BBR BRAZILIAN BUSINESS REVIEW

ARTICLE

A Theoretical Model to Discuss Tax Avoidance Based on Game Theory

Antônio Paulo Machado Gomes[1]
apmg.machado@gmail.com | 0000-0001-8919-1605

Jacqueline Veneroso Alves da Cunha[2]
jvac@face.ufmg.br | 0000-0003-2522-3035

José Roberto de Souza Francisco[2]
jroberto.ufmg@gmail.com | 0000-0002-1880-5304

Fabiano Teodoro de Rezende Lara[2]
fabiano@fabianolara.com.br | 0000-0002-7260-7659

ABSTRACT

A consolidated research line in Brazil identified the proxies for determining the tax aggressiveness of companies listed on the B3 stock exchange. However, none of these studies identified the instrument used by Brazilian companies to carry out tax aggressiveness. Thus, our research seeks to fill this gap by demonstrating that fiscal aggressiveness results from the Brazilian tax complexity, that providing prerogatives to avoid or delay tax payments. Besides, this study is the first accounting study to demonstrate that special installments reduce the actual value of taxes owed by taxpayers, encouraging them to be tax aggressive. Through the foundations of Game Theory, this research demonstrates the cost-benefit of tax aggressiveness in maximizing the profit of tax avoidance. We examined the best strategic decisions in the tax avoidance game concerning the tax complexity and special installments experienced in Brazil. In this game, the only NASH equilibrium is tax avoidance since it is the only option with a chance of remuneration. Therefore, this research contributes to understanding business behavior concerning the Brazilian tax system and provides subsidies to encourage reform of the current tax complexity.

KEYWORDS

Game Theory, Tax Complexity, Special Installments, Tax Avoidance

[1]Instituto Brasileiro de Mercado de Capitais, Belo Horizonte, MG, Brazil

[2]Universidade Federal de Minas Gerais, Belo Horizonte, MG, Brazil

Received: 06/25/2021.
Revised: 02/01/2022.
Accepted: 05/18/2022.
Published Online: 03/28/2023.
DOI: http://dx.doi.org/10.15728/bbr.2023.20.3.3.en

1. INTRODUCTION

This paper seeks to understand factors that affect the taxpayer's decision to collect, or not collect taxes, from the premise that individuals maximize the expected tax avoidance utility by counterbalancing uncertain success in the practice of reducing their tax liabilities against the risk of detection and punishment by the inspection. Several studies have sought proxies to identify the determinants of fiscal aggressiveness. However, none of them demonstrated how fiscal aggressiveness is made possible. Therefore, this research seeks to fill this gap, demonstrating that fiscal aggressiveness is only possible when there is a high tax complexity and mechanisms for postponing tax payments, such as special installments.

The research presents a theoretical model based on Game Theory, seeking to understand the logical and rational decision of both taxpayer and inspection in an environment with high tax complexity and demanded special installments. Therefore, the general objective of this study was to evaluate how tax complexity and special installments affect the strategic decision-making of Brazilian companies in collecting their federal taxes, based on Game Theory fundamentals. Justification for this research emerges from the consensus that understanding the high tax complexity related to tax avoidance will help elaborate more efficient public policies. Besides, according to Jacob (2018), tax research conducted in Brazil can produce interesting insights that academics from abroad will not readily find in their jurisdictions.

Thus, a theoretical model based on game theory was designed for the entity to make a strategic decision about obeying or disobeying the Brazilian tax legislation. On the other hand, the inspection will allow for the strategic decision to be made on either inspecting. The equilibrium in this game of tax avoidance displayed in the model is that the best strategy for the taxpayer, in the Brazilian environment of high tax complexity and special installments, is to disobey the tax legislation and collect the tax in special installments with benefits, whereas for inspection it is to fine the taxpayer and receive the taxes due in special installments. Therefore, this research advances knowledge about the determinants of tax avoidance by introducing the benefits of special installments in the model proposed by Alligham and Sandmo (1972), besides verifying whether taxpayers can use tax complexity and special installments as tools to enable tax avoidance.

Our study contributes to the literature on tax aggressiveness and tax planning in Brazilian companies since it sought to understand the tools used to make such strategic decisions. Moreover, it contributes to the whole society, first demonstrating the need for tax reform to reduce the unnecessary tax complexity of the Brazilian system and, second, assisting the debate on public policies to make special installments more efficient for tax collection.

2. THEORETICAL FUNDATION

2.1. Game Theory

Game Theory is a branch of applied mathematics concerned with the strategies used by players to improve their returns. In other words, Game Theory seeks to model situations in which two or more decision-makers interact with each other. According to Bierman and Fernandez (2010), game theory seeks to identify which are the best strategic decisions for players, given their strategic decision and the strategic decision of other players.

According to Sartini et al. (2004), a game has three basic elements. Namely, a finite set of players, usually represented by G = {g1, g2,...,gn}. A finite set of pure strategies, called Si = {s_{i1}, s_{i2},...,simi}. And a vector, called a pure strategy profile with the player's remuneration for that strategy, s = (s1j1, s2j2,...,snjn), where siji is a pure strategy for the player gi ∈ G.

Therefore, in a game, there are (i) the players, (ii) the strategies and (iii) the payoffs that can be positive or negative. In the game, each rational player adopts a strategy to maximize his reward based on his belief of what his competitor's strategy is. Based on these premises, the Nash equilibrium represents a situation in which no player has anything to gain by changing his strategy individually, which leads to stability in the game (Nash, 1951). However, in some games, the Nash equilibrium is not observed in pure strategies. Therefore, to overcome this limitation, Bierman and Fernandez (2010) advises considering the game from a probabilistic point of view, in which the player must choose a probability distribution over his pure strategies.

It is noteworthy that this research adopted the hypothesis of expected utility with risk by Von-Neumann and Morgenstern (1944) as a fundamental behavioral premise. According to this hypothesis, people seek to maximize their expected rewards. In other words, for each player in a game, a number can be assigned to each outcome of the game such that the player acts as if he were maximizing his expected utility (Bierman & Fernandez, 2010).

Allingham and Sandmo (1972) explain that to declare or not declare one's taxes is a decision under uncertainty since not properly remitting one's taxes does not provoke immediate punishment. Therefore, the taxpayer can choose between two main moves, that is, (i) remit or (ii) not remit the taxes due. According to Allingham and Sandmo (1972), the taxpayer will be better off in the second strategy if not investigated. However, he will be worse off if caught. To Graetz et al. (1986), when regarding tax discussions, one should always consider the gains of law enforcement agencies, as this is an interactive participant in a formal model of legal compliance. Thus, in the game of tax avoidance, the inspections' gains should also be considered, besides the taxpayers' gains.

Therefore, Game Theory can explain the tax relationship between taxpayers and the state since both are in a game with non-cooperative asymmetric information between these players. That is, taxpayers have all the information to compose their tax calculation base. On the other hand, the state depends on the information declared by taxpayers and still must incur costs to carry out tax audits to verify the integrity of such information. Besides, the complexity of the Brazilian Tax System makes the identification of the true tax calculation base even more arduous.

