Revista Universo Contábil, ISSN 1809-3337
Blumenau, v. 15, n. 4, p. 31-48, out./dez., 2019

doi:10.4270/ruc.2019426
Disponível em www.furb.br/universocontabil

EFICIÊNCIA DAS EMPRESAS E AGRESSIVIDADE TRIBUTÁRIA: EVIDÊNCIAS DO BRASIL

COMPANY EFFICIENCY AND TAX AGGRESSIVENESS: EVIDENCE FROM BRAZIL

EFICIENCIA DE LAS EMPRESAS Y AGRESIVIDAD TRIBUTARIA: EVIDENCIAS DE BRASIL

Recebido em: 21-11-2017
Avaliado em: 25-07-2020
Reformulado em: 14-08-2020
Aceito para publicação em: 29-09-2020
Publicado em: 31-12-2020
Editor Responsável: Moacir M. Rodrigues Junior

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ABSTRACT

This paper studies whether there is a relation between the operational efficiency measured through the Data Envelopment Analysis (DEA) models and the tax aggressiveness of the Brazilian public companies listed on B3 between the period of 2010 to 2015. The main hypothesis is that companies that are more operational efficient are in average less tax aggressive. Or, in other words, we predict that the less operational efficient companies have usually to engage in tax aggressiveness strategies more often. An efficiency score was calculated considering the outputs and inputs of the companies, classifying them according to the Data Envelopment Analysis (DEA) models to determine the relative company's operational efficiency. The tax aggressiveness was measured by the difference between the Effective Tax Rates (ETR) and the average of ETR of companies from specifics economic sectors. Five relevant economic sectors were evaluated. A Data Panel model was estimated using the fixed effects. Considering the regression of all sectors, the results confirmed the hypothesis that companies that are more operational efficient in average tend to be less tax aggressive. However, when the samples were separated by sectors, only in the Energy and Textile Sectors this relation is significant.

Keywords: Tax Aggressiveness. Operational Efficiency. Data Envelopment Analysis (DEA)

RESUMO

Este artigo busca verificar se há relação entre eficiência medida através da metodologia do *Data Envelopment Analysis* (DEA) e a agressividade tributária das empresas abertas, listadas na B3, no período de 2010 a 2015. Acredita-se que as empresas mais eficientes são menos agressivas tributariamente, uma vez que a agressividade tributaria pode afetar, dentre outros o valor de mercado das empresas. Para determinação da eficiência das empresas foi calculado um escore considerando os outputs e os inputs das empresas, classificados conforme o DEA. Já a agressividade tributária foi medida pela diferença entre *Effective Tax Rates* (ETR) e a média das ETR das empresas do setor específico. Foram avaliados 5 setores, compondo 451 observações no período de 2010 a 2015. O modelo foi estimado com regressão em dados em painel de efeito fixo. Os resultados encontrados,

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considerando a regressão com todos os setores, confirmam a hipótese de que empresas eficientes são menos agressivas tributariamente. No entanto, ao separar a amostra nos setores, apenas nas áreas de Energia e Têxtil essa relação é significativa.

Palavras-chave: Agressividade tributária; Eficiência relativa das empresas; Análise por envoltória de dados (DEA).

RESUMEN

Este artículo busca verificar si hay relación entre eficiencia medida a través de la metodología del *Data Envelopment Analysis* (DEA) y la agresividad tributaria de las empresas abiertas, listadas en la B3, en el período de 2010 a 2015. Se cree que las empresas más eficientes son menos agresivas tributariamente, ya que la agresividad tributaria puede afectar, entre otros, el valor de mercado de las empresas. Para la determinación de la eficiencia de las empresas se calculó un puntaje considerando los outputs y los inputs de las empresas, clasificados conforme al DEA. La agresividad tributaria fue medida por la diferencia entre *Effective Tax Rates* (ETR) y el promedio de las ETR de las empresas del sector específico. Se evaluaron 5 sectores, componiendo 451 observaciones en el período de 2010 a 2015. El modelo fue estimado con regresión en datos en panel de efecto fijo. Los resultados encontrados, considerando la regresión con todos los sectores, confirman la hipótesis de que empresas eficientes son menos agresivas tributariamente. Sin embargo, al separar la muestra en los sectores, sólo en las áreas de Energía y Textil esa relación es significativa.

Palabras-clave: Agresividad tributaria; Eficiencia relativa de las empresas; Análisis por envoltura de datos (DEA).

1 INTRODUCTION

According to Oliveira (2002), the efficiency is the optimization of resources that generates satisfactory results, i.e. optimum relation between consumed resources and generated products, which is linked to the use of and allocation of resources, to maximize the results or profits. Also, stands the concept related to the use and allocation of the resources (Ferreira, Reis & Pereira, 1997).

The efficiency or performance of the companies are measured and recognized by the multidimensional constructor, that, according to Lewin and Minton (1986), involves several objectives and types of organizations whose results (loss or profits) reflects the decisions made by the managers, that usually come through strategic plan.

As emphasized by Chavarthy (1986), part of the conventional references like the profit, ROI, ROS or Market analysis such as Market to book ratio, is limited in the composition of excellence. Some of these financial ratios evaluate products versus inputs, such as ROI (return on investment) and ROS (return on sales), which can serve as a direction or indicative for efficiency.

Also, according to Chavarthy (1986), efficiency is a complex phenomenon that needs to be evaluated by several ways, not having a unique method to be identified. As many researches point out that the multi-factorial model analysis of efficiency can improve the analysis.

The DEA (Data Envelopment Analysis) comes as a tool to be able to perform better metrics of performance, efficiency or a preliminary assessment of companies, also its future goals and strategies. The DEA emerged in the 70's, and had the authors Charnes, Cooper and Rhodes as its pioneer's users in 1978. The DEA is a nonparametric method that does the comparison between the Decision-Making Units – DMU's, generating quantitative data that delimitates the directions with the purpose of improving de performance or efficiency of the units that are evaluated as non-efficient.

