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Social Efficiency of For-profit Organizations in Brazil: An Empirical Analysis

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Abstract This study proposes and validates a social efficiency indicator for profit-seeking organizations and applies it to assess the social efficiency of companies in Brazil. The study is quantitative and contains two samples: one of 87 large companies and one of 33 small and medium enterprises. The data received quantitative treatment using parametric techniques. Efficiency was analyzed using DEA Online Software. The proposed degree of social efficiency indicator is positively and significantly related to the social efficiency calculated using the DEA method. The conclusions also show that companies tend to resort to automation (or the incorporation of technology) to become more productive, resulting in higher productivity, more profit, more taxes and fewer jobs. The reduction in the number of jobs could rapidly lead our society to a situation in which "certain neighborhoods could become isolated, with unnecessary and unqualified people in potential conflict and leading a marginal existence". This state of poverty would inevitably lead to environmental degradation.

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1 Introduction

The present study is concerned with the social efficiency of profitable organizations in Brazil and the possible developments of this efficiency. Although it is quite common to think of efficiency as a synonym for higher revenue for each unit invested (Sachs 2003), this is merely one of several very important connotations (Kuttner 1998). The concept of technical efficiency in relation to the performance of an organization is especially interesting, showing the capacity of the organization to transform input into output or products (Surco 2004). In this sense, efficiency is expressed by the relationship between the product and its inputs, measured in physical units of the output compared with the physical units of the inputs (Miller 1981). In other words, the measure of efficiency is relative and is calculated by comparing input and output.

The social efficiency indicators in the literature, such as the words of Graves and Waddock (1994), Turban and Greening (1996) and Chen and Delmas (2012), cannot be fully considered as being able to measure "social efficiency" as such because they do not have a way of relating the two variables, with output firmly linked to benefits for society.

Therefore, the objective of this study is to propose and validate a social efficiency indicator for profit-seeking organizations, applying the indicator to assess the social efficiency of these organizations in Brazil and discussing some of its implications. The subject is important for two particular reasons: there is an ongoing and somewhat heated debate regarding the concept, judging by the opinions of Scheer (2010), Svirina (2012), Ueda and Moffatt (2013) and Miller (2014); and the developments of the concept in question are related to topics that have recently featured in the media, especially unemployment and job loss, rising poverty levels and environmental degradation.

Regarding job losses, the following points deserve to be mentioned: (1) according to Amaral et al. (2013), "Brazil is one of the 30 countries with the highest rate of taxation in the world, but continues to offer the worst services to the population in terms of healthcare, education, transport, safety, sanitation, paved roads and other services"; (2) Vassallo (2014), in an article entitled "Technology will reap jobs", mentioned Bill Gates, the founder of Microsoft, who recently declared that the automation of the economy will eliminate millions of jobs, especially in developed countries, in the next 20 years: machines will replace waiters, drivers and nurses. This will happen quickly and will create social upheavals, but the problem has been neglected by most governments. Vassallo (2014) also noted that in a study Frey and Osborne (2013) argued that 47 % of today's jobs could be automated in the next two decades. The people who will be most quickly affected will be telemarketing operators, auditors, salespeople and real estate agents.

The loss of jobs leads to increased poverty. This issue, which "has been neglected by most governments", is a matter that needs to be reconsidered for governments to avoid facing what Becerra (2009, p. 100) calls the "subsidized subsistence that enables survival with the bare minimum, which would be considered unimaginable and intolerable today, for citizens of developed countries and to avoid people actively seeking alternatives, i.e., being responsible for their own existence". According to Becerra (p.116), the surplus of workers, especially people with medium, low and unskilled levels of qualification, could

end up requiring a "regulatory dynamic and a dynamic of delimitation" which could lead to

> certain neighborhoods becoming isolated, with unnecessary and unqualified people in potential conflict and leading a marginal existence. A policy along these lines could garner considerable support due to social protests. Otherwise, if the situation becomes serious for months, in some areas this could lead to urban guerrilla warfare.

Downsizing the number of employees in modern companies and the end of jobs and labor, as shown by Rifkin (1995) and Sejersted (1997), is an ongoing phenomenon that ought to be widely debated, even by governments that are anticipating its foreseeable effects. In this sense, the present study intends to make a contribution, albeit an incipient one, to the theme to encourage greater focus on this debate.

Finally, it is worth noting that there are numerous studies that have recorded unfavorable conditions for life and the environment, such as those of Boyce (1994), Leach and Mearns (1995), Duraiappah (1996) and Dale and Beyeler (2001). Tang (1998) and Hayes and Nadkarni (2001) claim that environmental degradation occurs in both developed and developing countries, with Brazil being an example of the latter.

The article is divided into four sections. Following this introduction, the second part examines the theoretical framework in which the main concepts concerning the proposed indicator are discussed. In this section, the hypotheses that guide the study are also introduced. The third part looks at the research method: type of research, samples, procedures and variables, handling of the data and limitations of the study. The fourth part shows the results, conclusions and implications.

2 Social Efficiency

The concept of social efficiency in a for-profit organization is not a pacific concept: it is a complex construct and, according to Costa and Castanhar (2003), there is a conceptual entanglement. The concepts that have been presented include cross comparisons of social indicators concerning social expenditure that have been used to measure and explain "social efficiency" as being analogous to "technical efficiency in production" (Ravallion 2003).

Although it is recognized that social efficiency only makes sense when applied to a whole or part of a social, economic, political and cultural system, it cannot be treated as an abstract theory without careful consideration of real aspects related to social issues (Lefeber and Vietorisz 2007). Thus, social efficiency would be "a construct that emphasizes a company's responsibilities to multiple stakeholders, such as employees and the community at large, in addition to its traditional responsibilities to economic shareholders" (Turban and Greening 1996, p. 658).

