

**ECOFFICIENCY OF COMPANIES OF VARIOUS ECONOMIC SECTORS LISTED IN THE
PUBLIC REGISTRY OF GREENHOUSE GAS EMISSIONS OF THE BRAZILIAN PROGRAM
GHG PROTOCOL**

FRANCISCO SANTANA DE SOUSA
FUNDAÇÃO GETULIO VARGAS
chicosans@uol.com.br

HENRY ONYEKACHI ANIUGBO
ayoke_4real@yahoo.com

EDNA DE SOUZA MACHADO SANTOS
UNIVERSIDADE NOVE DE JULHO - UNINOVE
proedna@uol.com.br

GIOVANNI GERSON CATELLINO
UNIVERSIDADE NOVE DE JULHO - UNINOVE
giovannicatellino@yahoo.com.br

ECOEFFICIENCY OF COMPANIES OF VARIOUS ECONOMIC SECTORS LISTED IN THE PUBLIC REGISTRY OF GREENHOUSE GAS EMISSIONS OF THE BRAZILIAN PROGRAM GHG PROTOCOL

ABSTRACT. This paper analyzes the eco-efficiency of a set of eighteen companies from several economic sectors, listed in the Brazilian Green House Gas Program (GHG). The central objective was to respond to the environmental impact caused by the economic activities of these sectors by calculating their eco-efficiency. This is a highly relevant subject for comparing the sectors that most affect the environment in the generation of its wealth. As for the objectives, it is considered an exploratory study; And with regard to procedures, a documentary and ex-post facto work. In order to calculate the eco-efficiency of each company, the Additional Values Statements (VAS) and environmental impacts were used, which were extracted from the inventories of greenhouse effect gases, equivalent to carbon dioxide, in tons. For a comparison of very disparate results, these ecoefficiencies were changed in logarithms in the base 10. The results show that the petroleum, chemical, civil construction and mining sectors were the ones that presented the smallest ecoefficiencies, already expected. Companies that generate products with higher aggregated values produce less environmental impacts.

Keywords: Eco-efficiency; Greenhouse gases; Brazilian Program of GHG protocol; Added value; Inventory of greenhouse gases.

1. INTRODUCTION

The economic approach to negative externalities brought about by the productive process of enterprises in the capitalist model of production was first discussed in 1920 by Pigou in *The Economics Welfare*. Vale recalls that the negative externality is included in the bulge of market failure.

At the end of the 20th century, when the environmental issue began to become explicit, not only with regard to pollution, but with all the impact of human action on Earth's climate, and even before the United Nations Conference on the Environment, In Stockholm, 1972, and Rio-92, many experiments were already taking place in several parts of the Planet (OLIVEIRA, 2008; OLIVEIRA, 2003).

Based on the policy instruments adopted by various governments before and after the Kyoto Protocol, this work has addressed eco-efficiency metrics. The main hypothesis of this work is that the companies of the concentrated economic sector (Andrade, Tachizawa, Carvalho 2000), such as the mining sector and the oil sector, present the greatest inefficiencies in their productive activities. The main gap in this study is that sectors with low greenhouse gas (GHG) emissions are being compared, mainly concentrated in the high value added products and services sectors, with companies with high GHG emissions and With low values added. In order to harmonize these gaps, ecoefficiencies have been metrified in logarithms, since wealth does not grow indefinitely, nor do environmental impacts diminish unlimitedly (HART, 1997; SEN, AMARTYA, 2012). This is the justification for introducing the concept of logarithm in this work.

This work is justified due to the need to know the sectors that are concerned with the issue of local and global governance and its impacts on the Earth's climate and the well-being of society and to seek, in the capitalist system itself, through Innovation, recycling, among others, the proper use of finite resources of nature.

2 THEORETICAL REFERENCE

The concept of eco-efficiency was proposed by the World Council for Sustainable Development (WBCSD).

For WBCSD (1992), an organization achieves eco-efficiency through

[...] delivery of goods and services at competitive prices that meet human needs and bring quality of life, while progressively reducing ecological impacts and resource consumption intensities throughout the life cycle to an in line with The Earth's estimated carrying capacity.

In order to measure eco-efficiency, Schmidheiny (1992) suggested the following model from the concept of eco-efficiency given by the WBCSD (1992):

$$ECOEFFICIENCY = \frac{Wealth}{Environmental\ impact}$$

But how to achieve the Eco-efficiency goal outlined by the WBCSD (1992)?

