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The impact of tax complexity and installment payments on tax noncompliance in Brazil: a study on federal taxation related to IRPJ, CSLL, PIS/Pasep, and Cofins

Antônio Paulo Machado Gomes
https://orcid.org/0000-0001-8919-1605

Jacqueline Veneroso Alves da Cunha
https://orcid.org/0000-0003-2522-3035

Jorge de Souza Bispo
https://orcid.org/0000-0002-1845-2473

Isabel Maria Estima da Costa Lourenço
https://orcid.org/0000-0003-4338-6778

Abstract

Objective: To verify within the scope of federal taxation whether tax complexity and repetitive special installment payments are associated with an increased probability of tax noncompliance among companies listed on B3.

Method: A panel logit model was developed to estimate the probability of a company being non-compliant based on the independent variables tax complexity, special installment payments, probability of inspection, inspection costs, Selic rate, and expected utility, which are controlled by current liquidity, EBITDA, and company size.

Results: This study identified that tax complexity and repetitive special installment payments increase the probability of tax noncompliance among companies listed on B3. The results also showed that low inspection probability, the high costs of inspection, the need for cash, and expected utility positively affect the probability of tax noncompliance among the companies in the sample. These results indicate that Brazil should decrease its unnecessary tax complexity.

Contributions: Understanding the determinants and consequences of tax noncompliance in Brazil is relevant to better manage scarce inspection resources, and guide efficient public policies to generate employment and income for the population. Thus, this study contributes to society as a whole by highlighting the need for a tax reform to reduce unnecessary tax complexity and facilitate the understanding of tax legislation.

Keywords: Tax noncompliance; Tax planning; Tax aggressiveness; Tax complexity; Special installments.

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1. Introduction

Tax noncompliance is considered a tax law violation, which Laffer *et al*. (2011) classify as voluntary and involuntary. In its voluntary form, taxpayers seek to avoid or decrease tax liabilities through tax avoidance or evasion. In its involuntary form, taxpayers are unable to correctly calculate their taxes and tax base due to the complexity of the law.

However, regardless of whether tax noncompliance is voluntary or involuntary, it harms the tax system by decreasing the government's tax revenue forecasting and, consequently, harming society, as it restricts investments in health, education, security, infrastructure, and others. Therefore, studying the factors that lead to tax noncompliance is relevant for a fair and efficient tax system that prevents loopholes that enable dishonest taxpayers to avoid paying taxes and prevent honest taxpayers from miscalculating their taxes.

International studies link tax complexity to tax noncompliance (Andreoni *et al*., 1998; Graetz *et al*., 1986; Richardson, 2006) based on two concepts: (i) tax complexity enables taxpayers to identify opportunities for not paying taxes (voluntary noncompliance), and (ii) tax complexity prevents taxpayers from correctly calculating their taxes and tax base (involuntary noncompliance).

Furthermore, tax noncompliance is associated with special installment plans (Tax Amnesty), which, according to Torgler (2003), represent tax benefits granted by governments to delinquent taxpayers, such as decreased fines and interests, forgiving tax crimes, and granting extended deadlines for the payment of taxes due. Special installment plans encourage tax noncompliance, as such plans decrease the present value of taxes, benefiting delinquent taxpayers and punishing compliant taxpayers, encouraging taxpayers not to collect their taxes timely, leading to a vicious cycle (Paes, 2014).

Nonetheless, most of the evidence in these studies was collected in the United States and developed countries, and little has been investigated in developing countries. Furthermore, few empirical studies jointly analyze tax complexity and special installment plans as determinants of tax noncompliance. According to Jacob (2018), understanding the determinants and consequences of tax noncompliance in a developing country with highly complex tax laws is relevant for allocating scarce enforcement resources.

Therefore, this study aims to fill in this gap. Its general objective is to verify whether, within the scope of federal taxation, tax complexity, and repetitive special installments are associated with an increased likelihood of tax noncompliance among companies listed on B3. Hence, this study aimed to identify which companies listed on B3 presented tax demands to the Federal Administrative Council of Tax Appeals (Carf), such as Corporate Income Tax (IRPJ), Social Contribution on Net Profits (CSLL), Social Integration Program (PIS), and Contribution for Social Security Financing (Cofins).

We propose a proxy to identify tax complexity based on the propositions of the Office of Tax Simplification (OTS, 2015) of the United Kingdom, i.e., using two leading indicators of tax complexity, quantity, and changes in tax legislation. Finally, we identified which companies listed on B3 adhered to the special federal installments from 2010 to 2018.

This study in the accounting field of a tax and fiscal nature is expected to contribute to debates on public policies linked to tax laws and, consequently, to the so-expected and necessary tax reform. It will also shed light on the behavior of Brazilian taxpayers when dealing with such complex tax legislation and the possibility of enjoying the benefit of special installments.

2. Theoretical Framework

2.1 Tax authorities and taxpayers: bets and strategies

Allingham and Sandmo (1972) explain that the decision to declare taxes or not is made under uncertainty, as not correctly collecting taxes does not result in an immediate penalty. Therefore, taxpayers can choose between two plays: collecting and not collecting taxes.

As noted by Allingham and Sandmo (1972), if not investigated, taxpayers are better off in the second strategy; however, if caught, not paying taxes is the worst option. The authors' logic is that taxpayers profit when they do not fully pay taxes and are not audited. On the other hand, if audited and fined, they pay more than just the tax. Graetz *et al.* (1986) consider that discussions concerning tax must consider law enforcement gains, as enforcement agencies interact in a formal model of legal compliance. The inspection strategies available include inspecting a taxpayer or not. Note that some taxpayers will always be audited. However, since tax authorities face numerous restrictions, some taxpayers will never be audited. But the truth is that tax surveillance has benefits. Therefore, the gains arising from surveillance and the taxpayers' gains must be considered in the tax noncompliance game. The Game Theory explains the tax relationship between taxpayers and the State, as both play a non-cooperative game with asymmetric information.

Tax evasion problems are based on information asymmetry between taxpayers and the State since the tax bases (e.g., revenue, profit, etc.) are generally not directly identifiable by the State; these are taxpayers' private information. In other words, the State generally cannot directly see the taxpayers' taxable base and, therefore, does not know the actual value of their taxes. Additionally, identifying the actual tax calculation base is even more challenging in Brazil due to the complexity of its tax system.