In comparison, by the DEA, the DMU's must have homogenous data, same information for inputs and for outputs. As result, the maximum productivity and efficiency is obtained, that considerate the perfect relation between inputs and outputs. The advantage of this method is the fact that it uses relative efficiency, without loss to the small companies, and more than one company can

be classified as efficient serving as comparison to the other companies. The DEA is widely used, on international and national researches, as Kassai (2002) points is his thesis.

In the context of the efficiency of companies, the managers use tax-planning seeking to maximize the results. One of these strategies is the tax avoidance, pointed by Martinez and Motta (2020).

According to (Scholes & Wolfson, 1992; Hanlon & Heitzman, 2010; Dyreng & Hanlon; Maydew, 2010; Blaylock, Shevlin & Wilson, 2012), tax-avoidance is defined as any method that legally reduces the amount of tax payable by means within the law being licit or illicit.

In Brazil, according to Iudícibus and Pohlmann (2007), there are difficulties to point the activities of tax avoidance, licit and illicit, by means of operations denominated as frauds, simulations, evasion, dissimulation, elision, indirect legal business, in addition to others practices that invalidate or make the identification of tax avoidance obscure, as pointed by (Santi, 2012; Shoueri et al.,2010).

By rules, the companies tend to seek efficiency in their tasks, generally or partially, in operational tasks, financial tasks and investments tasks, to maximize their results and, the company value.

Also contributing with this view, according to Baik et al. (2013), Demerjian et al. (2013) and Park (2013), the companies can maximize their results, not only aiming tax costs. Within this context, Hanlon and Slemrod (2009) mention that news about tax avoidance can reflect negatively in the market value of the companies, and companies that are more efficient have the tendency of been less tax aggressive.

The companies become more efficient when having a broader view of all parts, all costs and, consequently, all the tributes according to Scholes and Wolfson (1992). By working these points, the company reach a complete efficiency (Rosemburg, 2006).

With that said, examine the efficiency or the company's performance and the level of tax aggressiveness becomes a subject extremely important to be studied. So this paper aims to study studies if there is a relation between tax avoidance and the efficiency of companies. These companies considered efficient, will then be more or less tax aggressive? Can the efficiency of the companies explain the tax aggressiveness?

Yet, there is researches that approach the tax avoidance, while others have an approach to the DEA. However, this research is valid, as it seeks to explain the relation between efficiency through the DEA technique and the tax aggressiveness (tax avoidance) in Brazil, providing a new view to explain the tax avoidance. Likewise, it is relevant that the users of accounting information, regulators, and taxation authorities, being inserted in the peculiarities of Brazil (emerging economy), which provokes interest in national and foreigner investors.

2 THEORETICAL REFERENCE

2.1 Operational Efficiency

According to Oliveira (2002), optimization of the use of resources that generates satisfactory results, and the perfect relationship between the consumed resources and products produced resulting in the maximization of profits, can be considered efficiency.

Efficiency is the strategy and the process of applying the best practices, to detect the best production or performance of the company to obtain profits as pointed by Smith (2005). In addition to this research, the concept of efficiency is related direct to the DEA (Data Envelopment Analysis) technique, and according to Charnes et al. (1981), the relative efficiency seeks to minimize or maximize the inputs in comparison to the outputs (product), result of a balanced relationship of inputs and outputs.

The companies are in a continuous search for efficiency, productivity or performance and, according to Kaplan and Norton (2001), strategic planning is essential to reach the goals. However, their non-conformities points are the execution of theses planning, which requires well-defined

planning and efficient tools to monitor. Within this context of monitoring the planning, according to Berliner and Brimson (1992), it needs tools to measure the efficiency of the company, managing the company in a satisfactory way.

According to Macedo (2004), there is no method or form of analysis there is complete to analyze de companies. A lot of tools is being used by the companies to measure its efficiency, as Hammer (2007) points some of them, such as the Balanced Scorecard (BSC), Key Performance Indicator (KPYs), among others.

In addition to these tools, the DEA (Data Envelopment Analysis) contribute to analysis, as it is a technique used also in other areas, such as Accounting, Production Engineering, Economy, Business Administration, Psychology, Sociology and Law.

2.1.1 DEA – Data Envelopment Analysis

In 1957, Ferral developed a concept of efficiency, from a model that the product divided by the input generate an indicator of efficiency, technical or allocative. The first represents the resourcing of the company to extract the maximum of the product in relation to the range of inputs; the allocative efficiency is related to the use of inputs in a perfect proportion. On other hand Charnes, Cooper and Rhodes (1978), proposed the Data Envelopment Analysis model (DEA) which does this analyses by multiple products (outputs) and multiple inputs.

The studies by Charnes, Cooper and Rhodes (1984), pointed that, the use of mathematical programming contributes to obtain the evaluation of relative efficiency of the results of managers, of their planning and of what they executed.

The DEA, in terms of mathematical calculus, according to Charnes, Cooper and Rhodes (1981), is the result between the weighted sum ratio of the outputs (product) and the weighted sum ratio of the inputs (matter). It is a multivariate technique of estimation, non-parametric, that analyses the efficiency or the productivity of the companies, through the comparison of the company's individual efficiencies.

The non-parametric techniques are methods that obeys the information as they occur, and not in a hypothetic way, without requiring that the information applies to a determined classification. By this, The DEA is classified as a non-parametrical technique.

The non-parametrical technique depends on the chosen units the will be analyzed, because with this collection of information that stipulates the behavior of the data. With that said, the results will depend on the units included in the analysis, as these units may not be distinct.

The analyzed group needs to have the same parameters of comparison, be a homogeneous sample that has that same comparison metrics, the same inputs and the same outputs. The weighted of each factor, products or matter, is generated by the solution of a fractional programming problem.