Authors such as Aupperle (1984), Wolfe (1991) and Zahra et al. (1993) used the concept in a more diverse way: they measured the social performance of organizations using research questionnaires, analyses of annual reports, specialist evaluations and data from regulatory agencies. However, each author introduces the concept in a specific and limited way. Other forms of measurement are also used, such as the social efficiency indicators of profit-seeking organizations, including indexes related to jobs, the diversity of employees, whether the company forms close ties with the community, human rights, the relationship of the organization with the environment and corporate governance (Graves and Waddock

1994; Turban and Greening 1996; Waddock et al. 2002). Other examples may be given: Gutiérrez-nieto et al. (2009), in a study of 430 micro financial institutions, took the number of current account holders into consideration, in addition to the cost of operations, the number of employees and other indicators.

Given the diversity of a wide-ranging social efficiency indicator for profit-seeking organizations and the fact that this diversity does not come close to containing an indicator that is logical, widely applicable and easy to obtain, this study proposes one with these characteristics. The logic behind the construction of this social efficiency indicator harks back to Goldratt and Cox (1997), to whom a company is a money-making machine. If, in the eye of the owner of the capital, a company is a machine that pays dividends, to customers, the company is a machine that makes products, and to society, represented by the State, the company is a machine that pays taxes. Therefore, the output in the construction of a social efficiency indicator can be defined as tax and taxation.

A for-profit organization can be viewed as a "machine" that makes products, wages and tax (Fig. 1). Customers pay for products and services, and this constitutes the revenue from the sales of the organization. Society, represented by State agencies, collects all kinds of taxes and, in accordance with Madison (1906), quoted by Hunt (1906), responds with social organization and control, as it has a legitimate monopoly on the use of force and coercion. The workers supply the labor (both intellectual and physical) and receive wages, salaries and benefits. The owners of the capital receive profits and interest on the capital represented by the degree of technological incorporation (DTI).

In this context, society, represented by the agencies of the State, is interested in how much it receives in taxation. The production of the organization, when it comes to taxation, is expressed by Taxes Paid per Year. The productivity of the organization is expressed by Taxes per Employee per Year.

Concerning efficiency, this study proposes an indicator called the degree of social efficiency (DSE). This indicator, together with the productivity indicator mentioned above,

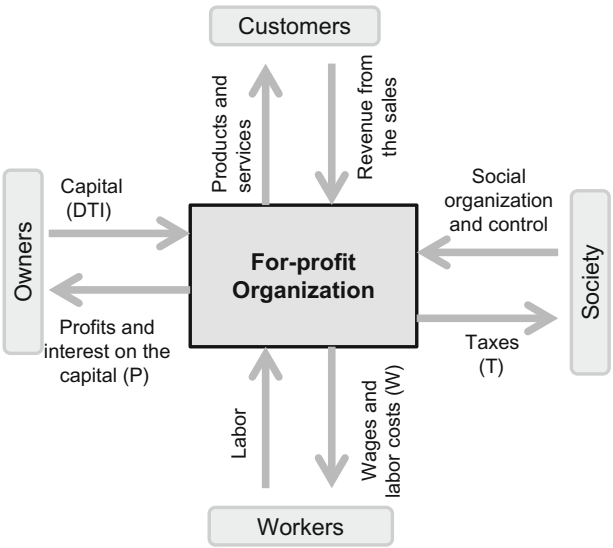

Fig. 1 For-profit organization as a "machine" that makes products, wages, profits and taxes

expresses how much a for-profit organization pays in tax for each monetary unit invested in wages during a given period of time and is calculated in the form of an oscillator $DSE = \frac{2T}{T+W}$ that takes two variables into account: the amount of tax (T) and the amount paid in wages (W).

The DTI works like a proxy variable of the Capital, meaning the degree of capital incorporated into the production process. Fundamentally, with the incorporation of technology, an effort is made to improve internal workings, i.e., raise productivity, especially in the field of production. This statement by Meireles et al. (2008) gives rise to Hypothesis Ha:

Ha There is a positive and significant association between the DTI of an organization and its productivity measured by the added value per employee (AVPE).

The added value, according to Bruno (1978), corresponds to the output of the organization and the sum of wages and labor costs and taxable interest on capital.

Theoretically, a company that does not incorporate technology, with wages being totally responsible for its added value, i.e., with $P_W = 1$, has null DTI; likewise, a company with a high degree of automated technology, with negligible wages in relation to added value, has unitary DTI. If an organization is highly efficient, then it must have high output levels, which can be linked to a higher volume of tax. This leads to the formulation of the second hypothesis:

Hb There is a positive and significant association between the AVPE and the amount of tax per employee (T_{PE}).

The studies conducted by Frey and Osborne (2013) on types of jobs and an estimation of how likely they are to be automated in the coming decades suggests that the DTI differs from one economic sector to another, which leads to the formulation of Hypothesis Hc:

Hc There is a positive and significant association between the DTI of an economic sector and its productivity measured by AVPE.

Observing the confirmation of Hypotheses Ha and Hb, another hypothesis resulting from these can be tested:

Hd There is a significant difference in the productivity of different economic sectors measured by the variable AVPE.

The DSE indicator is an efficiency indicator and, in accordance with Pindyck and Rubinfeld (1994), efficiency occurs as the result of the maximum exploitation of existing resources to meet the needs and desires of individuals and organizations. Geometrically, Kumbhakar and Lovell (2003) define efficiency in terms of the distance from a production frontier, which requires the use of mathematical modeling as a way of making such a concept concrete. One way of measuring efficiency is by using data envelopment analysis (DEA), a non-parametric mathematical programing technique, the foundations of which are found in Charnes et al. (1997). It is widely used in the literature to assess the efficiency of companies (Cooper et al. 2000) and the concept of benchmarking is used for the purpose of supplying a relative form of efficiency (Bogan and English 1997).

