Construction of a Consumption Aggregate Based on Information from the Brazilian Consumer Expenditure Survey 2008-2009 and its use in the Measurement of Welfare, Poverty, Inequality and Vulnerability of Families

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Paper Prepared for the IARIW-IBGE Conference
on Income, Wealth and Well-Being in Latin America

Rio de Janeiro, Brazil, September 11-14, 2013

Session 2: Output, Consumption and Price Statistics

Time: Thursday, September 12, 2:00-3:30

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Abstract

Given the complexity and multidimensionality of poverty phenomenon, a key issue for its study is to define an appropriate indicator that captures the well-being of individuals and families. The objective of this study is to explain in detail the methodology of constructing the family aggregate consumption, based on data from the Brazilian Family Expenditure Survey (Pesquisa de Orçamentos Familiares - POF 2008-2009 - IBGE), and then use it to measure and analyze well-being, poverty, inequality and vulnerability to poverty. Following the literature on this subject (DEATON and ZAIDI, 2002; LANJOUW, 2009), some aspects had to be taken in consideration: the definition of expenditure items that should be included, analysis of extreme values, imputation of food consumption, the calculation of the service value for durable goods and a spatial price deflator. The propensity score method was tested to deal with consumption units with null food expenses. After the definition of the consumption aggregate per family, the behavior of General Lorenz Curves, of (abbreviated) social welfare functions and of inequality measures was studied. In order to measure poverty, the sensibility of the identification exercise to different poverty lines and poverty severity were presented. Finally, based on Chaudhuri *et al* (2002) and Elbers *et al* (2002), the vulnerability to poverty was analyzed, taking into account area (clusters) effects. In this way, the probability of a family becoming poor was estimated. In this exercise, the poverty line was based on half of 2008 minimum wage. Following the proposal of the authors, the families with vulnerability index greater than 0.5 were classified as highly vulnerable. This study contributes to the Brazilian literature on social welfare, especially, regarding the use of family aggregate consumption as a well-being indicator.

Keywords: Consumption Distribution, Spatial Price Deflator, Social Welfare Functions, Poverty, Inequality, Vulnerability, Error Component Models, Heteroscedasticty, Imputation.

JEL: C21, D39, D63, I31, I32

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The authors would like to thank Elisa L. Caillaux and Marina Aguas for their comments.

Introduction

The Brazilian Family Expenditure Survey (POF) aims at providing the supply of information about the household budget composition, from the investigation about the consumer habits, expenditure and income distribution, in accordance with household and people characteristics[1]. The data gathering collection perspective is one of expenditure. To make a consumption aggregate it is necessary to identify among various components of current expenses those strongly associated with consumption as well as the value of consumption associated with the ownership of assets which guarantee a flow of services for the consumption unit[2]. Therefore, for constructing the consumption aggregate through the POF 2008-2009 a number of decisions had to be taken, based on theoretical hypothesis and empirical results, as it is presented in Section 1.

The choice of using consumption for measuring welfare, poverty, inequality and vulnerability of consumption units, instead of an analysis based on income, is justified by the fact that income only shows part of the families' available resources. Consumption is the result of use of those available resources (income), plus savings accounts, assets transformation in available income and access to credit in order for the consumption units to obtain goods and services[3]. Thus, the consumption reflects the consumption unit strategies sets which are determined by the value it attributes to the goods and services at its disposal, as well as the value-ranking among: food consumption; durable goods; housing; healthcare, education and transport and other non-food items. In this process the consumption units will base their choices on market prices and the possibility of replacement among goods and services[4]. As a result, the consumption aggregate weights the different goods and dimensions by market prices. In order to do that, it is necessary to build price deflators that indicate life costs differences among distinct Brazilian geographical contexts, as described in Section 2.

Even though both, income and consumption present a variation over time, consumption tends to be less variable than income and to reflect the average long term well-being more accurately (DEATON 1997; DEATON AND ZAIDE, 2002; HAUGHTON and KHANDKER, 2009). Income fluctuations do not replicate directly into consumption fluctuations, because the consumption unit residents might adapt, in the short time, in order to keep their consumption standard, using credit, donations or decrease in assets[5]. Such aspects are not captured by the income perspective. In this sense, the use of the consumption perspective allows the evaluation of the results of the

[1]The Brazilian Family Expenditure Survey has also investigated life quality self-perception (POF questionnaire 6) and the characteristic of the Brazilian population nutritional profile (POF questionnaire 7). However, in the present stage of the aggregate consumption construction these data will not be used.

[2] The Brazilian Family Expenditure Survey works with the concept of Consumption unit, which can be approximated to the idea of household units or family, for further details see IBGE (2008).

[3] Haughton and Khandker (2009) clearly emphasize that both consumption and income are imperfect proxies of utility, once they exclude important contributions to welfare such as publicly provided services and goods. Atkinson et al (2002) highlight that surveys on living conditions measure expenditure but not consumption, that is to say, that the amount spent by a consumption unit in the specific period of time of the survey expenditure collection may differ from the effective consumption in the same period of time. This difference can be due, for example, to the use of stock holdings. The same argument applies for durable goods (see Section 1.2). Limits, critics and alternatives to the use of both expenditure (consumption) and income as welfare measures can be found in Sen (2004, 2008 and 2010), Kakwani and Silber (2007 and 2008), Oliveira (2010) and in the Journal of Economic Inequality (2007).

[4] Ravallion (2011) emphasizes the role of prices in the definition of opportunity costs and marginal rates of substitution as one of the major advantages of using consumption aggregates as welfare indicators.