2.2. Tax Complexity

The Office of Tax Simplification (OTS, 2017), a body that studies tax simplification in the United Kingdom, formally defines tax complexity as the difficulty a taxpayer has in understanding and meeting their respective tax obligations. In these terms, the complexity comes from the number of laws, regulations, and the proper understanding of the tax system. According to Kopczuk (2006), the consequence of tax complexity is a net loss for the economy since the resources applied in the tax law reinforcement do not generate wealth for society. Furthermore, tax complexity encourages tax avoidance as it creates some difficulties for honest taxpayers and opens doors for dishonest taxpayers (Laffer et al., 2011). The authors also comment that complexity causes confusion and errors that hinder the distinction between dishonesty and law misinterpretation.

Thus, several studies (Aghion & Tirole, 1997; Follmann, 2001; Slemrod & Yitzhaki, 2002; Richardson, 2006; Laffer et al., 2011; Batrancea et al., 2012; Nugent, 2013; Budak & James, 2018) have associated tax complexity with tax avoidance since the underlying idea present in the literature is that complexity generates indecisions used by taxpayers to avoid their taxes.

Therefore, it is believed in this paper that tax complexity is related to tax disobedience, as it opens opportunities for taxpayers to reduce their tax liabilities. However, this reduction can be questioned by an eventual inspection, which, nonetheless, may be disputed by taxpayers, given the complexity of the tax legislation. In turn, the judging bodies can accept or deny taxpayers' arguments. In this sense, if there is a negative jurisprudence for the taxpayers, they still can resort to the government to grant special installments to settle the tax dispute. Therefore, there is a hypothesis on the connection between tax avoidance and special installments (Slemrod & Yitzhaki, 2002; Sandmo, 2005; Slemrod, 2007; Torgler, 2007). Given that, the next topic presents a literature review on installment payments.

2.3. Special Installments

Several studies (Mikesell, 1986; Alm, 1991; Torgler, 2003; Morais et al., 2011; Alm, 2012; Leitão Paes, 2012; Leitão Paes, 2014; Faber, 2016) have shown that special installments increase tax avoidance. According to Andreoni et al. (1998), the foundation of the understanding that installment payments negatively affect tax compliance lies in the feeling of injustice that it causes in regular taxpayers, as well as in the emergence of opportunities for defaulting taxpayers to settle their tax liabilities at assessed values lower than those at the time of payment.

According to Alm and Martinez-Vazquez (2003), in the last twenty years, almost forty states in the United States, like other countries, have enacted some form of special tax installment. The authors point out that special installments are controversial revenue tools whose main objective is to increase short-term revenue, something wich has not worked in practice. Besides, the expectation that future special installments can reduce the actual value of the taxpayers' taxes due causes a reduction in tax compliance (Alm & Martinez-Vazquez, 2003).

The Brazilian government has had special installment plans every three years since the year 2000, according to the Federal Revenue Service of Brazil (2017). Some studies by Cavalcante (2010), Morais et al. (2011), and Leitão Paes (2012, 2014) demonstrate that those special installments failed to increase short-term tax collection and ended up encouraging tax avoidance in Brazil. According to Leitão Paes (2014), special installments cause tax collection to be lower than if there were no special installments. Other studies also demonstrate the inefficiency in collecting the special installments in Brazil, which, according to data by Leitão Paes (2012), only 10% of the total was fully paid.

2.4. Tax Avoidance

In the seminal study by Allingham and Sandmo (1972), the authors applied Becker's theory (1968) to develop a mathematical model to identify which factors would affect the taxpayer's decision to remit or not remit taxes. The model presents the decision to remit taxes as a portfolio allocation problem. The taxpayer's decision to not pay taxes will maximize its expected utility, but if the taxpayer does not want to assume any risk, he will have to present his tax base in full.

Therefore, evasion is a problem of optimal choice of tax declaration, where a fixed-rate (t) taxes the declared tax base and a proportional fine (s) does the evaded tax. The probability of being inspected (p) or that the inspection verifies the actual tax calculation base is a constant. The taxpayer then decides the amount to be withheld to maximize its expected utility. In other words, the maximum return between what is taxed and what is not taxed. Thus, Y ($Y = W - t.X$) is the gain obtained by evasion not identified by the inspection (available income, with no auditing), and Z [$Z = W - t.X - s.(W - X)$] the result obtained when it is inspected (disposable income, auditing takes place). Yitzhaki's (1974) model extended from the Allingham and Sandmo's (1972) model furnishes the expected utility for the taxpayer as:

$$E[U] = (1 - p).U(W - t.X) + p.U[W - t.X - s.t(W - X)] \quad (1)$$

Where: W = real income; X = declared income; t = tax rate; s = fine; p = probability of inspection taking place.

Another study conducted by Graetz et al. (1986) advanced tax avoidance analysis and formally introduced the relationship between inspection and taxpayer. Therefore, the model made room for considering other variables that also impact tax compliance.

3. PREMISES OF THE TAX AVOIDANCE GAME

This descriptive study, characterized as theoretical-analytical, has a quantitative approach and a documental procedure (Martins, 1994). The research was based on game theory by analyzing a game in which the taxpayer decides whether to obey or disobey tax legislation because of its complexity, and the possibility of future special installments allowed in the Brazilian federal sphere. The model also considered the inspection's choices of either inspecting and fining, or not, the taxpayer, being entirely based on the fiscal administrative process.

The objective of the Tax Avoidance Game for the taxpayer is to reduce taxes payable to maximize expected utility, and, for the inspection, the goal is to avoid the reduction of taxes due. Therefore, it becomes a non-cooperative game in which the taxpayers and tax enforcement have different strategies and opposing goals. It means the taxpayer wants to pay the lowest amount of the tax due and the inspection to receive the highest one. Besides, the Tax Avoidance Game is dynamic and sequential, with the taxpayer making his strategic decision before the inspection. It is noteworthy that the game analyzes the strategic decisions of the taxes whose release occurs by homologation. It means that the taxpayer first anticipates the tax payment, without previous examination by authorities, who will have up to five years to exercise their right/duty to certify or correct the definitive constitution of the tax credit (tax due). The duration of the game is 13 years (average time of a tax administrative process), which begins with the calculation of the tax, followed by the inspection, the assessment, the challenge of the infraction notice, the appeal to the Administrative Council of Tax Appeals (CARF) and the final judgment of CARF (De Santi, 2009; IPEA, 2011; Mattos, 2017). Finally, the Tax Avoidance Game is an imperfect information game since the taxpayer does not know for sure if the inspection will inspect him, and the latter, in turn, does not have complete knowledge to determine the tax due, therefore incurring tax audits to establish the tax credit (tax due).

It is noteworthy that the Game Theory approach requires a rational pattern of players' attitudes, being expected that the involved agents (taxpayer and supervisor) have rational behavior, unaffected by emotions or ethical concepts, and seek all available information to make their strategic decisions. Therefore, we assume that, in the Tax Avoidance Game, the players are rational for having been playing the game for some time and for knowing it well.

The game takes place in an environment of high tax complexity that generates uncertainty for all participants. Thus, neither the taxpayer, nor the inspection, nor the judges know the actual tax due. This high tax complexity leads taxpayers either to involuntary disobedience by erring in their calculation due to the uncertainties caused by the tax complexity or voluntary disobedience due to tax evasion or avoidance. In both disobedience strategies (evasion or avoidance) caused by tax complexity, taxpayers have arguments to challenge and appeal the tax assessment notices. In this environment, the inspection knowledge is uncertain about the tax due. Thus, the judges may either consider the taxpayer's disobedience as a lawful attitude to determine his actual tax due or conversely support abuses from the inspection. All this tax complexity generates distrust and legal uncertainty for the whole society.