And, in order to measure the wealth generated by the company, the Value Added Statement of each selected company was used, whose calculation model is:

Figure 1: Overview of the calculation of the Statement of Value Added

Income			
(-) Inputs acquired from third parties			
Gross added value			
(-) Depreciation, amortization and depletion			
Net added value			

Source: Adapted from Almeida (2010, p.157)

Therefore, "The value added at a given stage of production is defined as the difference between the gross value of production and the intermediate consumption at this stage" (SIMONSEN, 1978 as quoted by DE LUCA, 1998, p.29).

The definition is the vision of Economic Sciences, that is, of production must be excluded inputs purchased from third parties to avoid double counting in the company's wealth generation.

For Accounting Sciences, the calculation of the Value Added Value (VAS) is given by the difference between gross sales and total inputs purchased from third parties (MARTINS, 1989 as quoted by DE LUCA, 1998, p.35).

Depreciation, amortization and depletion should be excluded from the gross DVA, as they are included in the price of the product sold, but these costs included in the

formation of sale prices of the products and / or services do not affect the cash of the company, since they only have Objectives of tax benefits.

The definition of WBCSD (1992) is a synthesis of Our Common Future (1987). But, how to achieve the goal outlined by the eco-efficiency is defined by the WBCSD (1992)?

The issue of corporate social responsibility is discussed in the context of decision-making issues of these organizations. "The social responsibility of organizations is related to the economic, legal, ethical and social expectations that society expects companies to meet in a given period of time" (CARROL, 1979 as cited by Donaire, 2009, p.22; FANTINATTI; ZUFFO; ARGOLLO, 2002).

For the variable environmental impact will be considered the total of the three scopes defined by the IPCC (1990), defined in the Kyoto Protocol, according to the model below.

Figure 2 - ISO 14,065 (GHG inventory)

GEE	Tonnes of greenhouse gas			Tonnes of GEE equivalent CO ₂			Overall
	Scope 1	Escope 2	Scope 3	Scope 1	Scope 2	Scope 3	
CO ₂							
CH ₄							
N ₂ O							
HFC ₅							
SF ₆							
NF ₃							
overall							

Source: Brazilian Program GHG Protocol (ABNT, 2006)

Therefore,

The inventory of direct and indirect emissions of greenhouse gases from an organization is a tool that allows for self-assessment and portrays corporate concern, accountability and engagement in addressing climate change issues, turning speech into a responsible attitude . (BM & FBOVESPA, 2009).

Besides that,

The quantification of GHG emissions depends on the structure of the company and the relationship with the parties involved. According to ISO 14064 and GHG Protocol Brazil, this is defined as the organizational boundary, and involves the level of operational control or financial control of business operations including wholly owned operations, merged and unincorporated joint ventures, etc. [...] classifying them as direct or indirect emissions and selecting the scope of registration and reporting for indirect emissions (BM & FBOVESPA, 2009).

Emissions are classified into scopes, based on the GHG inventories issued by the organizations. Therefore, scopes consist of accounting for both controlled and uncontrolled emissions of greenhouse gases.

In Scope 1, direct emissions are accounted for according to the IPCC (1988):

Direct emissions are those from sources that are owned and controlled by organizations. Examples: combustion in boilers, furnaces, vehicles of the company or contracted by them; Chemical production emissions in process equipment that are owned or controlled by organizations; Emissions from air conditioning and refrigeration systems, among others.

Direct emissions of Scope 1, according to the IPCC (1988), are subdivided into five categories:

- Stationary combustion: generation of electricity, steam, heat or energy through the use of equipment at a fixed location;
- **Mobile combustion:** transport in general (company's operational fleet) and vehicles used in construction, agriculture and forestry;
- **Emissions from physical and chemical processes:** non-combustion emissions from physical or chemical processes;
- **Fugitive emissions:** (i) release of production, processing, transmission, storage and fuel use; And (ii) unintentional release of substances not through chimneys, exhaust drains or other functionally equivalent apertures;
- **Agricultural emissions:** (i) enteric fermentation of methane fermentation in the rumen and animal waste; (Ii) management of manure (methane and nitrous oxide); (Iii) cultivation of rice (methane); (Iv) soil preparation (methane, carbon dioxide and nitrous oxide); (V) burning of agricultural waste (methane and nitrous oxide). (IPCC, 1988).

