The increase in Brazilian household income and its impact on CO_2 emissions: evidence for 2003 and 2009 from input-output tables

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Abstract

In recent years, Brazil has experienced economic growth and the recovery of income that has had a positive impact on the consumption of goods. In this paper, we evaluate the impact of household consumption on the CO_2 emissions in Brazil for the years of 2003 and 2009. We measure this impact with input-output tables from World Input-Output Database. Households are divided into eight consumption groups and eight income class. The input-output model is closed to the household. We apply a hypothetical extraction method to the consumption structure of each income class. This method provides the weight of the consumption basket of each household on the pollution in a systemic environment. We find that there is a trade-off between the households' greater satisfaction from consumption and the increasing setback in emissions from the restructuring and modification of the consumption basket. Thus, this study contributes to the research on emissions by mapping the recent behavior of the Brazilian economy in terms of increased income, changes in the consumption structure, and their impacts on emissions. The paper's aggregated results by income and consumption structure based on the intensity of the emissions and their systemic effects adds to the discussions on less polluting production processes, more conscious consumption of goods, and more rational uses of energy and transportation.

***Keywords*:** CO_2 emissions, household consumption, input-output analysis.

JEL Classification: D12; D57; C67; Q40; Q50.

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HIGHLIGHTS

- We map the recent behavior of the Brazilian economy in terms of increased income.
- We evaluates the impacts of household consumption on CO_2 emissions.
- The Transportation sector has the greatest impact for all household income groups.
- The emissions from food industry is more pronounced in the lower consumption classes.
- The results are partly due to the intensity of emissions and systemic effects.

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1. Introduction

The increasing levels of greenhouse gas (GHG) have existed since the beginning of industrialization. Therefore, the concentration of these gases in the atmosphere and the problems surrounding that concentration have increasingly become a focus of attention. In this context, an extensive amount of literature discusses the issues related to the emission of these gases. The literature focuses on two different aspects, for example: first the assignment of the responsibility for the emissions to producers and second, the assignment of the responsibility to consumers.

Two important questions have motivated recent studies: How to assign the responsibility for emissions? What economic agent is to be blamed? For example, Wyckoff and Roop (1994), Schaeffer and De Sá (1996), Lenzen (1998), Machado et al. (2001), Munksgaard and Pedersen (2001), Peters and Hertwich (2004), Lenzen, Pade and Munksgaard (2004), Gallego and Lenzen (2005), Hoekstra and Janssen (2006), Peters and Hertwich (2006), Turner et al. (2007), Wiedmann et al. (2007), Peters (2008), Davis and Caldeira (2010), Davis, Peters and Caldeira (2011), Carvalho, Santiago and Perobelli (2013), and Wiebe et al. (2012) are some of the numerous studies that show significant contributions to these areas.

In line with the discussion on the allocation of responsibility for GHG emissions, there is a great deal of debate on the issues inherent to the relation between household consumption and emissions. As discussed by Weber and Perrels (2000), a lifestyle influences the consumption of goods and energy and how "time" is spent, which in turn directly influences the pattern of emissions.

The attention paid to household consumption is primarily because of the fact that private consumption represents a major proportion of the final demand in most economies (Weber and Perrels, 2000; Hertwich, 2011). Thus, household consumption plays an important role in the diversity and volume of the produced commodities. In addition, as discussed by Weber and Perrels (2000), a detailed model of

the pattern in household consumption offers increased possibilities to account for the effects of non-economic influences on the direct and indirect use of energy that is related to household emissions.

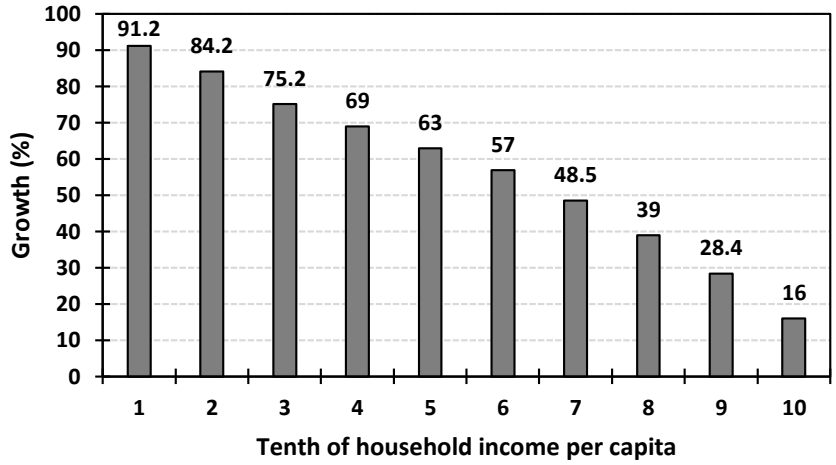
Recently, many studies link the consumption choices of households to energy through integrated input-output models; for example, Lenzen (1998), Mukhopadhyay and Chakraborty (1999), Wilting et al. (1999), Munksgaard et al. (2000), Wier, Lenzen and Munksgaard (2001), Wier et al. (2001), Lenzen and Dey (2002), Lenzen, Dey and Foran (2004), Lenzen et al. (2006), Kerkhof, Benders and Moll (2009), Kerkhof et al. (2009), Drunckman and Jackson (2009, 2010), Washizu and Nakano (2010), and Das and Paul (2014). Further, Cohen et al. (2005) asks the following questions: "What is the relationship between energy intensity and household expenditure?"; "Does the average household consume more energy directly through the purchase of energy itself than indirectly through the purchase of goods and services?" While the contributions of this literature are as diverse as possible, the empirical evidence needs more work on explaining how a structural change in income impacts GHG emissions. This is important for the formulation of public policies.

In recent years, Brazil has experienced economic growth and the recovery of income. The increase in income has had a positive impact on the consumption of goods. Furthermore, this increase in consumption has had positive multiplier effects on the economy, because the economy has had to offer more goods to meet the new and growing demand. On the one hand, structural change creates a favorable environment for the consolidation of a strong economy. This change in consumption and consequently the production process is often coupled with a higher level of pollution. Although seemingly unrelated issues, the evaluation of the impacts of variations in income on the level of emissions are correlated.