In this research, the DEA was used, constant returns to scale – (CCR) oriented to outputs.

2.2 Tax Avoidance

Tax avoidance is defined as the actions of tax planning that seeks to reduce administratively the income tax, by legal means or not, Chen et al. (2010). The tax avoidance, therefore, comprehend all behavior that seeks tax economy. Martinez and Motta (2020) describe a similar line of thought, by affirming that legal entities are counted by tax planning, to tax economy through several mechanisms, being those under de legislation or to the scope of the legislation.

In the same approach, there are other concepts such as Frischmann et al. (2008), that points tax avoidance with enticement of the tax position of relatively weak company. Lisowsky et al. (2010) also point as a group of tributary actions in the limit of illegality (fiscal evasion), abusive tributary actions.

Oliveira et al. (2006) describe that the reduction of taxes should not take the path of illegality. However, as affirmed by Latorraca (2000), the minimization of tax burden must be incorporated in an efficient tax planning, which seeks the minimization of all parts, costs and taxes, as pointed by

Scholes and Wolfson (1992). As the manager is the one responsible to plan the guidelines, seeking proceedings there are more efficient, or less costly to the company and results in efficiency.

On the researches of Slemrod and Yitzhaki (2002), Slemrod (2004), Hanlon and Heitzman (2010) and Chen et al. (2010), is noted that all of them points to the use of tax avoidance on the companies. In a way that tax avoidance is addressed to the tax planning of the legal entities, as they seek more reduction of tax burden then the one established by the legislation, therefore, classified as more tax aggressive.

As it does not have a universal concept, stood out the definition of Dyreng et al. (2008):

> [...] we define tax avoidance widely as anything that reduces the tax cash rate of the company for a long time. [...] our actions will reflect no only on the reduction of tax that are directly linked to the law enforcement, as to those that are results of obscure (DYRENG et al., 2008, p. 2).

It is important do point that the legal tax planning is, also, denominated as “tax elision” or, also, “tax evasion”.

A review survey of the metrics of tax avoidance in the literature of 2010, written by Dubar et al., point to the fact that ETR (Effective tax rate), BTD (Book – tax differences) and the other metrics, which are based on econometrics models, catch the abnormal effects of the tax planning.

2.2.1 ETR – Effective Tax Rate

For conceptualization purposes, the effective tax rate (ETR), is responsible for the representation, in percentage terms of the tax collected by income earned in the activity conducted by the company or legal entity (Minnick; Noga, 2010; Armstrong et al., 2011). According to Gupta and Newberry (1997), the ETR is the result of the actions of the tax management and of the tax incentives. In this study was used such metric, as followed by the authors Tang (2005), Formigoni, Antunes and Paulo (2009), Minnick and Noga (2010) and Armstrong et al. (2011).

There are counterpoints to authors in relation to the ETR, pointing some limitations at this rate, as the example mentioned in the teachings of Wilkie (1992), affirming that the ETR can be affected, for example, in the compensation of losses from previous years in the current tax profit. Another limitation pointed in Tang’s production (2005), highlights the tax incentive policy, that affects directly the corporate taxes and that, consequently, reflects in alteration of the ETR. Although, according to Gomes (2012), stand outs that tax incentive reflects one of the expressions of the tax planning.

Martinez e Dalfior (2016), defend the insertion of ETR as a metric in the tax planning estimation statement, as they illustrate the decisions made by managers. Although this indicator has limitations, as other metrics have, in this study, the ETR is identified as a preponderant factor of tax avoidance, as the resulting tax of the companies compared to the actual legislation tax (34% of the incident of taxes) denoted a tax planning, in which the higher the ETR, the lower the tax aggressiveness. In other hand, the lower the ETR, the higher the tax aggressiveness, in which points to an impact in the company’s efficiency and profits.

Based on Iudícibus and Pohlmann (2010, p. 7), the actual Brazilian legislation describes the theoretical percentage of approximately 34%, which represents the sum of the 15% IRPJ, added to the additional 10% of IRPJ and 9% of the CSLL.

Lammersen (2002) points the ETR as a management tool that supports the users of the accounting information, be it internal or external, for decision making the could directly affect the performance or efficiency of the companies. Janssem (2005) indicates in his study that researchers want to know the companies' RTE, if they collect less or more taxes compared to the current legislation, indicating their level of ETR.

Scholes and Wolfson (1992) point out that the ETR is a metric, which considers the real tax burden of the company, considering, therefore, the temporary and permanent differences between the taxable profit and the financial profit. Still Dunbar et al. (2010) argue that the ETR is a metric with the ability to assess the tax aggressiveness of companies. In the same chain of analysis, the authors

Giannini and Maggiulli (2002) affirm that the ETR can be used to evaluate the real impact of corporate taxation, also explaining the impacts of decision-making.

In the next topic, will be presented the methodology and the empirical model that was used with the scope to highlight if there is any correlation between the efficiency and the aggressiveness of taxation in the business branch, as already discussed in the above-mentioned sections.

3 METHODOLOGY

3.1 Efficiency

In this research, the efficiency (EFIC) of the companies is calculated according to the model proposed by Park et al. (2015), considering the ratio of outputs to inputs of the companies. This and other authors have also adopted this form or similar form to measure efficiency as shown in the work developed by Black, Jang and Kim (2006); Desai and Dharmapala (2006); Koh, Kim and Choi (2007) and Kang and Ko (2014). This shows the relationship between outputs and inputs:

$$EFIC._{.} = \frac{\text{Weighted sum of } \textit{outputs}}{\text{Weighted sum of } \textit{inputs}}$$

Alternatively, in this work:

$$EFIC._{.} = \frac{RLO}{CMV + D.V.ADM + TAN + INTAN} \quad (1)$$

As:
$\boldsymbol{EFIC._{.}}$ – Efficiency
Output variables:
$\boldsymbol{RLO_{.}}$ – Net Operating Revenue
Inputs variables:
$\boldsymbol{CMV_{.}}$ – Cost of Merchandise Sold
$\boldsymbol{D.V.ADM_{.}}$ – Sells and Administrative Expenses
$\boldsymbol{TAN_{.}}$ – Tangible Assets (Fixed Assets + Investment)
$\boldsymbol{INTAN_{.}}$ – Intangible assets

The Minato study (2006) points to the methodology of measuring relative efficiency between similar decision-making units (DMUs), in which the relative performance of the units is equal to 1 or 100%, where k DMU's will be compared between them.