Considering rational agents (taxpayers and the State), both seek to increase their expected return. Hence, taxpayers try to pay the lowest tax possible, using the tax opportunities the system provides (Scholes *et al.*, 2005) or even taking risks and evading taxes (Slemrod & Yitzhaki, 2002). On the other hand, tax authorities try to collect the highest amount of taxes possible to cover not only their demands but also the evasion of some taxpayers (Scholes *et al.*, 2005; Slemrod & Yitzhaki, 2002).

2.2 Tax noncompliance

Tax noncompliance concerns voluntary or involuntary noncompliance with tax laws (Laffer *et al.*, 2011). According to Andreoni *et al.* (1998), tax compliance can be considered from different perspectives, such as a problem of public finance, law enforcement, organizational design, labor supply, ethics, or a combination of all these.

Hence, this study considers an economic perspective in which taxpayers' behavior results from a rational calculation and careful assessment of tax noncompliance costs and benefits. Therefore, tax noncompliance is addressed here according to the approach used by Allingham and Sandmo (1972) and expanded by Graetz *et al.* (1986), i.e., a dynamic game in which the tax system complexity and the various special installments encourage tax noncompliance.

Richardson (2006) notes that several studies have sought to identify the main determinants of tax noncompliance; fourteen key variables were found. These variables are categorized into four groups: (i) demographic (age and sex); (ii) proxies of tax noncompliance opportunity (education, income level, source of income and occupation, inspection probability, fines, and tax rates); (iii) attitudinal (ethics, perception of fairness of the tax system and peer influence); and (iv) structural (complexity of the tax system, contact with tax authorities, sanctions and probability of detection and tax rates).

Thus, the literature highlights several factors that interfere in taxpayers' tax (non)compliance.

This study adopted the line of research on tax noncompliance because even taxpayers who want to pay their taxes correctly are subject to fines (confirmed by CARF) due to the complexity of the tax system in Brazil. At the same time, such complexity enables taxpayers to avoid or decrease their tax liabilities, such as by using simulated internal goodwill or business combinations such as "sham marriage". Therefore, this study seeks to identify Tax Avoidance among companies listed on B3 and show that tax complexity and special installments are instruments for tax noncompliance in Brazil.

2.3 Tax complexity and tax noncompliance

The OTS (2015) formally established tax complexity as the difficulty taxpayers experience in understanding tax laws and applying them to determine how much the taxes are due. Complexity arises from changes in tax legislation, the number of laws in the tax system, their regulation, and the level of comprehensibility (OTS, 2015). Ulph (2015) reports that complexity is not a term well defined or precise term in the economic analysis of taxes. According to Ulph (2015) understanding, tax complexity is a broad term encompassing the laws' lack of transparency and ambiguities. The author mentioned earlier clarifies that complexity arises from the tax system, considering it includes many taxes with different triggering events, calculation bases, and rates. Additionally, the system presents specific tax application situations.

Scholes *et al.* (2005) clarify that tax systems result from various socioeconomic forces, and taxes are designed to (i) finance public projects (national defense, legislative, judiciary, others); (ii) redistribute wealth (tax more heavily those who, presumably, can pay more and tax less heavily those who can pay less); and (iii) promote various economic activities. According to Budak and James (2018), these objectives explain tax complexity, considering that taxes are designed to achieve fiscal and non-fiscal objectives. However, to achieve these objectives, governments make concessions that increase costs for taxpayers and tax authorities, promoting a cycle that must be constantly reviewed to remove unnecessary complexity. Therefore, understanding the inevitable consequence that any tax system has a certain degree of complexity is crucial, considering that such complexity results from the need to achieve specific objectives, such as increasing revenue, redistributing income, and doing so in the least distorted way possible (Ulph, 2015).

Complexity means that laws (i) are sometimes unclear, (ii) sometimes are clear, but taxpayers are unaware of such laws, and (iii) sometimes are clear, but the administration effectively ignores a specific transaction activity. Therefore, the complexity lies in interpreting rules and their application (Batrancea, Nichita & Batrancea, 2013). Hence, even tax consultants and financial experts find it challenging to understand tax rules, let alone ordinary taxpayers (Alm, 2012).

Several studies (Batrancea, Nichita & Batrancea, 2013; Budak & James, 2018; Laffer *et al.*, 2011; Richardson, 2006) associate tax complexity with tax noncompliance, with the underlying idea being that complexity leads to indecision that taxpayers can use to avoid paying taxes or lead them to miscalculations.

In this sense, Beck and Jung (1989) studied the effects of tax complexity on American taxpayers' decisions on whether to declare their total income. They note that tax complexity has consequences for tax authorities and taxpayers when applying tax laws. Therefore, even with the risk of fines, taxpayers may not report their tax bases correctly. In this sense, Slemrod and Yitzhaki (2002) studied American tax evasion. They found that taxpayers might adopt tax planning when faced with tax changes in a complex tax environment that may affect their consumption basket to avoid decreasing their consumption. Therefore, tax complexity may encourage taxpayers not to comply with taxes to ensure their consumption basket.

Thus, tax complexity might also affect the results of tax audits and the behavior of taxpayers when dealing with such audits. Scotchmer and Slemrod (1989) report that, given tax evasion in the USA, increasing randomness in tax audits would increase reported revenue and profits. However, even random tax audits would not dissuade taxpayers from underreporting income and taxable profits, giving the possibility of questioning the results of tax audits. In this sense, Cronshaw and Alm (1995) show that even if taxpayers were unaware of the US government's tax audit policies, they would be encouraged not to fully report their income because tax complexity enables them to challenge infraction notices. Thus, the authors above conclude that increasing tax complexity is counterproductive, as this would affect the positive results of tax audits.

Follmann (2001) verified income tax evasion among natural persons in Brazil and found that the system's complexity facilitates tax noncompliance, given that the tax system is composed of laws and regulations that are difficult to apply and with several opportunities for tax noncompliance. Rezende (2015) also identified that Brazil has several incentives for tax noncompliance, such as cyclical programs for the installment payment of tax debts, under financial conditions that are more favorable than the opportunity costs, and this fact is reflected in the increased volume of provisions and contingent tax liabilities recorded and reported in companies' explanatory notes. Gomes, Cunha, Francisco, and Lara (2023) showed, in their Theoretical Model to discuss Tax Evasion based on Game Theory, that tax complexity is the great catalyst for the tax aggressiveness of Brazilian companies.