[5] Note that consumption units with restrict access to credit will face more difficulties to smooth their consumption.

consumption units' strategies to manage welfare maximization, considering its budget availability. Even considering some consumption seasonal fluctuations, associated to holidays or festivities, these are smooth when compared to the consumption units income fluctuations, especially when their members are own-account workers or employees without signed labor card. Income of those who work in extraction and agriculture sectors of activities is subject to higher fluctuations, because a higher dimension of their consumption comes from their own production and not from the market[6]. The fact of asking the informants to estimate the value of goods acquired outside the market (donations, production for their own consumption or withdrawal from their own businesses) in the survey allows the measurement of the non-monetary consumption[7]. If this non-monetary consumption was not considered there would be an underestimation of well-being and a super-estimation of poverty.

An analysis of individual welfare based on a consumption aggregate has implicit a money metric utility function[8] that returns the necessary amount for keeping the consumption unit welfare level and requires consumption to be adjusted by a price index . In Section 2 an analysis of social welfare is performed using the consumption aggregate constructed, where the Generalized Lorenz Curve and (abbreviate) social welfare fuctions based on Sen and Atkinson's works. In order to understand the weight of inequality in the reduction of social welfare, two breakdowns are done: i) through the Gini index, consumption inequality is breakdown by component; and ii) through the logarithmic average deviation the inequality of population subgroups will be studied, considering the years of study, sex, color and race of the consumption unit responsible. In Section 3 poverty and vulnerability analysis are presented, these are based on poverty curves, square poverty gap index (severity of poverty) and a estimation model on the probability of a consumption unit becoming poor.

1. Consumption aggregate

The consumption aggregate construction is such a complex exercise that requires fine discrimination between expenses items which might be included or excluded, so as to allow the comparability between the consumption units' welfare levels and its correct ranking. This discrimination is guided by subjective criteria based on theoretical hypothesis about welfare contribution of different goods and services, as well as the necessary adaptations to the culture of the country under study.

Deaton and Zaidi in "Guidelines for Constructing Consumption Aggregates for Welfare Analysis" advance in the discussion about the consumption aggregate for welfare analysis using family expenditure surveys data of eight countries. They suggest methodological ways to theoretical

[6] Haughton and Khandker (2009) compare the welfare measurement through income, which they call "potential", and through consumption, which they call "result". They show that income tends to be more seasonal and underreported than consumption, something upon which Atkinson (1998) and Deaton and Zaidi (2002) agree.

[7] The POF team makes evaluation and selects part of these data for imputation, in order to assure consistency. Nevertheless, if the informants were not asked to estimate the value attributed these goods, 100% of imputation would be needed.

[8] See Varian (1992, p. 108-110) and Deaton and Zaidi (2002, p. 4-13) about usefulness functions of monetary level and its advantages on relation to other forms of measuring welfare.

and practical problems faced in the construction of such aggregates. Thus, this working paper served as guideline for the construction of the consumption aggregate using POF data[9].

Considering the POF methodology, which measures expenses made per consumption unit, by type and in differentiated periods of time (7, 30 and 90 days and 12 months), some criteria became necessary to deal with the information collected by the survey, adapting them to the consumption aggregate construction. Firstly, it was necessary to group the expenses of the different POF blocs into consumption groups, in order to select the ones to compose the aggregate and the ones excluded. The following consumption groups were defined: food; durable goods; housing; education, health and transportation; and other noon-food items. Subsequently, each item of these groups was analyzed as to verify if they complied with the following criteria:

(a) The item acquisition is not sporadic, i.e., it is a frequently acquired item, in such a way that the collection period of the survey is sufficient and doesn't distort the welfare analysis among the consumption units. The durable goods whose acquisition tends not to occur annually were target of a differentiated treatment (see Section 1.2).

(b) The item is acquired for the consumption unit own consumption, i.e., acquisition of such good will increase the welfare of the consumption unit under analysis and not of another unit.

An elasticity study was made for the expenditure under the groups of education, health and transport as to define their inclusion or exclusion of the aggregate, because some of those expenses might have an inverse relation to welfare (see Section 1.4). A synthesis of the appliance of these criteria in the consumption groups is presented as follows.

1.1.Food Expenditure

The expenses with food were totally included[10], considering this is an important group when it comes to consumption units' welfare measuring. This is of greater importance in low income strata, where according to POF 2008- 2009, the participation of food in total expenditure was 31.7% in consumption units with *per capita* income in the 1st income decile, 28.0% for the 2nd decile and 25.8% for the 3rd. The food expenditure maintains its relevance in all income deciles.

[9] Deaton develops studies on the welfare measurement thematic and the use of consumption data from household surveys since 1980. He has become a reference for different authors, such as: Hentschel and Lanjouw (1996), Elbers et al (2002), Lanjouw (2009) and Haughton and Khandker (2009).

[10] Food expenditures are obtained in the questionnaire "Collective Acquisition Booklet" (POF 3) and in the bloc meals out-of-home (bloc 24) from the questionnaire "Individual Acquisition" (POF 4).

Table 1: Participation of consumption groups in total expenses by deciles of *per capita* income

Consumption Groups	Participations in the total expenses by deciles of *per capita* income									
	1º	2º	3º	4º	5º	6º	7º	8º	9º	10º
Housing	38.5	38.6	38.7	38.3	39.2	38.9	38.3	37.3	35.2	34.1
Food	31.7	28.0	25.8	24.0	22.8	21.1	19.7	18.4	16.2	12.8
Transportation	7.6	9.0	9.9	11.1	11.2	12.0	13.0	14.3	16.3	17.9
Clothing	6.5	6.2	6.2	6.0	5.3	5.1	5.0	4.7	4.4	3.7
Health	4.7	5.3	5.7	5.9	6.6	6.9	6.9	7.1	6.8	7.3
Hygiene and personal care	2.9	2.9	2.9	2.8	2.6	2.5	2.3	2.2	2.0	1.6
Increase in assets	1.4	1.7	1.8	1.9	2.0	2.3	2.8	2.9	3.4	5.6
Miscellaneous expenses	1.2	1.4	1.6	1.6	1.8	1.9	1.9	2.0	2.4	2.9
Other current expenses	0.9	1.4	1.8	2.2	2.6	2.9	3.1	3.5	4.4	5.6
Leisure and culture	1.0	1.3	1.3	1.5	1.4	1.4	1.5	1.6	1.8	1.8
Education	1.1	1.2	1.1	1.3	1.2	1.4	1.7	2.0	3.0	2.7
Decrease in liabilities	0.6	1.1	1.2	1.4	1.6	1.9	1.9	2.3	2.5	2.7
Smoking	1.0	1.0	0.9	1.0	0.8	0.8	0.7	0.6	0.4	0.3
Personal services	0.8	0.8	0.9	1.0	1.0	1.0	1.0	1.1	1.1	1.1

