GREENHOUSE GAS EMISSIONS BY AGRICULTURE IN THE BRAZILIAN AMAZON

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The Legal Amazon region includes the Amazon biome, the Pantanal (swamp) and the Cerrado (savannah). Starting in the early 1970s, agriculture, livestock, forestry and mining developed at fast speed in the region. In 2009, these activities accounted for 13.5% of GDP. Livestock alone produces, per cattle head, an average of 80-100 kg of methane per year. Deforestation has been a major cause of carbon dioxide emissions. The National Institute for Space Research (INPE) recorded and yearly average emission of around 850 million tons of CO_2 resulting from deforestation between 1988 and 2008. The objective of this paper is to estimate the GHG emissions generated by cattle ranching and deforestation in the Amazon region. This is done by applying a two Regions, Amazon and Rest of Brazil, input-output (I-O) model built specifically for these regions by using the database of the Regional and Urban Economics Laboratory of the University of São Paulo (NEREUS) of Municipal I-O tables for the year 2009. The paper makes an estimation of the GHG emissions produced by primary activities, their link with deflorations and the responsibility of the consumer at the internal and external markets. The paper also presents a discussion of the effective role of government policies aimed to emissions reduction.

Keywords: Brazilian Amazon; GHG; Deforestation; IOM

1 INTRODUCTION

This study aims to analyze the commercial interrelations between two Brazilian regions, now called Legal Amazon (AMAZ) and the Rest of Brazil (ROB), determine the interdependence degree between them and especially to estimate greenhouse gas emissions of greenhouse effect (GHG) emissions produced by primary activities, their connection to the energy requirements by economic sectors and the consumer responsibility in the domestic and foreign markets. Therefore, the article presents a discussion on the effective role of government policies to reduce these emissions. Thus, we used an Input-Output Interregional Matrix Model, comprising two (2) regions and 28 sectors, totaling 56 sectors. However, to understand the dynamics that involve the relations of trade in goods and services between the two main Brazilian regions (AMAZ and ROB), including CO_2 emissions and demands, it is necessary to understand the dynamics of the Brazilian regions, in economic, social and environmental terms for the year 2009, the date of the study.

The Rest of Brazil (ROB) represents all Brazilian states and their municipalities, excluding the data of the Amazon region (with 9 states and 771 municipalities), which covers 18 states and 4,794 municipalities, respectively, with a considerable economic, socio-cultural and environmental diversity. Its GDP in 2009 was R$ 2.98 trillion and a population of 166 million Brazilians, which added to the Amazon, was around 191 million people in the country (IBGE, 2009). Brazilian exportations in that year was US$ 12,321,617,241 (FOB values), of which the Amazon region represented 15.01% or US$ 1,856,970,559.

General data of Brazil: this is the fifth largest country in the world, with an area of 8,515,767.049 square kilometers of territorial extension. It is located in the South America and its estimated population in 2014 was 202,033,670 inhabitants. The Human Development Index registered in 2010 was 0.733. It has 26 states and a federal district (Brasilia), divided into five regions (South, Southeast, North, Northeast and Midwest). The Gross Domestic Product (GDP) in 2012 was 2,243,854 million US$, which corresponds to a *per capita* GDP of 11,199 US $ (IBGE, 2015).

The Legal Amazon (AMAZ) was established by a law device for the purpose of economic and environmental planning in that region. The normative definition of Legal Amazon came in the 1950s, during the creation and regulation of the Superintendency of the Amazon Appreciation Plan - SPVEA (BECKER, 2004). It covers the states of the North (Acre, Amazonas, Amapá, Pará, Rondônia, Roraima and Tocantins), plus the state of Mato Grosso (Midwest region), part of Maranhão, to the west of the 44º meridian (Northeast region) cut by the 13°. Currently, it has 771 municipalities (IBGE, 2016). Its area is 5,217,423 square kilometers and a population of 24,728,438 in 2009, which corresponded to around 13% of the Brazilian population (191,480,630), so a population density of 4.73 inhabitants/km^2. Its Gross Domestic Product (GDP) in 2009 was R$ 260.36 billion (nominal value), which corresponded to 8.04% of the national GDP.

As the largest rainforest in the world, in 2009, Amazon recorded a total of 3,250,529 km^2 and area of 961,054 km^2 non forest, which total deforestation was 736,830 km^2, it means, 18.48% in that year. And, in the social aspect, the Gini index, which measures income inequality in the world, it corresponded to 0.53 in 2009 to the Amazon region, the same index of Brazil (IPEA, 2010).

For its characteristic of great biodiversity in flora and fauna, the Amazon forest has been explored over the last 50 years as an inexhaustible source of raw materials resources for production and consumption of goods and services, without taking into account that most of these production factors are of finite order, or which cause considerable recovery time (resilience[1]) of the same so that they are again re-used as a source of production of new products and services. For this reason, the last 15 years, this region has been experiencing a productive re-ordering process, mainly through public policies that try to embed in society a new concept of "sustainability" or sustainable production, although some time is necessary to population as a whole to

[1] Resilience means back to normal state, and is a term from the Latin resiliens.

adapt to the new institutional rules, now underway. In the words of Homma (2008), the transformation of Amazonian biodiversity in economic activity to generate income and employment and even reduce the risk of biopiracy, depends on concrete measures for identification, domestication, production on a rational basis and its vertical integration.

Even because, over its settlement and exploitation history, the regional integration of the Amazon, from the 1960s, was given by the public policies of intervention to "integrate" this region in economic and social level to the rest of Brazil and the world, via the exhaustive exploration of its wealth and natural potentials (water, minerals, land and forests). So much that in Mato Grosso and Rondonia commodities for exportation (soybean and cotton) are predominantly high; in Pará, the economic base is livestock (sheep), roundwood and mining, as well as hydropower (Tucuruí and Belo Monte). Then, the expansion of the economic activities, especially the primaries, such as agriculture, mining, logging and fishing took place through the expansion of these via the forest clearing, so the main causes of deforestation, as reported by several studies (FEARNSIDE, 2001; MARGULIS, 2003, BARONA et al, 2010) and additionally the works of infrastructure (roads, ports, airports, warehouses, etc.), as Pfaff et al (2007).