For a better understanding of the efficiency calculation method, the DEA technique demonstrates the mathematical formula:

$$EFIC\ E_0 = \frac{\sum_{j=1}^{s} u_j\ y_{jc}}{\sum_{i=1}^{m} v_i\ x_{ic}}$$
$$S.a.: \frac{\sum_{j=1}^{s} u_j\ y_{jk}}{\sum_{i=1}^{m} v_i\ x_{ik}} \leq 1,\ k = 1,2,\ldots,c,\ldots,n \quad (2)$$
$$u_j \geq 0, \forall$$
$$v_i \geq 0, \forall$$

The values u and v (weights) of the variables will be sought from the maximization of the weighted sum of the y (products) divided by the weighted sum of the x (inputs) of the outstanding DMU_C, the result of which will be limited to 1 for all DMU's.

With the restriction of the summation $v_i\ x_{ic} = 1$ we avoid the infinite solutions problems by making the equation in PPL (Linear Programming Problem):

$$
\begin{gathered}
Max\ E_0 = \sum_{j=1}^{s} u_j\ y_{jc} \\
S.a.: \sum_{i=1}^{m} v_i\ x_{ic} = 1, \\
\sum_{j=1}^{s} u_j\ y_{jk} - \sum_{i=1}^{m} v_i\ x_{ik} \leq 0,\ \text{k} = 1,2, ..., \text{c}, ..., \text{n} \\
u_j\ v_i \geq 0,\ \forall\ \text{i, j}
\end{gathered}
\tag{3}
$$

Where:
$\boldsymbol{E_0}$ – Efficiency of the DMU_0
$\boldsymbol{u_j}$ - Weight assigned to *output*$_j$
$\boldsymbol{v_j}$ – Weight assigned to *input*$_j$
$\boldsymbol{y_{jc}}$ – *Output*$_j$ of the DMU_c
$\boldsymbol{y_{ic}}$ – *Input*$_j$ of the DMU_c
j – Number of outputs, i – number of inputs, c – number of DMU's,

Thus, DMU's individual efficiency is calculated by comparing DMU's products and inputs with DMU's total products and inputs.

In addition, according to Faria, Jannuzzi and Silva (2008), Decision Making Units (DMUs) considered efficient defines the relative efficiency frontier, generating for the non-efficient companies the non-conformities in which they need to improve.

In order to contribute to the efficiency calculations by the DEA technique, some software were developed, among them the SIAD software, which is used in this research.

3.1.1 SIAD software

The Integrated System of Decision Support (SIAD) is a software developed and available free of charge at Universidade Federal Fluminense - UFF, by Angulo Meza et al. (2005b), accessed through the electronic site http://www.uff.br/decisao/. This program was designed in order to calculate the DEA results in all classical models, whose answers provide information on efficiency, targets, weights, benchmarks and clearances.

The software is used in several researches and with several decision-making units. The SIAD calculations were duly compared and validated using the DEA Frontier Analyst program.

3.2 Tax avoidance

According to studies developed by Desai and Dharmapala (2006) and Chen et al. (2010), companies are classified as more or less aggressively taxed, considering their Effective Tax Rate (ETR). Khurama and Moser (2009) and Dunbar et al. (2010) define ETR as the division between the amount of taxes, income tax and social contribution for profit before income tax. Like this:

$$
ETR_{it} = \frac{IRPJ + CSLL}{LAIR} \tag{4}
$$

$\boldsymbol{ETR_{it}}$= Effective rate of company i in year t;
$\boldsymbol{IR_{it}}$ = Current income tax of company i, in year t;
$\boldsymbol{CSLL_{it}}$ = Social Contribution on current net income of company i, in year t;
$\boldsymbol{LAIR_{it}}$ = Income before income tax of company i, in year t.

Currently, the tax burden in Brazil reaches the level of 34%. The companies whose ETR is above 34% are considered less tax aggressive, while those with ETR below 34% are classified as tax aggressive companies.

According to the concept of efficiency used in this work, the measurement depends on the relativization of companies that are comparable (the DEA technique only makes sense with companies from the same productive sector). It is understood that a metric which compares the

company's fiscal policy with the average of its sector would bring a more meaningful result to the understanding of the relationship between EFIC and ETR. In this way, it is defined:

$$DifETR_{it} = ETR_{it} - avgETR_{jt} \quad (5)$$

$\boldsymbol{avgETR_{jt}}$= average of the ETR of the companies of sector j, in year t;

$\boldsymbol{DifETR_{it}}$ = Difference of the ETR practiced by the company$_i$ in the year$_t$ by the average of the ETR practiced by the companies of the same sector$_j$ of the company$_i$

3.3 Control Variables

The return on assets (ROA) is a variable present in the work of Lennox et al. (2012) and Martinez and Ramalho (2014), related to tax aggressiveness, and, according to Gupta and Newberry (1997), the higher the ROA, the lower the ETR. For Gomes (1999), the higher the ROA, the more efficient the companies are.

As for Indebtedness, Watts and Zimmerman (1990), have measured that companies with higher levels of indebtedness tend to be more aggressive tributary. However, Graham (1996) showed opposite behavior.