Source: IBGE, Research Directory, Brazilian Family Expenditure Survey POF -2008-2009.
Note: For the calculation the sampling design of the survey was considered.

It was found that 5.4% of the consumption units presented null food expenditure. This can be explained by the reference time period of information collection (7 days) that reports zero for consumption units that did not acquire food in that week. In order to correct possible distortions in social welfare, inequality, poverty and vulnerability, due to these null food expenditures, an imputation was made following the *Propensity Score* method[11].

1.2. Durable goods

The possession of durable goods has positive impacts over consumption units welfare. However, while the acquisition of durable goods occurs in a particular point in time, its consumption may occur along several years, as Haughton and Khandker (2009) and Atkinson (1998) point out. When consumption is used as a welfare proxy, it is important to assure the comparability between the different consumption units, and thus distinguish those that possess durable goods from those that need to rent them or simply do not have them.

There is a difficulty in defining which goods might be considered durable, once, as pointed out by Atkinson (1998), there is a durable element in several goods. In the construction of the consumption aggregate it was considered as durable goods the ones listed in: "Main household durable goods inventory" (bloc 14); "Machines, equipment and household utilities acquisition" (bloc 15); "Tools, pets, musical instruments and camping gear acquisition" (bloc 16)[12]; "Furniture acquisition" (bloc 17) and "Vehicles acquisition" (bloc 51).

However, these durable goods had to be selected and treated before including them in the aggregate. Following the suggestion made by Deaton and Zaide (2002)[13], the durable goods were considered in the consumption aggregate by their "service value", that is to say, "user cost" or

[11] This method estimates the effect of a determined treatment by comparing two groups: control and treatment groups. For each consumption unit of the treatment group, a consumption unit with a matching probability of having null food expenditure was identified in the control group. By the end, this consumption unit from the control group was used as the food expense value donor for the consumption unit treatment group. For further details see Rosenbaum and Rubin (1983).

[12] With the exception of veterinarian services and expenses with pets of bloc 16 that were included in the aggregate as other non-food expenses.

[13] Haughton and Khandker (2009) deffend the same approach for the treatment of durable goods in welfare studies based on consumption.

"rental equivalent" that the consumption unit "receives" for all durable goods in its possession during the period time of one year. This service value can be approximated by:

$$VS_{tij} = S_{tij}\, P_{ti}\, (r_t - \pi_t + \sigma_i) \quad (1)$$

where S_{tij} is the stock of the durable good i in the consumption unit j during the research period (t=2009); P_{ti} is the durable good i current value during the survey period (t); r_t is the nominal interest rate, π_t is the inflation in the survey period (t) and σ_i is the depreciation rate of the durable good i.

The depreciation rate is given by the following formula:

$$\sigma_i - \pi_t = 1 - (P_{ti} / P_{i(t-Ti)})^{1/Ti} \quad (2)$$

where T_i is the durable good i age in years and $P_{i(t-Ti)}$ is its price in the year it was acquired.

The POF bloc 14 enables us to identify which goods are owned by the consumption unit during POF collection period (t) and its stock (S_t). Moreover, in relation to the last acquisition of these goods, it is possible to know the way it was acquired, the year it was acquired and its condition, whether new or used. Thus, we have the amount of S_t and the item age in years (T). The exception is for the used goods, for which there is only the last acquisition date. Therefore, in order to obtain the service value for each good, it is necessary to calculate the current prices of each good, the average nominal interest rate for the POF time period and the regional deflators. These steps will be detailed below.

a) Median price calculation by Federative Unit ($P_{med\ ti\ UF}$)

Considering that through POF collected data is not possible to calculate the current price of each durable good, the solution was to estimate this through the calculation of the median price for every durable good, by Federative Unit, using the information about these goods price of acquisition collected in POF bloc 15. Through this calculation its assumed that the goods were acquired in the survey year of reference (P_t), according to the type of acquisition[14] and the condition (new or used) per Federative Unit. The use of the median price aims to minimize the outliers' impact in each estimate price.

It must be highlighted that the only goods that had their prices studied were the ones that appeared both in POF bloc 14 and POF bloc 15, since it was necessary to match the information on stock and price. Therefore, the goods that are not in the inventory but are in bloc 15 will be excluded from the consumption aggregate. Their insertion would generate a distortion between the consumption units that acquired durable goods during the time of the survey (May 2008 to May 2009), which as a result would have a higher consumption aggregate, and the ones which acquired the same goods in another time period not covered by POF, and would have a smaller aggregate.