It is considered tax avoidance in the game now analyzed the dilemmas experienced by Brazilian companies that are faced with uncertainties such as the place of payment of the Tax on Services (ISS), the characteristics for the appropriation of credits on intermediate products in the calculation of the Tax on Industrialized Products (IPI) and Tax on the Circulation of Goods and Services (ICMS), indemnity amounts in the calculation of social security contributions (INSS), the concept of inputs for calculating PIS and COFINS credits, the deductibility of the amortization of goodwill in a business combination, the deductibility of operating expenses in the calculation of IRPJ and CSLL, the reduction of capital stock in the calculation of capital gain, among many others that Brazilian tax legislation generates for taxpayers, inspection and judges.

Every three years, during the Tax Avoidance Game, there were special installment publications granting longer payment terms, reductions of fines and interest rates, and elimination of tax crimes. Therefore, these special installments not only reduce the actual tax due values as they do affect the tax morale of honest taxpayers. Thus, in the analyzed game, the special installments granted, on average, interest reductions of 90% and a 50% fine in cash payments of the tax debt, as was the case in the Special Tax Regularization Program (PERT) of Law 13,496/2017.

In the proposed avoidance game, there are two judging bodies, the Judgment Office (DRJ) and the Administrative Council of Tax Appeals (CARF), which make decisions independent of the players' strategies (Taxpayer and Inspection) and can make two possible moves (cancel or keep the infraction notice). All the players in the game (Taxpayer, Inspection, DRJ, and CARF) made their decisions in a high tax complexity environment and with special installments published every three years regarding the tax administrative process.

According to Decree No. 70,235/1972, which deals with the tax administrative process, the tax credit resulting from the tax assessment is suspended from being enforced until a final decision is approved by the Administrative Council of Tax Appeals – CARF. Figure 1 shows the simplified flow of the tax administrative process from the taxpayer's point of view.

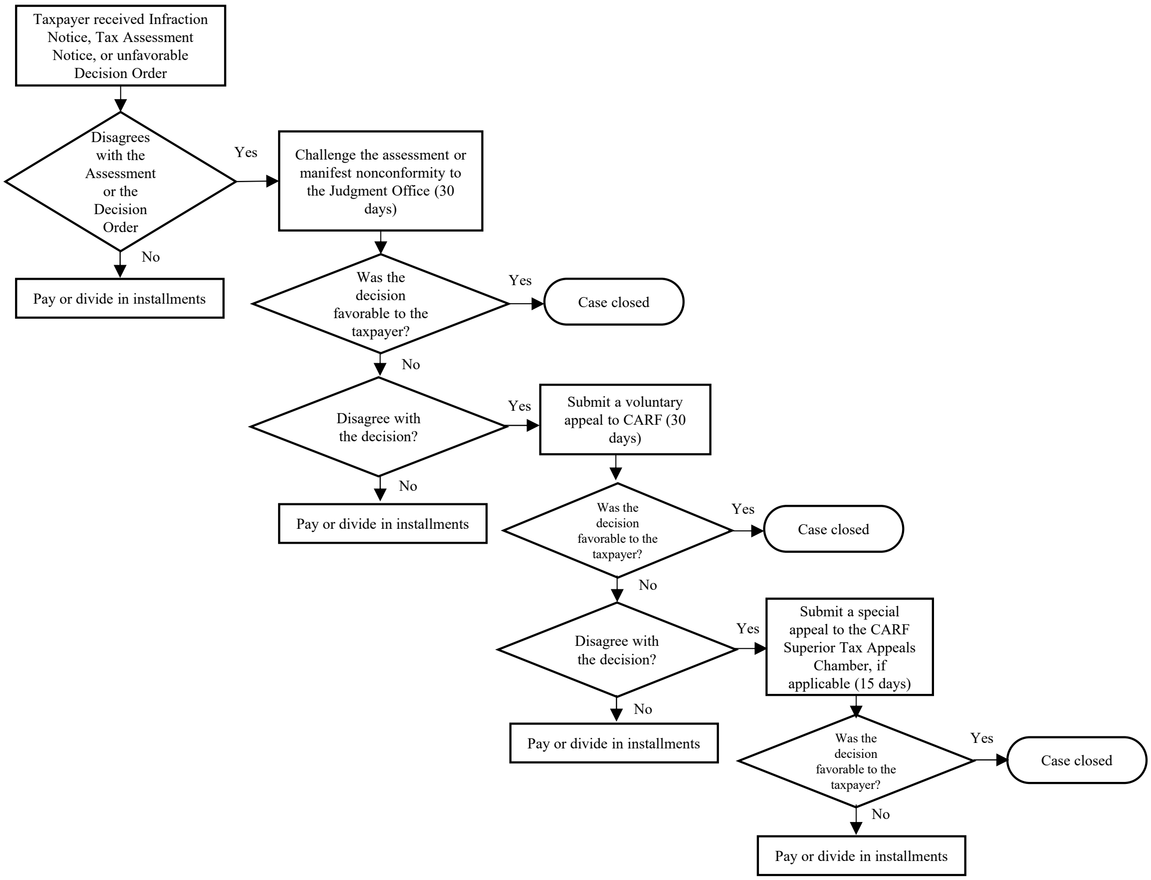

Figure 1. Simplified flow of the tax administrative process from the taxpayer's point of view
Source: RFB (2018)

According to Figure 1, after receiving the tax assessment notice, the taxpayer can question it at the Judgment Office, as in two CARF instances. It is noteworthy that the Taxpayer has a five-year deadline for the statute of limitations to file the petition after the end of the administrative process. However, the judicial process time is not considered in this game, being a limitation.

Finally, the game is based on two assumptions indicated by Allingham and Sandmo (1972): (i) the taxpayer behavior meets the axioms of Von-Neumann and Morgenstein (1944) of Consistency, Monotonicity, Continuity, Substitution, and Simplification, and (ii) the taxpayer exhibits risk aversion, which is granted by the assumption that the utility function is positive, increasing and concave [U = U(c) > 0; U'>0; U"< 0], according to the graph in Figure 2.

It can be seen from the graph by Soares (1994), reproduced in Figure 2, that the risk-taking utility, stochastically determined by the utilities in Y (disposable income without inspection) and Z (disposable income with inspection), is overcome by the deterministic utility in c = W(1-t), where W is the total income and t the tax rate (Soares, 1994). According to Soares (1994), the difference in utility between risk (50% chance of income pair Y and Z) and certainty (100% chance of income c) is -(dU). For example, if the deterministic utility at c = W(1-t) is equal to 10$, Y = 2$ and Z = -3$, the risk (50% chance of the income pair Y and Z) will be -0.5$, which means an expected utility of risk is -10.5$, while certainty will be -10$. It is noteworthy that (c) is the income evaded by the taxpayer that is fully discovered and received by the Inspection in the event of a tax audit.