Lanis and Richardson (2007) have shown that larger companies are considered more aggressive than the smaller companies due to their economic connection, political power, and generating conditions to reduce the effective tax burden. The relationship of companies' size and efficiency was studied by Sengupta (1998), who showed that larger companies are more efficient than smaller companies are.

3.4 Regression and Estimators

Based on the studies of Gupta and Newberry (1997), Richardson and Lanis (2007) and Chen et al. (2010), which describe the relationship of efficiency indicators with tax aggressiveness, we postulate the hypothesis of the research:

H_0: Companies that have a higher level of efficiency are less tax aggressive.

To test the hypothesis, the econometric model was developed, incorporating the variable of interest EFIC, controlled by size of company (Size), Indebtedness (ENDIV) and ROA.

$$dif\_etr_{it} = \beta_0 + \beta_1 efic_{it} + \beta_2 size_{it} + \beta_3 endiv_{it} + \beta_4 roa_{it} + \varepsilon_{it} \quad (6)$$

According to Copeland et al. (1996), conceptually the ROA is a proxy directly linked to the result of the operational efficiency. In order to eliminate any possibility of collinearity with the EFIC variable of interest (which by definition measures the efficiency of the company), a multi collinearity test (VIF) was performed, as no problem of this nature was identified among the variables.

The regression was estimated through a panel data model, with fixed effect in time (year) and the individual (company), after the Hausman test presented the best estimate between random and fixed effect panel <. The model is also robust to the problem of heteroscedasticity and serial correlation, and the standard deviations are corrected through a cluster by company.

3.5 Sample Selection

To conduct the study, all the publicly traded companies in the São Paulo stock exchange were selected in Economatica from 2010 to 2015.

Following treatment by Hanlon (2010), all negative ETRs and other values that were strange to the sample were excluded from the sample, broken down in the table below:

Table 1: Definition of the variables

VARIABLE	DESCRIPTION	CALCULUM
Y DIF_ETR	Represents the level of Company's Tax Aggressiveness in relation to the Sector Average.	Companies ETR (it) - Average ETR of the Sector (jt)
β0	Constant Regression interceptor	-
Normal efficiency indicators of the company	Normal efficiency indicators of the company	Weighted sum of Outputs / weighted sum of inputs - within an equation in PPL (Linear Programming Problem) through the DEA tool
β2 SIZE	Represents the size of the company.	Natural logarithm of the company's current assets (it)
β3 ENDIV	Represents the Company's Indebtedness	Total Liabilities (it) / Shareholders' Equity (it)
β4 ROA (Return on Assets)	Return on total assets, with Net Income divided by Total Assets, both measured at time t	Operating income (it) / total assets (it);
ε_{it} Erro	Regression Error	-

Table 2: Selection of the sample

	Total sample Economatica (All Sectors)	**2262**
(-)	Companies without an indentified Sector	516
(-)	Negative LAIR and Net Revenue equal to zero	490
(-)	Negative ETR and Loss.	497
(=)	**Total sample after Exclusions**	**759**

Source: Prepared by the author.

Table 3 - Observation by Avaliated Sector from the period of 2010 to 2015

SECTORS	Samples After Exclusions						Nº of observations in Period	Ranking	Nº of companies in the Sector
	2010	2011	2012	2013	2014	2015			
Energy	32	30	26	27	26	29	170	1	40
Transport Services	13	12	13	12	10	11	71	2	18
Siderurgical & Metallurgical	17	15	10	12	11	6	71	3	19
Textile	14	12	10	11	9	6	62	4	19
Commerce	13	14	13	13	13	11	77	5	16
Vehicles and spare parts	11	12	9	10	9	8	59	6	13
Food & Beverage	6	7	9	9	10	9	50	7	10
Finance and Insurance	5	5	5	5	6	6	32	8	7
Chemistry	5	4	5	6	6	5	31	9	10
Oil and Gas	4	4	4	4	4	4	24	10	6
Minerals not Met	3	3	3	3	3	3	18	11	3
Industrial Machinery	4	3	2	2	3	2	16	12	4
Software and Data	1	2	4	4	4	4	19	13	4
Paper And Cellulose	3	2	3	2	4	1	15	14	4
Food & Beverage Services	4	3	3	2	2	1	15	15	5
Agriculture and Fishing	2	2	2	2	2	2	12	16	4
Mining	4	2	2	2	1		11	17	4
Construction	1	1	1	1	1	1	6	18	1
TOTAL	**142**	**133**	**124**	**127**	**124**	**109**	**759**		**187**
Number of Observations Evaluated	**89**	**83**	**72**	**75**	**69**	**63**	**451**	**59,42%**	

Source: Elaborated by the author.

In Table 3, it is shown the distribution of the observations by sectors and years. The industries with more observations were selected for analysis, to provide robust analysis. Therefore, the sectors of Electric Energy, Transportation, Steel and Metallurgy, Textiles and Commerce were chosen, due to the number of companies in each of the sectors, providing a greater comparability of the companies, composing a sample of 451 firm-year observations, which corresponds to 59% of the total sample, as detailed in Table 3.

4 RESULTS

In this item, the results are shown in the tables 4, which show the descriptive statistics by sectors, such as Transport, Textile, Steel and Metallurgy, Energy and Commerce, all related to the studied period from 2010 to 2015, with 451 observations from 95 companies, as shown in Table 4.

