02***	4188.15***
BP	218.35***	212.36***	306.09***
TesteInv		1173.69***	1680.95***
TesteFin	524.83		1416.71***
TesteDiv	898.52***	1848.10***	
Wu	13.68***	18.76***	179.77***
Sargan	836.62***	1652.41***	1203.89***

Note: This table presents diagnostic tests to assess the validity of the instruments used. The endogenous variables include Investments, Financing, and Dividends. Coef are the coefficients of the lagged endogenous variables, while tTest, R2, and Ftest represent the t-statistic, the coefficient of determination, and the F-statistic, respectively. BP refers to the Pagan-Hall heteroscedasticity test. TesteInv, TesteFin, and TesteDiv assess the strength of the instruments. Wu is the Hausman specification test, and Sargan corresponds to the Sargan-Hansen test. The symbols ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.
Source: Elaborated by the authors.

Based on the Coefficient of Determination (R^2), the regressions for the Financing model ($R^2 = 0.77$) and the Dividends model ($R^2 = 0.79$) explain most of the variability of the variables, suggesting endogeneity. In the Investment model ($R^2 = 0.54$), the explanatory power was lower, but the F-test rejected the hypothesis that all instruments are jointly equal to zero ($Ftest_{Inv} = 1159.22$; $Ftest_{Fin} = 1884.02$; $Ftest_{Div} = 4188.15$), confirming the adequacy of the instruments and explanatory variables for investigating this relationship.

Regarding the Pagan and Hall heteroscedasticity test (1983), the values $BP_{Inv} = 218.35$, $BP_{Fin} = 212.36$ and $BP_{Div} = 306.09$ were all significant at the 1% level, confirming the presence of heteroscedasticity, justifying the need to use more robust models with simultaneous equations. Additionally, the Hausman specification test (Wu), which assesses the exogeneity of the instruments, revealed $Wu_{Inv} = 13.68$, $Wu_{Fin} = 18.76$ and $Wu_{Div} = 179.77$, also significant at the 1% level, justifying the use of instrumental variables.

To verify the validity of the instruments, the Sargan-Hansen test ($Sargan$), showed significance for all variables ($Sargan_{Inv} = 836.62$, $Sargan_{Fin} = 1652.41$ and $Sargan_{Div} = 1203.89$), suggesting that the instruments may not be completely exogenous. This justifies the need for different tests to confirm the hypothesis that the decisions on investment, financing, and dividend policy of companies listed in the Brazilian stock market are interdependent and influenced by endogenous relationships, where changes in one area directly impact the others.

The results indicated that Ordinary Least Squares (OLS) based tests do not meet the conditions of consistency and efficiency of the estimators. The presence

of endogenous variables justifies the use of 2SLS, especially due to the results from the instrument strength tests (TesteInv, TesteFin, TesteDiv), which were significant, except for Investments as an explanatory variable for Financing ($TesteFin = 524.83$). Furthermore, 3SLS, as an extension of 2SLS, is suitable for simultaneous equation systems and suggests that endogenous variables may mutually influence each other, forming an interdependent system. The presence of heteroscedasticity, detected by the Pagan-Hall test, points to the need for GMM as a robust estimator to correct these violations. Therefore, the combination of these issues justified the use of instrument-based methods to address endogeneity in the decision-making processes of these policies in the Brazilian stock market.

4.3 Equation system estimated by 2SLS

After verifying the strength of the instruments and the endogeneity of the variables, Table 3 presents the results of the simultaneous equations estimated by 2SLS regression.

Table 3
Simultaneous Equations Estimated by 2SLS Regression

	Investments	Financing	Dividends
Constant	-0.0058***	-0.0094***	1.9204***
	(-1.49)	(-1.58)	(3.97)
Inv		0.0653***	0.0025***
		(6.48)	(2.72)
Fin	-0.5352***		-0.2219***
	(-1.24)		(-1.32)
Div	0.2149***	0.0037***	
	(4.90)	(2.51)	
Inv (t-1)	0.6443***		
	(35.55)		
Fin (t-1)		0.8216***	
		(53.77)	
Div (t-1)			0.7712***
			(67.09)
Q	0.0664***		
	(9.06)		
P		0.0833	
		(3.69)	
ln At (t-1)		-0.0866	
		(-4.04)	
EbitAt (t-1)		1.0195***	
		(5.36)	
MSetor		0.1533***	
		(7.48)	

Note: This table presents the estimated coefficients for simultaneous equations by 2SLS Regression. Constant is the intercept coefficient for each equation. Inv, Fin, and Div are endogenous explanatory variables, while Inv (t-1), Fin (t-1), and Div (t-1) represent lagged variables. Q, P, ln At (t-1), EbitAt (t-1), and MSetor are exogenous variables. The values in parentheses are robust standard errors. The symbols ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.
Source: Elaborated by the authors.