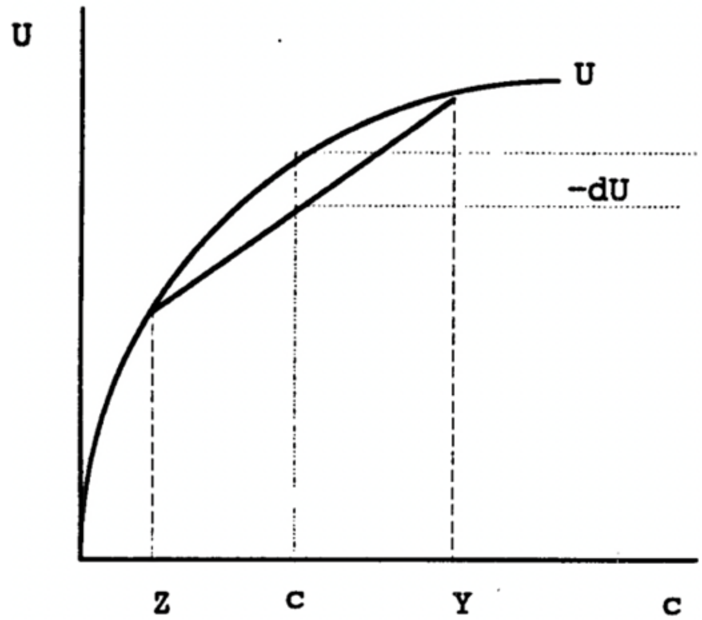

Figure 2. Graph – positive, increasing, concave utility function
Source: Soares (1994)

According to Soares (1994), the first and second-order conditions for this maximization problem are given by the following expressions below, where s is the fine for evasion and X is the declared income.

$$\frac{dEU}{dX} = -t\,.\,(1-p)\,.\,U'(Y) - (t-s)\,.\,p\,.\,U'(Z) = 0$$

$$\frac{dEU^2}{d^2X} = t^2\,.\,(1-p)\,.\,U''(Y) - (t-s)^2\,.\,p\,.\,U''(Z) = D < 0$$

The second-order condition (D) is met since U” < 0. The condition for the taxpayer to enter tax evasion can be achieved since, at the point of the corner solution of total honesty (X = W), the utility function curve is decreasing, that is, $\frac{dEU}{dX} < 0$.

From the first-order condition, we have that:

$$\frac{dEU}{dX} = -t\,.\,(1-p)\,.\,U'(W-tW) - (t-s)\,.\,p\,.\,U'(W-tW) < 0$$

$$U'(W-tW)[-t(1-p)-(t-s)p] < 0$$

$$[-t(1-p)-(t-s)p] < 0$$

$$-t + tp - tp + sp < 0$$

$$sp < t$$

Thus, to avoid tax evasion, the "price of the safe asset" [t] (tax due) must be higher than the expectation of the "price of the risk asset" [E(sp)] (return to apply in the evasion) (Soares, 1994).

4. PLAYERS'ERS REWARDS (*PAYOFFS*)

In the Tax Avoidance Game, the taxpayer is an economic-rational subject who calculates his taxes for later approval by the Inspection. The tax complexity generates uncertainty concerning tax calculations for all participants (taxpayers, inspection, and judges). Special installments are published every three years with reductions in fines and interest. The duration of a tax administrative procedure is 13 years. Therefore, during the tax administrative process, there would be three special installments that, in the proposed game, would coincide: (1) with the receipt of the tax assessment notice by the taxpayer, (2) with the decision of the DRJ, (3) with the decision of the lower chamber of the CARF and (4) with CARF's top board decision.

The taxpayer's goal is to maximize its utility, so he must choose whether to pay a tax close to that estimated by the inspection or remit the tax according to his understanding and can be classified as a disobedient taxpayer by the Inspection. We may deduce that the highest tax amount to be collected is the one imposed by the inspection. Thus, Tt = the maximum amount of tax due according to the inspection; Tro = the amount paid by the obedient taxpayer close to the amount estimated by the inspection; and Trd = the amount paid by the taxpayer according to his understanding of the legislation and which can be classified as disobedient by the inspection. Thus, it is assumed that Trd < Tro < Tt.

Thus, the taxpayer's relevant decision is to determine the tax amount to be collected, taking as parameters the tax legislation complexity (x), the repetitive special installments (r), the probability of being inspected (p), the penalties in the case of a tax assessment (m) and the costs of the tax administrative process (c). On the other hand, the relevant decision of the inspection is to determine whether to inspect the taxpayer or not, taking as parameters the tax legislation complexity (x), the repetitive special installments (r), the penalties in case of the tax assessment (m) and the inspection costs (cf).

The expected remuneration of a disobedient Taxpayer (Ri) is given by the difference between the tax due according to inspection (Tt) minus the Tax Paid (Tp) multiplied by its opportunity cost (δ) raised to the number of months between the due date of the unpaid tax and the new payment or installment date or deadline date for inspecting the taxpayer, here referred to as n.

$$R_i = \left(T_t - T_p\right).(1+\delta)^n \quad (2)$$

Where: Ri is the expected remuneration of a disobedient taxpayer; Tt is the tax estimated by the inspection; Tp is the tax paid by the disobedient taxpayer; δ is the taxpayer's opportunity cost; and ^{n} is the number of months between the date of the tax due and its settlement, which may occur through prescription, cash payment, or installments.

The remuneration of the Rf Inspection is connected to the disobedience disclosure, to the application of the fine, which can vary from 75% to 225% of the unpaid tax, added to the tax updating by the Selic.

$$R_f = (T_t - T_p) . [(1 + \left(multa + \sum_1^n selic\right)] \quad (3)$$

Where: Rf is the expected remuneration of the inspection; Tt is the tax estimated by the inspection; Tp is the tax paid; fine is the one imposed on the unpaid tax; the Selic is the interest rate calculated between the due date of tax payment and the effective date of tax payment plus 1% in the month of the untimely tax. For simplification purposes, the fine and the Selic interest will be represented by m, $[(multa + \sum_1^n selic)[= m]$.

$$R_f = (T_t - T_p) . (1 + m) \quad (4)$$

Where: Rf is the inspection expected remuneration; Tt is the tax estimated by the inspection; Tp is the tax paid; m are the penalties for the tax assessment.

From this function, it emerges that the expected remuneration of the inspection will be corrected by the Selic at simple interest. Another point of Equation 4 is that the inspection remuneration (Rf) will only be favorable if the amount is greater than the inspection cost Cf, that is, [$R_f > 0$, *se* $R_f > C_f$].

Comparing the remuneration of the disobedient taxpayer Ri with the inspection remuneration Rf, we verified that the updating of the disobedient will be greater than that of the inspection if, and only if, the opportunity cost δ is higher than the Selic, restricted to the time between the tax due date and the tax payment date. Therefore, the remuneration Ri will be greater than the remuneration Rf (Ri > Rf) if, and only if, the disobedient opportunity cost (δ) is higher than Selic or the time between the due time and final payment provides a remuneration greater than the penalties, fines, and interest, since the fine is static over time, and the Selic interest calculated at simple interest. This statement is mathematically proven by equating R_i to R_f ($R_i = R_f$).

$$(T_t - T_p) . (1 + \delta)^n = (T_t - T_p) . (1 + \mathrm{m})$$
$$(1 + \delta)^n = (1 + m) \quad (5)$$
$$\delta = \sqrt[n]{(1 + m)} - 1$$

It follows from the equality result (Ri = Rf) (i) that the shorter the inspection time, the higher the difference between the opportunity cost and the Selic rate; (ii) that the lower the Selic rate, the higher the difference between the opportunity cost and the Selic rate; (iii) correcting the opportunity cost by compound interest and the Selic by simple interest, depending on the time and the difference between the opportunity cost and Selic rates, the remuneration of tax avoidance Ri will be higher than the punishment Rf.