Given this context, what it is to be pointed out, in line to the exposed by Homma (2012, p.108), is that:

> "In this space of five decades, the Amazon region has suffered great economic, social, political and environmental changes. The international repercussion of Chico Mendes' murder constituted in a watershed on the development model that had been developed in the Amazon. The holding of Rio 1992 put the environmental issue of the region on the global agenda, in which the reduction of deforestation and burning became charged in all international forums. "

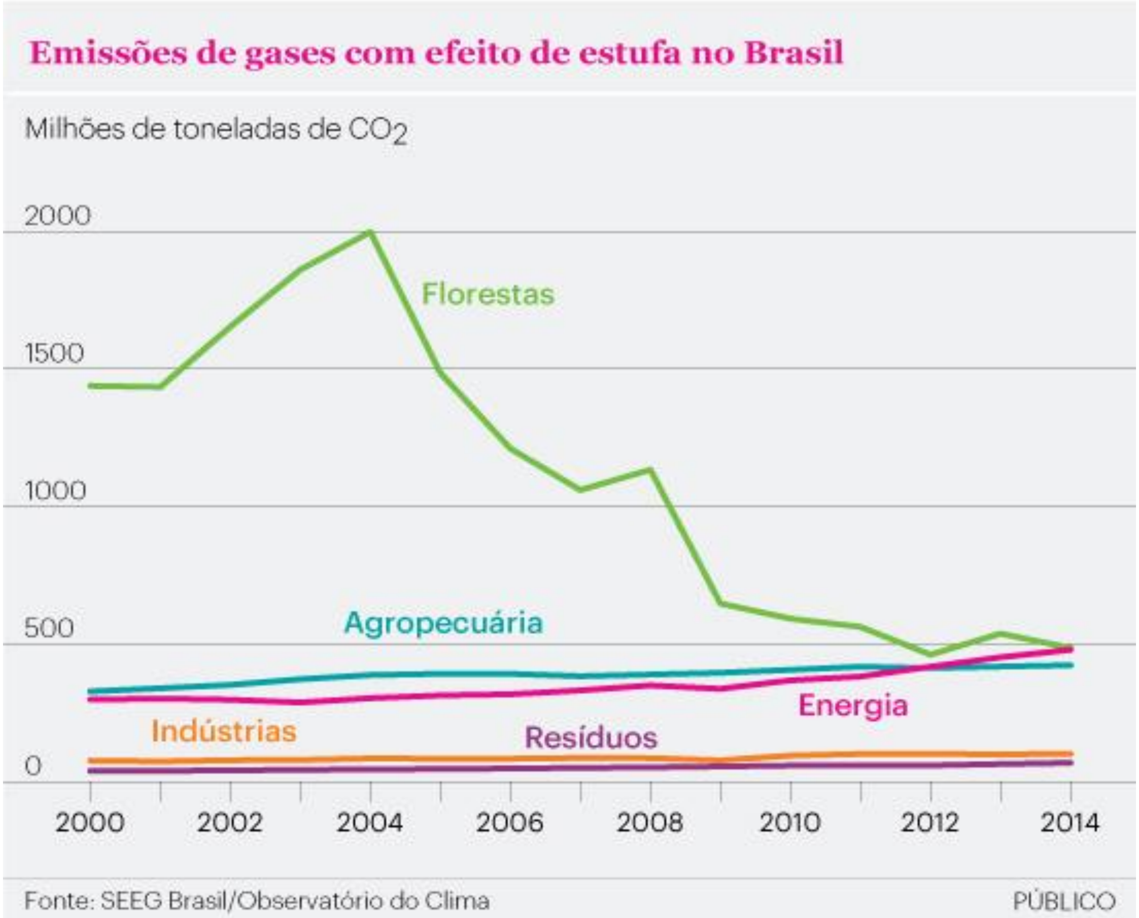
It is then from these facts that in recent years public policies proliferated to a new paradigm of Amazon exploration, which main goal is to reduce deforestation and have a sustainable agriculture. The classic example was the effort to approve the "new" Forest Code of 2012, which although it has reduced the restoration requirements of the modified area in the properties new mechanisms to deal with fire management, forest carbon and payments for environmental services were introduced, which may reduce (in the medium and long term) deforestation and bring environmental benefits. Still, there is an ongoing requirement for agricultural properties of the Rural Environmental Registry - CAR, as well as various financing programs for rural activities, aiming the restoration of the tropical forest at the areas that have already been changed.

In practice, all of this (re) starts in 2003, with the focus of combat deforestation through the creation of the Amazon Deforestation Combat Program (PPCDAm), from which new programs, projects and sustainable agricultural production processes are generated. Also, it is in 2000 that the number of forest reserves increased, either under sustainable use, such as Extractive Reserves (RESEX) or of sustainable timber exploitation in National Forests (FLONAS), through bidding processes.

In addition, there is the Amazon Fund, created in August 2008 by Decree 6527, as a result of a proposal by the Brazilian government presented at the 13th Conference of the Parties of the UN Convention on Climate Change. This Fund aims to finance control actions, monitoring and preventing of deforestation in the Amazon. However, the capture of this resource by the Government is subjected to proof of reduction of greenhouse gas (GHG) emissions from deforestation in the Amazon (MEDIA ..., 2014).

Whereas the major problems of the world today is poverty and pollution and that the first is the cause of the second, as well as the form of production and consumption of goods and services, Figure 1 presents, at the national level the main causes of GEE generation.

Figure 1: Greenhouse Gas Emission in Brazil**.**



It is clear, from the Figure above that - in fact, emissions from deforestation fall and can be exceeded by other sources of emissions, such as automobiles, industry and homes (SEEG, 2015). Finally, it is emphasized that higher CO_2 emissions, higher concentration of greenhouse gases in the atmosphere, which can cause climate changes or increase in average temperature in the climate system, resulting in global warming, bringing social, economic and environmental consequences from environmental disasters resulting from climate change.

2. THEORICAL BASIS AND METHODOGOLY

In this section, follow the methodological bases studies on i-o matrix inter-regional of Gonçalves Júnior and Guilhoto (2015) and how many the methodologies described with CO2 emissions, the studies of Imori et al (2011); Souza et al. (2015), Imori and Guilhoto (2016).

Developed by Leontief (1951), the input-output model shows the flows of goods and services among the sectors and agents of the economy for a given year. The inter-industries flows are determined by economic as well as technological factors and can be expressed through a system of simultaneous equations (MILLER and BLAIR, 2009).

In reason of the importance of the economical flows among regions, several recent studies have been contributing in the Inter-regional analysis, using, it broadly, the model of Leontief, of which Silva (2004) has prominence, Gonçalves Júnior and Guilhoto (2015), whose methodology proceeds closely, given the similarity of the research type or study in subject.