Table 4 - Descriptive statistics of the complete sample and sectors

Sample consists of 451 observations (year-signatures) in the period from 2010 to 1015						
	Average	Standard deviation	Minimum	Medium	Maximum	Nº of Obs
Panel A: All Sector						
DIF_ETR	0,000	0,247	(0,44)	0,004	3,257	451
EFIC	0,904	0,156	0,214	1,000	1,000	451
SIZE	6,390	0,796	4,377	6,560	8,213	451
ENDIV	2,003	4,537	(13,73)	1,303	8,180	451
ROA	0,072	0,056	0,001	0,062	0,294	451
Panel B: Commerce Sector						
DIF_ETR	0,000	0,099	(0,23)	0,022	0,283	77
EFIC	0,989	0,031	0,828	1,000	1,000	77
SIZE	6,250	0,843	4,377	6,414	7,674	77
ENDIV	3,801	9,967	(13,73)	1,583	81,802	77
ROA	0,058	0,050	0,001	0,053	0,294	77
Panel C: Energy Sector						
DIF_ETR	0,000	0,110	(0,21)	(0,00)	0,293	170
EFIC	0,840	0,176	0,234	0,910	1,000	170
SIZE	6,756	0,658	4,674	6,840	8,213	170
ENDIV	1,701	1,120	0,076	1,546	8,286	170
ROA	0,073	0,049	0,002	0,064	0,233	170
Panel D: Metal and Sider. Sector						
DIF_ETR	0,000	0,097	(0,19)	0,004	0,407	71
EFIC	0,963	0,055	0,760	1,000	1,000	71
SIZE	6,026	1,011	4,547	5,742	7,801	71
ENDIV	1,573	3,253	(1,61)	0,863	24,496	71
ROA	0,053	0,042	0,001	0,043	0,236	71
Panel E: Textile Sector						
DIF_ETR	0,000	0,100	(0,19)	0,044	0,155	62
EFIC	0,900	0,181	0,396	1,000	1,000	62
SIZE	5,948	0,448	5,244	5,824	6,847	62
ENDIV	1,141	2,109	0,136	0,635	1,419	62
ROA	0,099	0,074	0,001	0,080	0,268	62
Panel F: Transportation Sector						
DIF_ETR	0,000	0,578	(0,44)	(0,04)	3,257	71
EFIC	0,909	0,166	0,214	1,000	1,000	71
SIZE	6,419	0,637	5,083	6,619	7,374	71
ENDIV	1,956	1,537	0,044	1,488	7,572	71
ROA	0,079	0,060	0,001	0,071	0,253	71

Note: DIF_ETR = Difference of ETR = Company ETR (it) - Average ETR of Sector (jt); EFIC = Normal Efficiency of the Company; SIZE = Company Size; ENDIV = Indebtedness of the Company; ROA = Return on assets; Number of Obs = Number of observations.
Source: Research Data, 2017.

The sample is made up of 451 observations of the companies, with the Commerce sector with 77 observations (17.07% of the sample). The Energy sector with 170 observations (37.69% of the sample). Metallurgy and Steel sector and the Transport sector, both with 71 observations (15.74% of the sample each) and, finally, the Textile sector with 62 observations (corresponding to 13.75% of the sample).

When considering the sample with all sectors, it is observed that the average of the DIF_ETR is zero, suggesting that the companies, on average, are practicing the same ETRs within their sectors. Although the ETR is not a variable explicitly used in the model, given its degree of importance in the perfect understanding of how the dependent variable DIF_ETR is distributed, it is highlighted in Table 5. It should be emphasized that among the average of the ETRs presented by the sectors, in terms of classification, only the Transport sector would have its classification as a less tax aggressive sector, since its average ETR is higher than 0.34. Nevertheless, these results have to be observed with caution, given that some firms' results may be explained the findings, such as the extreme value of 3.84 in the transports sector.One of the possibilities to explain this indicator would be the appropriation of accelerated depreciation due to the branch of activity, wear and tear of the assets and their replacements. For example, Law 12.788, which originated in provisional measure 578/2012, approved by the National Congress, in 2012, which allows the reduction of the income tax calculation base through the accelerated depreciation for the Freight transport sector. Dentro dessa visão, geraria uma diferença entre o lucro tributável e o lucro contábil, impactando a ETR. Within this view, it would generate a difference between the taxable profit and the accounting profit, affecting the ETR. According to Tang (2005), Wilkie (1992) points out that, one of the limitations of ETR is that it can be affected.

The other sectors would be classified as tax aggressive, because they had average indicators lower than 0.34.

Table 5 - Descriptive Statistics of the complete sample and sectors

Detalhe da amostra das ETR						
	Average	**Standard deviation**	**Minimum**	**Medium**	**Maximum**	**Nº of Obs**
All Sector	0,276	0,261	0,013	0,264	3,845	451
Commerce	0,262	0,101	0,013	0,287	0,586	77
Energy	0,272	0,111	0,081	0,266	0,561	170
Metal and Sider.	0,232	0,098	0,066	0,251	0,655	71
Textile	0,197	0,101	0,028	0,242	0,372	62
Transport	0,415	0,593	0,169	0,330	3,846	71

Note: Obs No. = Number of observations.
Source: Research Data, 2017.

By separating the sample by sectors, it is observed that, on average, companies in the Commerce sector are more efficient, while those in the Energy sector are the least efficient. Also noteworthy is the high standard deviation of DIF_ETR in the Transportation (0.578) and Energy (0.110) sectors, indicating that in the sample there are companies that practice several ETR rates, indicating different behaviors in relation to fiscal aggressiveness in this sector. In the energy sector, the median is very close to the average and indicates a distribution tending to normality (same distribution of the metallurgy and steel industry).

Regarding the ROA variable, the sector with the highest average ROA among the sectors is the Textile, with 9.9%. In turn, the steel and metallurgy sector have the lowest ROA, on average, among sectors, with an index of 5.3%. Note the variable ENDIV of the Commerce sector, which represents the indebtedness index. In the sample studied, this sector, on average, has twice as much indebtedness as the sector in the second position.

Regarding the SIZE indicator, which represents the size of the companies surveyed, among the analyzed sectors, the results suggest that, on average, the size of the companies in the sample is similar among the evaluated sectors, since the lowest SIZE was the Textile sector with 5,948, while the highest value was of 6,756, related to the Energy sector.