There are two classic DEA models with guidelines for output and input: the CRS (Constant Returns to Scale), developed by Charnes et al. (1978); and the VRS (Variable Returns to Scale), which is non-proportional and was developed by Banker et al. (1984). To incorporate the possibility of variable returns to scale, Banker et al. (1984) proposed the

VRS model from the DEA, introducing a restriction of connectivity in the CRS model. The VRS is less restrictive than the CRS and, according to Banker and Thrall (1992), makes it possible to break down technical efficiency into efficiency of scale and "pure" technical efficiency.

According to Zhu (2003), the DEA models have two paths for arriving at the efficiency frontier: one for input and one for output. It is input-oriented when the aim is to minimize the resources available without altering production levels. It is output-oriented when the intention is to increase the quantity produced without interfering in the amounts of resources that are used.

To calculate efficiency using the DEA method, it is necessary to have data on the input and output of each company designated by Decision Making Unit (DMU). In the literature on DEA, the term DMU is used for the reference units in efficiency analysis, which include companies, processes and people (Castelli et al. 2004).

If greater productivity can be linked to the DTI, then two phenomena should be observed: capitalists seek to incorporate technology, increasing the DTI and the for-profit organization should also be more efficient in generating taxes, leading to the following hypotheses:

He There is a significant difference between the DTI in 1998 and the DTI in 2012 in companies that are seen as the largest in the *Exame Magazine* Biggest and Best Index (editions for 1999 and 2013) and

Hf There is a positive and significant association between the DTI of a for-profit organization and its DSE.

If the proposed DSE model is adequate, i.e., it expresses the efficiency of an organization from the viewpoint of society, then there should be considerable congruence between it and the efficiency determined by the profits, thus enabling the formulation of the following hypothesis:

Hg There is a positive and significant association between the DSE and company profits.

This study also includes small and medium-size for-profit firms for the purpose of comparison. According to Raymond and St-Pierre (2013), small and medium enterprises suffer from a range of limiting factors, such as financial limitations and less information and experience in management. As a result, they are more vulnerable to environmental changes, which hinder their expansion and internationalization. This finding leads to a further two hypotheses. The first is that due to the lack of resources, technical incorporation in small and medium-size companies occurs on a smaller scale as

Hh There is a significant difference between large companies and small and medium enterprises in terms of DTI

The other hypothesis is that due to the difference in the incorporation of technology, social efficiency should also be affected as it may be assumed that

Hi There is a significant difference between large companies and small and medium enterprises in terms of social efficiency evaluated by the DSE.

Having outlined the hypotheses, we will now move on to the following section for a description of the method.

3 Methods

3.1 Type of Study

The study is quantitative and based on secondary data extracted from the 2013 edition of *Exame* Magazine Biggest and Best (Revista Exame Melhores and Maiores de 2013) (500 M&M), based on the balance sheets that were finalized on 31 December, 2012.

3.2 Samples

The analysis contained two samples. Sample 1 included large companies on the Biggest Seller lists of the 500 M&M. This sample, with balance sheets for 2012, was restricted to the 87 largest companies with sufficient and adequate information for calculating the variables of the present study. These companies are all included in the top 200. Companies were not considered for the study in cases when there was: (a) no information on added value; (b) negative added value and (c) negative equity. Sample 2 included 33 small and medium-sized companies. These financial reports were also for 2012 and the companies are soundly structured, with adequate accounting performed by accounting firms in the regions of Jundiaí and Campinas in São Paulo State.

3.3 Procedures

The data for determining the variables mentioned below were tabulated taking into account the sector in which each company operates. The companies were grouped by sector: agribusiness, wholesale, consumer goods, construction, energy, cellulose and paper, chemicals, services, steelworks, telecommunications and retail.

3.4 Variables

The variables that were collected are the name of the company, sector, net assets, number of employees (Q), wealth created per employee AVPE, wages and labor costs (W) and taxes collected (T). Other variables include:

V: added value or wealth created by the organization. The added value created by the company as a whole generally constitutes wages and salaries, tax and profits (Bruno 1978). Cassing (1996) claims that added value is the difference between the output value and the cost of materials or intermediate inputs. When the added value of all industries is calculated, it is equal to gross national product.

P_W: share of labor in added value V: consists of the share of wages and labor costs in relation to added value: $P_W = W/V$.

P_K: share of capital in added value (V): consists of the complement of P_W to 1. The assumption is that the two macro factors for the generation of taxes are the capital and labor. Thus, $P_K = 1 - P_W$.

DTI: degree of technological incorporation is calculated in accordance with Meireles et al. (2008) as: $DTI = \left(\frac{2}{(1+Pw)}\right) - 1$ or $DTI = \frac{V-W}{V+W}$ where V is added value and W represents wages and labor costs.

DSE: degree of social efficiency, expressing how much tax is generated by a for-profit organization per monetary unit invested in wages during a given period, and is calculated in the form of a stochastic oscillator: $DSE = \frac{2T}{T+W}$ where T represents the total taxes paid by

Table 1 Extract from Sample 1 (large companies)