In Brazil, as discussed by Neri and Souza (2012), income growth between 2001 and 2011 is evident.

Figure 1shows the growth of per capita household income divided into deciles of income. This figure shows that the lower income classes had higher growth in per capita incomes. This growth was greater than 50% up to the sixth decile.

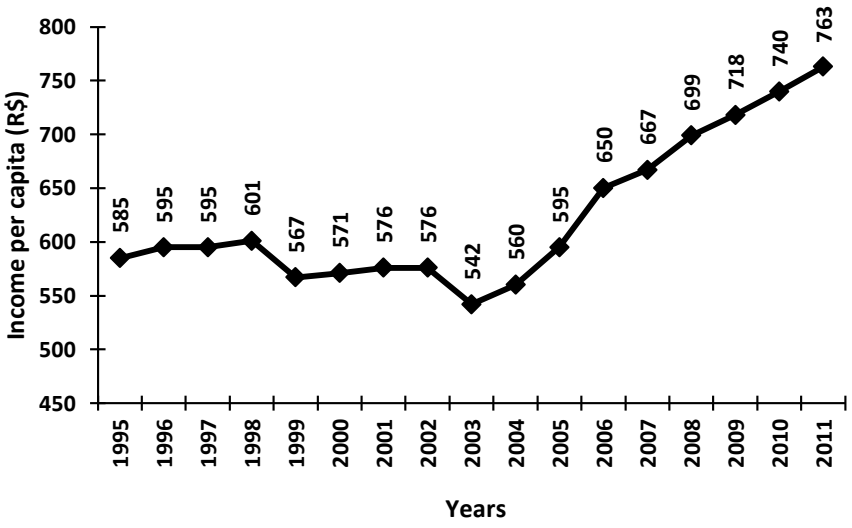
Figure 1 – Growth of household income per capita (2001-2011)



Source: Neri and Souza (2011) based on the data from PNAD

Figure 2 shows the evolution of the average income for a period of 16 years. The average income grew mainly from 2003 to 2011.

Figure 2– Average income (R$)



Source: Neri and Souza (2011) based on the data from PNAD

Thus, given the evident variation in income levels in Brazil and to those related to household consumption and emissions, this study aims to assess the impact of household consumption on GHG, more specifically on the emissions of carbon dioxide (CO_2). The households are divided into eight consumption intervals based on the data from the Household Budget Survey (POF) and into eight income classes based on the National Household Sample Survey (PNAD)[4]. These data provide the basis to disaggregate the consumption vector of the households and the vector of wages in the input-output table. The input-output tables are used for the years 2003 and 2009 in order to harmonize with the POF.

Because we seek to assess the impact of household consumption on GHG levels, we use a hypothetical extraction method on the expenditure structure. The use of such method is justified to allow for the quantification of the interdependence between the sectors of the economy in terms of CO_2 emissions. The main idea behind this method is that hypothetically extracting one household group of income makes it possible to check how the products change, and therefore, how the emissions change. Because we have different income classes and therefore different preferences in consumption for a time horizon, the extraction of each one shows the relative importance of each consumption structure for emissions in Brazil. Therefore, the method used aims to provide arguments on the weight of the consumption preferences for each household on the pollution in a systemic input-output environment. In other words, in the extreme case, if there is no consumption by a particular income class, how much of a reduction in emissions would be achieved. Answering this question could identify the relative importance of each income class to the pollution process and the relation between consumption and pollution.

Besides this introduction, the paper is organized as follows: the second section provides a description of the methods and the database; the subsequent section presents the results; and the fourth section presents the final remarks.

[4] POF - Pesquisa de Orçamento Familiar. PNAD - Pesquisa Nacional de Amostra Domiciliar. Further details can be observed in the next section.

2. Methods and database

2.1. Hypothetical extraction method

According to Miller and Blair (2009) the objective of the hypothetical extraction method is to quantify how the total output of an economy with *n* sectors might change (e.g., decrease) if a particular industry or sector, the *j-th*, is removed from the economy. This extraction can be performed in three ways: a) the total extraction of an industry (or an agent) — columns and rows; b) extraction of the consumption structure (backward linkages) — extraction of the columns; and c) the extraction of the sales structure (forward linkages) — extraction of the rows. We are interested in the extraction of the consumption structure.

Consider the general case of a closed input-output model for households with *n* productive sectors and *m* households. In this model with endogenous households, the matrices have the following dimensions: *(n+m)x(n+m)*.

The model is given by

$$x^* = A^* x + f^* \tag{1}$$

where *x** is a column vector of output with *(n+m)*-elements, *A** is a matrix *(n+m)x(n+m)* of input coefficients, and *f** is a column vector of final demand with *(n+m)*-elements.

The solution to Equation 1 is

$$x^* = (I - A^*)^{-1} f^* \tag{2}$$

where $B^* = (I - A^*)^{-1}$ is the Leontief inverse matrix. Equation 2 induces the impacts of the hypothetical extraction of a particular agent. In this paper, we extract the consumption structure of each household group. Thus, generically, the *j-th* household group does not acquire inputs from the productive sectors; that is, we extract the backward linkages.

The new matrix A^* is represented by $\bar{A}^*_{(cj)}$ that is the hypothetical extraction of the *j-th* column from matrix *A*.

Therefore, the solution to this problem is

$$\bar{X}^*_{(cj)} = \left[I - \bar{A}^*_{(cj)}\right]^{-1} f^* \tag{3}$$

Comparing Equations 2 and 3, we can calculate the impacts of the extraction of the backward linkages from $i'x^* - i'\bar{x}^*_{(cj)}$, that is, a measure of the total backward linkage for the sector *j*. The result can also be disaggregated by sectors in which each element of the vector $x_i - \bar{x}^*_{(cj)i}$ shows the backward dependence of the sector or agent *j* relative to sector *i*.