According to the IPCC (1988), "Indirect emissions are those produced by the acquisition of electric and thermal energy and consumed by the companies, that is, they are those bought by the companies and used at the organizational limit", and Can be classified as follows (Scope 2):

- **Indirect emissions related** to transmission and distribution of energy. These emissions have already been accounted for in energy distribution companies, but the final consumer was not included in order to avoid double counting. However, in the final consumer's production process, the share of the impact on that production must be taken into account;
- **Other indirect emissions** related to energy. Emissions from the use of electric energy in prospecting, drilling of wells, burning of discarded gases and transportation, among others, should be accounted for in this scope.

And finally, in scope 3, there are also indirect emissions, accounting for the business travel of employees and the outsourcing of activities not related.

In order to analyze the issue of corporate social responsibility, one must ascertain the classification of the economic sectors. According to Tachizwa; Scaico (1977 as cited by ANDRADE, TACHIZAWA; CARVALHO, 2000, p 51) classified the companies, according to the environmental impact provoked, in:

- Concentrated economic sector;
- Semi-concentrated economic sector;
- Sector of differentiated companies;
- Sector of competitive companies;
- Financial services industry; and
- Public service sector

The concentrated economic sector is made up of few companies in the industrial sector, interdependent with each other (Andrade and Tchizawa, Carvalho 2000). In this role are companies in the mining, cement, chemical and petrochemical sectors, pulp and paper, hydroelectric and heavy construction.

For Andrade, Tchizawa; Carvalho (2000):

This sector of the economy, as far as environmental variables are concerned, is eventually influenced by the growth of the demand for investments, with the corresponding increase in the sales of the companies in the sector, which tends to reduce the normal idle capacity in this business area [...] (Andrade and Tchizawa, Carvalho 2000, 53).

That is, the environmental impact caused by this sector is one of the highest among the other sectors and, in this case, the environmental impact is a dependent variable of the production of the companies of this sector; That is, if demand for products increases, the environmental impact will increase; If demand declines, the environmental impact will decrease. The environmental variable of the citation refers to the business environment of the companies and not to the issue of environment.

The semi-concentrated economic sector has characteristics such as: low concentration; Little differentiation of their products; Influence of suppliers that have high bargaining power, due to logistics (Andrade, Tchizawa, Carvalho 2000). Non-durable consumer goods such as food, textiles, clothing, metallurgy, plastics and rubber, wood and furniture are in this sector.

Therefore,

[...] is a sector of the economy that, given the performance of environmental variables, is negatively influenced by market opening, consistent with the trend of globalization of the economy. This sector is highly influenced by the social policies and measures established by the government. (Andrade and Tchizawa, Carvalho 2000, 54).

This sector, unlike the concentrated economic sector, which is mostly made up of commodity-exporting companies, which depends on the global economy and the price of these commodities, is subject to the internal market and to the economic, fiscal and social policies of the Local government. As for responses to environmental issues, they become more sensitive to internal regulations.

The sector of differentiated companies is constituted by companies of the branches of non-durable consumer goods, such as pharmaceuticals, beverages, tobacco, and hygiene and cleaning (ANDRADE; TCHIZAWA; CARVALHO, 2000). The characteristics of this branch of economic activity are: there is no differentiation of technologies between the companies of this branch of activity; Diversified distribution in various parts of the country; Existence of innumerable small businesses, among others (Andrade, Tchizawa, Carvalho 2000). Therefore, this sector is dependent on the domestic market and governmental fiscal and economic policies. With regard to the issue of the environment, it is dependent on state regulation.

The sector of competitive companies has as characteristics: competition via price; Low technological level; Spraying of participating companies; Without entry barriers, among others (ANDRADE; TCHIZAWA; CARVALHO, 2000). Examples of this branch of business are retail trade, auto parts and vehicle distribution. This sector has a high inventory turnover, but low rate of return. The environmental issue is not part of your primary concern.

The business sector in the financial sector has the following characteristics: high regulation; High barrier of entrance; The competition takes place through the launch of new products, but soon copied by the competition; High technological development; Constant technological innovation and high volume of capital (ANDRADE; TCHIZAWA; CARVALHO, 2000).