For the durable goods current price calculation i (P_{ti}) the median price of the Federative Unit where the consumption unit locates was chosen. However, in some Federative Units there was no

[14] The ways of acquisition considered for the calculation of the median price of the good in each Federative Unit, in the cases where there where acquisitions in the Federative Unit, or for the Major Region, were: a) cash prompt payment to the consumption unit and b) credit card prompt payment to the consumption unit.

occurrence of determined goods acquisition, according to previously established standards: goods acquired new and prompt payment. For these cases where it was not possible to calculate the median price of the durable good *i* per Federative Unit, the median price of the good *i* of the corresponding Major Region was used for the calculation of the service value.

b) Average nominal rate of interest calculation (r_t)

Deaton and Zaidi (2002) suggest the use of one real interest rate only, based on an average of several years, for all durable goods. SELIC (Special System of Settlement and Custody) daily rate information provided by the Central Bank[15] was used to calculate the average nominal interest rate (1.1261), opting for the POF period – from May 2008 to May 2009.

c) Calculation of the average regionalized real interest rate of the period

For the calculation of the real interest rate, besides the average nominal interest rate the inflation rate of the period is needed. Even though there is not available price index (IPCA) information for all Federative Units, a deflator of a geographical area of influence was used for those in which such information was unavailable (see Appendix 2).

d) Depreciation rate (σ)

POF bloc 14 provides no information on prices of goods price when acquired ($P_{i(t-Ti)}$), however through POF bloc 15 it is possible to calculate the current price (P_{ti}) of similar goods acquired in the same Federative Unit or Major Region. Thus, an estimative of the depreciation rate (equation 2) had to be made, following the approach suggested by Deaton and Zaidi (2002), learning from other countries experiences, such as: Vietnam, Nepal, Ecuador and Panama.

The calculation of the average usage time ($T_{i\ avg}$) of the durable goods, acquired new and through cash or credit card prompt payment, is made by using the data of the year of acquisition registered in the inventory (POF bloc 14). It is understood by usage time (T) the difference of years between 2009 (top limit of the survey period) and the year of the acquisition (A) of the durable good reported in the inventory:

$$T_{i\,avg} = average\ (T_{ij} = 2009 - A_{ij}) \tag{3}$$

Also according to Deaton and Zaidi (2002) suggestion, the average useful lifetime of each durable good was considered as twice the average usage time (T)[16] for each durable good[17], considering the sampling design of the survey:

$$(VU_{i\,avg} = 2T_{i\,avg}) \tag{4}$$

[15] See http://www.bcb.gov.br/?COPOMJUROS.

[16] These results were compared to the Regulatory Instruction SRF number 162 from December 31 1998, that establishes the useful lifetime and depreciation rate of goods related to the Mercosur Common Nomenclature (MCN) and other goods. Through this analysis it was observed that the average useful lifetime ($2T_{avg}$) corresponds to 1.7 the useful lifetime defined by the Regulatory Instruction. This makes sense, considering that the Regulatory Instruction focus on durable goods for commercial purposes and not the durable goods of a household consumption unit.

[17] It is assumed as hypothesis that the acquisitions are distributed in a uniform way over time and none of the inventory items was recently introduced in the market. It must be noted that the mean time was calculated only for goods acquired new, once there is no information about the real usage time for second-hand goods.

Around 10.7% of the durable goods in POF inventory are totally depreciated[18]. Nevertheless, it is considered that the ownership of these goods, independently of their condition (whether new, used, partially or totally depreciated), must be valued in the consumption aggregate, once its "service value" must be considered due to the well being enjoyed by the consumption unit residents for owning these durable goods. Independently of the durable good condition, it is key to differentiate between those who have and those who do not have access to the goods in their consumption unit.

The depreciation rate is calculated by the following formula:

$$\sigma_i = 1/(VU_{i\,avg}), \tag{5}$$

where $VU_{i\,avg}$ is the average useful lifetime of the good *i*.

For the durable goods that are not in the inventory and that were acquired by the consumption unit during the 12 months of the survey (POF blocs 16[19] and 17), there is no information about the date of acquisition. Thus, the option was to exclude them, since they are considered occasional expenses of the consumption units and their inclusion would introduce a distortion in the consumption aggregate, detailing positively the units which consumed these durable goods that year in relation to those that acquired goods out of the survey period.

A critical data review was made in order to verifiy if machines, equipment and household utilities acquired during the survey period (POF bloc 15) were already part of the inventory (POF bloc 14). It concluded that the number of goods in stock is higher than the number of the durable goods acquired for all consumption units. Therefore, the goods of POF bloc 15 can be excluded without losing information on durable goods' stock.

e) Service value

After gathering all variables, the service value of each of the durable goods was calculated, according to the formula below:

$$VS_{tij} = S_{tij}\, P_{med\ it\ UFj}\, (r_t - \pi_{tj} + 1/VU_{i\,avg}) \tag{6}$$

where $S_{tij}\, P_{med\ ti\ UFj}$ is the quantity of durable good *i* multiplied by its median price in the Federative Unit[20] where the consumption unit *j* is located, $r_t - \pi_{tj}$ is the regional real interest rate and $VU_{i\,avg} = 2T_{i\,avg}$. The results originated for the durable goods service value per Federative Unit are available in Appendix 1.

1.3. Housing

The housing group has the biggest participation in the total expenditure of Brazilian consumption units across all income classes (Figure1). Thus, this group has important relevance for the welfare analysis. Items related to housing of the main household were classified in seven types

[18] Totally depreciated goods are those which their useful lifetime (*T*) is higher or equal to the average useful lifetime estimated for those goods ($2T_{avg}$).
[19] See footnote 12.
[20] Remember that for some durable goods it was not possible to calculate the median price by Federative Unit, for lack of information of acquisition of the referred good. In these cases the median price of the corresponding Major Region was used.

of expenditure, these are: rent, public services, household refurbishment, furniture and household goods, electrical appliances, electrical appliances repairs, and cleaning material.

Expenses with rent were totally included. The inclusion of paid rent does not distort the comparability between the consumption units, because POF investigates, for residence-owned households, the estimate value of the amount that they would have to pay in case they were renting it. Thus, families that own their estates are not measured with lower welfare that the ones that pay rent.