2.2. Impact on emissions

The hypothetical extraction method provides the impact on production from the extraction of the households' consumption structure. The method's results can be interpreted as the change in the output of the economy due to that extraction. Therefore, to verify the impacts on emissions it is necessary to interpret the decrease in production in terms of emissions. To do this, we use the following emission intensity vector (e_i),

$$e_i = \frac{E_i}{X_i} \tag{4}$$

where E_i is the sectorial CO_2 emissions, and X_i is the sectorial total output.

The impact of the extraction of each household group on emissions is

$$Emissions^I_i = diag(e^I_i) * \left(x^{*I}_i - \bar{x}^{*I}_{(cj)i}\right) \tag{5}$$

where $Emissions_i^I$ is the total CO_2 emissions for each household extraction I, sector i, $diag(e_i^I)$ is the diagonal matrix of e_i^I, and $\left(x_i^{*I} - \bar{x}_{(cj)i}^{*I}\right)$ is the backward dependence of sector *j* relative to sector *i*. The impact on sectorial output is the extraction of household group *I*.

It is important to note that in this paper we have *I = 1,...,8* and *i =1,...,15*.

2.3. Database

We use the data from the WIOD (World Input-Output Database[5]). It consists of input-output tables on 35 productive sectors for 40 countries (27 EU countries and 13 other selected countries) plus the "Rest of the World" for the period from 1995 to 2011. In terms of CO_2 emissions, the WIOD has data for the same 40 selected countries and sectors from 1995 to 2009. In this study, we use two input-output tables on Brazil for 2003 and 2009. We use these years in order to harmonize the input-output data set with the disposable information from the POF. Furthermore, we use atmospheric CO_2 emissions (in tons) for the same country and the same range of time and the same sector[6].

Despite the sectorial structure of the WIOD tables, we aggregate the sectors into 15 new sectors to better identify a household consumption structure. To do this aggregation, we follow the structure proposed by Jorgenson et al. (2013). Table A1 in the appendix contains our typology. Furthermore, we use income data for Brazil from the PNAD[7] for 2003 and 2009, and consumption data for the POF[8] for 2000 to 2003 and 2008 to 2009.

[5] For more details about the WIOD project see: Dietzenbacher et al. (2013).
[6] For more details about the sectors, see Appendix A1.
[7] The PNAD is a survey by the Brazilian Institute of Geography and Statistics (IBGE - Instituto Brasileiro de Geografia e Estatística) for a sample of Brazilian households. There is information on various socioeconomic characteristics of Brazilian society; such as, population, education, labor, income, housing, social security, migration, fertility, marriage, health, nutrition, among others. In this work, we use the income module to capture the income received from work, retirement, pension, permanent allowance, rent, and other income.
[8] The POF is a sample survey also by IBGE that aims to study the pattern of consumption and expenses of the Brazilian population by monitoring households for 12 months. The POF provides information about individuals (e.g., age, level of education, and income), households (e.g., existence of sewage, walls, and vehicles) and different records for each type of expenditure carried out.

2.3.1. Reconcile of POF with the input-output tables

Given the brief description of the database made in the previous subsection, it is important to consider the reconciliation of the data from the POF with the data from WIOD input-output tables. The first step is to match the POF products with the goods and services that make up the household consumption's column vector (1×35) in the input-output tables. We create a translator that collapses the 10,360 products in the POF with the 35 products in the WIOD input-output tables. The second step after the aggregation of the expenditure items is to build a matrix that distributes the spending of 35 different products in eight household groups that are based on the income module of the PNAD. Therefore, we disaggregate the household group (consumption units) into eight types by income per capita (percentiles of income). Further, we weight each yield by the respective sample expansion factor to have the universal data. Table 1 shows the intervals.

Table 1 – Household's consumption structure by percentiles of income

Consumption data – POF		
Household Group	**Year: 2003 Intervals**	**Year: 2009 Intervals**
Household 1	Below 96.00	Below 186.70
Household 2	[96.00, 158.87)	[186.70, 297.00)
Household 3	[158.87, 227.66)	[297.00, 422.43)
Household 4	[227.66, 310.41)	[422.43, 570.02)
Household 5	[310.41, 432.50)	[570.02, 767.91)
Household 6	[432.50, 641.23)	[767.91, 1095.55)
Household 7	[641.23, 1156.46]	[1095.55, 1833.58]
Household 8	Above 1156.46	Above 1833.58

Source: the authors based on data from POF

The final aggregation into the 15 productive sectors is as we described in the previous section. The aggregation is available in the appendix (Table A1).

2.3.2. Income and Emissions: a first approach

Given the focus of this study, the behavior of the income in each household group in terms of variation between the years 2003 and 2009 is important.

Table 2 shows the annual income growth rate of each household group (HH1 to HH8). The table shows that there is growing income for the lowest group as expected. The annual income growth rate of the lowest household group is 73.55%, and the highest is 19.88%.

Table 2 - Annual Income Growth Rate: 2003 and 2009

	HH1	HH2	HH3	HH4	HH5	HH6	HH7	HH8
Annual Income Growth Rate	73.55%	43.84%	22.87%	26.16%	38.50%	36.57%	27.47%	19.88%

Source: the authors based on data from the POF

For illustrative purposes, Table 3 shows the distribution of the CO_2 emissions between the intermediate consumption and the household consumption. The distribution illustrates a stable structure. The data show that households are responsible for approximately 22% of the emissions in 2003 and 2009. Although there are no significant changes in the period under review, the results show the importance in the study of the relation between household consumption in an income growth environment and the amount of CO_2 emissions. This is due to the household consumption's significant share in the economy.