The constants indicated that, in the absence of other explanatory variables, the average levels of Investments (-0.0058) and Financing (-0.0094) would be slightly negative. For Dividends (1.9204), the results suggest that the payment is significant, reflecting a corporate policy oriented towards dividend payments as a standard practice, regardless of the levels of Investments or Financing in the companies.

The first observation to be considered regarding the endogenous variables is the positive and statistically significant relationship between Investments and Financing (0.0653), suggesting that, on average, for every R$ 1.00 per share invested in the company, there is an increase of R$ 0.065 per share in current financing. These results align with the findings of Peterson and Benesh (1983) and Switzer (1984), who found a positively significant coefficient in this relationship.

Similarly, a positive relationship between Investments and Dividends (0.0025) was observed, albeit with a smaller coefficient. Studies by Lambrecht and Myers (2012), Gomes et al. (2023), and Maqbool et al. (2024) confirm this interaction. When analyzing all three policies together, there is evidence that, to ensure investments without compromising dividends, companies increase their indebtedness. These results support the hypothesis proposed by Lambrecht and Myers (2012), that investments influence profit generation and, consequently, *payout*. In other words, *payout* and investment decisions are made simultaneously, as indicated by Brav et al. (2005).

Regarding Financing decisions, the coefficients of the independent variable in the simultaneous equation estimated by the 2SLS regression showed values of -0.5352 for Investments and -0.2219 for Dividends. These negative coefficients indicate that an increase in the financing level reduces both Investments and Dividends. This suggests that higher indebtedness compromises resources for new investments and the distribution of dividends to shareholders. These findings confirm the results of Lee et al. (2016), who identify a significant negative relationship between debt financing and dividend payments. The result also aligns with the *pecking order* theory, which asserts that companies with lower leverage have more internal resources and, therefore, greater capacity to pay dividends (Myers & Majluf, 1984).

The negative and statistically significant relationship between investments and financing was also observed by Lang et al. (1996) and Aivazian et al. (2005), who investigated financial leverage and corporate investment, finding that more indebted companies tend to invest less. In the Brazilian context, this result corroborates the findings of Albuquerque and Matias (2013), who demonstrated that financial leverage negatively affects investment decisions: companies with higher debt tend to invest less.

In the analysis of the Div variable in the simultaneous equation estimated by 2SLS regression, the coefficients 0.2149 and 0.0037, associated with the Investment and Financing equations, indicated that dividends have a positive effect on these variables. The coefficient 0.2149 in the investment equation suggests that an increase in dividend payments is associated with an increase in investments. This result is consistent with the findings of McDonald et al. (1975) and Yoon and Starks (1995), who observed a positive relationship between dividend policy and investments. However, these results are divergent from the conclusions of McCabe

(1979) and Peterson and Benesh (1983), who identified a negative relationship between these variables.

The lagged variables showed high statistical significance in the coefficients Inv_{t-1} (0.6443), Fin_{t-1} (0.8216), and Div_{t-1} (0.7712), indicating strong persistence in financial decisions. These results suggest that past decisions substantially influence current choices, being statistically significant and of practical relevance in the decision-making process of companies. This continuity can be explained by the tendency of companies to smooth their financial policies, avoiding abrupt fluctuations in investment, financing, and dividend distribution levels.

The control variables showed the expected signs and significances. Sales revenue, combined with inventory variation (Q), showed a positive and significant relationship at the 1% level with investments, corroborating the findings of Fama (1974) and Lee et al. (2016). This indicates that companies with higher sales revenue and that invest in inventory replenishment tend to allocate more resources to investments. Similarly, the variable of dividends available to common shareholders (P) showed statistical significance and a positive sign. This suggests that more profitable companies, after allocating the mandatory portion to preferred shareholders, have more resources available to remunerate the capital invested through common shares (Fama, 1974; Lee et al., 2016).