Large companies	Sector	Wages	Taxes	Profits	(V) Added value	AVPE	T_{PE}	P_W	DTI	DSE	BCC
BR Distribuidora	Wholesale	483.6	7588.5	925.4	8995.0	2000.0	1690.1	0.05	0.90	1.88	1.00
Ipiranga Produtos	Wholesale	154.8	308.8	379.7	893.4	413.8	139.0	0.17	0.70	1.33	1.00
Ale	Wholesale	49.2	39.9	14.6	170.0	151.4	34.4	0.29	0.55	0.90	0.99
Sotreq	Wholesale	96.4	237.2	83.6	455.5	110.0	56.0	0.21	0.65	1.42	1.00
Grupo Martins	Wholesale	74.5	295.5	24.1	440.0	92.3	61.4	0.17	0.71	1.60	1.00
Profarma	Wholesale	47.9	136.3	19.9	205.2	78.5	50.4	0.23	0.62	1.48	1.00
Cargill	Consumer goods	252.8	507.1	197.8	1549.1	218.8	70.3	0.16	0.72	1.33	1.00
BRF	Consumer goods	905.5	714.8	398.0	1783.5	31.8	13.2	0.51	0.33	0.88	0.99
Ambev	Consumer goods	596.5	3944.1	5142.2	6345.2	310.8	208.6	0.09	0.83	1.74	1.00
Natura	Consumer goods	49.6	691.5	421.4	1307.5	192.7	103.5	0.04	0.93	1.87	1.00
Souza Cruz	Consumer goods	364.5	4656.3	802.9	5810.9	785.3	629.2	0.06	0.88	1.85	1.00
Marfrig	Consumer goods	147.5	260.8	−109.6	956.7	89.0	25.0	0.15	0.73	1.28	1.00
Hypermarcas	Consumer goods	244.8	176.8	99.8	795.3	142.5	29.1	0.31	0.53	0.84	0.99
Brasil Kirin-Itu	Consumer goods	187.5	605.1	64.9	880.1	165.0	102.0	0.21	0.65	1.53	1.00
M. Dias Branco	Consumer goods	163.7	146.1	229.2	535.1	54.3	11.6	0.31	0.53	0.94	0.99
Votorantim Cimentos	Construction	277.0	847.8	791.2	2159.1	294.0	109.9	0.13	0.77	1.51	0.99
Camargo Corrêa	Construction	905.9	182.9	97.8	1302.0	64.3	10.6	0.70	0.18	0.34	0.99
Andrade Gutierrez	Construction	731.2	166.7	59.9	1050.6	80.8	12.3	0.70	0.18	0.37	0.99
Construtora OAS	Construction	545.4	197.0	55.5	935.0	17.1	3.0	0.58	0.26	0.53	1.00
Queiroz Galvão	Construction	520.2	166.8	76.3	812.2	51.3	10.2	0.64	0.22	0.49	0.99
Duratex	Construction	242.5	289.1	224.7	759.1	71.4	27.3	0.32	0.52	1.09	0.99
Galvão	Construction	398.9	146.1	64.9	721.0	104.6	17.7	0.55	0.29	0.54	1.00
UTC Engenharia	Construction	374.7	229.1	64.7	631.6	50.9	14.4	0.59	0.26	0.76	0.99
MRV	Construction	139.2	108.6	258.2	483.2	46.3	10.2	0.29	0.55	0.88	0.99
AES Eletropaulo	Energy	235.6	2482.0	52.8	2882.8	499.6	422.7	0.08	0.85	1.83	1.00
Cemig Distribuição	Energy	382.1	2300.2	93.6	3109.5	475.1	358.6	0.12	0.78	1.72	1.00

Table 1 continued

Large companies	Sector	Wages	Taxes	Profits	(V) Added value	AVPE	T_{PE}	P_W	DTI	DSE	BCC
Light Sesa	Energy	96.8	1938.4	141.4	2469.8	629.9	490.1	0.04	0.92	1.90	1.00
CPFL Paulista	Energy	141.1	1420.9	225.2	1816.2	623.1	490.1	0.08	0.86	1.82	0.99
Copel	Energy	360.3	1900.1	−21.2	2310.7	325.4	265.0	0.16	0.73	1.68	1.00
Coelba	Energy	98.2	1083.9	394.2	1649.8	653.5	430.8	0.06	0.89	1.83	0.99
Eletronorte	Energy	554.8	671.3	−361.5	1389.9	367.1	178.7	0.40	0.43	1.10	0.99
Celesc	Energy	183.1	1320.0	−66.4	1539.6	430.1	374.5	0.12	0.79	1.76	1.00
Ampla	Energy	67.6	1075.3	241.1	1372.9	1181.0	944.9	0.05	0.91	1.88	0.99
Elektro	Energy	112.2	881.6	175.0	1174.7	311.2	240.2	0.10	0.83	1.77	0.98
Celpe	Energy	72.8	683.9	7.4	793.8	473.2	403.7	0.09	0.83	1.81	1.00
Tractebel	Energy	101.7	565.9	733.8	1335.7	1233.3	523.0	0.08	0.86	1.70	0.98
Cesp	Energy	111.3	501.6	72.4	1196.6	915.9	391.0	0.09	0.83	1.64	1.00
Coelce	Energy	58.2	691.5	205.5	952.0	745.8	555.9	0.06	0.88	1.84	1.00
Liquigás	Energy	135.6	96.1	22.0	285.6	87.8	29.3	0.47	0.36	0.83	1.00
CEG	Energy	41.4	182.4	142.1	389.2	861.1	393.1	0.11	0.81	1.63	0.99
RGE	Energy	42.6	611.0	156.5	819.9	540.3	392.7	0.05	0.90	1.87	1.00
Celg D	Energy	160.5	977.3	390.5	1187.9	576.2	506.6	0.14	0.76	1.72	1.00
CPFL Piratininga	Energy	51.6	700.7	75.3	833.5	784.1	668.6	0.06	0.88	1.86	1.00
Bandeirante	Energy	40.2	784.4	39.6	892.2	781.6	664.2	0.05	0.91	1.90	1.00
E.C.T	Services	3404.9	1288.5	510.9	5152.1	44.0	10.9	0.66	0.20	0.55	1.00
Cielo	Services	80.5	903.7	1132.7	1752.7	2006.5	1013.1	0.05	0.91	1.84	0.99
Infraero	Services	728.7	169.5	52.7	1165.2	83.5	12.0	0.63	0.23	0.38	0.99
Copasa MG	Services	377.1	270.4	283.3	967.5	83.6	23.3	0.39	0.44	0.84	0.99
Cedae	Services	270.4	394.3	79.8	889.3	130.3	58.4	0.30	0.53	1.19	1.00
ArcelorMittal	Steelworks	542.0	1044.6	−468.6	1744.6	205.5	124.3	0.31	0.53	1.32	1.00
Usiminas	Steelworks	607.7	453.1	−313.0	755.3	52.5	32.8	0.80	0.11	0.85	1.00
Paranapanema	Steelworks	101.6	328.6	−101.0	366.7	164.1	147.7	0.28	0.57	1.53	1.00