Besides, as well it stresses Leite and Pereira (2010) the "analysis input-outputis considered as important analytical instrument in the identification of the interdependence among the several sectors of the economy, as well as to know the productive structure and to analyze the impacts of economical politics, be of a country, a region, a state or smaller spaces."

In matrix terms the inter-industries flows in the economy can be represented by

$$AX + Y = X \tag{1}$$

where X is a vector (*n x 1*) and it contains the value of total production by sector; *Y* is also a vector (*n x 1*) and it contains the final demand values; and *A* is a (*n x n*) matrix which contains the production technical coefficient

In the model above, the final demand vector is usually considered exogenous to the system; thus, the total production vector is determined only by the final demand vector, which is given by:

$$Y = BX \tag{2}$$

$$B = \left(I - A\right)^{-1} \tag{3}$$

where B, the Leontief inverse, is a (*n x n*) matrix of direct and indirect coefficients, in which the element b_{ij} shows the total amount of production that is required from sector *i* to produce one unit of final demand of sector *j*.

From equation (3) one can estimate the output multipliers of type (I), which shows the direct and indirect effects for a given sector (MILLER and BLAIR 2009), i.e., the total amount of production generated in the economy to produce one unit of final demand of the given sector, and is given by:

$$P_j = \sum_{i=1}^{n} b_{ij} \tag{4}$$

where P_j is the output multiplier of sector *j*.

One can also estimate, for each sector in the economy, the total amount of employment, value added, emissions, etc, that is generated directly and indirectly in the economy to produce one unit of final demand of the given sector. In order to do so, one needs to calculate the direct coefficient of the variable of interest:

$$v_i = \frac{V_i}{X_i} \tag{5}$$

where v_i is the direct coefficient of the variable of interest of sector *i*; V_i is the total of the variable of interest corresponding to sector *i* (for example, total employment of sector *i*); and X_i is the value of total production of sector *i*.

Then, the total impact, direct and indirect, on the variable of interest will be given by:

$$GV_j = \sum_{i=1}^{n} b_{ij} v_i \tag{6}$$

where GV_j is the generator of the variable of interest corresponding to sector *j*, which represents the total impact, direct and indirect, on the variable of interest given a new final demand of one monetary unit in sector *j*.

Based on the Leontief system other indicators can be estimated and used to better understand the economic relations and the productive structure of a given economy. In this way, this chapter makes use of backward and forward linkages (Hirschman-Rasmussen and Pure), to better understand the productive structure of the six regions economics. These indicators are described and defined in the following sections.

2.1. THE HIRSCHMAN-RASMUSSEN APPROACH

The work of Rasmussen (1956) and Hirschman (1958) led to the development of indices of linkage that have now become part of the generally accepted procedures for identifying key sectors in the economy. Being b_{ij} a typical element of the Leontief inverse matrix, B; B^* the average value of all elements of B, and $B_{\bullet j}$ associated typical column sums, then the backward linkage index can be defined as follows:

$$U_j = [B_{\bullet j} / n] / B^* \qquad (7)$$

Defining F as the matrix of row coefficients derived from the matrix of intermediate consumption, *G* as the Ghosh matrix given by $G = (I - F)^{-1}$ (MILLER and BLAIR, 2009), G^* as the average of all elements of *G*, and G_{i*} as being the sum of a typical row of *G*, the forward linkages can be defined as:

$$U_i = [G_{i*}/n] / G^* \quad (8)$$

The Hirschman-Rasmussen indices of linkages measure the importance of a sector in the economy in terms of buyer (backward) or supplier (forward) of inputs. The Pure linkage approach presented below is similar to the Hirschman-Rasmussen, however it also takes into consideration the total production value of each sector in the economy, i.e., the size of the sector. The sectors indicated as the most important inside the economy, using the Pure linkage, in general are sectors with a great interaction among the other sectors and with a significant level of production.

In general the Hirschman-Rasmussen are concerned mainly with the technical coefficients, while the pure linkage also take into consideration the importance of the values supplied and demanded by each economic sector.

2.2 CALCULATION OF CO_2 EMISSIONS

2.2.1 Interregional model: Amazon and the other Brazilian regions

The interregional model was obtained according to the methodology presented in Guilhoto and Sesso Filho (2005a) and the Brazilian national table was estimated according to the methodology of Guilhoto et al (2010).

The definition of the two regions, Amazon (AMZ) and rest of Brazil (RBR), was based in the states that compose each of them. Thus, the flows related to the Amazon are the sum of the flows of the states of North region of Brazil (Acre, Amapá, Amazonas, Pará, Rondônia, Roraima and Tocantins), Mato Grosso and Maranhão. On the other hand, the sectorial definition was determined so that the relationship with GHGs emissions would be explicit. The final system is composed by 28 sectors and the aggregation is illustrated by the table below. The numbers presented therein will be maintained throughout this paper for simplicity.

Table 1 – Sectorial Aggregation

N°	Sectors
1	Agriculture
2	Petroleum and natural gas
3	Mining
4	Processing and preserving of meat
5	Other manufacture of food products
6	Manufacture of textiles clothing, leather and footwear
7	Wood products, except furniture
8	Oil refinery and coke
9	Alcohol distillery
10	Chemicals and chemical products
11	Rubber and plastic products
12	Manufacture of cement
13	Glass, ceramics and otherr non-metallic mineral products
14	Basic Metals and Fabricated Metal
15	Machinery, Nec
16	Electrical, electronics materials and other equipment
17	Transport Equipment
18	Manufacture of Furniture
19	Other manufacturing
20	Electric power generation, transmission and distribution
21	Water supply, sewage and cleaning
22	Construction
23	Wholesale and retail trade
24	Transport and postal services
25	Information and communication
26	Other service activities
27	Public health and education
28	Other public services

Source: Research Data

2.2.2. Brazilian greenhouse gas emissions

The data source for emissions was the second Brazilian Inventory of Anthropogenic Emissions and Removals of Greenhouse Gases, elaborated by the Ministry of Science and Technology and published in the late 2010. In general terms, the Inventory classifies the emissions in those resulting from use of energy, industrial processes, land-use change, agriculture and waste management. In the present paper, one will analyze the emissions of the GHGs Carbon Dioxide (CO_2), Methane (CH_4).