Therefore, these various studies (Beck & Jung, 1989; Scotchmer & Slemrod, 1989; Cronshaw & Alm, 1995; Aghion & Tirole, 1997; Slemrod & Yitzhaki, 2002; Follmann, 2001; Rezende, 2015; Gomes *et al.*, 2023) associate tax complexity with tax noncompliance, showing that it leads to uncertainty on how to apply and interpret tax laws. Therefore, tax complexity incurs high costs for taxpayers and economic losses, discourages tax compliance, promotes tax noncompliance, and imposes uncertainty in future decision returns.

Tax complexity in the Brazilian context results from a vast number of tax laws, which are frequently changed, besides ancillary obligations, leading to a significant increase in tax burden and tax disputes, representing a considerable percentage of Brazilian GDP. Hence, (voluntary or involuntary) noncompliance is common given such a complex situation and the constant changes in legislation.

In short, tax complexity in Brazil creates a challenging scenario for companies and taxpayers, increasing operating costs, promoting litigation, and encouraging strategies to avoid paying taxes.

Therefore, based on the previous discussion, the first hypothesis is proposed:

H_1: Tax complexity is associated with more significant tax non-compliance among companies listed on B3.

2.4 Special installments and tax non-compliance

Baer and Le Borgne (2008) define Tax Amnesty as a limited-time offer the government gives to a specific group of taxpayers to pay their delinquent taxes from the previous tax period(s) in exchange for reduced interest and fines and the non-application of criminal law. According to Mikesell and Ross (2012), these temporary programs allow taxpayers in debt with the government to voluntarily pay their due taxes without being subject to sanctions that failure to pay on time usually entails. Typically, if these taxes were collected through tax enforcement actions, delinquent taxpayers would have to pay them late with fines and interest on the unpaid amount and would also be subject to criminal prosecution (Mikesell and Ross, 2012). Therefore, by participating in the special installment plan, delinquent taxpayers can avoid punitive and criminal economic consequences while benefiting from the government.

According to Paes (2014), research shows that special installment plans encourage tax noncompliance because they decrease the present value of taxpayers' taxes, encouraging them not to pay on time. According to Torgler (2003) and Andreoni *et al.* (1998), a special installment plan affects taxpayers' tax morale, leaving room for dishonest taxpayers not to pay their taxes on time by financing themselves with government resources. Furthermore, it may make honest taxpayers feel outraged and discouraged from honoring their tax commitments on time, as they see that their dishonest competitors benefit from tax subsidies.

Hasseldine (1998) analyzed 43 special installment programs in 35 U.S. states between 1982 and 1997 and found that the largest amount collected did not exceed 2.6% of total tax revenue. However, a 0.008% decrease in revenue was found in the granting states after these programs were implemented, suggesting a decline in tax compliance after the installment programs.

Mikesell (1986) reports that 25 American states have implemented or authorized special installment plans with different structures and policies to decrease fines since 1981. However, the conclusion is that these programs have not generated significant revenue increases; instead, they encourage tax noncompliance.

Studies by Alm (1991), Crane and Nourzad (1990), Das-Gupta, Lahiri and Mookherjee (1995), Paes (2014), Morais *et al.* (2011) and others indicate that special installment payments decrease tax compliance, with high rates of unpaid installment debts.

Ross and Buckwalter (2013) suggest that these programs alter the taxpayers' perception regarding the detection of noncompliance, increasing tax aggressiveness after their implementation. Luitel and Sobel (2007) found evidence that the repeated implementation of these installment plans decreases tax revenue.

Bayer *et al.* (2015) developed a theoretical model and showed that special installment offers are influenced by government debts and taxpayers' expectations about future programs.

Shevlin, Thornock, and Williams (2017) found that repeated installment payments alter taxpayers' perceptions of detection, leading to more significant tax noncompliance. Morais *et al.* (2011), Cavalcante (2010), and Paes (2014) also identified adverse impacts of special installment payments on tax collection in Brazil. Gomes *et al.* (2023) also demonstrated in the Tax Noncompliance Game that special installment payments decrease the present value of taxes, encouraging taxpayers to be tax aggressive in collecting unpaid taxes under the benefits of special installment payments.

In short, the studies show that special tax installments do not increase tax revenue but encourage tax noncompliance, create perceived injustices, and change taxpayer behavior, harming the government's tax collection efficiency. Thus, the second hypothesis proposes that:

H_2: Special installments are associated with more significant tax non-compliance among companies listed on B3.

3. Method

3.1 Study's Sample

This study's intentional sample comprised 449 publicly held companies listed on B3 between 2010 and 2018. However, in view of outliers, we followed what Fávero and Belfiore (2015) proposed and excluded 26 companies (234 observations). Therefore, 423 publicly held companies listed on B3 (3,807 observations) remained in the analysis.

The timeframe chosen here is because publicly traded Brazilian companies were required to adopt the new accounting standard in 2010. The Brazilian Secretariat of the Federal Revenue (RFB) established a new inspection parameter with the publication of RFB Ordinance No. 11,211 in 2007, which established the focus of RFB inspection based on the economic-tax potential of legal entities. Thus, the focus of the Brazilian Secretariat of the Federal Revenue from that ordinance onwards was supervising large taxpayers. Furthermore, during this period, 6 (six) laws were published granting special conditions for tax regularization (special installments): Laws No. 12,863 from 2013, No. 12,973 from 2014, No. 12,996 from 2014, and No. 13,043 from 2014 reopening the term for payment of tax debts in installments by Law No. 11,941 from 2009 (*Refis da Crise*). In 2017, Provisional Measure No. 766 of 2017 was published in the Tax Regularization Program (PRT), and the same year, Law No. 13,496 from 2017, with the Special Tax Regularization Program (PERT).

Table 1 shows the sample according to sector, following the guidelines established by the RFB to describe inspection processes.

Table 1
Sample according to sectors from 2010 and 2018

Sector	Total	%
Commerce	24	5,67%
Civil Construction	28	6,62%
Industry	119	28,13%
Service provisions	35	8,27%
Communication. energy and water	76	17,97%
Financial services	59	13,95%
Holding companies	31	7,33%
Transportation and related services	33	7,80%
Other sectors	18	4,26%
TOTAL	**423**	**100.00%**

Source: developed by the authors.