Table 1 continued

Large companies	Sector	Wages	Taxes	Profits	(V) Added value	AVPE	T_{PE}	P_W	DTI	DSE	BCC
CBMM	Steelworks	113.4	511.8	711.6	1545.1	865.3	268.4	0.07	0.86	1.64	1.00
CBA	Steelworks	227.9	289.0	−324.6	396.5	71.5	52.4	0.57	0.27	1.12	1.00
Alcoa	Steelworks	213.6	277.3	−43.2	485.7	139.3	80.9	0.44	0.39	1.13	1.00
Aperam	Steelworks	87.5	93.0	−30.8	251.1	107.3	42.3	0.35	0.48	1.03	0.99
Pão de Açúcar	Retail sector	740.1	428.1	514.4	1998.1	33.5	7.0	0.37	0.46	0.73	0.99
Magazine Luiza	Retail sector	326.3	264.9	−3.3	834.7	36.7	10.5	0.39	0.44	0.90	0.99
Ponto Frio	Retail sector	163.3	154.7	156.9	527.1	47.4	14.2	0.31	0.53	0.97	0.99
Renner	Retail sector	217.1	502.4	173.9	1028.0	72.9	33.8	0.21	0.65	1.40	1.00
Casas Pernambucana	Retail sector	310.2	357.0	83.5	696.0	41.9	21.5	0.45	0.38	1.07	0.99
Pague Menos	Retail sector	184.6	50.7	52.5	326.8	22.8	3.3	0.56	0.28	0.43	1.00
Raia Drogasil	Retail sector	154.2	195.4	51.3	468.3	33.0	9.7	0.33	0.50	1.12	1.00
Ultragaz	Retail sector	133.6	38.7	20.9	236.1	63.4	9.8	0.57	0.28	0.45	0.99
Lojas Riachuelo	Retail sector	244.5	288.7	57.4	604.8	33.8	15.1	0.40	0.42	1.08	1.00

Large companies name of the company, *Sector* economic sector, *Wages* total wages and salaries paid in the year, *Taxes* total taxes paid in the year, *Profits* profit earned in the year, *Added value* added value, *AVPE* added value per employee, *TPE* tax per employee, *SL* share of labor in added value, *DTI* degree of technological incorporation, *DSE* degree of social efficiency, *CRS* efficiency of DEA considering BCC model

the company and W wages and labor costs. The formula follows the proposal of Wilder (1981) and generates a number >1 for organizations in which the total of taxes paid is higher than the total of wages paid in a given period of time. The social production of the organization in this context is expressed by Taxes per year and productivity is expressed as Taxes per Employee per year.

T_{PE}: tax per employee. $T_{PE} = T/Q$.

3.5 Data Treatment

The variables that did not conform adequately to the normal distribution (as measured by the Anderson–Darling test) were analyzed using three non-parametric tests such as Spearman's rank correlation coefficient, the Kruskal–Wallis test and the median test. The tests were performed using Minitab and BioEstat software.

Efficiency was analyzed using DEA Online Software, available at https://www.deaos.com. The model that was used was BCC model with orientation for products. Hollingsworth and Smith (2003) suggested that ratios may be used as inputs and outputs in DEA, if the nature of data availability is mostly ratios or the ratios reflect the underlying production function accurately rather than absolute values. They prove that in the presence of ratio variables, use of the standard CCR model with the CRS assumption is technically incorrect, and should be rejected in favour of the BCC model. They argue that this advantage of DEA is due to its VRS assumption. The present study uses following ratios: input 1 = P_W related to the labor factor; input 2 = DTI related to capital; and output = DSE, related to social efficiency. DEA is a non-parametric technique and makes no assumptions about the form of the production technology or function and designates each element as an object of treatment of a DMU, with each DMU representing a for-profit organization.

To stratify certain variables, the Nihans Index was used. This is a classifier of elements that is capable of dividing a set of numerical values into a number of subsets, especially classes A and non-A. The Nihans Index is calculated using the following formula: $N_A = \frac{\sum x^2}{\sum x}$. The value of N_A corresponds to the "cutoff" that divides the collection of elements x into classes A and non-A, the latter commonly referred to as class B.

3.6 Limitations of the Method and Difficulties of This Study

The present study deals with secondary data from financial reports published by the organizations in question that were adequately groups in the 500 M&M list. Even assuming that the data express reality, it is still necessary to approach them with caution as they may contain some form of bias or diverge from reality. As it is difficult to investigate these factors, they were not taken into consideration. There are also caveats regarding the financial statements of the small and medium-sized companies. Although the data were collected with the aid of accounting firms, who ensured that the companies had an adequate financial and accounting structure, and the values reflected the facts, none of the companies in question had been subjected to external auditing.

4 Results and Discussion

In this section, the tested and descriptive statistics of the hypotheses are presented. Table 1 shows an extract of the tabulation of the companies from Sample 1. This table includes the companies from the wholesale, consumer goods, construction, energy, services, steelworks

Table 2 Wages, tax, profits and added values of Samples 1 and 2

Variable	N	Mean	SE Mean	SD	Minimum	Median	Maximum
Wages	87	430.6	99.8	931.2	40.2	227.9	7950.3
Taxes	87	1234	457	4262	32	357	38874
Profits	87	449	144	1342	−469	141	10225
V	87	2363	812	7574	170	968	69497
Wages s	33	5.367	0.990	5.685	0.800	2.700	21.100
Taxes s	33	5.798	0.878	5.044	0.860	3.500	19.600
Profits s	33	2.564	0.712	4.091	0.203	1.531	23.000
V s	33	13.73	2.14	12.30	2.31	9.02	44.00

The s index indicates that the variable refers to small and medium size companies

Variable name of variable, *N* sample size, *Mean* mean, *SE Mean* sample error, *SD* standard deviation, *Minimum* minimum observed, *Median* median, *Maximum* maximum observed

and retail sectors. The companies from the agribusiness, cellulose and paper, chemicals and telecommunications sectors are not shown in Table 1 as they are fewer in number. Weg Equipamentos, Casa da Moeda, Embraer and Petrobrás are part of this sample, but given their specific details, they were not included in any of the sectors in question. The values of the wages, taxes, profits and added values are given in millions of dollars.