In view of these characteristics,

[...] is a sector whose profitability of the companies that compose it is directly linked to economic macro policies, where periods of high inflation are associated with high margins of profitability or, alternatively, in normal periods of the economy, profitability based on intermediation And expansion of its normal operations (Andrade and Tchizawa, Carvalho 2000, pp. 56-57).

Examples of this economic branch are: banks, insurance, financial, real estate credit, leasing, brokerage firms and distributors of securities.

And, finally, the public services sector. It is classified in this economic sector the direct and indirect administration of the Union, the States, the Municipalities and the Federal District. In Brazil, due to its characteristic of current economic development, in sectors that should be, in principle, by the private sector, but some specific sectors, already mentioned, need high investment. Due to the characteristics of our capitalism, the private sector does not have these resources, so the Brazilian State starts to work in these sectors: financial, metallurgy, mechanics, communications, paper and cardboard, chemicals, petrochemicals, sanitation, among others (ANDRADE; TCHIZAWA).

Therefore, the companies listed in this study fall into these classifications to understand why some have high ecoefficiencies and other, low ecoefficiencies.

3 METHODOLOGY

The work proposed to calculate the degree of eco-efficiency of a group of companies listed in the Brazilian Program of GHG Protocol, that is, companies that voluntarily make the inventory of greenhouse gases, equivalent to carbon dioxide, in ton

And finally, this work on the objectives is an exploratory research. A research is exploratory, according to Gil (2007) "[...] when it aims to provide greater familiarity with the problem, in order to make it more explicit or to construct the hypothesis ..." (GIL, 2007) By SILVEIRA; CÓRDOVA, 2009, p.35).

From the information extracted from the economic-financial reports and inventories of greenhouse gases, equivalent to carbon dioxide, in tons, the ecoefficiencies of each listed company were constructed in the Brazilian GHG Protocol Program. Regarding the approach, this work is classified as quantitative because,

[...] Quantitative research focuses on objectivity, [...] considers that reality can only be understood based on the analysis of raw data, collected with the aid of standardized and neutral instruments. The quantitative research uses mathematical language to describe the causes of a phenomenon, the relationships between the variables [...] (FONSECA, 2002, p.20 as quoted by SILVEIRA, CÓRDOVA, 2009, p.33).

For the development of this work, 18 companies from the various economic sectors were selected and that they satisfied the following conditions: (a) publish economic-financial reports (among them, the Statement of Added Value), in accordance with the Law of the Corporations; (B) inventory their greenhouse gas emissions in accordance with the Brazilian GHG Program, in line with the IPCC (1992). These requirements are justified because the eco-efficiency calculation model proposed by the WBSCD (1992) and Schmidheiny (1992) require this information. Companies that did not meet these criteria were not selected by the analysis of this article.

4 ANALYSIS OF RESULTS

Research data such as percentage of participation in scopes; Wealth generated (SAVs); And environmental impacts, were collected in tables and graphs (Figures), in order to analyze the selected companies. This format is justified because it takes as basis of analysis the model introduced by SEN (2002), that is, it introduced the concept of Economic Development Index (HDI) that replaced the Gross Domestic Product (GDP), which was the only indicator of good Of a country (OLIVEIRA, 2003).

Table 2 lists the companies selected along with the branches of activity of these companies. It was also considered that the most important scope of these companies is the one in which it assumes a percentage greater than 50%. The minimum base of 50% is justified because it accounts for half of the use of a scope; The other 50% are diluted in the other scopes.

It was considered, in this work, that a participation of more than 50% in a scope will be the main source of GHG emission of the organization, that is, they are emissions produced in the internal scope of these organizations. According to Table 2, the companies, whose activities are concentrated in the internal scope (scope 1), are: GOL (air transport); Votorantim Cement (cement); AMBEV (beverages); Alcoa aluminum (metallurgy); Fibria (paper and cellulose); And EMBRAER (aircraft construction). It is perceived that they are concentrated economic sectors (ANDRADE; TCHIZAWA; CARVALHO, 2000; LA TORRE; FAJNZYLBER & NASH, 2009).