Table 1 shows that this study considers all sectors, including the financial sector. The Industry sector is the most representative, followed by the communication, energy, and water oligopolies and financial services.

A sensitivity test was performed by removing the financial sector companies from the sample and comparing the results to those presented here, which showed no statistically significant differences.

3.2 Variable description and construction

The dependent variable, Tax Noncompliance (TNC), was based on the analysis of CARF judgments. The data collected to develop this variable started by identifying the National Registry of Legal Entities (CNPJ) of the companies in the sample, and the CARF website was consulted to verify the companies' tax demands. Content analysis was performed on the summaries of the companies' decisions regarding IRPJ, CSLL, PIS, and COFINS to classify the companies as non-compliant (1) or compliant (0). Hence, the content analysis steps suggested by Martins and Theóphilo (2009) were followed: (i) pre-analysis, including the collection and organization of decisions; (ii) analytical description by choosing the analysis units; and (iii) classification according to inferential interpretation.

In this context, a decision was classified as unfavorable (1) to the taxpayer if the summary contained the following terms: *Deny the request for voluntary appeal, Grant the appeal ex officio,* or *Deny the voluntary appeal*. Favorable decisions (0) to the taxpayer were based on the summary containing the following terms: *Cancel the entry, Grant the voluntary appeal,* or *Partially grant the voluntary appeal.* All decisions analyzed here concern taxes subject to the study IRPJ, CSLL, PIS, and Cofins, published between 2010 and 2018, whose assessments concerned the year analyzed.

The independent variable Tax Complexity (Complx) is an index *[COMPLX = [(Z^1 + §^{1}) / 2]* of the tax complexity of federal legislation faced by Brazilian companies, considering the two main indicators of tax complexity of the OTS (2015) work: quantity and changes in tax legislation. The data source for constructing this index was Decree No. 9,580 of 2018 (Income Tax Regulation) and IN RFB No. 1,911 of 2019 (Regulations of PIS and Cofins Contributions) obtained through the Planalto and RFB websites, respectively. The percentage between specific legislation and total legislation (Z^1) was identified by dividing the number of characters without spaces in the legislation of the tax modality collected by the company (actual, presumed, non-cumulative, and cumulative profit) by the total number of characters without spaces in the respective tax (IRPJ, CSLL, PIS and Cofins). The variable Changes in Tax Legislation (§1) was based on the changes implemented to the laws composing Decree No. 9,580 of 2018, and Laws No. 9,701 from 1998, No. 9,718 from 1998, MP No. 2,158 from 2001, Law No. 10,637 from 2002, and Law No. 10,833 of 2003, which were retrieved from the Planalto website.

The variable Installments (I) was obtained from the explanatory notes of the companies listed on B3 published in the study period. A search was performed in the explanatory notes to identify, through the reference words Installment, Refis, PRT, and PERT, whether the company had adhered to any installment plan; the number of times the company had adhered to such plans was summed up.

The independent variable inspection probability (P%) considered the annual inspection plan – RFB (2018). Revenues were obtained from the Economática database, and inspection procedures were retrieved from the RFB website in the inspection item of the Annual Inspection Plan. Thus, each company's net operating revenue was identified and the companies were classified according to the RFB's economic sectors, as reported in their Annual Inspection Plan. Thus, the net operating revenue of the economic sector was identified in addition to the number of tax procedures per sector to calculate the inspection probability proxy. Since the publication of the Allingham and Sandmo (1972) model, the inspection probability has been considered a controller of intentional tax noncompliance, as the more significant the inspection probability, the lower the intentional tax noncompliance should be. Therefore, verifying whether the inspection probability perceived by companies affects their decision to comply with tax noncompliance is vital.

The RFB Annual Inspection Plan focuses on large taxpayers with high tax collection power. Hence, the proxy follows this reasoning, i.e., the companies with the highest revenues in their sectors and the highest number of tax procedures are the most likely to be inspected.

The projected Selic variable was obtained from the Focus report published by the Brazilian Central Bank in the Aggregate Median – Selic Target Rate – end of period (% p.a.) for the year prior to the one studied. Therefore, all Focus reports from the last day of the year between 2010 and 2018 were downloaded to identify the Selic variable. It is important to highlight that the Selic increases tax debt, inhibiting tax noncompliance. Therefore, the model seeks to verify this relationship.

The Inspection Cost variable is the ratio between the amount due in federal taxes declared in the DVA (TDVA) and the result of dividing the total cost of the RFB in the year by the number of tax procedures performed in that year, according to the Annual Inspection Plan. According to the model developed by Gomes (2020), the inspection of a taxpayer would only be feasible if the returns from such inspection, through the recovery of taxes, plus fines and interest, were more significant than the cost of the inspection. Therefore, if the inspection cost were more significant than the taxpayer's tax collection potential, it would not be worth the inspection, which may influence a taxpayer's decision to comply or not comply. Therefore, this relationship was verified in the model.

The RFB's total cost is published on the transparency portal, where there is a link to *Revenues* and *Expenses,* where citizens can click on public expenses to consult according to the executing agency/entity. The Brazilian Secretariat of the Federal Revenue was chosen for this study. It also enables citizens to choose the period they want to search, which in this study's case was between 2010 and 2018. This search generated an Excel file with four columns: the amount committed, the amount settled, the amount paid, and the amount remaining to be paid and paid; only the amounts paid were considered actual RFB expenses.

The number of tax auditors and procedures were obtained from the RFB website under the link *Open Data, Results, Inspection, Files,* and *Images*, where the Annual Inspection Plan is published every year since 2006.

The Expected Utility variable had its parameters identified in the explanatory notes of the companies listed on B3 and the Economática database. It assesses the cost-benefit of noncompliance by comparing the expected return on noncompliance (WACC) to the tax payment for noncompliance reduced by the average tax benefits of the special installments (*Refis da Crise*, PRT, and PERT). This variable aimed to identify whether the financial cost-benefit of non-payment of a tax is related to tax noncompliance, that is, whether it is feasible for the companies in the sample to decide for tax aggressiveness, in other words, for the decision of tax noncompliance. Does this positive or negative return influence the tax noncompliance of the companies analyzed? Therefore, this variable seeks to verify this relationship.