Table 2 shows descriptive statistics of the wages, taxes, profit and added value variables of Samples 1 and 2. The total mean value of the salaries of the large companies (Sample 1) is 80 times the total mean of the small and medium-sized companies in Sample 2. The rate is over 200 times higher when the taxes collected are taken into account.

Table 3 shows the descriptive statistics of the share of wages (P_W), taxes (P_T) and profits (P_K) in the added value (V) of the large and small and medium-size companies. The share of taxes in added value of both samples is similar: 45.66 and 42.70 %.

The mean share of profits in the added value of the small and medium enterprises (0.1936) is higher than the mean share of the profits of the large companies (0.1547). However, these values do not necessarily mean a better performance on the part of the owners of the companies, given that the profits in added value refer to the remuneration from capital, and this could belong to third parties (such as banks and other financial institutions).

Table 3 Share of wages, taxes and profits in added value

Variable	N	Mean	SE Mean	SD	Minimum	Median	Maximum
Pw	87	0.2879	0.0220	0.2054	0.0379	0.2510	0.8046
Pk	87	0.1547	0.0258	0.2405	−0.8187	0.1255	0.8104
PT	87	0.4566	0.0252	0.2354	0.0865	0.4173	0.8961
Pws	33	0.3794	0.0205	0.1175	0.1022	0.3992	0.5411
Pks	33	0.1936	0.0230	0.1319	0.0438	0.1479	0.5231
PTs	33	0.4270	0.0109	0.0626	0.3016	0.4436	0.5562

The s index indicates that the variable refers to small and medium-sized companies

Variable name of variable, *N* sample size, *Mean* mean, *SE Mean* sample error, *SD* standard deviation, *Minimum* minimum observed, *Median* median, *Maximum* maximum observed

4.1 Testing the Hypotheses

The hypotheses outlined above are now tested. The first hypothesis is that there is a positive and significant association between the DTI of an organization and its productivity measured by the AVPE. The Spearman correlation coefficient (r_s) was calculated: 0.8373 with t = 12.1557 and p value <0.0001. Figure 2 shows the plotted values of the DTI and AVPE variables. Hypothesis Ha was not rejected.

Hypothesis Hb states that there is a positive and significant association between the AVPE and the value of tax per employee (T_{PE}). This hypothesis is also not rejected. Spearman's rank correlation coefficient (r_s) was calculated, obtaining the following values: 0.9505 with t = 24.2803 and p value <0.0001. Figure 3 shows the plotted values of the AVPE and T_{PE} variables.

Hypothesis Hc states that there is a positive and significant association between the DTI of an economic sector and its productivity as measured by the AVPE. Table 4 shows, for each sector, the respective median values of AVPE and DTI. Spearman's rank correlation coefficient (r_s) was calculated, with the following values obtained: 0.8469 with t = 3.5610 and p value = 0.0162. Hypothesis Hc was not rejected and it can be said that there is a positive and significant association between the DTI of an economic sector and its productivity as measured by the AVPE (Fig. 4).

Hypothesis Hd states that there is a significant difference in terms of productivity in the different economic sectors as measured by the AVPE variable. This means that not all the sectors are equally productive. The Kruskal–Wallis test identified a significant difference in terms of productivity between the economic sectors with the following results: H = 31.7168 and $p < 0.0001$. Table 5 shows the AVPE variable of the sectors, stratified in accordance with Nihans into two classes designated A and B. The class A sectors in AVPE are energy, wholesale and services, and the class B sectors are consumer goods, steelworks, retail and construction. The median test shows that there is a significant difference between the values of the two classes, with a p value = 0.05. Hypothesis Hd is thus not rejected: the productivity of sectors such as energy, wholesale and services (measured by AVPE) is

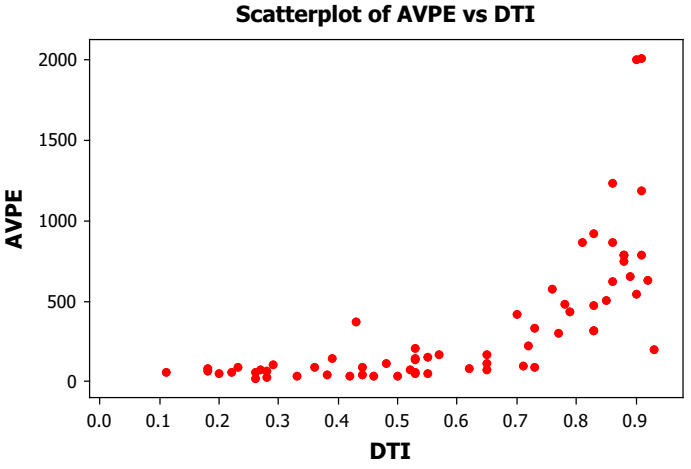

Fig. 2 Plotted values of degree of technological incorporation (DTI) and added value per employee (AVPE) variables