In order to aggregate the mentioned emissions – and also those of Perfluorocarbons (PFCs) and Sulfur hexafluoride (SF6) – in units of CO_2 equivalent, two alternative metric will be utilized: the 100 years Global Warming Potential (GWP) and the 100 years Global Temperature Potential (GTP). The Brazilian Ministry of Science and Technology argues that the GWP (based on the relative importance of GHGs in relation to CO_2 in the production of a certain amount of energy per unit area) does not fairly represent an appropriate relative contribution of different GHGs to climate change. The use of GWP, then, would provide inadequate mitigation policies. Moreover, its use would greatly and mistakenly emphasize the importance of GHGs with short period of permanence in the atmosphere, especially CH_4. Thus, the Brazilian Ministry presents the GTP as a more appropriate metric to measure the effects of different gases on climate change, despite the greater uncertainty in its calculation due to the requirement of considering the sensitivity of the climate system (Ministry of Science and Technology, 2010).

An important point is that emissions from the residential subsector, that is, families, were discarded, since the focus of the work is those resulting from economic activities. Among the emissions from the residential subsector, there are those produced by passenger cars, responsible for approximately 2.2% of the Brazilian CO2 emissions in 2005.

Another important point is that the sectorial aggregation provided by the Inventory is different from that adopted by this work, with different numbers, aggregation and sorts of sectors. Emissions, therefore, had to be distributed among the sectors of our input-output model.

Special attention was needed for the emissions resulting from land-use change, since, as previously indicated, it is responsible for almost 60% of GHGs emissions in Brazil[2]. The Inventory presents the emissions of this kind by biome. Thus, those coming of the Amazon are already separated from the others. In order to allocate the emissions to the agricultural sectors of the input-output model (Sugarcane, Soybean, Cattle and Other Activities of Agriculture and Livestock), one considered the variation of the areas occupied by each of them in state level. It was assumed that such variation is representative of the deforestation, and that emissions are released equally per hectare in each biome.

In the case of agricultural crops, estimation of the deforested area was based on variation of the areas in hectares of temporary and permanent crops between years 2004 and 2005. These data were obtained at the state level from the Municipal Agricultural Survey of IBGE (Brazilian Institute of Geography and Statistics). For the Cattle sector, the implemented method was different, since there is not available annual data on pasture area. From the Census of Agriculture 2006, of IBGE, one obtained the pasture area occupied per bovine animal in state level, which was multiplied by the variation in the number of bovines between 2004 and 2005. Furthermore, the raising of other animals occurs predominantly in sheds (especially poultry and pigs), not causing, in a

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[2] Emissions related to land-use change are largely caused about by deforestation in Brazil. In the Amazon biome, 97% of the emissions in the period 1994-2002 were due to the conversion of forests in agricultural land (Ministry of Science and technology, 2010). One should point that, for the year 2005, only data relative to total liquid emission due to land-use change is available. Because of this, the present work underestimates the emissions resulting from land-use change, since the carbon capture resulting from the maintenance of forests was computed in the liquid emissions, which were allocated to the different productive sectors.

short period of time, deforestation. Thus, they were disregarded as causes of land-use change.

Having obtained the variation of the occupied areas for crop and rising of Sugarcane, Soybean, Cattle and Other Activities of Agriculture and Livestock, emissions resulting from land-use changes were weighted among these sectors. The importance of each sector in terms of emissions will be evaluated by its input-output indicators.

2.4 DATABASE

Table 2 presents information on the two regions, with emphasis on the most important ones: Legal Amazônia showing their socioeconomic picture and a reference map. The main regions are formed by 771 municipalities with a population of close to 25 million, and Indice de Gini is igual for all regions.

Table 2: Economical and social information of the two regions, Brazil (2009)

Regions	Area km^2	Pop Density (hab/km^2)	Population millions	GDP (R$ millions)	Per capita GDP	IGINI	Cities
AMAZ	5.217.423,000	4,74	24.728.438	260.357	10.528,83	0,53	771
RBR	3.298.344,049	50,56	166.752.192	2.979.047	17.865,14	0,53	4.794
BRAZIL	8.515.767,049	22,49	191.480.630	3.239.404	16.917,63	0,53	5.565

Source: Research data

Legend

AMAZ – region of Legal Amazônia

RDB - The Rest of Brazil

Figure 2: Map of the regions in analysis

Source: https://www.google.com.br/search?q=mapa+da+amazônia+legal

The interregional input-output system used in this paper was derived from the NEREUS (University of São Paulo Regional and Urban Economics Laboratory) database which consists of the Brazilian Interregional Input-Output System estimate for all the 5.565 Municipalities of the Brazilian economy, at the level of 134 industries and 187 commodities, for the year of 2009.

3 ANALYSIS AND DISCUSSION OF THE RESULTS

In this section the analysis of the results in two parts. The first part concerns the economic structure of the two regions and second, issuing demand analysis of greenhouse gas emissions from burning fossil and due to enteric fermentation of cattle.

3.1 KEY SECTORS

The intersectorial flows in a given economy are determined by technological and economic factors, and can be described from the basic model of Leontief, as previously described. With the Leontief matrix calculated, it can be determined what are the sectors with the greatest power of chaining within an economy, that is, it calculates its indices of back links, which would provide how much a sector would require from others, as well as the bond indices forward, which would provide the amount of demanded products from other sectors of the economy for the relevant sector (GUILHOTO, 2011). The indexes back and forward are called Rasmussen (1956) and Hirschman (1958). Values greater than one for these indices are related to above-average sectors, i.e, key sectors of the economy.

In terms of sectors which demand from other sectors, both AMAZ region as the ROB had 16 sectors, which corresponds to 57.14% of the total examined sections. As for the sectors that are demanded, or the forward effect of IHR, the number is smaller in the two regions 13 and 15 respectively.

In the Table below, only the key sectors are observed, in restricted terms, for the two regions, ie, sectors that have the back IHR and forward of more than one unit.