Table 3 - Distribution of emissions in intermediate consumption and household consumption

	1995	2000	2003	2005	2009
Intermediate consumption	76.3%	77.3%	77.9%	78.1%	77.9%
Household consumption	23.7%	22.7%	22.1%	21.9%	22.1%

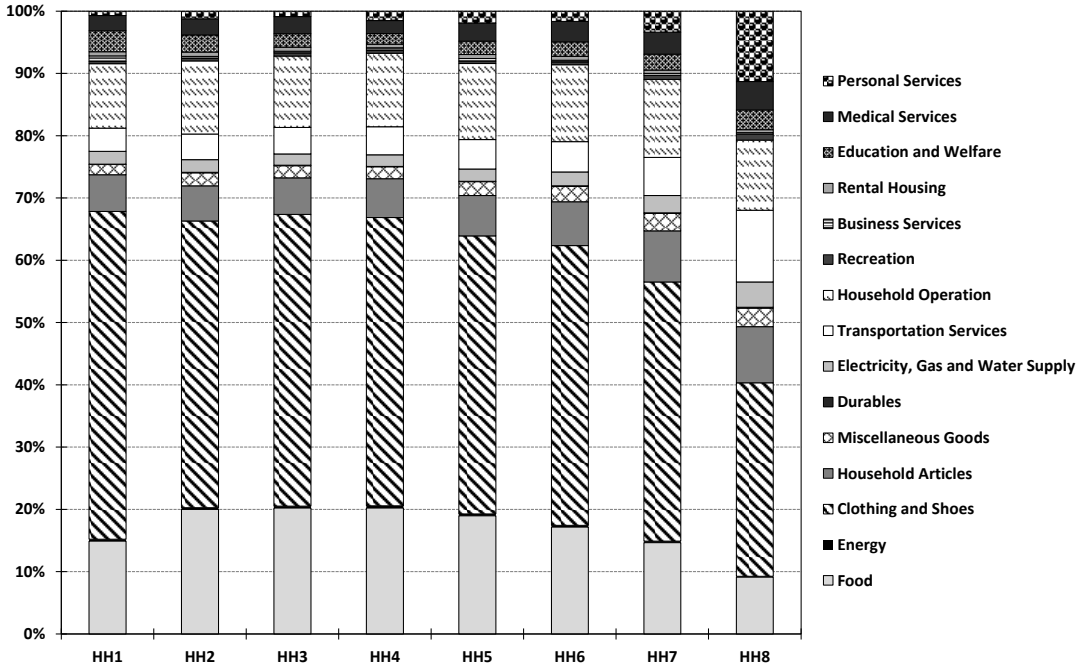
Source: the authors based on data from WIOD

With regard to sectorial emissions, Figures 3 and 4 present the distributions of the emissions for each household group (HH1 to HH8) within the industry structure for the years 2003 and 2009 respectively. In general, the sectorial structure of the emissions by household group is similar when a comparison is made between the years 2003 and 2009. The main changes can be observed for HH1 and HH8 respectively. For the lowest income class there is a loss of participation in the Clothing and Shoes sector in terms of emissions, from 52.63% in 2003 to 37.55% in 2009. This loss of participation is mainly because of the increased consumption of this household group relative to the other sectors, which can be seen through the percentage increase of all of the other sectors in relation to the emissions[9]. Similarly, for the highest household group, Household 8, we can also observe a loss of participation in the Clothing and Shoes sector, but at a lower rate (31.08% in 2003 and 26.87% in 2009). This loss of participation is mainly because of the increased participation in the Personal Services sector, which has an increase from 11.30% in 2003 to 17.57% in 2009. The participation of the Transportation Services sector for HH8 is approximately 11% and 10% for 2003 and 2009, respectively, and is significant. For HH1 to HH6 the participation is approximately 4%, and is 6.13% for HH7 in 2003. But it is 2% for HH1 to HH5 and 4% for HHs 6 and 7 in 2009.

Just as in the Transportation Services sector, for the Personal Services sector we also observe a significant difference in terms of participation among the different household groups. While for HH1 to HH7 the largest share is 3.38% in 2003 and 6.43% in 2009; for HH8, this participation is 11.30% and 17.57% for 2003 and 2009 respectively.

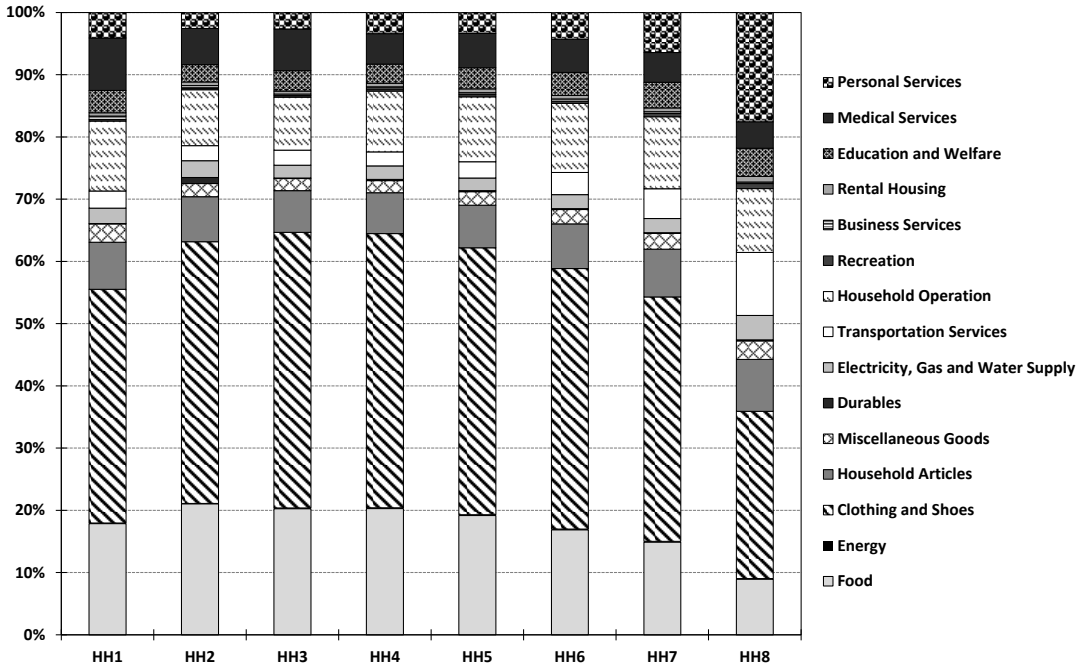
[9] Sectorial emissions are directly and proportionally related with the structure of consumption, given the method we use in this paper.