Deaton and Zaidi (2002) also recommend including public services expenses (water, sewage treatment, electricity, etc.) in the consumption aggregate. These services add welfare to the consumption units. The inclusion or not of the items related to household refurbishment relates to the possibility of finding if these expenses aggregate value to the household or not. In POF 2008-2009 household maintenance expenses were investigated in a period of 90 days and construction expenses in a period of 12 months, the later aggregates value to the household and as such is excluded of the consumption aggregate. All expenditures with cleaning material were included because they are current expenses and increase the consumption units' welfare.

1.4.Education, health and transportation

According to Deaton and Zaidi (2002), the decision to include healthcare expenses must only be considered in cases where these expenses' price elasticity in relation to the total expenditure is above one. This because healthcare expenses do not allow adequate measurement of welfare loss and gain associated to them, once the healthcare expenses do not necessarily generate welfare gains, because they can be mere ways of minimizing welfare losses. For example, high healthcare expenditure on terminally ill patients cannot be compared to a surgery or treatment expenditures that contribute to recovering a patient, or even to an aesthetic-cosmetic procedure. Education expenditure may cause distortion due to the consumption unit age structure, because it is an investment that usually occurs at the beginning of a person's life cycle. Thus, in order to decide about the inclusion or exclusion of these items an analysis of these expenditure elasticities in relation to the total expenditure has to be done.

As it can be observed in Table 2, education expenditure elasticity is above one, justifying the total inclusion of these expenses in the aggregate (POF bloc 49). However the healthcare elasticity is 0.92, requiring a more detailed analysis of elasticity to decide on its inclusion or exclusion.

Table 2: Health and education expenses elasticity

Variable	Elasticity	Standard Error	t Value	P-value
Education * Expenses	1.20	0.0200	59.96	<0.0001
Education * Income	1.05	0.0203	52.04	<0.0001
Health * Expenses	0.92	0.0122	75.51	<0.0001
Health * Income	0.83	0.0110	75.48	<0.0001

Source: IBGE, Research Directory, Brazilian Family Expenditure Survey POF -2008-2009.
Note: For the calculation the sampling design of the survey was considered.

Considering the low values of the healthcare expenditure elasticity in all income classes, the decision was for including solely the healthcare and dental insurances contracts (POF bloc 42), this

due to their characteristic of providing welfare to the consumption units which access these services. Furthermore, these expenses are responsible for a significant proportion of the consumption units' current expenses.

Table 3: Health expenses elasticity versus total expenses by deciles of the *per capita* income distribution

Deciles of income	Elasticity	Standard Error	t Value	P-value	Consumption units
1º	0.75	0.0430	17.37	<0.0001	5695
2º	0.72	0.0429	16.71	<0.0001	5552
3º	0.72	0.0381	18.85	<0.0001	5407
4º	0.75	0.0369	20.4	<0.0001	5263
5º	0.68	0.0339	19.92	<0.0001	5118
6º	0.63	0.0411	15.23	<0.0001	4759
7º	0.67	0.0445	15.01	<0.0001	4501
8º	0.83	0.0505	16.38	<0.0001	4073
9º	0.77	0.0416	18.46	<0.0001	4038
10º	0.73	0.0388	18.84	<0.0001	3480

Source: IBGE, Research Directory, Brazilian Family Expenditure Survey POF -2008-2009.
Note: For the calculation the sampling design of the survey was considered.

The available information on transportation (POF bloc 23), doesn't allow us to determine the motive of its use, i.e., it is difficult to separate between "regrettable needs" and welfare. Taking it into account, the transportation elasticity was calculated considering the contribution to the transportation expenditure general classes[21] elasticity (mass transportation, "own" transportation, other transportation expenses), as it can be seen in the Table 4.

Table 4: Elasticity of expenditure and income, by transportation classes - Brazil

Transportation Classes	Elasticity	
	Expenditure	Income
Total	0.74	0.61
Mass	0.34	0.27
Own	0.62	0.50
Other expenses	0.34	0.24

Source: IBGE, Research Directory, Brazilian Family Expenditure Survey POF -2008-2009.

In an analysis which combines the transportation component weight in total expenditure and elasticity, the decision was to exclude mass transportation (low elasticity and high weight in total expenses) and the inclusion of "own" transportation and other transportation expenses, whose elasticity becomes more relevant when considering they have lower levels of participation in the total transportation expenditure.

Travel expenses (POF bloc 41) that are not motivated by business and professional reasons or health treatment were included in the aggregate. This kind of information allows us to consider the transport expenses on leisure and to perform a differentiation of consumptions units through luxury goods expenses.

1.5. Other non-food goods

[21] Some examples of the incomes concerning each transport category are: Mass (bus, alternative transport, subway, train, farry-boat, integrations); own transport (fuel, parking, toll and carwash); other spending concerning transport (taxi, airplane, car rent).

This group aggregates expenses related to clothing[22], culture and leisure, personal services[23], hygiene and personal care, smoking habits[24] and other miscellaneous expenses. Among the miscellaneous expenses are expenses with other properties, parties, communication and professional services, such as registry office, lawyer and forwarding agents. From these, expenses related to ceremonies and parties[25] were excluded due to occasional character and high values, and expenses with tickets for parties or social events were included, the same with expenses related to games and professional services.

Frequent expenses with utilities (such as light, water, sewage, condominium fees, parking spaces fees, etc) made to other properties of the consumption unit and used for their own benefit (summer house, as an example) were included. While taxes, social contributions, pensions, allowances, donations and private social security taxes were excluded. The banking expenses were included in the consumption aggregate except the overdraft banking services and credit card expenses.