The function Ri can be presented regarding Rf, given that Ri > Rf since $(1+\delta)^n$ > Selic, as shown in Figure 3.

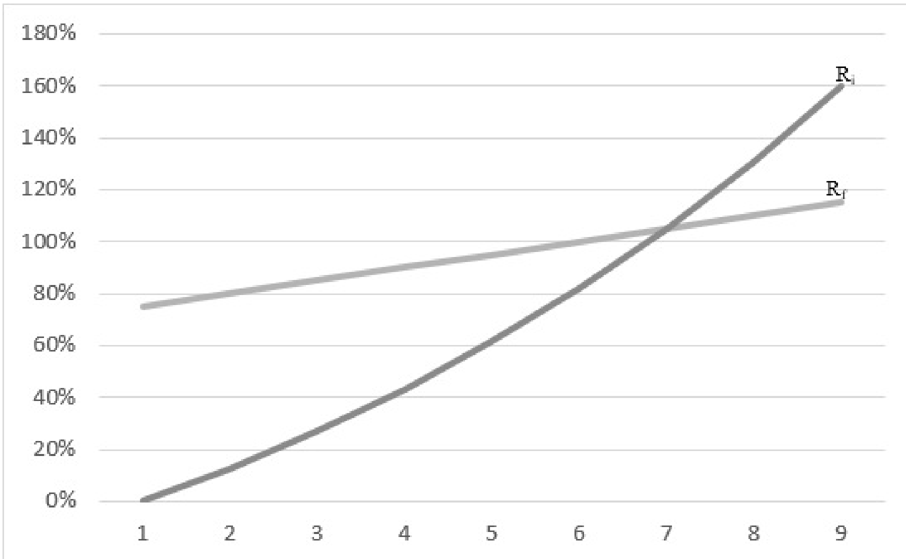

Figure 3. Representative graph of the function Ri regarding Rf
Source: Prepared by the authors

Besides, in an environment where special installments that reduce fines and interest occur, granting long payment terms, the inspection remuneration is no longer Rf to become Pf with the unpaid tax collected under the special installment conditions:

$$P_f = \{(T_t - T_p) . [1 + (m . r)]\} \quad (6)$$

Where: Pf is the expected inspection remuneration; Tt is the tax estimated by the inspection; Tp is the tax paid; m are the penalties applied in the assessment; r are the benefits of special installments.

By comparing equations 6 (Pf) and 4 (Rf), we verified that Pf < Rf due to the special installments, confirming that the amount received by the inspection is lower due to the benefits.

From the taxpayer's point of view, it is possible to see the possibility of a return to tax avoidance since the income from disobedience (Ri) can be greater than the payment in the special installments (P_f), that is, ($R_i - P_f > 0$) = P_i

$$P_i = [(T_t - T_p) . (1 + \delta)^n] - \{(T_t - T_p) . [1 + (m . r)]\} \quad (7)$$

Where: Pi is the taxpayer expected remuneration; Tt is the tax estimated by the inspection; Tp is the tax paid; δ is the taxpayer's opportunity cost; ^{n} is the number of months between the date of the tax due and its settlement in installments; m is the penalties applied in the assessment; r is the benefits of special installments.

It emerges from Equation 7 that the result of the disobedient Pi will be favorable if, and only if, Ri > Pf: Therefore, for this to happen, the opportunity cost δ must be higher than the inspection remuneration minus the benefits of the special installment, that is, $\delta > \sqrt[n]{[1 + (m\,.r)]} - 1$.

From this information, the taxpayer's utility function can be presented by rewriting the Allingham and Sandmo (1972) model as follows:

$$\mathrm{E[U]} = (1 - \mathrm{p}).\,\mathrm{U}\left[\left(T_t - T_p\right).(1+\delta)^n\right] + \mathrm{p}.\,\mathrm{U}\{\left[\left(T_t - T_p\right).(1+\delta)^n\right] - \left[\left(T_t - T_p\right).(1 + (m\,.r)\right]\} \quad \textbf{(8)}$$

Or simplifying:

$$E[U] = (1 - p).\,U(R_i) + p.\,U(P_i) \quad \textbf{(9)}$$

Where: E is the expectation operator; U is the utility function; Ri is the income from disobedience updated according to Equation 2; Pi is the income from disobedience minus the payment in special installments according to Equation 6.

The utility function of tax disobedience presented in equation 9 differs from the utility function of Allingham and Sandmo (1972) (Equation 1) because (i) Ri considers the opportunity cost of disobedience and (ii) it has exponential growth to the detriment of the linear growth of punishment (Selic), as well as (iii) the benefits of special installments (r). These three differentiations make the "price of the risky asset" [E(p.s)] (return to apply in disobedience) more advantageous than the "price of the safe asset" [t] (tax due), corroborating the conclusions of Allingham and Sandmo (1972).

Mathematically, these statements can be proven, because, in total honesty (Tt - Tp = 0), the expected utility is zero:

$$\begin{gathered}\mathrm{E[U]} = (1 - \mathrm{p}).\,\mathrm{U}\left[\left(T_t - T_p\right).(1+\delta)^n\right] + \mathrm{p}.\,\mathrm{U}\{\left[\left(T_t - T_p\right).(1+\delta)^n\right] - \left[\left(T_t - T_p\right).(1 + (m\,.r)\right]\} \\ \mathrm{E[U]} = (1 - \mathrm{p}).\,\mathrm{U}[(0).(1+\delta)^n] + \mathrm{p}.\,\mathrm{U}\{[(0).(1+\delta)^n] - [(0).(1 + (m\,.r)]\} \\ \mathrm{E[U]} = 0\end{gathered} \quad \textbf{(10)}$$

On the other hand, if the opportunity cost is higher than the punishment - decreased by the benefits of the special installments ($\delta > \sqrt[n]{[1 + (m\,.r)]} - 1$), the expected utility will be favorable, higher than 1. Therefore, the maximization of the utility function, proposed in equation 9, is obtained by replacing (1+δ)^n with δ and 1+(m .r) with m. Thus, the opportunity cost derivative works as a function of the Selic maximum period, as the maximum difference between the opportunity cost and the Selic.

From the first-order condition, we have:

$$\frac{dEU}{dSelic} = \delta\,.\,(1-p)\,.\,U'\big(T_t - T_p\big) + (\delta - m)\,.\,p\,.\,U'\big(T_t - T_p\big) > 0$$

$$U'\big(T_t - T_p\big)[\delta.\,(1-p) + (\delta - m).\,p] > 0$$

$$[\delta.\,(1-p) + (\delta - m).\,p] > 0$$

$$\delta - \delta p + \delta p - mp > 0$$

$$\delta > mp$$

Thus, we verified that the opportunity cost of tax avoidance is higher than the probability of punishment payment decreased by the benefits of the special installments, that is, $(\delta > \sqrt[n]{[1+(m\,.\,r)]} - 1)$.

Didactically, one can return to the example given earlier, when explaining the model by Allingham and Sandmo (1972), in which after-tax income was 10$ [c = W(1-t)], Y = 2$ and Z = -3$ the expected utility of the risk was -10.5$, while the certainty was -10$, with probabilities of the inspection running at 50%. Now, adding the proposed variables, namely, the opportunity cost of 1.3% per month, mulct of 75%, Selic of 1% per month, reductions of 70% due to special installments and a 13-year term for the risk expected utility to increase to 14$, that is, 1.30% > 0.34%, as shown in Table 1.