Table 2 - Percentage share of the most important IPCC scope

	Company	sector	Year	Scope	%
1	Gol	Air transport	2015	1	98.21
2	Votorantim Cimento	Cement	2015	1	95.58
3	AMBEV	Drinks	2009	1	86.57
4	Alcoa Alumínio	Metalic	2015	1	84.79
5	Fibria	Paper And Cellulose	2015	1	72.61
6	Embraer	Construction of aircraft	2010	1	59.19
7	Telefónica	Telecommunications	2015	2	86.13
8	Lojas Renner	Retail business	2015	2	63.86
9	Grupo Fleury	Human health	2015	2	55;39
10	Banco do Brasil	Financial	2015	2	53.62
11	Natura	Beauty and hygiene	2015	3	96.63
12	Vale	Ore	2015	3	96.68
13	Petrobrás	Extractive industry	2010	3	91.08
14	Camargo Correa	Construction	2015	3	90.22
15	Souza Cruz	Tobacco	2015	3	75.33
16	Porto Seguro	Safe	2015	3	74.67
17	BRFoods	Food production	2015	3	61.88
18	Braskem	Chemistry	2015	3	56.77

Source: Research Data

In scope 2 (indirect emissions), focused on the electricity utilities of the concessionaires are the companies: Telefônica (fixed telephony and mobile telephony); CPFL (supplier of electricity and gas); Lojas Renner (retail trade); Fleury Group (human health); Bank of Brazil (financial service) (LA TORRE, FAJNZYLBER & NASH, 2009; FELLEBERG, 1977).

In scope 3 (indirect emissions), related to the business trips of employees and outsourcing of their activities not related, are the most numerous companies: Natura (hygiene and beauty); Vale do Rio Doce (extraction and transport of minerals); Copersucar (alcohol and sugar); Petrobras (extraction and sale of oil); Camargo Correa (civil construction); Souza Cruz (tobacco, Porto Seguro (insurance), BRFoods (food) and Braskem (chemistry).

It is noted that 33.33% (more than 50%) of the analyzed companies have of their activities classified in scope 1; In scope 2 (more than 50%), are 26.32% and, 40.11% (more than 50%), in scope 3; GHGs are generated in their external activities (indirect). Table 3 shows the Additional Values Statements and total greenhouse gases equivalent to carbon dioxide in tons, and in Table 3 the percentage shares of each company In the DVA. (Elkington, 2012, SEN, 2002).

Table 3 - Ecoefficiencies of selected companiesSource:

	Company	Sector	Eco Efficiencies	%
			US\$ mi	
1	BB	Financial	78.270,70	26.34
2	Porto Seguro	Insurance	44.925,06	15.11
3	Telefónica	Telecommunications	42.389,55	14.26
4	Grupo Fleury	Human health	39.913,53	13.43
5	Lojas Renner	Retail business	32.199,85	10.83
6	Souza Cruz	Tobacco	21.295,91	7.17
7	Embraer	Construction of aircraft	18.211,31	6.13
8	Natura	Beauty and hygiene	6.220,82	2.09
9	AMBEV	Drinks	3.889,23	1.31
10	BRFoods	food production	3.691,35	1.24
11	Alcoa Alumínio	Metallurgy	3.030,23	1.02
12	Fibria	Paper And Cellulose	1.951,62	0.66
13	GOL	Air transport	594,30	0.20
14	Camargo Correa	Civil Construction	182,92	0.06
15	Brasken	Chemical	160.57	0.05
16	Petrobras	Extractive industry	160.56	0.05
17	Votoratim	Cement	120.31	0.04
18	Vale	Miner	11,96	0.004
		Total	296.778,33	100.00

Reseache data

According to Table 3, the most eco-efficient company is Banco do Brasil; That is, for every 100 dollar generated from wealth in relation to one ton of GHG, it generates twenty-six reais and thirty-four cents, less the effects of environmental impacts. The companies in the concentrated sector (pulp and paper, air transport, construction, chemical, petroleum, cement and ore) generate less than a cent of net wealth in relation to the 100 dollar generated by the group. Thus, Vale do Rio Doce generates net less than four thousandths of net cents net after deducting environmental impacts.