The Big4 variable was collected at the Finance and Risk Laboratory of FEA/USP at https://www.tatianaalbanez.com/riskfinlab. Finally, the control variables—leverage, to control the companies' debt; ADR, to control the type of rules to which the companies were subject for trading on the stock exchange; Current and Dry liquidity, to control the need for cash; and Ebitda and ROE, to control the companies' profitability—were collected on the Economática website.

Figure 1 presents an overview of the variables addressed here, along with descriptions, formulas, expected signs, literature, and the source of data.

Variable	Proxy description	Formula	Signal	Literature	Source
Tax noncompliance (TNC) – Dependent variable	Dummy assumes 1 for those companies with adverse decisions in Carf concerning – IRPJ, CSLL, PIS, and Cofins in the year analyzed and 0 for those companies with favorable decisions for the same taxes or with no issues being judged in Carf in the year analyzed.	Dummy		Hanlon and Heitzman, 2010.	CARF website:: *http://carf.fazenda.gov.br/sincon/public/pages/ConsultarJurisprudencia/consultarJurisprudenciaCarf.jsf*
Complexity (Compx) – Independent variable	The index was calculated by adding (i) the percentage difference between specific legislation and total legislation (Z^1) and (ii) the percentage change in tax legislation ($§^1$) and dividing the result by 2.	$COMPLX = [(Z^1 + §^1) / 2]$	+	OTS, 2015	Planalto website: *http://www4.planalto.gov.br/legislacao/*
	Z_1 is the tax legislation for calculating the company's tax in year t; L_{Tx} is the number of characters without spaces in the legislation regarding the tax collected by the company in year t; Lt is the total number of characters without spaces in the tax in year t	$Z^1 = \frac{L_{Tx}}{L_t}$			
	$§^1$ is the number of changes in tax legislation; s is the number of changes in tax legislation for the tax due between 2010 and 2018; s is the total tax legislation for the tax in question between its institution and the year 2018.	$§^1 = \frac{s}{s}$			
Installments PIN (I) – Independent variable	P is the proxy for the installments made by the company; x is the number of installments accepted by the company.	$P = \frac{x}{3}$	+	Paes, 2014.	Explanatory notes of the financial statements of companies listed on B3.
Inter - Independent variable	Interaction between the complexity variables (complx) and special installments (I).	$Inter = COMPLX$	+	OTS, 2015; Paes, 2014.	Study's data
Inspection probability (P%) - Independent variable	P% is the inspection probability of the company in the year; R_{it} is the total gross revenue of the company in the year; Tt is the total gross revenue of all companies in the economic sector of the company studied in the year; Et is the number of companies in the economic sector listed on B3; PF_t is the number of tax procedures carried out by the RFB for the economic sector of the company studied in the year.	$P\% = \frac{R_{it}}{T_t} x \frac{E_t}{PF_t}$	-	Allingham and Sandmo, 1972.	The companies' revenue was obtained through Economática and the inspection procedures on the RFB website under the inspection link.

Variable	Proxy description	Formula	Signal	Literature	Source
Selic (Selic) - Independent variable	The projected Selic rate obtained in the Focus report published by the Central Bank is shown in the Aggregate Median—Selic Target Rate—end of period (% p.a.) table.	Selic	-	Allingham e Sandmo, 1972.	Focus Bacen Bulletin
Inspection costs (custos) - Independent variable	Costs are the amount due in federal taxes declared in the DVA (TDVA) divided by the result of the division between the RFB's total cost in the year and the tax procedures carried out by the RFB in that year, in accordance with the annual inspection plan.	$Costs = \frac{TDVA_{it}}{\left[\frac{TotalCost}{procedures}\right]_t}$	+	Bertolucci and Nascimento, 2006.	Economática; Transparence Portal; RFB.
Expected utility (EU) – Inspection costs	Difference between the company's WACC update (δ) for 60 months, minus the fine (m) plus the Selic interest (ρ) for 60 months, reduced by the average of the tax benefits of the special installments studied (y).	$E[U] = U\left\{[(1+\delta)^{60}] - 1\right\} - \{[(m + \sum_1^{60}\rho) * (1-y)]$	+	Allingham and Sandmo, 1972.	The Brazilian companies' WACC was obtained from the Assaf Neto Institute website..
Leverage – Control variable	Short and long-term debt.	$\frac{Leverage = Total\ Liabilities_{it}}{Total\ Assets_{it-1}}$	+	Martinez and Martins, 2016	Economática.
Size (Size) – Control variable	Natural logarithm of the asset.	$Log(asset_{it})$	-	Zimmerman, 1983.	Economática.
Big4- Control variable	Dummy assumes 1 for those companies audited by one of the 4 major auditing companies (KPMG, EY, Delloite and PWC) and 0 otherwise.	*Dummy*	-	Martinez, 2017.	Laboratório de Finanças e Risco da FEA/USP.
ADR – Control variable	Dummy assumes value 1 for companies with shares traded on the New York Stock Exchange and value 0 otherwise.	*Dummy*	-	Teixeira, 2018.	Economática.
Restriction – Control variable	The current and dry liquidity index, as well as the company's EBITDA.	Liquidity and Ebitda	+	Teixeira, 2018.	Economática.
ROE – Control variable	The company's return on equity ratio.	$ROE = \frac{LL_{it}}{PL_{it-1}}$	+	Martinez, 2017.	Economática.

Source: developed by the authors.

Figure 1. Variables' description and expected signs

3.3 Statistical Model

The estimation technique was the panel logit model, which allows for estimating the probability of an event to occur and identifying the independent variables that contribute to its prediction (Mingoti, 2010). The model is described in Equation 1:

$$\begin{aligned} & ln\left(\frac{prob(Y_{it}=1)}{prob(Y_{it}=0)}\right) \\ & = \beta_0 + \beta_1 COMPLX_{it} + \beta_2 P_{it} + \beta_3 Inter_{it} + \beta_4 P\%_{it} + \beta_5 Selic_{it} \\ & + \beta_6 Costs_{it} + \beta_7 EU_{it} + \beta_8 Debts_{it} + \beta_9 Size_{it} + \beta_{10} Big4_{it} \\ & + \beta_{11} ADR_{it} + \beta_{12} Liquidity_{it} + \beta_{13} Ebtida_{it} + \beta_{14} ROE_{it} + e_{1t} \end{aligned} \quad (1)$$