Table 1
EU result

Tt	10
Tp	8
Avoidance	2
δ	1,30%
(m)	231%
(r)	70%
$(\delta > \sqrt[n]{[1+(m\,.\,r)]} - 1)$	0,34
Probability	50%
Time	13 years
Ri	15
Pi	13
EU	14

Source: Prepared by the authors

Therefore, in an environment of tax complexity that generates insecurity for all participants and with repetitive special installments, even with high penalties applicable to tax avoidance and with high probabilities of being inspected, given the time and opportunity cost of the disobedient, the utility expected from the disobedient taxpayer will be favorable.

5. THEORETICAL MODEL OF TAX AVOIDANCE

Based on the assumptions presented, the variables of the theoretical model for the game of tax avoidance are established as:

Table 2
Reward Matrix (Pay-offs)

Taxpayer	Inspection	Movements – inspection (taxpayer, [judges])	Rewards (Taxpayer, Inspection)
{Strategy}			
Obey	Not Inspect		(0, 0)
Obey	Inspect	Not charge	(-Ci, -Cf)
Obey	Inspect	Charge (challenge, appeal, [annul])	(-Ci, -Cf)
Obey	Inspect	Charge (challenge, appeal, [maintain], pay)	(-Rf*, Rf*)
Obey	Inspect	Charge (challenge, appeal, [maintain], divide)	(-Pf**, Pf**)
Disobey	Not Inspect		(Ri, 0)
Disobey	Inspect	Not charge	(Ri*, -Cf)
Disobey	Inspect	Charge (challenge, appeal, [annul])	(Ri*, -Cf*)
Disobey	Inspect	Charge (challenge, appeal, [maintain], pay)	(Ri** - Cf**)
Disobey	Inspect	Charge (challenge, appeal, [maintain], divide)	(Pi**, Pf**)

Source: Prepared by the authors

(j) the set of players, j = [taxpayers (1) e inspection (2)];
(b) the set of independent participants, the judges, b = [DRJ and CARF];
(i) the set of strategies: for taxpayers is and for inspection is ;
(k) the set of possible movements of the players, for the taxpayers k1 = (pay, challenge, appeal, and divide), for the inspection k2 = (to assess and not to assess), for the judges kb = (to cancel or to maintain the infraction notices).

(U) the set of rewards for players, where Ci = cost of complying with the inspection, Ci* = cost of complying with the tax administrative process, Cf = inspection cost, Cf* = the tax administrative procedure cost, Rf = infraction notice with the penalties, Pf = infraction notice with the reductions of penalties for the special installment, Ri = profitability of the tax avoidance, Pi = profitability of the tax avoidance minus the payment of the infraction notice with reductions of the penalties for the special installment (Table 2).

Therefore, rewards occur when taxpayers adopt the following {strategies} and (movements) {obey, disobey (pay, challenge, appeal and pay in installments (divide))} and inspection {inspect, not inspect (charge and not charge)}, and the rewards will be increased or decreased as the judges make their decisions [annul and maintain].

The tax assessment and inspection costs of taxpayers whose strategy is to comply are lower than those of the disobedient taxpayer. Therefore, if the inspection notifies an obedient taxpayer, it will only have costs since it will not recover the investment in that tax audit. Moreover, the inspected obedient taxpayer will only have costs, from the inspection compliance going through the tax administrative process and the possible payment or installment of the tax assessment.

It is also assumed that δ $\delta > \sqrt[n]{[1+(m.r)]}-1$ when the taxpayer adopts the disobeying strategy, so $P_f < R_f$ e $P_i < R_i$. The tax assessment notice collected in the special installment is higher than the inspection cost and the tax administrative process ($P_i > C_f$). The game equilibrium occurs when the objective is achieved, meaning that the taxpayer maximized its expected utility, and the inspection received the applied tax assessment.

The dynamics of the tax avoidance game begins with the Taxpayer choosing one of the two strategies {obey or *disobey*}, the Inspection moves in the sequence choosing {*inspect* or *not Inspect*} and adopting one of the two possible moves (*charge* or *not charge*). Then, the Taxpayer adopts his movements: (pay, divide, challenge, and appeal). As it is a sequential game, the representation happens through decision trees. Figure 4 presents the tree for the Tax Avoidance Game, with the game starting on the left-hand side of the flowchart, where the Taxpayer chooses between disobeying or obeying tax legislation. Two branches emerge from the root to the right, representing one of the two choices, disobey or obey. Each one of the branches points to an RFB decision node since that player makes his entry decision after the taxpayer has reckoned and collected his tribute. From each of these two decision nodes extend two other branches that represent the two possible movements to the RFB, to inspect or not to inspect. If the RFB decides to inspect, two more decision nodes emerge, whether to charge or not to charge. In each terminal decision node, the possible rewards for the RFB and the taxpayer are shown, always in that order. And the game thus follows from left to right until the end, which takes place when the taxpayer chooses between paying or dividing the tax assessment notice.

According to Bierman and Fernandez (2010), although there is still no universally accepted solution concept applicable to all games, there is a consensus in the literature that any solution to a non-cooperative game must be a Nash equilibrium. Thus, to identify this equilibrium in the model, the retroactive induction algorithm presented by Bierman and Fernandez (2010) was applied to the proposed game, which requests the deletion of all non-optimal branches spotted in the game to identify the Nash equilibrium.

Therefore, we analyzed the game tree (Figure 4) and the rewards matrix (Table 2) and verified that the obedience strategy generates costs (-Ci, -Cf) or payment (-Rf) or installment payment (-Pf) for the taxpayer and a tax assessment notice lower than the inspection cost (Cf) and tax administrative process. Therefore, the equilibrium in the strategic decision of obedience is S_i^1={obey} and S_i^2={not inspect} whose rewards are (0,0) for taxpayer and enforcement.

Now, by analyzing the game from the perspective of the strategic decision of disobedience, we verify a favorable remuneration for the taxpayer and inspection even under the haven of the benefits of special installments. Thus, the "not inspect" strategy is overcome by "the inspect and charge." The movement of "paying the tax assessment notice"' is overcome by the "divide the tax assessment notice" (Pf < Rf) for the taxpayer. Besides Pi > (Ri – Rf) since the tax benefits of special installments reduce the actual value of the tax due. Finally, knowing that the infraction notice for the installment is higher than the cost of inspection (Pf > Cf). We can conclude that the equilibrium in the strategic decision of disobedience is for the taxpayer S_i^1={disobey (divide)} and for inspection S_i^2={inspect(charge)} whose rewards are (Pi, Pf). Therefore, as there is remuneration for both players in disobedience (Pi, Pf) against a nullity in obedience (0, 0), the equilibrium in the game is {*disobey* (*challenge*, *appeal*, *divide*)} for the taxpayer and {*inspect* (*charge*) } for inspection. This way, the game objective is achieved when the taxpayer maximizes its expected utility, and the inspection receives its tax assessment overcoming its inspection and tax administrative process costs.