1.6. Deflator[26]

Aiming at ensuring the comparability of the consumption aggregate among different geographical spaces and price patterns, in the same period of time, a deflator was calculated using data from the consumption units with income between the 2nd and 5th deciles. Excluding those consumption units outside the range made consumption baskets more homogeneous preventing that the luxury goods, with low frequency, or goods with excessive quantities prejudiced the analysis.

As the rationale is to create a common consumption basket for all analyzed geographical areas, only the essential expenses for the consumption units were selected for the deflator calculation. Expenses with significant participation on POF total expenditure, were considered essentials, these are: public services such as electric power, water and sewage, gas and communication[27] (landline phone, mobile phone, pay TV and internet); housing expenses[28] (rent and condominium); food expenses; personal hygiene; cleaning material; and home maintenance.

For the spatial price analysis the choice was to use geographical contexts instead of Federative Units used at standard dissemination of the POF expenses. Studying prices behavior through geographical contexts minimizes distortions caused by regional characteristics. Thus, according to POF sampling design particularities it is possible to assess with statistical significance the following geographical strata: Metropolitan Areas (Belém, Fortaleza, Recife, Salvador, Belo Horizonte, Rio

[22] Except the item wedding dress.
[23] The personal services include services such as manicure, pedicure, barber, hairdresser among other related matters.
[24] Smoking and its derivates are part of the group of drugs which prejudice health. Yet, in the low income classes, smoking expenses participation is, approximately, 1% of the total expenditure, being equitable to the other participation of groups such as education, leisure and culture. Likewise, it was decided to include these expenses entirety.
[25] According to Haughton and Khandker (2009), wedding and funeral expenses must not be considered in the consumption aggregate, as well as voluminous and irregular expenses. Deaton and Zaidi (2002) have the same reading on the exclusion of these items.
[26] This stage relied on the collaboration of Paulo Roberto Coutinho Pinto (IBGE/DPE/COREN).
[27] There is no data available for communication services quantity. Thus it was used the ratio between the total number of people in consumption units having expenses on communication services and the consumption unit total, by geographical area, to calculate the average amount.
[28] The decision not to include information on estimated rent in the housing category in the referred consumption basket, is due to the fact that further study is needed in order to use it in the deflator.

de Janeiro, São Paulo, Curitiba and Porto Alegre) and Federal District[29]; non-metropolitan Urban Area and Rural Areas of each Major Region.

The chosen price index for deflating the consumption aggregate constructed from the registered expenses in POF was the Paasche index, once the analysis is restrict to one specific moment in time (one year), in distinct geographical spaces. Appendix 2 shows the result obtained from the consumption basket deflated by the Paasche index to each Geographical Context[30].

2. Analysis of social welfare and inequality based on aggregated consumption

The social welfare functions are usually defined in terms of utilities or in terms of the value of consumption (or income). The social welfare functions that become the sum or the average of individual utilities are called utilitarian. In this section, we work, at first, with the Generalized Lorenz Curve, which permits, in some cases, the ranking of social welfare for an extensive pool of functions. In this case, the functions are strictly S-concaves[31] and increasing. That is to say, one assumes that the social welfare ascends due to the growth of consumption and progressive transfers[32]. Thus, the Generalized Lorenz Curve (GLC), will point the social welfare in three Geographic Areas (Metropolitan area and Federal District, Urban Area and Rural Area) and the Major Regions, without the need to define a specific social welfare function.

The second step of the analysis, one also assumes that the social welfare function is homogenous of level 1 (or that there is a monotonous transformation that makes it into homogeneous of level 1). Thus, it is possible to obtain functions (abbreviated) that show the effects of inequality toward social welfare. This analysis will be based on the average of Sen and the geometric average and their relations with Gini and Atkinson indexes for inequality.

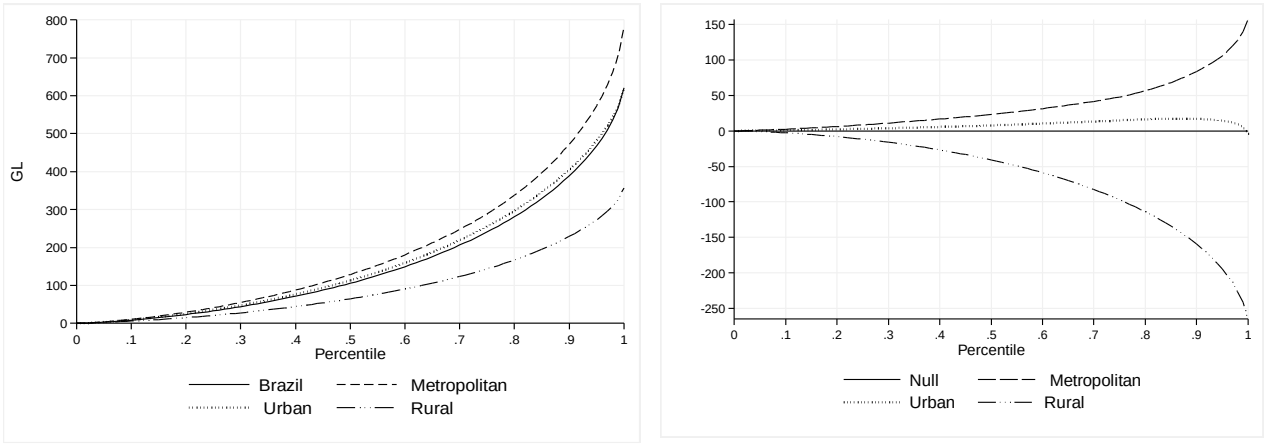
Once the loss of welfare due to inequality is described, the following constitute a study of inequality by components of the consumption aggregate, using the Gini index, and by subgroup of the population, through mean logarithmic deviation.