Where ln is the natural logarithm; *P(=1)* is the probability of the company being non-compliant in year *t*; P(=0) is the probability of the company being compliant in year *t*; $COMPLX_{it}$ is the complexity of company *i* at time *t*; P_{it} is the special installment plan of company *i* at time *t*; $Inter_{it}$ is the interaction variable between complexity and installments of company *i* at time *t*; P $P\%_{it}$ is the probability of company *i* being inspected at time *t*; $Selic_{it}$ is the projected Selic rate of company *i* at time *t*; $Costs_{it}$ are the inspection costs of company *i* at time *t*; EU_{it} is the expected utility of company *i* at time *t*; $Debts_{it}$ is the leverage of company *i* at time *t*; T $Size_{it}$ is the natural logarithm of the total assets of company *i* at time *t*; $Big4_{it}$ is the dummy for the auditing firm of company *i* at time *t*; ADR_{it} is the dummy if the company has shares traded on the New York Stock Exchange *i* at time *t*; $Liquidity_{it}$ is the current and dry liquidity of company *i* at time *t*; $Ebitda_{it}$ is the Ebitda of company *i* at time *t*; ROE_{it} is the ROE of company *i* at time *t*; and ε, is the error term that follows a normal distribution, with zero mean and constant variance.

All the variables are related to the decision for tax noncompliance. Inspection probability may either encourage or discourage noncompliance: the greater the probability of inspection, the lower noncompliance should be. Likewise, the Selic rate corrects the infraction notice in the event of an inspection. On the other hand, very high inspection costs would make inspection unfeasible. However, if the cost-benefit of tax noncompliance is greater than the payment of the infraction notice after reductions enabled by a special installment plan, it would encourage tax noncompliance. Debts can be a catalyst for a company to opt for noncompliance and finance itself by not paying taxes, in addition to a lack of liquidity or a desire to increase its cash flow potential or return on investment. On the other hand, strong audits or developed markets can inhibit the decision for noncompliance. Therefore, all variables in the model may increase or decrease the probability of a company's decision to opt for noncompliance. Hence, these variables were used to identify the ones with the most relevant relationship with tax noncompliance.

4. Results and Analysis

4.1 Descriptive analyses

The 423 companies addressed here are distributed across almost all Brazilian states, with the Southeast concentrating most of them, with 75% of the total sample (319), followed by the South with 14% (61).

Tables 2 and 3 present the variables' descriptive statistics separated into two sets, non-compliant (1) and compliant (0).

Table 2
Variables' descriptive statistics concerning non-compliant companies

Variable	Observations	Mean	Standard-deviation	Minimum	Maximum	Mann-Whitney Test
Complx	1131	0.8275862	0.3779068	0	1	-13.848***
Parcl	1131	0.557763	0.4079999	0	1	-40.331***
Intc	1131	0.2669761	0.2293744	0	0.65	-39.653***
Probl	1131	0.3265252	0.3828644	0	1	-16.031***
Selic	1131	101.409	2.732.954	6.75	15.38	2.321***
Eu	1131	1.027.339	0.6368274	0	1.74	-11.690***
Alav	1131	3097259	118688	-1361	3545.1	-10.659***
Tam	1131	6.377.984	112.622	0	9.18	-17.631***
Big4	1131	0.6374889	0.4809379	0	1	-10.052***
Adr	1131	0.0769231	0.2665872	0	1	-5.037***
Corrente	1131	2206985	5004035	0	99.2	-3.939***
Ebitda	1131	119720.5	3865838 -2	21736.2	1.30e+08	-9.620***
Roe	1131	9.321.839	3.024.007	-195.7	273	-10.060***

*** significant at 1% in the Mann-Whitney test.
Independent variables
Complx = complexity of the company's tax legislation
Parcl = number of times the company adhered to installment plans
Intc = interaction between complexity and numbers of installment plans
Probl = inspection probability
Selic = Selic projection
Eu = company's expected utility
Alav = leverage
Size = natural logarithm of the company's assets
Big4 = companies audited by one of the Big4 (or not)
Adr = companies w/ shares traded on the New York Stock Exchange (or not)
Current = company's current liquidity
Ebtida = company's Ebtida
Roe = company's return on equity index

Source: developed by the authors.

Table 3

Variables' descriptive statistics concerning compliant companies

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
Complx	2676	0.5956652	0.4908546	0	1
Parcl	2676	0.05108	0.1610103	0	1
Intc	2676	0.0242526	0.0831349	0	0.65
Probl	2676	0.1646263	0.2696348	0	1
Selic	2676	1.037.673	2.740.594	6.75	15.38
Eu	2676	0.6293386	0.7222555	0	1.74
Alav	2676	1109361	3836519	-3046.2	15110.6
Tam	2676	5.188.457	2.130.145	0	9.18
Big4	2676	0.4592676	0.4984312	0	1
Adr	2676	0.0381166	0.1915135	0	1
Corrente	2676	2670056	2463023	0	7622.2
Ebitda	2676	102844.6	-4.359.092	5300000	2.00e+08
Roe	2676	-0.3599402	7.609.846	-1352.9	990.3

Independent variables
Complx = complexity of the company's tax legislation
Parcl = number of times the company adhered to an installment plan
Intc = interaction between complexity and numbers of installment plans
Probl = inspection probability
Selic = Selic projection
Eu = company's expected utility
Alav = leverage
Size = natural logarithm of the company's assets
Big4 = companies audited by one of the Big4 (or not)
Adr = companies w/ shares traded on the New York Stock Exchange (or not)
Current = company's current liquidity
Ebtida = company's Ebtida
Roe = company's return on equity index

Source: developed by the authors.

The comparison between Table 2 and Table 3 shows that non-compliant companies present higher means for Complx, Parcl, Intc, Probl, Costs, EU, Size, Ebitda, and ROE. This piece of information shows that non-compliant companies have greater tax complexity and have more frequently adhered to special installments than compliant companies. Consequently, the combination of these two variables is reflected in the Inter (Interaction) variable, showing that the mean Interaction of the non-compliant companies almost doubles that of compliant companies.

Furthermore, the inspection probability of non-compliant companies is more than twice that of their compliant counterparts. Additionally, the inspection cost for non-compliant companies is lower than that of compliant companies. Therefore, inspecting non-compliant companies would be more beneficial than inspecting compliant companies, considering that the cost-benefit of the former is close to 1 (0.8974519). This means that the return on inspection will exceed its costs, and tax authorities will be better off if inspecting non-compliant companies.