Table 3: Key sectors in the two analyzed regions, 2009

	AMAZ		**RDB**	
Sectors	IHR BACKWARD	IHR FORWARD	IHR BACKWARD	IHR FORWARD
Petroleum and natural gas	**1,02**	**1,80**	**1,01**	**1,51**
Oil refinery and coke	**1,16**	**1,37**	**1,15**	**1,30**
Alcohol distillery	**1,14**	**1,12**	**1,12**	**1,11**
Chemicals and chemical products	**1,17**	**1,38**	**1,07**	**1,20**
Rubber and plastic products	**1,09**	**1,41**	**1,05**	**1,36**
Manufacture of cement	**1,10**	**1,23**	**1,08**	**1,27**
Glass, ceramics and other non-metallic mineral products	**1,03**	**1,20**	**1,01**	**1,22**

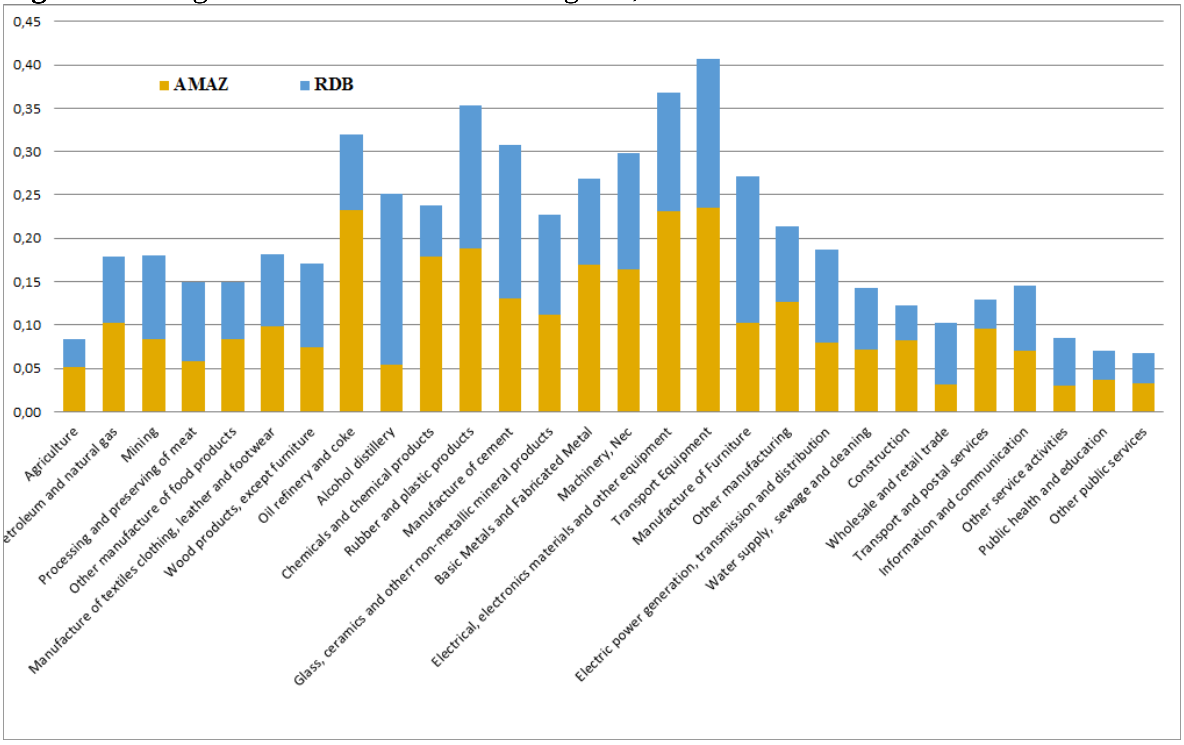
Source: Research data

Seven key sectors in the economy of the two regions, which would signal to incentives, through the government - through public policies, encourage them as they will have greater chances to boost the regional economy with supply and demand of goods and services.

3.2 TAX GENERATORS, VALUE ADDED AND EMPLOYMENT

To Guilhoto (2000), from the coefficient of interest variables (tax, added value, employment, etc.), you can estimate the generator of these variables, ie, how much it is necessary from these in all sectors of the economy to meet the increase in a monetary unit in the final demand for that sector. In Figure 3 it is presented the tax generation for the two regions in focus.

Figure 3: Tax generators in the Brazilian regions, MIP-2009

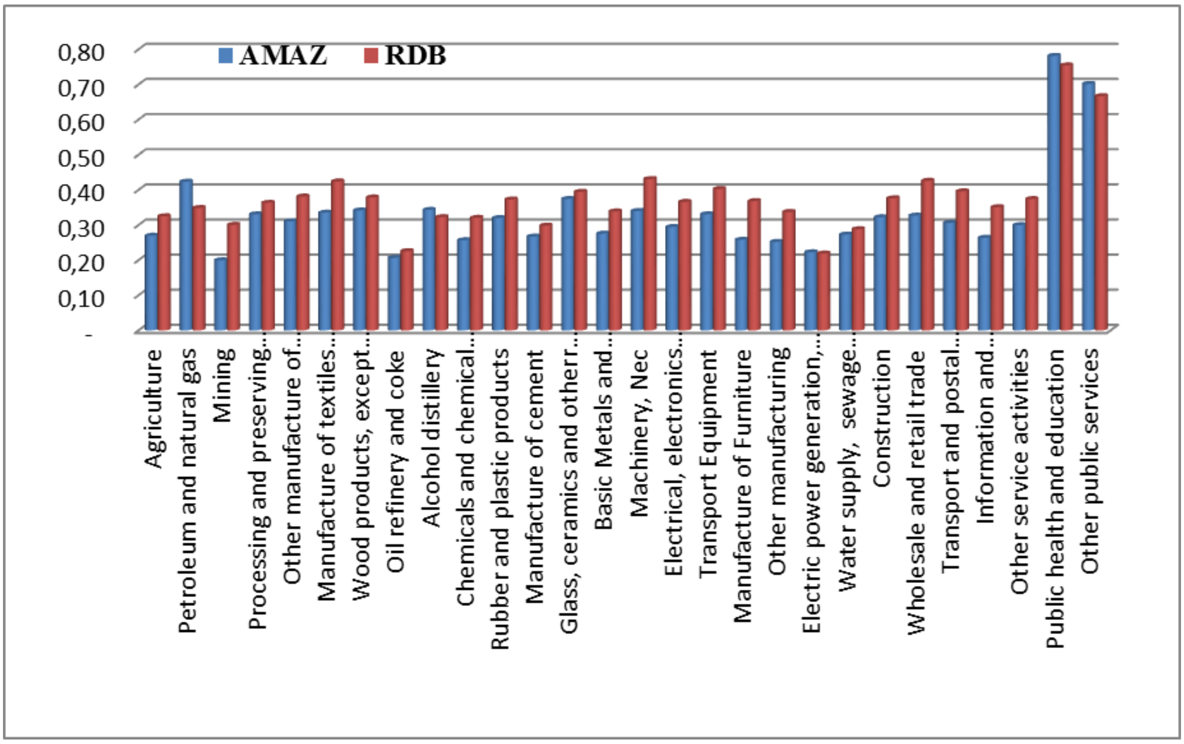


Source: Research data

As it is seen in Figure 3, the AMAZ region, comparatively, generates more taxes than the ROB to meet the change of a monetary unit in the final demand. And, the sectors that most respond to generate taxes in both regions are Transport Equipment and Alcohol distillery and the smallest would be linked to public services.