The negative coefficient for company size indicates that larger companies tend to be more leveraged, which can be attributed to their higher reputation in the market and lower informational asymmetry, facilitating access to financing at reduced costs (Lee et al., 2016). Studies by Fama and French (2002), Frank and Goyal (2009), and Lee et al. (2016) confirm this relationship. Moreover, the positive relationship between leverage and the variable $EbitAT$ suggests that more profitable companies are more leveraged, likely due to greater investments in capital goods to increase revenue generation. Finally, the average sector leverage value ($MSetor$) showed statistical significance, highlighting that sector-specific factors may influence companies' leverage decisions.

4.4 System of equations estimated by 3SLS

To strengthen the statistical consistency of the models, the estimation of the simultaneous equations was also performed using the 3SLS regression method. According to Chen and Lee (2010), it is more efficient than 2SLS, as it incorporates information from the variance-covariance matrix of the system, considering all model specifications. Table 4 presents the regression results, with the average coefficient estimates for the variables investment, financing, and dividends.

The results confirm the previous findings, with signs and significance consistent with 2SLS and an increase in the marginal magnitude of the coefficients. The 3SLS method, being more efficient than 2SLS when the model is well-specified (2010), indicates that the proposed model is econometrically consistent. The most notable differences were in the coefficients for Fin and Div, with 3SLS showing a smaller impact for Fin and a greater impact for Div on the dependent variables, suggesting that 3SLS captures the simultaneous relationships more accurately, offering a more robust analysis.

Table 4
Simultaneous Equations Estimated by 3SLS Regression

	Investments	Financing	Dividends
Constant	-0.0056***	-0.0111***	1.9133***
	(-1.45)	(-1.86)	(3.96)
Inv		0.0651***	0.0025***
		(6.46)	(2.72)
Fin	-0.5033***		-0.2305***
	(-1.17)		(-1.37)
Div	0.2160***	0.0040***	
	(4.94)	(2.69)	
Inv (t-1)	0.6466***		
	(35.69)		
Fin (t-1)		0.8239***	
		(53.95)	
Div (t-1)			0.7683***
			(66.85)
Q	0.0651***		
	(8.90)		
P		0.0920***	
		(4.08)	
ln At (t-1)		-0.0860	
		(-4.02)	
EbitAt (t-1)		1.0267***	
		(5.41)	
MSetor		0.1485***	
		(7.25)	

Note: This table presents the estimated coefficients for simultaneous equations by 3SLS regression. Constant represents the intercept coefficient for each equation. Inv, Fin, and Div are endogenous explanatory variables, while Inv (t-1), Fin (t-1), and Div (t-1) are lagged variables. Q, P, ln At (t-1), EbitAt (t-1), and MSetor are exogenous variables. The values in parentheses are robust standard errors. The symbols ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.
Source: Elaborated by the authors.

As highlighted in Table 2, the improvement in the R^2 values and the statistical efficiency of the coefficients when using the 3SLS method reinforces its ability to more accurately capture the simultaneous relationships within the system, compared to 2SLS. The coefficients adjusted by 3SLS show greater consistency, more faithfully reflecting the complex interactions between the variables. Despite the observed differences, the coefficients maintained the same direction and significance, supporting the consistency between the models.

4.5 Estimated equation system by GMM

The analysis was further complemented by applying the GMM method to the system of equations. This method is recognized for its robustness in the presence of endogeneity, by using moments as restrictions, and for its flexibility regarding the variance and covariance structure of the errors. The results of the system of equations estimated via GMM are presented in Table 5.

Table 5
Simultaneous Equations Estimated by GMM Regression

	Investments	Financing	Dividends
Constant	-0.0341	1.9292***	-1.4394*
	(-0.26)	(4.44)	(-1.78)
Inv		-0.0087	0.8079***
		(-0.16)	(4.54)
Fin	29.0906***		-12.9270***
	(3.95)		(-2.61)
Div	5.0458**	0.4799*	
	(2.44)	(1.77)	
Inv (t-1)	0.7080***		
	(44.51)		
Fin (t-1)		0.8185***	
		(54.87)	
Div (t-1)			0.7961***
			(73.08)
Q	0.0699***		
	(9.40)		
P			0.1411***
			(8.98)
ln At (t-1)		-0.0699	
		(-3.40)	
EbitAt (t-1)		0.8270***	
		(5.16)	
MSetor		0.1586***	
		(7.79)	

Note: This table presents the estimated coefficients for simultaneous equations using GMM Regression. 'Constante' is the intercept coefficient for each equation. Inv, Fin, and Div are endogenous explanatory variables, while Inv (t-1), Fin (t-1), and Div (t-1) represent lagged variables. Q, P, ln At (t-1), EbitAt (t-1), and FinSetor are exogenous variables. The values in parentheses are robust standard errors. The symbols ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.
Source: Elaborated by the authors.