The expected utility of non-compliant companies is more than twice that of compliant companies, showing that for these companies, noncompliance was worthwhile. The current liquidity of non-compliant companies is lower than that of compliant ones. Additionally, non-compliant companies have higher mean leverage, and higher EBITDA and ROE than compliant companies. Regarding the Big4 and ADR variables, non-compliant companies are more frequently audited by large audit firms than their compliant counterparts. They also have more companies with more shares traded on the New York Stock Exchange. Finally, Table 2 shows statistically significant differences between non-compliant and compliant companies for each variable highlighted. The significance shown by the Mann-Whitney test confirms the differences indicated by the previously described data.

4.2 Estimation of the proposed model

Table 4 summarizes the results regarding the estimations of the analysis models. According to Fávero and Belfiore (2015), the stepwise procedure should be adopted to remove all variables that are not statistically significant at the 10% level to have a more robust model. Hence, after adopting these procedures, the following variables were excluded from the model (Debt, Big4, ADR, Dry Liquidity, and ROE), as they were not statistically significant.

Table 4

Results of the estimates of the models of corporate tax noncompliance

Variables	Marginal Effect	*Pooled*	Random	Fixed
Complx	0.0249921***	1.252654***	1.61224***	1.609868***
		0.392682	0.507668	0.508305
Parcl	0.0096016**	0.481252***	1.037931**	1.017952**
		0.156012	0.445673	0.445489
Intc	0.0201711**	0.964774***	0.9634***	0.955911***
		0.287413	0.287916	0.288317
Probl	0.0228834***	1.146958***	1.15069***	1.181851***
		0.181291	0.186063	0.186739
Selic	-0.0015605***	-0.07822***	-0.08171***	(omitted)
		0.022736	0.027749	
Custos	0.0017723*	0.088833*	0.083778*	0.07938*
		0.048447	0.048602	0.048758
Eu	0.054033***	2.708241***	2.688234***	2.723273***
		0.259233	0.265211	0.271112
Corrente	0.0055535*	0.278353*	0.520956***	0.52927***
		0.150102	0.19608	0.196322
Ebtida	0.001199**	0.060095**	0.061689**	0.063303**
		0.026393	0.027738	0.027726
Tam	0.0071791***	0.359832***	0.328584***	0.325673***
		0.061325	0.066286	0.066034
_cons		-8.00104***	-7.94805***	
		0.611027	0.675548	
Number of observations		3804	3804	3804
Number of groups			9	9
McFadden R2		0.2756		
Sensitivity (cutoff 0.1)		86.03%		
Specificity (cutoff 0.1)		69.52%		
Model goodness of fit		71.16%		
area under the ROC curve		0.8643		
Likelihood-ratio test		0.202	0.6251	
Hosmer-Lemeshow Test		0.2527		
Insig2u		-413.736		
Sigma_u		0.126352		
Rho		0.004829		

*** significant at 1%, ** significant at 5%, * significant at 10%
Dependent variable: 1 = non-compliant; 0 = compliant
Independent variables
Complx = complexity of the company's tax legislation
Parcl = number of times the company adhered to an installment plan
Intc = interaction between complexity and numbers of installment plans
Probl = inspection probability
Selic = Selic projection
Costs= inspection costs
Eu = company's expected utility
Alav = leverage
Size = natural logarithm of the company's assets
Big4 = companies audited by one of the Big4 (or not)
Adr = companies w/ shares traded on the New York Stock Exchange (or not)

Source: developed by the authors.

Table 4 shows that all model variables are statistically significant and present the expected signs. Thus, the complexity of the legislation and repetitive special installments were expected to encourage tax noncompliance among the companies in the sample, as tax complexity gives opportunities for companies to avoid and/or postpone paying their taxes. Special installments decrease the present value of taxes, encouraging payment to be postponed to benefit from special installments. The combination of these two variables creates the perfect environment for tax noncompliance, considering that the complexity of tax legislation hinders the payment of taxes, even when there is a violation notice, because companies may still challenge such a notice of violation within the tax administrative process. Hence, companies postpone the payment of taxes until a special installment plan is available in the future, resulting in a vicious cycle within society.

Furthermore, even though there is a high inspection probability and Selic increases the tax debt, given the tax complexity that enables companies to defend non-payment, the prospect of being able to collect unpaid taxes under the benefits of a special installment plan encourages tax noncompliance as the return of noncompliance in the future is higher than the payment of taxes.

High inspection costs mean that few companies are eligible for inspection, which decreases the feeling of punishment and, together with other variables, encourages tax noncompliance.

Thus, from a financial point of view, the return on tax non-payment is positive; hence, tax noncompliance becomes feasible, considering that the projection is for a positive return, and complexity and installments facilitate the decision for noncompliance.

The Size variable (Size) presented a positive sign, while, according to the literature (Graham *et al.*, 2014; Zimmerman, 1983), a negative sign was expected. However, considering that the study sample comprises large companies only, which bear political costs at similar levels, we infer that there is a bias in the sample since all the companies are large, so the positive sign is not surprising.

Furthermore, due to the characteristics of the Brazilian context, in which there is high tax complexity and specific inspections of large taxpayers, in which the infraction notices deal in most cases with the interpretation of complex Brazilian tax legislation, taxpayers have one perception of the legislation and inspection agencies hold a different one. However, both views are supported by legislation; see internal premium, Complementary Law No. 160 of 2017, and in other cases, the political costs of companies would not increase. Therefore, it would not become a variable that would reduce noncompliance.

Note that the proposed model presented goodness of fit for predicting tax non-compliance, as it correctly classified 71.16% of the companies.

Regarding non-compliant companies, the accuracy rate was 86.03%, while for compliant companies, the accuracy rate was 69.52%. The ROC curve of 86.43% shows the model's goodness of fit and corroborates this understanding. Additionally, the model showed a mean probability of 2% of companies becoming tax non-compliant in the period. However, the probability of tax non-compliance increases to 28%, given the high tax complexity and the possibility of companies adhering to special installment plans.