5 DISCUSSION OF RESULTS

According to the hypothesis raised in this study, the results indicate that the companies in the concentrated sector show the greatest inefficiencies. It is likely that this was already certain, because most of these companies have activities in which their products do not have added values. But the degree of inefficiencies of this group of companies is alarming. A company is considered efficient if the ratio of wealth generated to environmental impact was greater than one dollar unit. Vale do Rio Doce, in the mining sector, in relation to the group is extremely inefficient. For every 100 dollars net of environmental impact, Vale do Rio Doce only presents four thousands dollars; And then comes to Votorantim Cimentos with four hundredths of dollars. Companies in the petroleum and chemical sectors (Petrobrás and Braskem) only produce five hundreds of dollars (for each hundred dollars of net wealth that the study group generates). The construction sector (Camargo Correa) is only responsible for six hundred of dollars of each hundred dollars generated of net wealth generated by the group under study. Another

inefficient company is the airline industry (GOL). This presents only twenty cents of efficiency of dollars. To close the inefficient group, the paper and pulp sector (Fibria) with sixty-six cents of dollars. That is, the companies in the concentrated industry generate more negative externalities in the environment. The environmental damages that these groups of companies generate are far superior to the added benefit in the form of riches.

The group of companies with efficiency above a real and ten real net of wealth, are the companies of the sectors of metallurgy (aluminum Alcoa with a real and two cents); Processed foods (BRFoods with one dollar and twenty-four cents); The beverage sector (AMBEV with one dollar and ink and a few cents); The health and beauty sector (Natura with two dollars and nine cents). This group of companies can be found to be in a low level of efficiency.

In the average efficiency group are the following companies: aircraft construction (EMBRAER with six dollar and thirteen cents); (Souza Cruz with seven dollars and seventeen cents). In the group of high efficiency are the companies: the retail sector (Lojas Renner with ten dollars and eighty-three cents). But the companies that present the highest levels of ecoefficiencies are companies in the service sector: human health (Fleury Group with thirteen dollars and forty-three cents); Fixed and mobile telephony (Telefónica with fourteen dollars and twenty six cents); (Porto Seguro with fifteen dollars and eleven cents.

The most eco-efficient sector is the financial one (Banco do Brasil with twenty-six dollars and thirty four cents).

6 FINAL CONSIDERATIONS

The result found suggests that companies in the concentrated economic sector, as defined by Andrade, Tchizawa; Carvalho (2000), present low level of ecoefficiency, according to the hypothesis raised in this study, such as the mining sectors (Vale do Rio Doce); Extraction and commercialization of petroleum (Petrobrás); Cement (Votorantim); Chemical industry (Braskem); Construction (Camargo Correa); Air transport (GOL); Paper and cellulose (Fibria); Beverages (AMBEV); Metallurgy (Alcoa). Taking as base of comparison of net wealth (excluding environmental impact) the base 100, that is, the total net wealth generated from the group of companies studied total 100 reais. The use of base 100 is justified because there are companies that have Additional Value Demonstrations expressed in billions of reais, while others have DVAs in millions of reais. The same is true of the environmental impact measured in tonnes of greenhouse gases equivalent to carbon dioxide; Some generate trillions tons of environmental impacts; While others generate billions of tons of environmental impacts; Other millions and thousands of tons of GEES. In other words, there are companies that present high SAVs and low environmental impacts; Others generate low SAVs and high environmental impacts. That is, there is no relationship of proportionality between the generations of wealth and environmental impacts. They present, therefore, asymmetry between wealth generation and environmental impact production.

By unifying the base of comparison one has the contribution of each company in the generation of wealth of the group for each hundred dollars total. With this information, in relative values, it can be observed that the companies in the concentrated sector contribute very little to the well-being of the population given the immense negative

environmental impact of their activities. That is, the riches generated are infinitely small in relation to the impact of their activities on the environment and on the well-being of the population.

Throughout this work, it was noted that the companies that cause the greatest negative externalities are those in the concentrated economic sector that use non-renewable resources of the Planet (except water). Therefore, companies in the agricultural, petrochemical, mining, pulp and paper, and construction industries significantly affect the Earth's climate change.

To measure and standardize for all companies in terms of carbon footprint (LA TORRE, FAJNZYLBER & NASH, 2009), the Kyoto Protocol introduced the concept of direct and indirect emissions issued by organizations, subdivided into three scopes. These are measured in terms of global warming potential whose unit of comparison is carbon dioxide and then converted into tonnes of gases equivalent to the global warming potential in tons of carbon dioxide. It was noticed that some companies concentrate their activities in a single scope, varying from 99% to 50%. There is no rule that defines which economic sector identifies with greater concentration in a scope (Figure 2).

It is suggested for future analysis, to study the companies of this study using the Kuznets environmental curve model (STERN, 2004).

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