As for wages generators, which corresponds to compensation of employees, the sectors that best remunerate in both regions (AMAZ and ROB) are public services (health and education, followed by other public services). With low wages are Mining (0.20) in the AMAZ and Electric power generation, transmission and distribution (0.22) in the ROB. Therefore, the change in currency in final demand impact positively in these sectors and hence the economy as a whole, since it increases the power of consumption of the mass of employees (Figure 4).

Figure 4: Wages generators in the Brazilian regions, MIP-2009

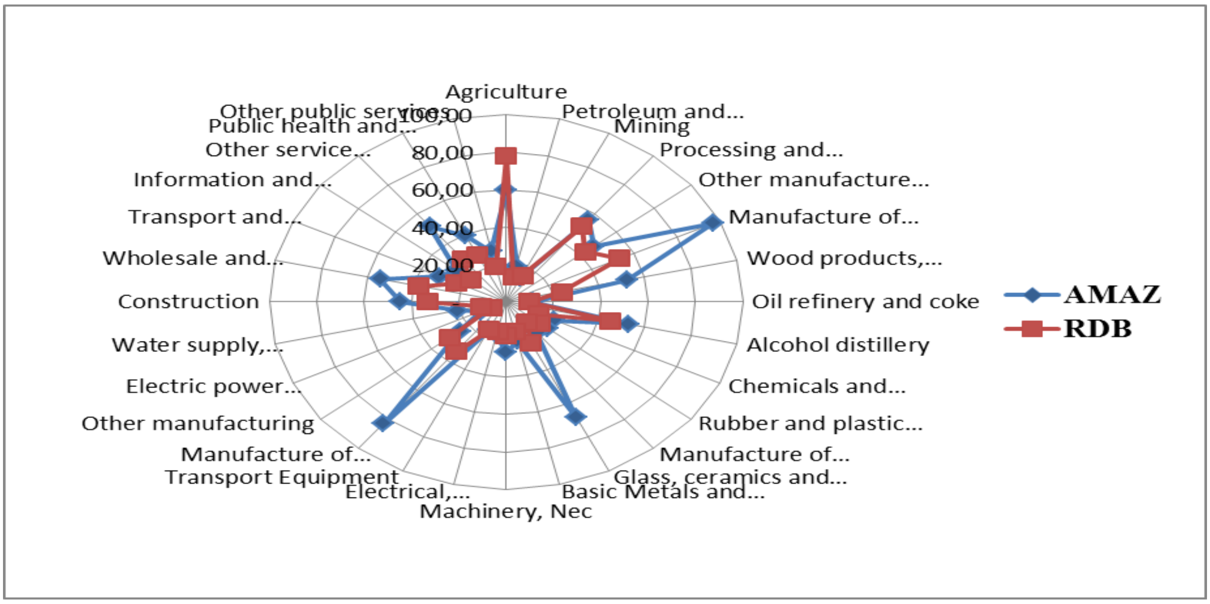


Source: Research data

Another highlight to make of this generator (wages) is that for the ROB the values on average are higher than the ones in the AMAZ as it is displayed in Figure 4.

The generation of jobs, indicating the ability to generate jobs in the sector to meet the variation of one currency, the AMAZ region on average generates more jobs than the RDB region, in the order of 37 and 27 jobs, respectively. Perhaps this fact is explained due to the expansion of productive activities in the states of the Brazilian Amazon. In terms of ranking, in the AMAZ region the highlight at job creation, for each sectoral currency unit is: Manufacture of textiles clothing, leather and footwear (97 jobs); Manufacture of Furniture (83 jobs); Glass, ceramics and other non-metallic mineral products (83 jobs). For the ROB region, major impacts to generate direct and indirect employment are: Agriculture (78 jobs); Manufacture of textiles clothing, leather and footwear (53 jobs) and Processing and preserving of meat (52 jobs), as it is shown in Figure (5).

Figure 5: Job Generators in the two Brazilian regions (AMAZ and ROB), MIP-2009

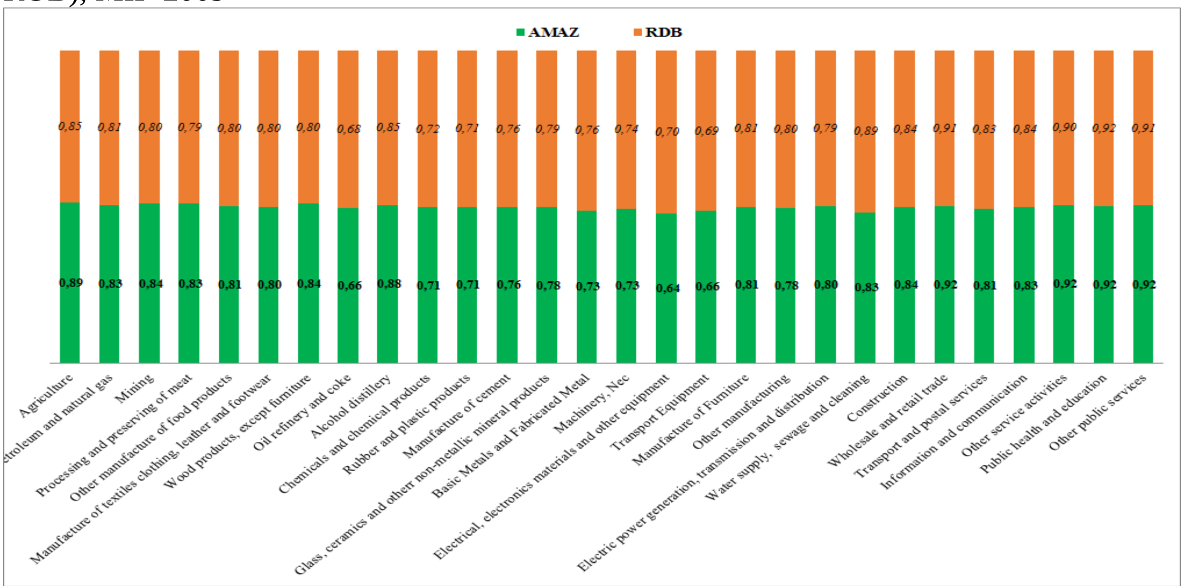


Source: Research data

The added value generator refers to the increase in the added value in the economy as a whole when it rises in the sector itself in a currency. The added value refers to the sum of remuneration, gross operating surplus and taxes (AZZONI, et al 2015). Referring to Figure 6, we observe the sectors of AMAZ and ROB recorded average equal in added value (0.80).