These results indicate that the sample companies in highly complex environments exposed to repeated special installment plans are more likely to become non-compliant than companies not exposed to these elements. The reason is that tax complexity has a positive effect of 2.5% on tax noncompliance, meaning that the emergence of complex tax laws within an already complex tax system increases the probability of a company becoming non-compliant. Likewise, special installment plans have a marginal effect of 0.0096016, indicating that a one-unit variation in special installment plans causes a positive variation of 1%, doubling the chances of the companies addressed here becoming tax non-compliant. In other words, repetitive special installment plans lead taxpayers to opt for tax noncompliance, knowing that they can collect their taxes under the law's benefits.

According to Ross (2013), special installment payments alter taxpayers' perceptions of the likelihood of detection, leading to greater tax aggressiveness. Furthermore, the author above found evidence that tax aggressiveness increases incrementally with each additional repetition of a special installment payment, suggesting that repeated special installment payments have increasingly negative implications for tax collection. Paes (2012) also found that the expectation of future tax installment payments in Brazil affects taxpayers' propensity to pay their current taxes.

Therefore, this study's results align with scientific research on special installments. Additionally, the expected utility for the Brazilian companies in the sample was found to be positive in most cases. The marginal effect identified for this variable was 0.054033, and its estimator (2.708241) shows that an increase in expected utility increases by 15 times the chances of a company in the sample becoming non-compliant.

The high cost of inspections, combined with the low probability of their occurrence, considerably increases the probability of tax noncompliance. Few companies are eligible for inspection due to the high costs of inspections in Brazil; hence, there is a low probability of a company being inspected, leading companies to opt for tax noncompliance, expecting they will not be inspected.

Additionally, the model showed that the need for cash positively affects the probability of tax noncompliance among the companies addressed here. The cost arising from increases in the Selic rate inhibits tax noncompliance. However, a decrease in the Selic rate has an extra effect of 1.08% on noncompliance than the effect of an increase in the Selic rate on tax compliance. Therefore, the results did not allow us to reject the research hypotheses that tax complexity and special installments positively affect the probability of tax noncompliance among the Brazilian companies listed on B3 addressed in this study.

These findings are consistent with those of Richardson (2006) who studied the determinants of tax noncompliance in 48 countries. The author showed that tax complexity is one of the main factors leading to tax noncompliance. Likewise, there is evidence from Nugent (2013), who found that tax complexity is related to tax noncompliance among American taxpayers.

The results linked to special installments are consistent with those of Paes (2014), who also studied special installments in Brazil and found that such installments negatively influence tax compliance. Therefore, tax collection under special installments is always lower than what would be obtained otherwise.

Furthermore, Paes (2014) also found that the expectation of future tax installments affects the taxpayer's propensity to pay taxes in the present, which is also aligned with this study's results. Likewise, Shevlin *et al.* (2017) verified how American companies perceive special installments, especially those headquartered in states that repeatedly grant special installments. They found that companies become increasingly tax aggressive after repeated special installments, corroborating this study's results.

5. Final Considerations

This study's general objective was to verify whether tax complexity and repetitive special installments within the scope of federal taxation are associated with an increased probability of tax noncompliance among companies listed on B3. Therefore, a panel logit model was developed to empirically verify whether tax complexity, special installments, inspection probability, inspection costs, the expected utility of tax noncompliance, current liquidity, EBITDA, and company size increased the probability of the companies in the sample becoming tax non-compliant.

The results lead to the conclusion that the complexity of Brazilian taxes and repeated installment plans positively affect companies' tax noncompliance. The model presented a good prediction of noncompliance among the companies in the sample; the ROC curve was 86.43%, and the percentage of correct answers was 71.16%, with 86.03% indicating noncompliance and 69.52% indicating compliance. Regarding the other variables, the low inspection probability and high inspection costs, the need for cash, the Selic rate, and the expected utility positively affected the probability of tax noncompliance.

Thus, these results are aligned with those presented by several similar studies that verified tax complexity and special installments in the United States. Although Brazil and the United States present different economic contexts, tax complexity appears to be one of the factors generating tax noncompliance in these countries.

To our knowledge, this is the first Brazilian accounting study to examine tax noncompliance by proposing proxies to measure the companies' tax complexity in addition to special installments, inspection probability, the costs of inspection, expected utility of tax noncompliance, verifying the impact of these on tax noncompliance.

More than two decades have passed since the literature review by Andreoni *et al.* (1998) was published. They found that tax complexity and installments are associated with tax noncompliance, and this study's results corroborate their findings. This study is expected to contribute to the literature on tax aggressiveness and tax planning of Brazilian companies, considering that no other studies on tax aggressiveness have sought to understand what instruments companies use to perform tax planning and aggressiveness (Martinez, 2017).

This study found an association between the independent and dependent variables of tax noncompliance. The findings suggest that the legislation is complex for all companies; however, exploring ambiguities and omissions is the essence of tax planning. Hence, the more complex the legislation, the more opportunities for tax planning and noncompliance. Additionally, the complexity of Brazilian tax legislation allows companies to challenge and question infraction notices, which prevents the immediate payment of such notices. In addition to the expectation of repetitive special installments, taxpayers may design scenarios in which they align tax complexity with future tax payments under the tax benefits of special installments, encouraging tax noncompliance.

Moreover, a vulnerable environment can affect taxpayers' morale, leaving room for dishonest taxpayers not to collect taxes on time by financing themselves with government resources. Therefore, honest taxpayers may feel outraged and unmotivated to honor their tax commitments on time because they see their dishonest competitors benefiting from tax subsidies. Therefore, this study suggests a perception that special installment plans might not be fair to society.

This study contributes to the discussion on the need to establish an independent body to identify unnecessary tax complexity in Brazil, along the lines currently developed by the Office of Tax Simplification (OTS) in the United Kingdom.

One limitation of this study is that its findings cannot be generalized to other groups of companies, as the sample was non-probabilistic; hence, the analyses' results only apply to the companies in the sample. Another limitation of this and other studies involving tax noncompliance is that tax noncompliance is not fully captured because it continues to be performed until it is unveiled. Therefore, we cannot state that the statistical model performed here captured the companies' tax noncompliance in its totality.

These limitations indicate possibilities for further field research, including demographic variables (age, gender, etc.), cash flow metrics, and tax aggressiveness proxies in the model. Additionally, a suggestion is to expand the model to a sample of limited companies and estimate the variables using other models to verify the accuracy of the results. One variant would be to verify whether Carf's decisions influence the decision to publish special installments.

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