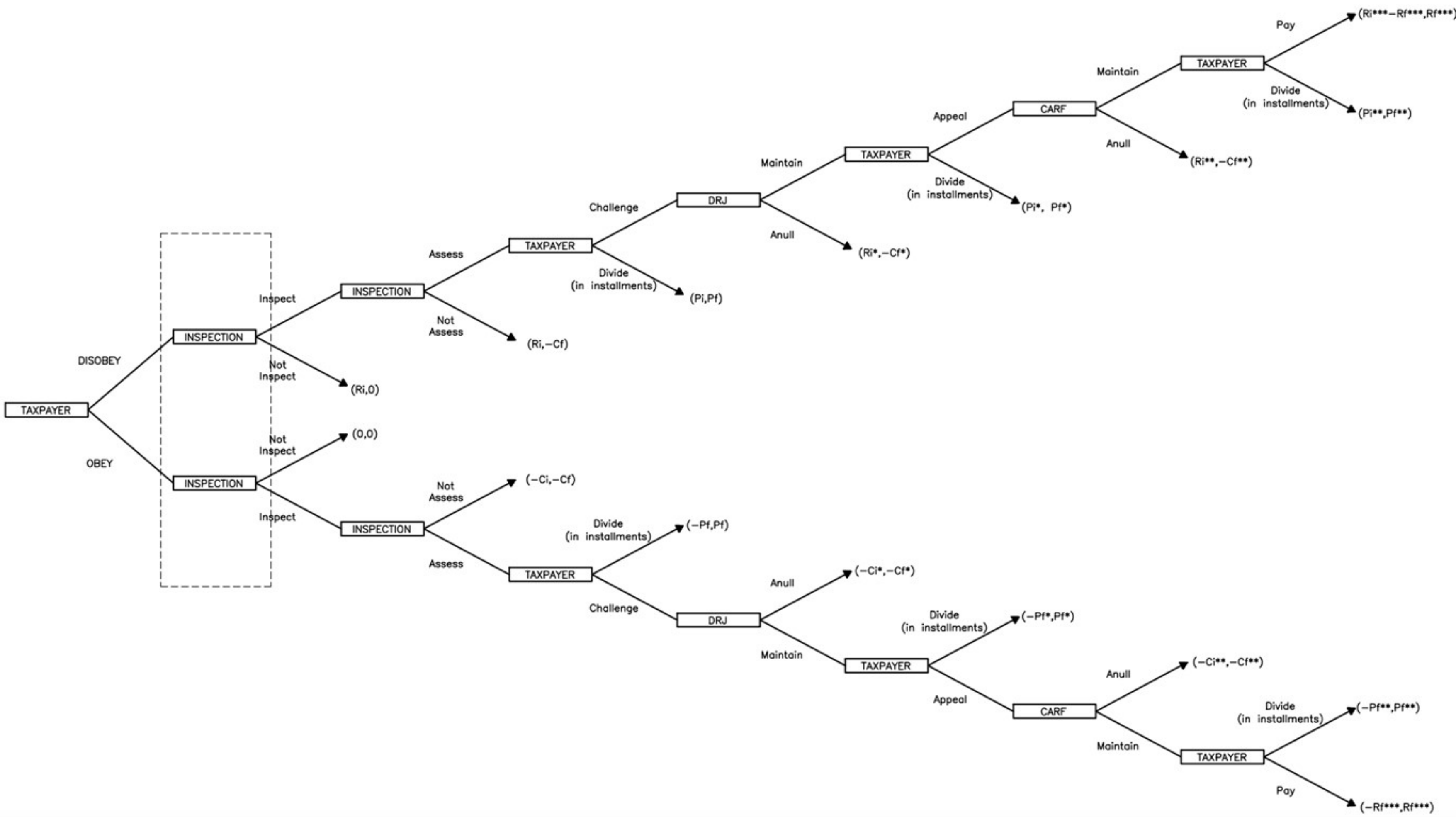

Figure 4. Tree for the Tax (Dis)obedience Game in an environment of tax complexity and with special installments
Source: Prepared by the author.

This conclusion is even more evident considering that: (i) the disobedient Taxpayer has remuneration Ri, while the obedient one has costs -Ci, this makes the disobedience decision prevail from a rational economic point of view; (ii) the remuneration after the CARF decision is the maximum obtained by the disobedient Taxpayer. Therefore, Ri** > Ri* > Ri. At this moment, the remuneration for disobedience will probably be higher than the payment in special installments; (iii) the tax debt is suspended until the conclusion of the tax administrative process, which, according to Mattos (2017), has an average term of 13 years; (iv) the installment amount is lower than the tax assessment notice after the CARF decision (Pf < Rf**), but higher than the inspection cost (Pf > Cf).

The result obtained can explain the low adherence to the payments of the infraction notices drawn up by the Federal Revenue between 2010 and 2017 (RFB, 2018), as well as the high probability that, when being inspected by the Federal Revenue, the organ responsible for the inspection, the taxpayer will be charged in 91.76 In % of cases as reported by the Annual Inspection Plan (RFB, 2018). Furthermore, it demonstrates that tax disobedience can bring remuneration, while obedience will not, making it the prevailing decision. Besides, the game result showed that the complexity and the special installments make the Brazilian tax system unfair since they remunerate the disobedient Taxpayer and bring losses to the obedient Taxpayer.

The vicious cycle of tax avoidance experienced in Brazil can also be based on the Two-Level Game Theory since the taxpayer who is in level I of the game decides to disobey the tax legislation if and only if at level II there is ratification for this disobedience with the special installments or favorable jurisprudence in the administrative and judicial judging bodies. That is, if decisions in the judging courts recognize opportunities for aggressive tax credits or accept the deductibility of questionable expenses, the taxpayer at the level I verifies a set of victories at level II to ratify his tax avoidance. The same can be observed when the taxpayer in level I is aware of special installments at level II that will ratify his tax avoidance, granting him tax benefits for not timely paying his taxes. Thus, according to the Two-Level Game Theory, a level I negotiator will have a better chance of success if he has a large set of level II wins that ratify his level I decisions.

6. FINAL REMARKS

The general objective of this study was to analyze how tax complexity and special installments affect the decision-making of Brazilian taxpayers in disobeying tax legislation. Therefore, a theoretical model was developed along the lines of Game Theory to identify what would be the best strategic decision for the taxpayer given the Brazilian tax complexity and repetitive special installments. As a result, we observed that the only possible Nash equilibrium is {*Disobey* (*challenge*, *appeal*, *divide*); *Inspect* (*charge*)}, which showed that tax complexity and repetitive special installments encourage tax avoidance. Therefore, despite being a common sense that companies finance themselves through non-payment of taxes, theoretical studies that proved this assertion was unknown.

The literature on tax complexity and special installments is extensive but scarce in Brazil, a country with the ideal characteristics for this study. Therefore, paper sought to fill this gap, thus contributing to the literature on fiscal aggressiveness. Since none of the studies on this theme sought to understand the instruments used by taxpayers to practice tax aggressiveness, this research advanced the knowledge of the tax accounting literature by verifying that companies can use tax complexity and special installments to make their decision for tax avoidance. Thus, this research can contribute to society, demonstrating the need for a tax reform that reduces the tax complexity of the Brazilian tax system and develops more efficient special installments.

This research also showed that high tax complexity elicits dishonest taxpayers to find spaces for their voluntary tax avoidance, and honest taxpayers make mistakes while applying the tax legislation and fall into involuntary disobedience. Besides, it brings uncertainty to the population, as judges have doubts concerning the tax law application, burdening the State with inspections that will not result in new resources and bearing numerous administrative and judicial processes.

We highlight that this research opens space for a discussion on the need to set up an independent body to identify unnecessary tax complexity in Brazil, along the lines currently developed by the OTS - Office of Tax Simplification in the United Kingdom.