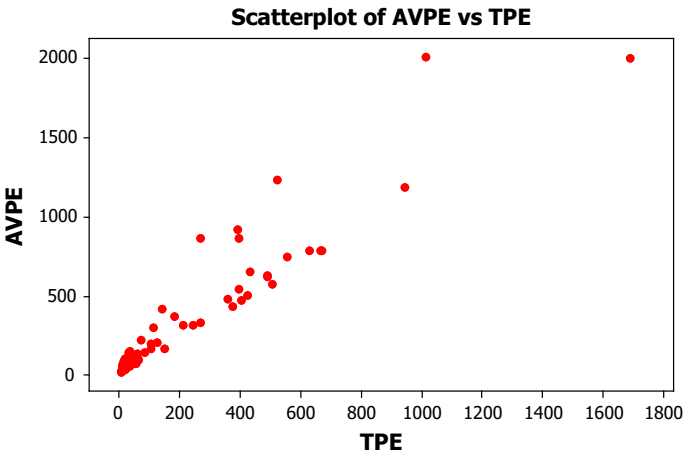

Fig. 3 Plotted values of taxes per employee (TPE) and added value per employee (AVPE) variables

Table 4 Medium values of AVPE and DTI according to sector

Sector	n	av.AVPE	av.DTI
Wholesale	6	474.33	0.69
Consumer goods	9	221.13	0.68
Construction	9	86.74	0.36
Energy	20	624.77	0.80
Services	5	469.58	0.46
Steelworks	7	229.36	0.46
Retail sector	9	42.82	0.44

Sector economic sector, *n* number of companies analyzed in the sector *av.AVPE* average added value per employee in the sector, *av.DTI* average Degree of Technological Incorporation of the sector

significantly higher than sectors such as consumer goods, steelworks, retail and construction. The productivity levels for services may seem high, but it should be remembered that the companies in question include E.C.T, Cielo, Infraero, Copasa MG, Cedae and Contax.

Hypothesis He states that there is a significant difference between the DTI of 1998 and the DTI for 2012 in the companies listed by the *Exame* Magazine Biggest and Best (1999, 2013 editions). Although the companies had a higher mean DTI in 2012, as shown in Table 6, the difference is not significant (p value = 0.549). Therefore, the hypothesis was rejected. The annual growth rate of DTI in big companies was 0.323 %.

Hypothesis Hf states that there is a positive and significant association between the DTI of a profitable organization and its DSE. This hypothesis was not rejected, showing that the more automated a company is, the more tax it will pay into society. Spearman's rank correlation coefficient (r_s) was calculated, and the following values were obtained: 0.9451 with t = 22.9503 and p value <0.0001. Figure 5 shows the plotted values of the DTI and DSE variables.

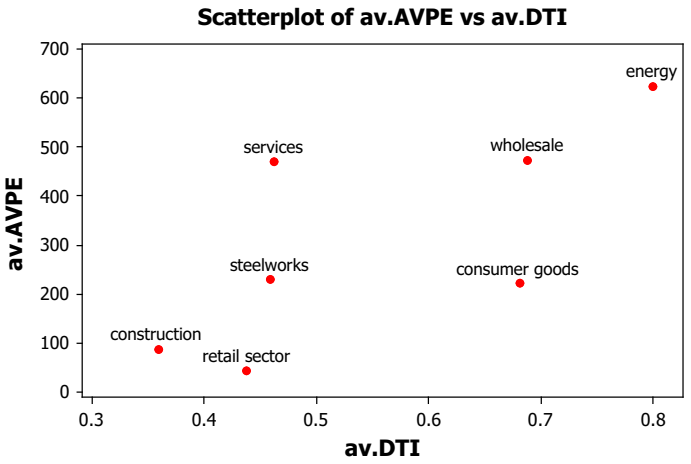

Fig. 4 Plotted values of the average added value per employee in the sector (av.AVPE) and average degree of technological incorporation of the sector (av.DTI) variables

Table 5 There is a significant difference between the AVPE of the different sectors

Sector	AVPE	AVPE^2	Nihans
Energy	624.77	390337.55	A
Wholesale	474.33	224988.95	A
Services	469.58	220505.38	A
Consumer goods	221.13	48898.48	B
Steelworks	229.36	52606.01	B
Retail sector	42.82	1833.55	B
Construction	86.74	7523.83	B
Total	2148.73	946693.74	
Nihans A>		440.58	

Table 6 The mean DTI of 2012 was higher than that of 1998

DTI (1998 e 2012) Individual 95% CIs For Mean Based on Pooled StDev				
Level	N	Mean	StDev	-------+---------+---------+---------+--
DTI 1998	35	0.5637	0.1553	(----------*----------)
DTI 2012	87	0.5897	0.2362	(----------*----------)
				-------+---------+---------+---------+--
				0.520 0.560 0.600 0.640

Hypothesis Hg states that there is a positive and significant association between the DSE and profits of companies. This hypothesis was not rejected, with a significance level of 0.05, which is crucial for the proposed model as it shows that the DSE calculated for a profitable organization by the formula $DSE = \frac{2T}{T+W}$ is adequately adjusted to the profitability of the company: more socially efficient companies are more profitable. Spearman's rank correlation coefficient (r_s) was calculated, and the following values were

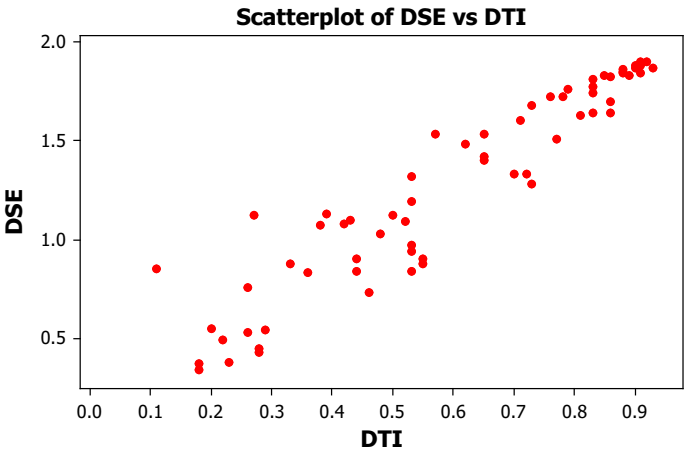

Fig. 5 Plotted values of degree of technological incorporation (DTI) and degree of social efficiency (DSE) variables of each company

obtained: 0.2699 with t = 2.2244 and p value = 0.0296. It could be said that the acceptance of this hypothesis constitutes the validation of the proposed model.