However, some sectors that stand out for both regions (AMAZ and ROB), respectively were: Wholesale and retail trade (0.92, 0.91); Other service activities (0.92; 0.90), Public health and education (0.92; 0.92); Other public services (0.92; 0.91).

Figure 6: Added Value generators in the two Brazilian regions (AMAZ and ROB), MIP-2009



Source: Research data

3.3 DEMAND EFFECTS ON GREENHOUSE GASES

Table 4 shows CO_2 eq. emissions, in Gg, due to burning of fossil fuels and enteric fermentation of cattle for both two regions, after the compatibility of Input-Output Matrices (2009 Base) with the Emissions Matrix of the Ministry of Science and Technology (MCT, 2014) according to the methodology of Montoya et al (2014). As described in Table 4, because of the size in volume and territorial extension and economic activities, the ROB region is always higher than the AMAZ, having the largest emitters the three basic sectors of any economic activity in a society: Agriculture (38.76%); Transport and postal services (22.20%) and Basic Metals and Fabricated Metal (11.80%), which together account for 72.76% in national level. In the region of the AMAZ, Agriculture corresponds to 79.80% of emissions, largely due to cattle, indicating the intensive use of primary activity in the region.

Table 4: CO_2eq emissions (GWP) in Gg - due to the burning of fossil fuels and enteric fermentation of cattle

Order	Sectors	**AMAZ total - CO_2eq**	**ROB total - CO_2eq**
1	Agriculture	**89,463.44**	**167,199.70**
2	Petroleum and natural gas	17.76	975.34
3	Mining	1,960.28	5,951.46
4	Processing and preserving of meat	251.26	1,077.25
5	Other manufacture of food products	397.94	3,926.20
6	Manufacture of textiles clothing, leather and footwear	21.77	1,766.36
7	Wood products, except furniture	1,719.56	19,575.71
8	Oil refinery and coke	641.21	11,418.91
9	Alcohol distillery	16.78	486.44
10	Chemicals and chemical products	302.93	13,598.03
11	Rubber and plastic products	130.96	2,476.79
12	Manufacture of cement	794.30	8,168.69
13	Glass, ceramics and otherr non-metallic mineral products	277.47	5,660.65
14	Basic Metals and Fabricated Metal	**3,779.82**	**50,900.96**
15	Machinery, Nec	13.39	1,608.46
16	Electrical, electronics materials and other equipment	373.62	2,149.00
17	Transport Equipment	239.75	3,942.34
18	Manufacture of Furniture	9.50	359.79
19	Other manufacturing	18.43	209.55
20	Electric power generation, transmission and distribution	1,154.68	9,726.93
21	Water supply, sewage and cleaning	339.68	4,711.09
22	Construction	167.45	1,409.22
23	Wholesale and retail trade	318.40	3,552.75
24	Transport and postal services	**8,665.07**	**95,783.73**
25	Information and communication	43.92	919.19
26	Other service activities	352.61	6,678.18
27	Public health and education	186.37	1,518.43
28	Other public services	587.46	5,648.54
	TOTAL EMISSIONS	112,245.80	431,399.68

Source: Research data

Following (Table 5), we have the emission in each of the regions when a change in the final demand of R $ 1 million in the sectors of the AMAZ region occurs. The change in the final demand of the AMAZ Agriculture sector is the one which leads to greater emission of CO_2 eq, mainly in the own region (96.69% of emissions). The overflow for the RDB region is in general residual. The Processing and preserving of meat sector had the highest record of CO_2e emission overflow to the ROB (35.97% of emissions).

Table 5: CO_2 eq emissions (GWP) in Gg - due to variation in final demand of R $ 1 million in the sectors of the AMAZ.

Sector (Δ% Final Demand)	Emissions in AMAZ (Gg de CO_2eq)	Emissions ROB (Gg de CO_2eq)	Total Emissions (Gg de CO2eq)
Agriculture	1.7909	0.0612	1.8521
Petroleum and natural gas	0.0692	0.0526	0.1218
Mining	0.2087	0.0473	0.2559
Processing and preserving of meat	0.5445	0.3059	0.8504
Other manufacture of food products	0.5321	0.1767	0.7088
Manufacture of textiles clothing, leather and footwear	0.1190	0.0605	0.1795
Wood products, except furniture	0.2969	0.0963	0.3933
Oil refinery and coke	0.1109	0.0760	0.1868
Alcohol distillery	0.7579	0.1536	0.9115
Chemicals and chemical products	0.1392	0.0818	0.2209
Rubber and plastic products	0.0804	0.0724	0.1527
Manufacture of cement	0.8200	0.0760	0.8959
Glass, ceramics and otherr non-metallic mineral products	0.2355	0.0634	0.2989
Basic Metals and Fabricated Metal	0.3885	0.0955	0.4840
Machinery, Nec	0.0883	0.0925	0.1808
Electrical, electronics materials and other equipment	0.0504	0.0705	0.1209
Transport Equipment	0.0470	0.0816	0.1286
Manufacture of Furniture	0.0948	0.0590	0.1539
Other manufacturing	0.0556	0.0887	0.1443
Electric power generation, transmission and distribution	0.1253	0.0377	0.1630
Water supply, sewage and cleaning	0.1173	0.0466	0.1639
Construction	0.0529	0.0703	0.1232
Wholesale and retail trade	0.0298	0.0197	0.0495
Transport and postal services	0.4573	0.0477	0.5050
Information and communication	0.0268	0.0278	0.0546
Other service activities	0.0290	0.0209	0.0500
Public health and education	0.0202	0.0188	0.0390
Other public services	0.0258	0.0153	0.0411

Source: Research data

Another way of reading Table 5 can be made as follows: to meet final demand of R $ 1 million by the AMAZ Agriculture sector, the sectors of the own region emit 1.7909 Gg of CO_2eq, while the sectors of the ROB emit 0.0616 Gg of CO_2 eq more, totalizing 1.8521 Gg of CO_2eq in the total process in the country.