The results obtained differ significantly from previous estimates, both in terms of magnitude and in the identified signs. In the investment equation, statistical significance was observed only in the relationship with Dividends (-12.9270). This finding suggests that dividends continue to play a relevant role in investment decisions, even when using alternative methods to control endogeneity in the equations. Thus, the hypothesis is reinforced that companies consider dividend distribution as one of the determinants for allocating resources to new investment projects.

In the financing equation, investments had an extremely positive and significant impact (29.0906), indicating that an increase in financing is one of the main drivers of investments. In contrast, dividends had a negative and highly significant impact (−12.927), suggesting that the increase in financing is associated with a reduction in dividend distribution. These results corroborate Forti et al. (2015), who observed an inverse relationship between leverage and dividends, showing that more leveraged companies tend to reduce dividends. Jensen (1992) points out that increased debt signals the expectation of high future cash flows, while

Lambrecht and Myers (2012) highlight that these results are in line with the joint theory of leverage and dividend policy.

In general, the 2SLS and 3SLS methods yielded consistent results, while GMM produced divergent results, highlighting that the choice of method influences the conclusions of the analysis. While 3SLS is theoretically more efficient than 2SLS, and GMM is more robust to endogeneity, both methods presented limitations in the analyzed context. 2SLS proved effective when using lagged variables as instruments to capture the interactions between investments, financing, and dividends. Thus, due to its simplicity and effectiveness in dealing with endogeneity, 2SLS stood out as the preferred approach over more complex methods.

Given the results, the hypothesis that the investment, financing, and dividend policies of companies listed on the Brazilian stock market are interdependent and influenced by endogenous relationships was partially confirmed. After controlling for endogeneities in these simultaneous decisions, it was observed that investment, financing, and dividend policies are interconnected. However, the financing equation did not exhibit the expected relationships between investments and dividends. Furthermore, the results were sensitive to the methods used for endogeneity control.

5 CONCLUSIONS

The objective of this study was to identify the structural interdependencies between investment, financing, and dividend decisions of companies in the Brazilian market. It was considered that these approaches do not occur in isolation, as there is strong endogeneity between the variables, which prevents the obtaining of consistent results from isolated OLS regressions. By using simultaneous equations estimated by 2SLS, 3SLS, and GMM to address the problem of endogeneity of variables, the results partially converged across the three approaches analyzed.

The 2SLS estimations indicated a positive relationship between investments made and dividends paid, suggesting that companies use investments as a signal for future cash flow generation, which enables the continuous increase in dividend payments. On the other hand, the financing policy did not show statistical significance in relation to dividends. This implies that companies primarily raise external funds to increase their investments, rather than to maintain a constant dividend payout.

With the 3SLS method, the same consistency in coefficients and signs was observed. However, the marginal magnitude of these coefficients was relatively larger. Since 3SLS is more consistent when the equations are correctly specified, there is a strong indication that the model presented has the appropriate characteristics of a good estimation, indicating robustness in the results. Finally, when estimating the equations using GMM, the results diverged in magnitude and in the relationship between the variables.

In conclusion, the hypothesis was partially confirmed. Only the financing equation did not present the expected relationships between investments and dividends. The reason for this partial resolution of the system can be explained by

the nature of the Brazilian market, which, based on the propositions of Modigliani and Miller (1958), still faces imperfections in several aspects. Another relevant point is that the study relied on traditionally used metrics, without considering the changes proposed by Lambrecht and Myers (2012), who defined new approaches for studying these variables. Thus, it is suggested that future studies take into account the endogeneity of variables as per these new propositions.

Although the results are consistent with the methodology employed, the study has some limitations. The evidence presented is limited to the period from 2010 to 2023 and is restricted to the sample and number of observations used. The control variables were those confirmed in the literature in studies with simultaneous equations involving the three financial policies of companies. As a suggestion, it is recommended to incorporate additional variables, including the corporate life cycle. Finally, it is suggested to assess the sensitivity of investment, financing, and dividend decisions based on sectoral endogeneity.

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