Figure 3 – Sectorial Participation of the CO_2 Emissions - 2003



Source: the authors based on data from WIOD

Figure 4 – Sectorial Participation of the CO_2 Emissions - 2009



Source: the authors based on data from WIOD

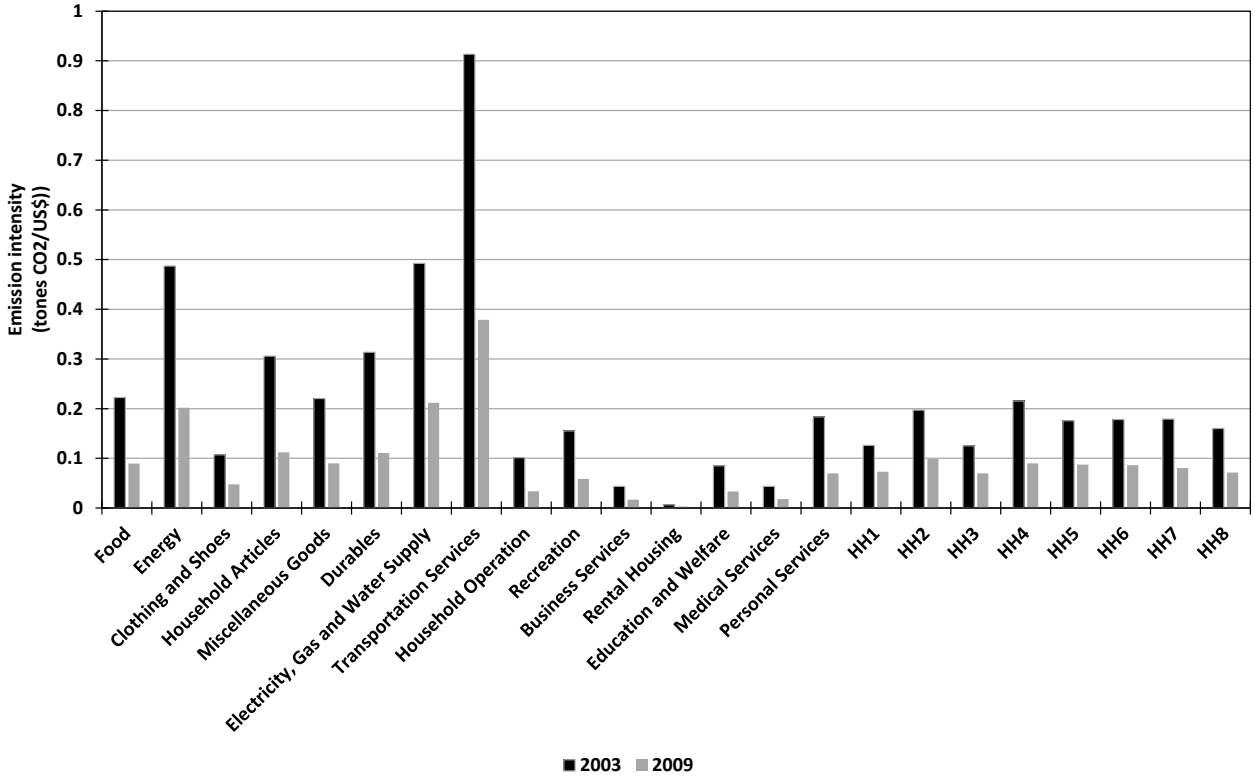
3. Results

In this section, we analyze the results. We present the disaggregated results in sectorial terms and by household group. These results illustrate the correlation between income, consumption, and emissions in the Brazilian economy.

Figure 5 shows the intensity coefficients of the CO_2 emissions by sector and income class. These coefficients evaluate the impacts with regard to emissions given the hypothetical extraction. They also allow for the measurement of the sectorial losses in the total output of the emissions. Thus, the coefficients are important because they have a direct relation with the result of the environmental impact.

Figure 5 also shows that the intensity of the CO_2 emissions is lower in 2009 than in 2003 for all of the sectors, and similarly for all eight of the income classes; in particular, for the coefficients of the Transportation Services, Electricity, Gas and Water Supplies, and Energy sectors. Although it is possible to observe lower intensities in 2009 compared to 2003, these results do not necessarily indicate that the production processes of these sectors have lower emissions.

Figure 5 - Intensity coefficients of CO_2 emissions (2003 and 2009)