Table 6 - Spearman correlation of the complete sample and sectors

Sample consists of 451 observations (year-signatures) in the period from 2010 to 1015*p<0.05					
	Dif_ETR	EFIC	SIZE	ENDIV	ROA
Painel A: All Sectors					
Dif_ETR	1,000				
EFIC	-0,024	1,000			
SIZE	-0,021	-0,281*	1,000		
ENDIV	0,007	-0,072	0,537*	1,000	
ROA	-0,223*	0,153*	-0,243*	-0,420*	1,000
Panel B: Commerce Sector					
Dif_ETR	1,000				
EFIC	0,259*	1,000			
SIZE	-0,062	-0,157	1,000		
ENDIV	0,040	0,104	0,526*	1,000	
ROA	0,150	0,182	-0,391*	-0,389*	1,000
Panel C: Energy Sector					
Dif_ETR	1,000				
EFIC	-0,121	1,000			
SIZE	0,183*	-0,391*	1,000		
ENDIV	0,156*	0,009	0,323*	1,000	
ROA	-0,451*	0,246*	-0,285*	-0,367*	1,000
Panel D: Metal. And Sider. Sector					
Dif_ETR	1,000				
EFIC	-0,163	1,000			
SIZE	-0,398*	0,041	1,000		
ENDIV	-0,071	-0,226	0,432*	1,000	
ROA	-0,164	0,285*	-0,192	-0,419*	1,000
Panel E: Textile Sector					
Dif_ETR	1,000				
EFIC	0,236	1,000			
SIZE	-0,064	0,074	1,000		
ENDIV	-0,102	-0,317*	-0,108	1,000	
ROA	-0,132	0,236	0,294*	-0,523*	1,000
Panel F: Transport Sector					
Dif_ETR	1,000				
EFIC	-0,148	1,000			
SIZE	0,078	-0,139	1,000		
ENDIV	0,121	0,095	0,812*	1,000	
ROA	-0,318*	0,198	-0,482*	-0,619*	1,000

Nota: DIF_ETR = Diferença da ETR = ETR da Empresa (it) – ETR Média do Setor (jt); EFIC = Eficiência Normal da Empresa; SIZE = Tamanho da Empresa; ENDIV = Endividamento da Empresa; ROA = Retorno sobre ativos.]
Source: Research Data, 2017.

Considering the sample, we identified that the ROA is inversely correlated with the DIF_ETR suggesting that companies, by increasing their return on assets, tend to practice ETR according to their sector average. There is also a negative (positive) correlation between the SIZE (ROA) variable and the variable that measures the normal efficiency, EFIC. These results suggest, as expected, that, more profitable companies (higher ROA) are more efficient, confirming the results of Gomes (1999). However, unlike Sengupta (1998), the larger the size of the company, the lower its efficiency. One possible explanation for this is that there are companies in the sample whose investments have not yet had the expected return. In the matrix of correlation by sectors, attention is drawn to the Energy sector. We observed the distribution of the most well-behaved sample, verifying the significance in

the correlation of the dependent variable (DIF_ETR) with the independent SIZE, ENDIV and ROA considering the first two as positively correlated according to Zimmerman (1983) and the last negatively correlated according to Derashid and Zhang (2003).

4.1 Regression Results

In order to test the hypothesis that the normal efficiency measured by the DEA methodology explains the tax aggressiveness of the companies, it was estimated the regression using panel data with fixed effect of time (year) and individual (firm), robust to heteroscedasticity and serial correlation, using cluster by company. The variable of interest, Normal Efficiency, is significant by being responsible, on average, for the explanation of 3.7% of the total variation of DIF_ETR.

Table 7 - Results of data panel regression

Results of panel data regression (FE in i and t), robust (cluster in the company)
(t-statistic in parentheses)
***p<0.05 ; **p<0.01 ; ***p<0.001**

$$dif\_etr_{it} = \beta_0 + \beta_1 efic_{it} + \beta_2 size_{it} + \beta_3 endiv_{it} + \beta_4 roa_{it} + \varepsilon_{it}$$

Panel A: Full sample with all five sectors

	F-test = 56.43	
β0	0,175 (1,27)	
β1	**0,037** **(2,20)**	*
β2	- 0,031 (-1,37)	
β3	0,000 (1,28)	
β4	- 0,176 (-1,59)	
N	451	
R^2	0,150	

Panel B: Regression with the sample separated by sectors

	Commerce		*Energy*		*Metal and Siderur*		*Textile*		*Transport*	
	F-test = 3,180		F-test= 32,890		F-test = 1,84		F-test = 10,21		F-test = 5,46	
β0	0,273 (1,64)	**	- 0,215 (-3,37)	**	- 0,234 (-1,8)		- 0,654 (-5,99)	***	4,314 (3,17)	**
β1	0,089 (0,64)		**0,042** **(4,10)**	***	0,053 (1,18)		**- 0,009** **(-2,41)**	*	- 0,107 (-0,93)	
β2	- 0,058 (-3,06)	**	0,027 (2,77)	**	0,031 (1,29)		0,109 (5,91)	***	- 0,667 (-2,96)	*
β3	- 0,000 (-0,36)		0,002 (0,91)		- 0,000 (-0,69)		0,001 (0,95)		0,081 (3,47)	**
β4	0,058 (1,52)		- 0,089 (-3,2)	**	- 0,026 (-0,23)		0,109 (2,29)	*	- 1,165 (-2,25)	*
N	77		170		71		62		71	
R^2	0,192		0,226		0,534		0,534		0,161	

Note: DIF_ETR = Difference of ETR = Company ETR (it) - Average ETR of Sector (jt); EFIC = Normal Efficiency of the Company; SIZE = Company Size; ENDIV = Indebtedness of the Company; ROA = Return on assets; N = Number of observations.
Source: Research Data, 2017.