As possible paths for new research in this field, we suggest the empirical application of this study to verify if they will reach the same results and expand the model to encompass the judicial process.

REFERENCES

Aghion, P., & Tirole, J. (1997). Formal and real authority in organizations. *Journal of Political Economy*, *105*(1), 1-29.

Allingham, M., & Sandmo, A. (1972). Income Tax Evasion: A Theoretical Analysis, *Journal of Public Economics*, *1*(3-4), 323-338.

Alm, J., & Martinez-Vazquez, J. (2003). Institutions, paradigms, and tax evasion in developing and transition countries. In *Public Finance in Developing and Transitional Countries: Essays in Honor of Richard Bird* (pp. 146-178). Edward Elgar Pub.

Alm, J. (1991). A perspective on the experimental analysis of taxpayer reporting. *The Accounting Review*, *66*(3), 577-593.

Alm, J. (2012). Measuring, explaining, and controlling tax evasion: lessons from theory, experiments, and field studies. *International Tax and Public Finance*, *19*(1), 54-77. https://doi.org/10.1007/s10797-011-9171-2

Andreoni, J., Erard, B., & Feinstein, J. (1998). Tax compliance. *Journal of Economic Literature*, *36*(2), 818-860.

Batrancea, L. M., Nichita, R. A., & Batrancea, I. (2012). Understanding the determinants of tax compliance behavior as a prerequisite for increasing public levies. *The USV Annals of Economics and Public Administration*, *12*(15), 201-210.

Becker, G. S. (1968). Crime and punishment: An economic approach. In *The economic dimensions of crime* (pp. 13-68). Palgrave Macmillan.

Bierman, H. S., & Fernandez, L. (2010). *Teoria dos Jogos* (2nd ed.). Pearson Universidades.

Budak, T., & James, S. R. (2018). The level of tax complexity: A comparative analysis between the UK and Turkey based on the OTS Index. *International Tax Journal*, 27-40.

Cavalcante, R. (2010). *Estudo exploratório acerca da influência do parcelamento de débitos sobre a arrecadação tributária da união*. [Monografia Especialização em Orçamento Público. Instituto Serzedello Corrêa].

Cunha, A. D. S., Klin, I. D. V., & Pessoa, O. A. G. (2011). Custo e tempo do processo de execução fiscal promovido pela Procuradoria Geral da Fazenda Nacional.

De Santi, E. M. D. (2009). *Relatório final NEF 2009: Reforma do Processo Administrativo Fiscal Federal (PAF)/CARF: Excelência, celeridade e eficiência*. Editora FGV, 21.

Faber, F. I. L.; Silva, J. P. R. F. M. (2016). Parcelamentos tributários – análise de comportamento e impacto. *Revista da Receita Federal Estudos Tributários e Aduaneiros Brasília*, 3(1-2).

Follmann, C. A. S. (2001). *Evasão do imposto de renda pessoa física: estimativa para o caso brasileiro* [Doctoral dissertation, University of São Paulo].

Graetz, M. J., Reinganum, J. F., & Wilde, L. L. (1986). The tax compliance game: toward an interactive theory of law enforcement. *Journal of Law, Economics, and Organization*, *2*, 1-32.

Jacob, M. (2018). Uma nota sobre a pesquisa tributária. *Revista Contabilidade & Finanças*, 29, 339-342.

Kopczuk, W. (2006). Tax simplification and tax compliance: An economic perspective. In *Bridging the Tax Gap. Addressing the Crisis in Tax Administration* (pp. 111-143). Economic Policy Institute.

Laffer, A. B., Winegarden, W. H., & Childs, J. (2011). *The economic burden caused by tax code complexity*. The Laffer Center for Supply-Side Economics.

Leitão Paes, N. (2012). O Parcelamento Tributário e Seus Efeitos sobre o Comportamento dos Contribuintes. *Revista Economia*, *13*(2), 345-363.

Leitão Paes, N. (2014). Os efeitos dos parcelamentos sobre a arrecadação tributária. *Estudos Econômicos*, *44*(2), 323-350.

Martins, G. A. (1994). *Manual para elaboração de monografias e dissertações*. Atlas.

Mattos, A. J. N. D. (2017). Maximização da utilidade esperada, planejamento tributário e governança corporativa [Doctoral dissertation]. Universidade de São Paulo.

Mikesell, J. L. (1986). Amnesties for state tax evaders: The nature of and response to recent programs. *National Tax Journal*, *39*(4), 507.

Morais, C., Macedo, L., & Borges, R. (2011). *O Resultado Arrecadatório do REFIS, do PAES e do PAEX e seu Impacto na Sensação de Risco Subjetivo pelos Devedores* [Monografia, Escola de Administração Fazendária].

Nash, J. (1951). Non-cooperative games. *Annals of Mathematics*, *54*(2), 286-295.

Nugent, D. A. (2013). Legislating morality: The effects of tax law complexity on taxpayers' attitudes. *Journal of Applied Business Research*, *29*(5), 1479.

Office of Tax Simplification (OTS) (2017), *The OTS Complexity Index – Version 3*, Retrieved 2017, 26 September, from https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/603479/OTS__complexity_index_paper_2017.pdf

Receita Federal do Brasil (2018). *Plano Anual de Fiscalização 2018*. Retrieved 2017, February 14, from https://static.poder360.com.br/2018/02/plano-anual-de-fiscalizacao-2018-e-resultados-2017.pdf

Richardson, G. (2006). Determinants of tax evasion: A cross-country investigation. *Journal of International Accounting, Auditing and Taxation*, *15*(2), 150-169.

Sandmo, A. (2005). The theory of tax evasion: A retrospective view. *National Tax Journal*, *58*(4), 643-663.

Sartini, B. A., Garbugio, G., Bortolossi, H. J., Santos, P. A., & Barreto, L. S. (2004). *Uma introdução à teoria dos jogos*. II Bienal da SBM–Universidade Federal da Bahia.

Slemrod, J., & Yitzhaki, S. (2002). Tax avoidance, evasion, and administration. In *Handbook of Public Economics* (Vol. 3, pp. 1423-1470). Elsevier.

Slemrod, J. (2007). Cheating ourselves: the economics of tax evasion. *Journal of Economic Perspectives*, *21*(1), 25-48. https://doi.org/10.1257/jep.21.1.25

Soares, M. R. D. C. (1994). *Evasão fiscal: a teoria do comportamento dos agentes públicos e privados* [Doctoral dissertation]. Fundação Getúlio Vargas.

Torgler, B. (2003). *Tax morale: Theory and empirical analysis of tax compliance* [Doctoral dissertation]. University of Basel.

Torgler, B. (2007). *Tax Compliance and Tax Morale: A Theoretical and Empirical Analysis*. Edward Elgar.

Von-Neumann, J., & Morgenstern, O. (1944). *Theory of Games and Economic Behavior*. Princeton University Press.

Yitzhaki, S. (1974). A note on income tax evasion: A theoretical analysis. *Journal of Public Economics*, *3*(2), 201-202.

AUTHOR'S CONTRIBUTION

APMG: Study conception and design; Data acquisition; Analysis and/or interpretation of data; Preparation of the manuscript. **JC:** Study conception and design; Analysis and/or interpretation of data; Critical review of the manuscript; Final version approval; Correction and Evaluation. **JRSF:** Critical review of the manuscript; Final version approval; Correction and Evaluation. **FTRL:** Critical review of the manuscript; Final version approval; Correction and Evaluation.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.