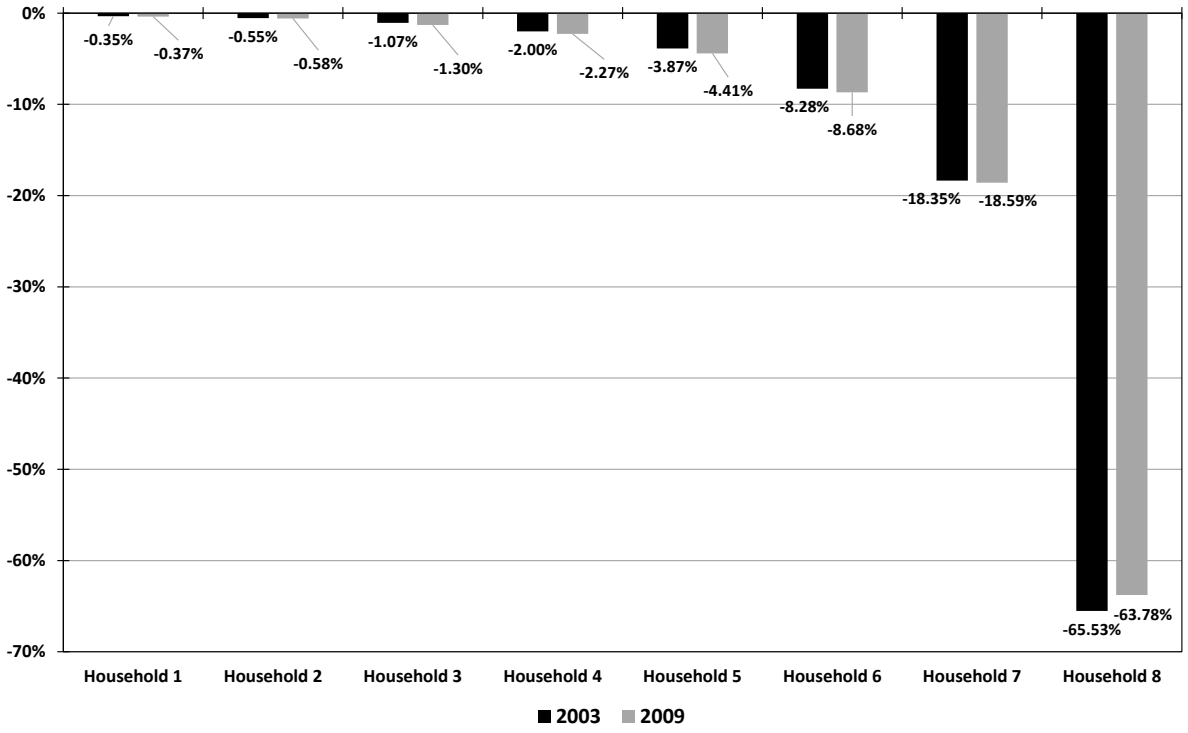


Source: Authors' calculations based on data from WIOD.

Figure 6 shows the proportion of the impact on emissions according to the eight household income classes considered in 2003 and 2009. Given the impact in terms of CO_2 emissions derived from the extraction of each income class, we sum the impacts and then calculate the relative proportion of each class in each year separately. The figure shows that the highest income class (HH 8), when removed from the analysis, produces the most negative impact on the CO_2 emissions compared with the other classes: -65.53% in 2003 and -63.78% in 2009. Although the results are still concentrated in the class with the higher income, there is a small structural change in 2009 compared to 2003. By 2009 the increased participation of the seven classes have larger negative effects on the CO_2 emissions than those produced in 2003, even though in small proportions.

Overall, these results capture the increase in income experienced by the Brazilian economy and the increase's major impact in terms of CO_2 emissions. Because the highest growth rates of income are in the lowest classes, these classes are major contributors to the CO_2 emissions.

Figure 6 - Share of the impact on emissions according to the household groups[10]



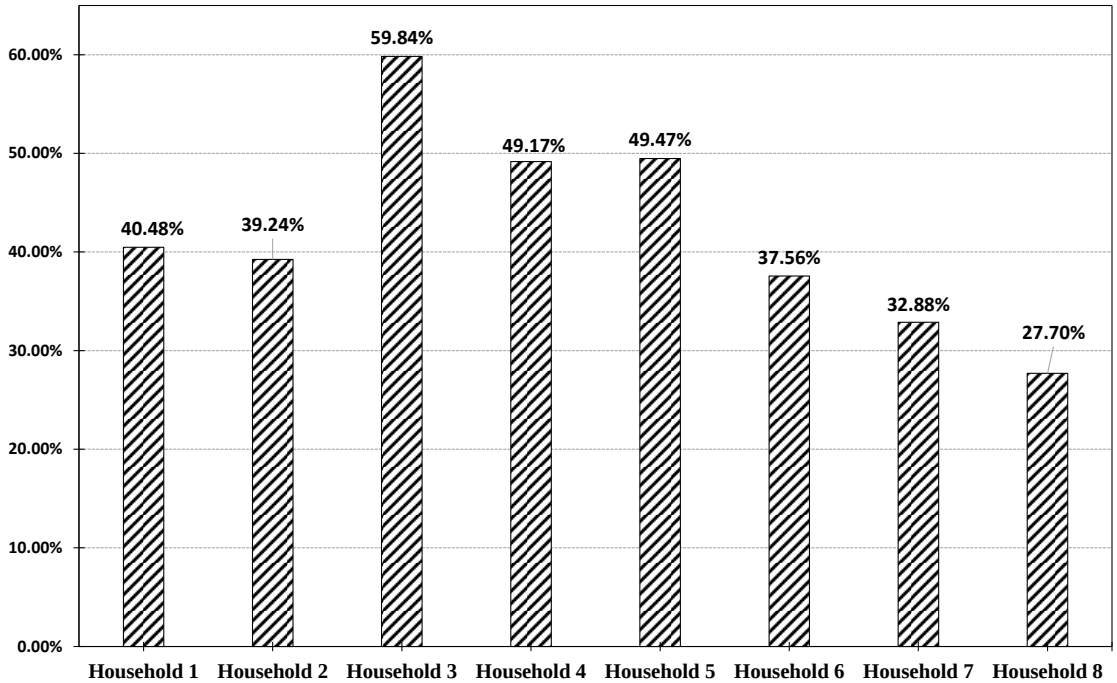
Source: Authors' calculations based on data from WIOD

[10] Important to note that since we use the hypothetical extraction method we present the results in negative terms because they indicate how much CO_2 emissions would no longer be associated and/or generated from the Brazilian production process, if, roughly speaking, the extracted income class does not exist.

In order to capture the changes and to measure the effect of income growth within the income class, Figure 7 presents the growth rates of the impacts generated by the hypothetical extraction. The figure shows that HH3 has the highest growth rate at 59.84%, followed by HH5 at 49.47%, and HH4 at 49.17%. But, the higher income class (HH8) has the lowest growth rate at 27.70%.

Thus, this result shows how the income growth of the lower income classes affects the CO_2 emissions. However, there is no direct relation because the class with the highest growth rate in income is not the one with the highest growth rate in terms of its impact on the CO_2 emissions, which can be explained by the different structure of consumption between the classes. Because the impacts are dependent on the emission intensity coefficients, we generally expect that the greater growth rate of the impact is associated with the class that has a consumption pattern based on industries more intensive in CO_2.