This result suggests that companies with high normal performance tend to practice ETR rates that are more distant from the sector average and thus stand out in their tax policy in a more

conservative way (higher RTE rates) and, therefore, less tax aggressive, following the studies of Baik et al. (2013), Demerjian et al. (2013), Park (2013) and Slemrod (2009). This result confirms our initial hypothesis (H0) which suggests that companies that are more efficient are less tax aggressive. The EFIC (normal efficiency) is a metric that makes sense when comparing companies with similar characteristics. Thus, in addition to analyzing the model with a complete sample of the 5 sectors, it is necessary, for a perfect understanding of the degree of explanation that this variable has in the level of ETR, to perform regressions considering only companies of the same sector.

When making regressions considering only companies from each sector, we observed that the EFIC variable is significant only in the Energy and Textile sectors. We identify significant results when analyzing the signal and magnitude of the EFIC estimator (B1) of these two sectors. In the Energy (Textile) sector, the coefficient is positive (negative) with a statistically relevant magnitude. Possible explanation is that because it is a highly regulated sector and with some state-owned companies, the efficient companies of the Energy Sector seeks a more conservative fiscal policy. Thus, it can be inferred that, on average, for the Energy sector, higher levels of efficiency imply lower levels of tax aggressiveness. It is also observed that practically all the positive variation of EFIC, when we estimate the model with the complete sample, is attributed only to the Energy sector. In the textile sector, the magnitude of the coefficient suggests that the most efficient companies adopt ETR, on average, slightly lower than the average of this sector (-0.9%) as a way of increasing profitability. In fact, we observed that the Spearman correlation between ROA and DIF_ETR is significant and negative for the Textile sector, corroborating with the regression results. It should also be noted that the SIZE variable was significant in all sectors, except for the Metallurgy and Steel sector, although in the complete sample there was no significance. For this variable, it can be seen in the Transport sector, as smaller companies, on average, are more tax aggressive than the industry average, confirming Martinez and Ramalho (2014), as mentioned by Lanis and Richardson (2007).

In the Metallurgy and Steel Industry sector, the efficiency variable is not statistically significant either, indicating that, on average, efficiency does not have an impact on tax aggressiveness. The metallurgy and steel industry was the only one where, no variable with significance level was identified in this study. The indebtedness was significant only in the Transportation sector and, on average, the sector that presented the highest ETR, therefore, was less tax aggressive. The Transportation sector is fairly regulated with companies participating in concessions from the governmental sphere. Thus, the result found, such as that of Watts and Zimmerman (1990), suggests that companies in this sector are, on average, more indebted and are the least aggressive, that is, they are the most conservative in their tax policy possibly by state regulation.

5. Conclusion

There is a growing interest in the issues associated with tax aggressiveness and tax avoidance in Brazil, and the theme has become even more prominent in recent years in view of a combination of political, economic and technological factors that have driven the focus of the public interest towards corporate decisions, especially those related to taxation according to Martinez (2017). This paper tries to offer a contribute in the literature of determinants of tax aggressiveness.

The present research identified that companies with greater efficiency, calculated using the DEA methodology, are, on average, less tax aggressive, considering the results of the regression with 451 observations (year-to-year), with 95 companies from five sectors (Electric Energy, Transport, Metallurgy and Steel, Textile and Commerce), in the period between 2010 and 2015. This result confirms the initial hypothesis of the research and is in line with the results of Baik et al. (2013), Demerjian et al. (2013), Park (2013) and Slemrod (2009).

It is demonstrated, therefore, that once they are efficient, within a complete strategic planning and a complete tax planning, the tax costs tend to have a less relevance, as the companies that are more tax aggressive suffer from their market value, according to Hanlon and Slemrod (2009).

When the efficiency score is observed, the most efficient companies are able to optimize their strategic and tax planning, maximizing the net operating income (output), in relation to their costs and investments, such as the cost of the merchandise sold, sales strategies, acquisition of assets, its operational and administrative processes (inputs), aiming, to an increase of the value of the company and consequently to an increase of wealth to its owners, according to Perez and Martins (2005).

By separating the sample by sectors, we observed that the efficiency variable is significant only for companies in the Energy and Textiles sectors. However, in the first, the coefficient of the estimator is positive with a relevant magnitude. For the second, the coefficient is negative. It is also observed that practically all the positive efficiency variation (EFIC variable), when we estimate the model with the complete sample, is attributed only to the Energy sector. One possible explanation is that it owns some state-owned companies and is a sector with strong government regulation. Thus, the most efficient companies tend to maintain their level of tax payment.

Our results suggest that companies' ability to efficiently utilize firm resources has an economically significant impact on corporate tax avoidance. We believe contribute to the tax literature by identifying a new and economically significant determinant of tax aggressiveness.

Another relevant issue the paper, as it broadens the framework for measuring efficiency through the DEA methodology and its relationship with the tax avoidance in Brazil, important question to users, regulators and tax authorities. The present research is unprecedented in the object of study and in the use of the DEA tool for taxation purposes. Brazil, due to its economy, still emerging and having a fertile field for new enterprises in the most varied sectors, arouses interest of foreign and national investors.

With limitation to this research it is important to highlight the use of a non-probabilistic sample, limited to only four major sectors in terms of obsevations. In addition, there is a limitation in the variables and constructs employed, such as the metric of relative fiscal aggressiveness in the sector.The research on the DEA and tax avoidance can be continued to advance and deepen in future researches, identifying a correlation now no longer to efficiency and tax avoidance, but rather if managerial ability is related to tax aggressiveness. The following research questions can then arise: Is it possible for managerial ability to influence tax avoidance in companies? Are companies less or more tax aggressive depending on their manager?

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