2.1. *Generalized Lorenz Curve*

The GLC shows the population share (ordered from poorest to richest) on the horizontal axis and shows the consumption partial mean times the population share on the vertical axis. When the curve of an area is always above the other, it is noticed that there is Generalized Lorenz dominance[33]; that is what occurs to the Metropolitan Area, as we see in Figure 1. The Metropolitan Area dominates the Urban Area and the latter dominates the Rural. The conclusion is that any social welfare function that respects the criteria defined above will maintain the social welfare hierarchy: higher welfare in the Metropolitan area, then in the Urban Area, lastly the Rural Area.

[29] The Metropolitan Areas denomination also refers to Brasília (Federal District).
[30] A first presentation on life cost indexes can be found in Barbosa (1995).
[31] The $W(X_n)$ function is strictly S-concave when $W(X_n.A_{nxn})>W(X)$ for any X_n that belongs to its domain and any matrix (A_{nxn}) non-negative and that sums one in each line and column, having at least one line or column with two elements different from zero. See Chakravarty (2009).
[32] Progressive transfers occur when consumption (income) is transferred from a richer to a poor person, requiring that this transfer elevates the consumption (income) level. This is known as the Pigou-Dalton principle.
[33] This dominance points an increase in the social welfare function for all strictly S-concave and increasing. See Foster *et al* (2013), Chakravarty (2009), Shorrocks (1983).

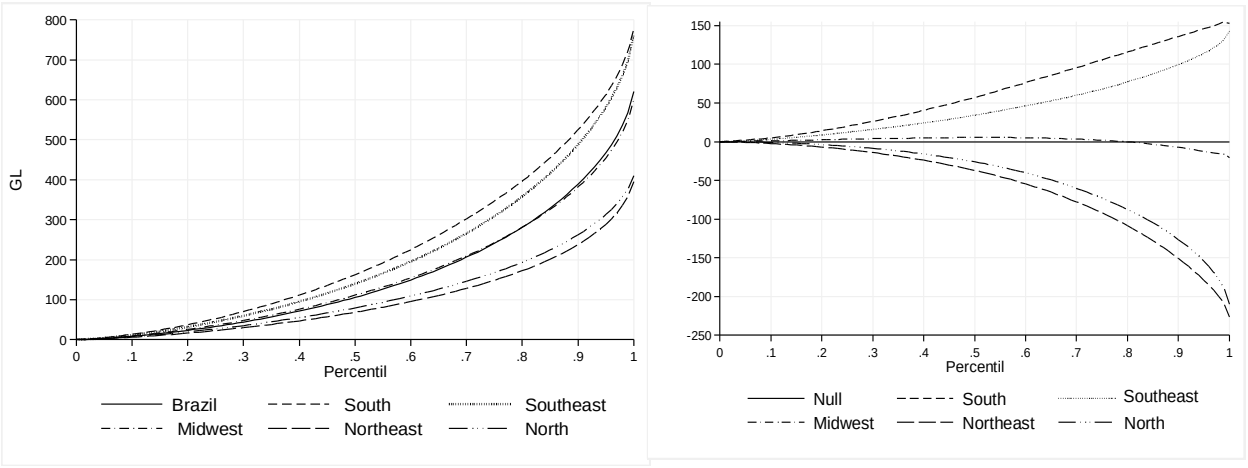
Figure 1: Generalized Lorenz Curve and Generalized Lorenz Curve Differences (Area - Brazil)by Geographical Areas



Source: IBGE, Research Directory, Brazilian Family Expenditure Survey POF -2008-2009.

In the analysis by Major Regions (Figure 2), the following welfare hierarchy is seen: South, Southeast, Midwest, North and Northeast. It is noticeable that the GLC of Midwest is closer to the GLC of Brazil, which reflects a similar distribution in terms of consumption.

Figure 2: Generalized Lorenz Curve and Generalized Lorenz Curve Differences (Region – Brazil) by Major Regions



Source: IBGE, Research Directory, Brazilian Family Expenditure Survey POF -2008-2009.

The GLC is important to establish the welfare hierarchy among the Geographical Areas and the Major Regions. However, this analysis does not aim to provide a numerical value to social welfare associated to each Geographical Area or Major Region; neither to measure the loss of welfare due to inequality. To fill this gap, the following subsections will present two measures that permit the measuring of welfare in terms of inequality and in terms of average consumption, respecting the hierarchy found through the GLC.

2.2. Welfare and Inequality

In this section, one assumes that the function of social welfare is homogeneous of level 1 (or that there is a monotonous transformation that makes it into homogeneous of level 1). Thus, a proportional increase in the consumption enhances social welfare equivalently. Consequently, it is

possible to obtain functions (abbreviated) that show the effects of inequality on social welfare. This study is based on the average of Sen and on the geometrical average. More specifically, the average of Sen can be described as the Sen welfare function (abbreviated) that depends on the average of *per capita* consumption and on the Gini index (equation 7)[34].

$$W_S(c) = \sum_i \sum_j \min\{c_i,c_j\}/ N^2 = \mu.(1-I_G) \quad (7)$$

Similarly, the geometrical average can be seen as a welfare function (abbreviated) that depends on the average of *per capita* consumption and on the Atkinson inequality índex (equation 8)[35].

$$W_G(c) = (\prod_i c_i)^{1/N} = \mu.(1-I_A) \quad (8)$$

where c_i is the consumption of the individual *i*, c_j is the consumption of individual *j*, *N* is the total population, I_G is the Gini índex, I_A is the Atkinson index for inequality and μ is the average of the *per capita* consumption.