Figure 7 - Growth rate of impact within the same income class



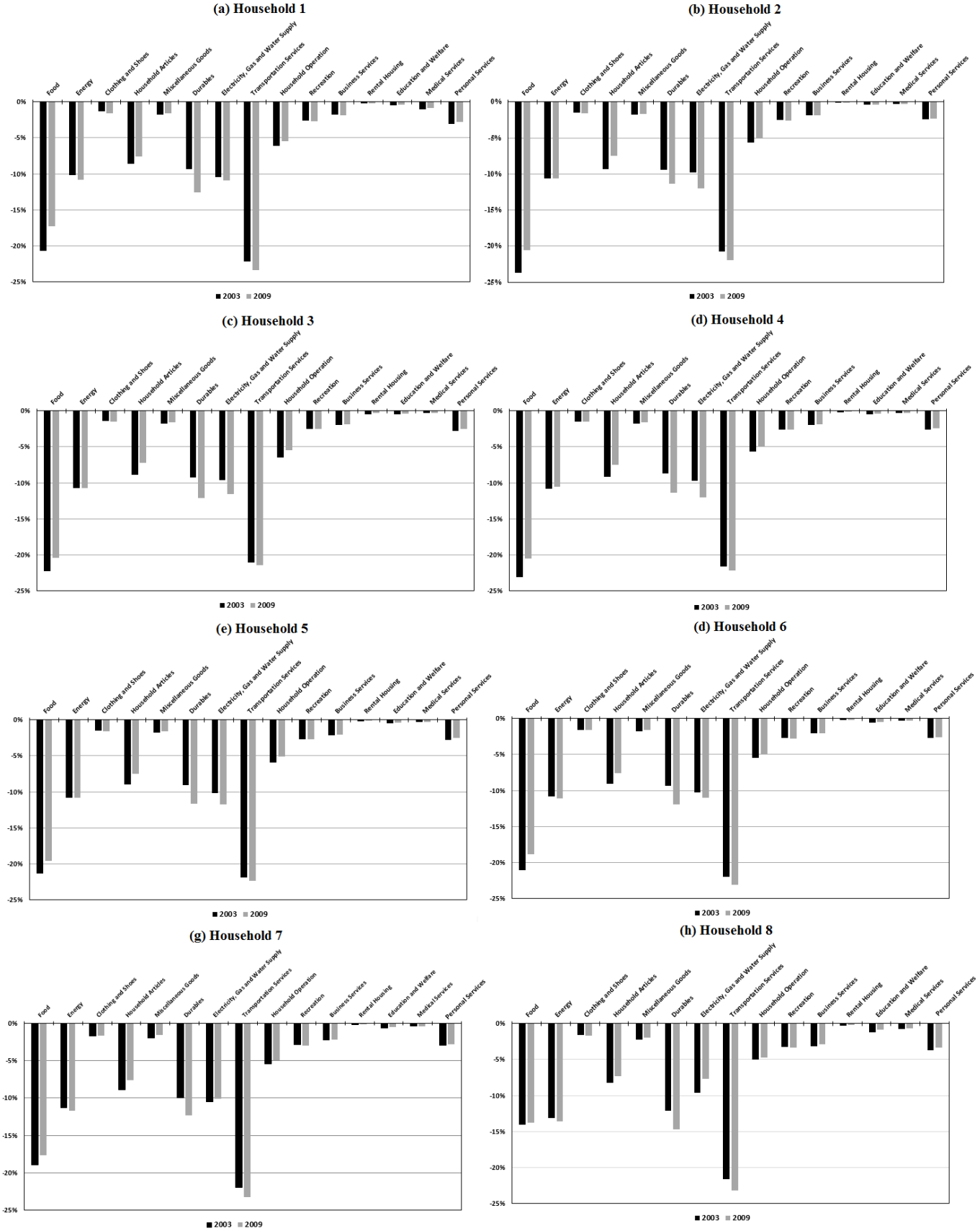
Source: Authors' calculations based on data from WIOD

Thus, in order to observe these results in terms of sectors, Figure 8 shows the proportion of the impact on sectorial emissions according to the household income classes. Observing the figure we verify how much of the consumption structure and the income of each household group systemically affects the production and, consequently, the sectorial emissions.

Figure 8(a) shows the results for the lowest income group (HH1). In this case, the consumption structure and income of this household group affects the economy such that the Transportation Service, Food, Durables, Energy and Electricity, and the Gas and Water Supplies sectors are the most negatively impacted in terms of emissions in 2003 and 2009. Thus, this is the expected result because the household groups of lower income tend to have a structure of spending that more intensively mobilizes the inputs related to the food production chain, transportation, and the provision of basic services. The withdrawal of this household group provides obvious but major negative effects on the production and emissions from these sectors.

As we observe the results for the other income classes in ascending order of income, Figure 8(b) to Figure 8(h), there is a change in the pattern of the proportion of the most affected sectors. The Transportation sector, for example, has two peculiarities in this process, especially in 2003. The first is that the households groups with higher levels of income mobilize the economy more strongly, including the Transportation sector. Thus, the higher the income level of the household group the higher the effect on the Transportation sector tends to be. The second peculiarity is that the Transportation sector has one of the highest emission intensity ratios (see Figure 5) of that year. Thus, it follows that these two coupled effects play an important role in the Transportation sector in terms of reducing emissions.

Figure 8 - Proportion of the impact on sectorial emissions according to the household groups



Source: Authors' calculations based on data from WIOD

Another important result is the significant change of the impacts in the Food sector among the different income classes. The negative impact is much higher for the lowest income class. On the one hand, for HH1, the impact is approximately 20% in 2003 and 17.3% in 2009. However, for the highest income group (HH8), the impact is approximately -14% and -13.8% for 2003 and 2009 respectively. Moreover, when withdrawing in the order of increasing income levels, the effects tend to be less concentrated. The sectors such as Energy and Durables, for example, now have a greater contribution to the fall in emissions.

The results presented by the Durable Goods, Energy, and Transportation sectors imply that the increase in income in the Brazilian economy leads to higher consumption of these goods. However, what this study shows is that there is a "price" in terms of CO_2 emissions. Therefore, the results show that there is a trade-off between the greater satisfaction that the households groups find in consumption and the increasing setbacks in emissions from restructuring and modification of the consumption basket.

The apparent differences in the impact on emissions between 2003 and 2009 is due to two effects when a household group is withdrawn from the analysis: the systemic effect on production and the effect on the emission coefficients. In 2009, there are major changes in the intensity of the emissions coefficients in relation to 2003. The standard deviation of the emission coefficients in 2009 is equal to 0.0798, while the standard deviation of the coefficients in 2003 is equal to 0.1940. Therefore, the variability of emission intensity coefficients in part explains the difference in the results between 2003 and 2009.