In Table 6, we have the emission of the regions when there is variation in the final demand of R $ 1 million in the sectors of the ROB region. The variation in the final demand that leads to higher emissions of CO_2 eq is the Agriculture sector, with most of the effect (96.36%) in the own region. The overflow for the AMAZ region is residual, except for the Processing and preserving of meat sector, which had the highest registration overflow of CO_2eq (24.03% of that sector). However, it is worth noting that, in comparative terms, the AMAZ region emits higher amount of CO_2eq (GWP) in Gg than the ROB region. Such justification is due to the expansion of the agricultural frontier, where the request of inputs, low-tech and waste of production resources are common in the border region.

Table 6: CO_2 eq emissions (GWP) in Gg - due to variation in the final demand of R $ 1 million in the ROB.

Sector (Δ% Final Demand)	Emissions in AMAZ (Gg de CO_2eq)	Emissions ROB (Gg de CO_2eq)	Total Emissions (Gg de CO_2eq)
Agriculture	0.0328	0.8675	0.9003
Petroleum and natural gas	0.0056	0.1130	0.1186
Mining	0.0068	0.2663	0.2731
Processing and preserving of meat	0.1476	0.4666	0.6142
Other manufacture of food products	0.0824	0.3363	0.4188
Manufacture of textiles clothing, leather and footwear	0.0427	0.0925	0.1351
Wood products, except furniture	0.0272	0.3610	0.3882
Oil refinery and coke	0.0064	0.1752	0.1816
Alcohol distillery	0.0502	0.4498	0.5000
Chemicals and chemical products	0.0164	0.1688	0.1851
Rubber and plastic products	0.0096	0.1352	0.1448
Manufacture of cement	0.0067	0.8832	0.8899
Glass, ceramics and otherr non-metallic mineral products	0.0110	0.2733	0.2843
Basic Metals and Fabricated Metal	0.0080	0.4739	0.4819
Machinery, Nec	0.0098	0.1695	0.1793
Electrical, electronics materials and other equipment	0.0078	0.1259	0.1337
Transport Equipment	0.0062	0.1429	0.1490
Manufacture of Furniture	0.0125	0.1331	0.1456
Other manufacturing	0.0154	0.1199	0.1353
Electric power generation, transmission and distribution	0.0069	0.1534	0.1603
Water supply, sewage and cleaning	0.0026	0.1282	0.1308
Construction	0.0060	0.1154	0.1214
Wholesale and retail trade	0.0026	0.0491	0.0517
Transport and postal services	0.0039	0.4880	0.4919
Information and communication	0.0036	0.0450	0.0487

Other service activities	0.0068	0.0439	0.0508
Public health and education	0.0040	0.0387	0.0427
Other public services	0.0032	0.0407	0.0438

Source: Research data

To get an overview of the emissions in the 2009 economic system, by the two regions in question, there is Table 7, where we can note the total requirements at the level of domestic consumption, as well as to meet the foreign market.

Table 7: Necessary Requirements of CO_2eq (Gg) emission to meet domestic demand and the rest of the world in 2009.

Emissions to satisfy:	Domestic Demand AMAZ	Domestic Demand ROB	Exports AMAZ	Exports ROB
In AMAZ (Gg de CO_2eq)	23,645	52,655	27,818	8,007
In ROB (Gg de CO_2eq)	22,307	322,425	3,679	82,298
Shares of emissions:	**Domestic demand AMAZ**	**Domestic demand ROB**	**Exports AMAZ**	**Exports ROB**
AMAZ	21%	47%	25%	7%
ROB	5%	75%	1%	19%

Source: Research data

For the above Table, it appears that in 2009 emissions of CO_2 eq generated in the AMAZ to meet the demand itself were close to the necessary for what this region exported, i.e., 21% and 25%, respectively, of total emissions of CO_2eq in the region. To meet the domestic demand of the ROB, the AMAZ delivered greater amount of CO_2eq (52,655 Gg) or 47% of the total emissions in the region.
As for the ROB region, this emitted greater amount of CO_2eq (75% of the total of the region) to meet its own demand (intern) and 19% to export. Thus, the requirements in terms of emissions in this region to meet the AMAZ in terms of domestic and foreign markets are relatively low (5% and 1%, respectively).

4 CONCLUSION

In this work we tried to make an analysis of the intensity of carbon dioxide emissions from the burning of fossil fuels and enteric fermentation of cattle in 28 sectors of two Brazilian regions, called Legal Amazon (AMAZ) and the Rest of Brazil (ROB), using the 2009 MIP, coming from the NEREUS Laboratory (USP-SP). We followed the guidelines of other works that have addressed the issue, highlighting IMORI and Guilhoto (2016). Firstly, we analyzed the economic structure of the two regions (AMAZ; ROB) by the basic indicators, such as inter-sector bond indices (Hirschman-Rasmussen) and analysis of employment generators, taxes, salaries and added value. In sequence an environmental analysis was done when the Gg CO_2eq emission in final demand level of variation (R $ 1 million) and service of domestic and external requirements and eternal for the two regions.

The importance of this study is to put in question the policies developed over the last 15 years to the Amazon region, since the primary activities are the main responsible for the emission of CO_2 and CH_4, the main gases responsible for the greenhouse effect, which ultimately produce changes in climate. Therefore, the primary sector - for the two regions in question, which most emitted such gases were Agriculture, and the AMAZ region emits relatively more than the ROB, given the expansion of the agricultural frontier since the 70s. However, it is noteworthy in the medium and long term, this scenario is likely to change, as many public policies have been taken to curb deforestation and the non-sustainable production in the Legal Amazon. Thus, we can mention the programs for this purpose, as legal farming, increase in the environmental reserves, green city program and even the requirement of the Environmental Rural Register elaboration, as well as resources (funding) for forest replanting, as the North Constitutional Financing Fund (FNO) and the Amazon Fund.

In this context, institutional governances need to work and strengthen together so that the command and control process at the level of environmental legislation is complied with for the referred region, since in the ranking of the 25 world's largest CO_2 emitters (derived from fossil fuels and cement production, not counting the fires), Brazil was in the 13th place, which made the Brazilian government be involved and committed in international forum in reducing the emission of greenhouse gases.

Regarding the issue of analyzed gases (CO_2, CH_4, Fossils gases) by 28 sectors, the greatest demand is to meet the domestic market, both AMAZ as ROB, the demand of the foreign market.

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