Hypothesis Hh states that there is a significant difference between large and small and medium-sized companies in terms of DTI. The hypothesis was not rejected, with a significance level of 0.05 (p value = 0.001). Table 7 shows the confidence interval for the mean DTI for large companies and small and medium-sized companies at a significance level of 0.05. The large companies had a mean DTI of 0.5897 (on a scale of 0–1), differing from the mean DTIs of 0.4437 for small and medium enterprises.

Hypothesis Hi states that there is a significant difference between large companies and small and medium enterprises in terms of social efficiency assessed using the DSE indicator. This hypothesis was not rejected, with a significance level of 0.05 (p value = 0.006). The mean DSE of the large enterprises is 1.21, meaning that the total amount of taxes paid is higher than the total paid in wages in a given time period. Meanwhile, the DSEs of the small and medium enterprises is lower than 1: these companies, on average, pay more in salaries than in taxes (see Table 8).

4.2 Conclusions and Implications

What conclusions can be reached? To the claim made by Amaral et al. (2013) that "Brazil is one of the 30 countries with the highest rate of taxation in the world" can be added that the share of taxes in the added value of the companies in question (45.66 % for large companies and 42.70 % for small and medium-size companies) is higher than the 36.27 % tax rate identified by these authors in relation to GDP in 2012. And the GDP is nothing more than the sum of the added values of all companies.

Concerning the claim made by Frey and Osborne (2013) that the automation of labor will lead to job losses, Table 6 shows that there is a growing trend in this respect. Mastrostefano and Pianta (2004, p. 3) also claimed that the diffusion of innovation, i.e., wider use of technology, could cause unemployment. In 2012, the companies from the sample in the energy sector had a mean DTI of 0.800, with a standard deviation of 0.149. Total automation is 1. The mean annual growth of DTI was 0.323 %, according to the data in

Table 7 Large companies are more automated

		DTI -Individual 95% CIs For Mean Based on Pooled StDev					
Level	N	Mean	StDev	-------+---------+---------+---------+--			
DTI	87	0.5897	0.2362			(-----*------)	
DTIs	33	0.4437	0.1364	(---------*----------)			
				-------+---------+---------+---------+--			
				0.420	0.490	0.560	0.630

Level DTI of both samples, *N* sample size, *Mean* mean of DTI of each sample, *SD* standard deviation of the DTI; (—*—) Confidence interval of the DTI, with a value of ± 3 SD of the mean represented by an asterisk. The confidence interval takes the size of the sample into account (based on pooled SD)

Table 8 Large companies are more socially efficient

		Individual 95% CIs For Mean Based on Pooled StDev					
Level	N	Mean	StDev	-----+---------+---------+---------+----			
DSE	87	1.2147	0.4885			(-----*-----)	
DSEs	33	0.9686	0.2280	(---------*---------)			
				-----+---------+---------+---------+----			
				0.90	1.05	1.20	1.35

Level DSE of both samples, *N* sample size, *Mean* mean DSE of each sample, *SD* standard deviation of the DSE; (—*—) Confidence interval of the DSE, with a value of ± 3 SD of the mean, represented by an asterisk. The confidence interval takes the sample size into account (based on pooled SD)

Table 6. Assuming that DTI continues to grow at this rate, for companies to go from a current mean of 0.5897 to one of 0.70 would take 68 years, which is not such a long time in terms of public policies. This growth in the use of technology and the consequent job losses is an issue that needs to be addressed by governments to avoid resorting to the "subsidized subsistence" of Becerra (2009).

Other conclusions can be drawn from the study:

There is a positive and significant association between the DTI of an organization and its productivity measured by the AVPE, as shown in Fig. 2. This explains why capitalists, in their drive for productivity, resort to automation (Frey and Osborne 2013);

There is a positive and significant association between the AVPE and the amount of taxes per employee (T_{PE}), as shown in Fig. 3. This means that greater productivity measured by the AVPE variable is positively correlated with higher amount of taxes paid per employee;

There is a significant difference regarding productivity in the different economic sectors when measured by AVPE, as shown in Table 5;

There is a positive and significant association between the median DTI and the median AVPE of the economic sectors, meaning that sectors that incorporate more technology are more productive (Table 4; Fig. 4);

There is a positive and significant association between the DTI of a for-profit organization and its DSE, as shown in Fig. 5. This means that the more automated an enterprise is, the more it will pay in taxes to society;

There is a positive and significant association between the DSE and profits of companies. This means that the proposed DSE indicator is positively related, and at significant levels, to company profits;

There is a significant difference between large companies and small and medium enterprises concerning DTI, as shown in Table 7. The fact that this hypothesis was not rejected implies that the growth of for-profit companies is conditioned to the inclusion of technology in the production process;

There is a significant difference between large companies and small medium enterprises in terms of social efficiency as assessed using the DSE indicator, as shown in Table 8. This result is not surprising given the fact that social efficiency is linked to the DTI.

As companies become more productive with automation (or the incorporation of technology), the use of automation tends to grow: higher productivity means more profits, more tax and fewer jobs, as stated by Frey and Osborne (2013). Job losses can rapidly lead our society into the situation that Becerra (2009) warned of, with "certain neighborhoods becoming isolated, with unnecessary and unqualified people in potential conflict and leading a marginal existence". U Thant, the former Secretary General of the United Nations (from 1962 to 1971) had already warned of "the division of the world into rich and poor is much more real and much more serious and ultimately much more explosive than the division of the world on ideological grounds". This problem has to be decisively addressed in academic and political circles.

Considering the limitations that are inherent to this type of study, the results suggest some practical recommendations, such as conducting research with a larger base of organizations and verifying the accuracy of the DSE indicator in studies with organizations from other countries.

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