4. Concluding remarks

This study evaluates the impact of household consumption on CO_2 emissions. By implementing the hypothetical extraction method, we verify how the extraction of each household group (divided into eight groups) affects the sectorial output of emissions in the Brazilian economy. The input-output structure highlights the impacts in their systemic form. Therefore, the structure contributes to the results in terms of sectorial interdependence. By longitudinally evaluating the emission process, the results show that there is a reduction in emissions in 2009. This result is of great importance in our context.

From the hypothetical extraction of each household income class, we find some interesting results: the Transportation sector has the greatest negative impact over the period analyzed for all household income groups. The food industry, like most other sectors, decreases its emissions and is more pronounced in the lower consumption classes. And the service sector has the least impact. These results are in line with the arguments that consider the evaluation of emissions with particular attention to household consumption important. This is the most significant component of the final demand in most countries and therefore plays a key role in the growth multiplier effect. In this paper we report the logic of consumption (or non-consumption—given the extraction of consumption vectors) to account for the effects of the influence of lower consumption in favor of the evaluation of the emissions.

The analysis should consider two factors. First that the highest income groups have a lower marginal propensity to consume. Therefore, the increase in income does not influence the result in terms of consumption too much. On the other hand, because the consumption levels of these income classes are large, they should generate more emissions and a small variation in the consumption could have a significant impact on emissions. Second, those household groups with lower levels of income have more significant increases in income. This additional income tends to become almost completely consumed and, therefore, has greater effects on emissions.

It is also necessary to consider at this point the direction of consumption arising from additional income. The consumption pattern has changed over the years and the level of energy intensity in most consumed products from additional income drives the identification parameter of the impacts on emissions. Again, the income groups have different patterns of consumption, and this is an important part of the explanation of the results.

Thus, the study contributes to the research agenda in the area of emissions by mapping the recent behavior of the Brazilian economy in terms of increased income, changes in consumption structure, and their impact on emissions. It is not the aim of the paper to provide an ample discussion on mitigation processes. However, as the paper shows, the aggregated results by income and by consuming structure are partly due to the intensity of the emissions and the systemic effects. Thus, it is possible to discuss less

polluting production processes, more conscious consumption of goods, more rational uses of energy and the transportation system.

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Appendix A

Table A1 – Sector Typologies

WIOD Code	WIOD Sectors	Typology I	Typology II	Typology III	Our Typology
1	Agriculture, Hunting, Forestry and Fishing	Non-durables	Food	Food	Food
2	Mining and Quarrying	Non-durables	Energy	Fuel-Coal	Energy
3	Food, Beverages and Tobacco	Non-durables	Food	Beverages and Tobacco	Food
4	Textiles and Textile Products	Non-durables	Consumer Goods	Clothing	Clothing and Shoes
5	Leather, Leather and Footwear	Non-durables	Consumer Goods	Shoe	Clothing and Shoes
6	Wood and Products of Wood and Cork	Durables	Consumer Goods	Household Articles	Household Articles
7	Pulp, Paper, Paper , Printing and Publishing	Non-durables	Consumer Goods	Miscellaneous Goods	Miscellaneous Goods
8	Coke, Refined Petroleum and Nuclear Fuel	Non-durables	Energy	Gasoline and Oil	Energy
9	Chemicals and Chemical Products	Non-durables	Consumer Goods	Household Articles	Household Articles
10	Rubber and Plastics	Non-durables	Consumer Goods	Household Articles	Household Articles
11	Other Non-Metallic Mineral	Durables	Durables	Durables	Durables
12	Basic Metals and Fabricated Metal	Durables	Durables	Durables	Durables
13	Machinery, Nec	Durables	Durables	Durables	Durables
14	Electrical and Optical Equipment	Durables	Durables	Durables	Durables
15	Transport Equipment	Durables	Durables	Durables	Durables
16	Manufacturing, Nec; Recycling	Durables	Durables	Durables	Durables
17	Electricity, Gas and Water Supply	Non-durables	Energy + Water Supply	Electricity, Gas and Water Supply	Electricity, Gas and Water Supply
18	Construction	Durables	Durables	Durables	Durables
19	Sale, Maintenance and Repair of Motor Vehicles and Motorcycles; Retail Sale of Fuel	Consumer Services	Transportation	Transportation Services	Transportation Services
20	Wholesale Trade and Commission Trade, Except of Motor Vehicles and Motorcycles	Consumer Services	Household Operation	Other Household Services	Household Operation
21	Retail Trade, Except of Motor Vehicles and Motorcycles; Repair of Household Goods	Consumer Services	Household Operation	Domestic Service	Household Operation
22	Hotels and Restaurants	Consumer Services	Miscellaneous Services	Recreation	Recreation
23	Inland Transport	Consumer Services	Transportation	Transportation Services	Transportation Services
24	Water Transport	Consumer Services	Transportation	Transportation Services	Transportation Services
25	Air Transport	Consumer Services	Transportation	Transportation Services	Transportation Services
26	Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies	Consumer Services	Transportation	Recreation	Recreation
27	Post and Telecommunications	Consumer Services	Household Operation	Communication	Household Operation
28	Financial Intermediation	Consumer Services	Miscellaneous Services	Business Services	Business Services
29	Real Estate Activities	Consumer Services	Housing	Rental Housing	Rental Housing
30	Renting of M&Eq and Other Business Activities	Consumer Services	Household Operation	Business Services	Business Services
31	Public Admin and Defence; Compulsory Social Security	Consumer Services	Miscellaneous Services	Welfare	Education and Welfare
32	Education	Consumer Services	Miscellaneous Services	Education	Education and Welfare
33	Health and Social Work	Consumer Services	Medical	Medical Services	Medical Services
34	Other Community, Social and Personal Services	Consumer Services	Consumer Services	Personal Services	Personal Services
35	Private Households with Employed Persons	Consumer Services	Consumer Services	Personal Services	Personal Services

Note: This classification is an adaptation from Jorgenson et al. (2013).