The Table 5 shows the values of W_S, W_G, μ, I_G and I_A. As we can see, both the average of consumption (μ) and the welfare measures (W_S and W_G) rank the geographical areas equally. Moreover, as expected, the values of W_S and W_G are lower than the μ in all these areas. This difference represents the loss of social welfare attributed to the inequality in the consumption. For Brazil as a whole, the I_G and the Sen measurements (W_S) both indicate that half of welfare is lost due to inequality of consumption. The Atkinson measure (I_A) and the geometrical measure (W_G) indicate a loss of 36.0%. Another way of saying this is that the social welfare would be unchanged if the consumption of families reduced 36.0% as long as it was distributed equally.

Table 5: Average *per capita* consumption, welfare functions and inequality indexes, by Geographical Areas and Major Regions

Geographical Areas and Major Regions	Mean (μ)	I_G	I_A	$W_S(c)$	$W_G(c)$
Metropolitan	777.45	0.5149	0.3752	377.14	485.75
	(21.45)	(0.0074)	(0.0091)	(5.78)	(7.09)
Urban	616.72	0.4714	0.3274	326.00	414.81
	(8.72)	(0.0038)	(0.0044)	(2.21)	(2.63)
Rural	356.02	0.4802	0.3329	185.06	237.5
	(6.69)	(0.0054)	(0.0064)	(2.05)	(2.31)
North	410.59	0.4696	0.3142	217.78	281.58
	(11.83)	(0.0078)	(0.009)	(3.21)	(3.71)
Northeast	394.66	0.5075	0.3609	194.37	252.23
	(8.57)	(0.0066)	(0.0079)	(2.63)	(3.13)
Southeast	763.6	0.4808	0.3361	396.46	506.95
	(17.2)	(0.0065)	(0.0077)	(4.94)	(5.89)
South	773.75	0.4333	0.2816	438.49	555.86
	(15.3)	(0.0057)	(0.0064)	(4.44)	(4.99)
Midwest	600.52	0.4805	0.3319	311.97	401.21
	(17.4)	(0.0087)	(0.0101)	(5.30)	(6.11)
Brazil	620.83	0.5010	0.3626	309.79	395.72
	(8.12)	(0.0037)	(0.0045)	(2.28)	(2.73)

Source: IBGE, Research Directory, Brazilian Family Expenditure Survey POF -2008-2009.

[34] This abbreviated social welfare function can have different motivation, in general one assumes that the contribution of the consumption of one person (family) in social welfare depends on his/her position (or ranking) in the consumption distribution. In some cases, the original welfare function value is identical to the abbreviated function and to the equivalent consumption (DUCLOS and ABDLKRIM, 2006). On this matter also consult Sen and Foster (1997) and Lambert (2001).

[35] This abbreviated social welfare function can be motivated by a logarithmic utility function and a social welfare function that considers the average of the utilities. A monotonous transformation (the exponential of this function) generated the geometric average that assures the needed level 1 homogeneity. One needs to highlight that the logarithmic utility function adopted is a particular case of utility function with constant elasticity, as presented in Atkinson (1970). On this matter also consult Lambert (2001) and (Duclos and Abdlkrim, 2006).

The other areas on Table 5 show a similar result. Welfare losses between 43.0% and 51.0% by the W_S function and between 28.0% and 38.0% by the W_G function.

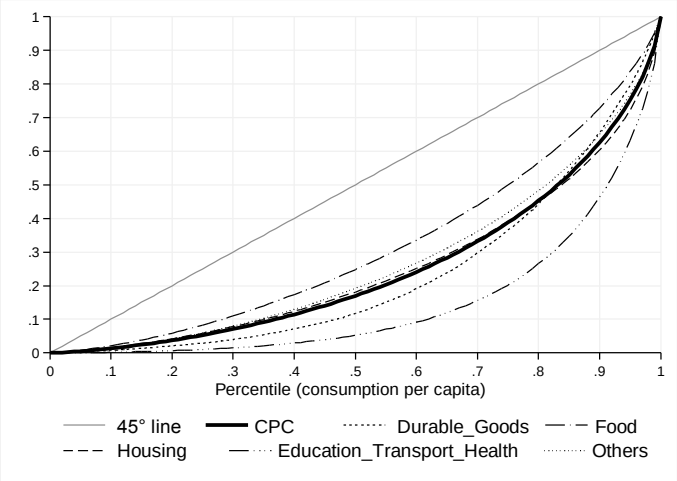
Given the impact of social welfare inequalities, the following subsections will present two decompositions: the first one, by consumption aggregate components; and the second one, by subgroups of the population.

2.3. Decomposition of inequality by component of consumption

The decomposition of inequality by component of consumption is based on the fact that the Gini index is the result of the concentration of each component of consumption and of the participation of these components in the total consumption. Thus, it is possible to find out which are the factors with higher contribution to the level of inequality found in the studied area.

Figure 3 shows the concentration curves of the five components used in the construction of the consumption aggregate. The farther the curve is from the 45º line, the more concentrated the component in analysis will be. Therefore, the biggest concentrations are in the consumption of the groups "Education, health and transport" and "Durable goods". Concerning the group "Education, health and transport" it must be highlighted that the public education and public health as well as the mass transport were not included in the consumption aggregate composition. The food group presents the lowest concentration; this is a coherent result since food consumption is vital to living conditions.

Figure 3: Concentration and Lorenz Curves, by component of consumption, Brazil



Source: IBGE, Research Directory, Brazilian Family Expenditure Survey POF -2008-2009.
Note: CPC = *Per capita* consumption.

In Table 6, we see the results of the consumption aggregate decomposition with data for Brazil represented. The product of the expenditure group participation in total consumption and its corresponding concentration index will indicate the contribution of each component. It is noticeable that the housing group has the highest participation on the total consumption, 32.5%. It also has a high concentration (49.8%), which makes this group the main responsible for inequality, with a relative contribution of 32.3%[36].

[36] It is important to highlight that the high concentration of this expenses is also a consequence of the decisions taken and commented in Subsection 1.4. These aimed at selecting expenses with higher chances of welfare increase.

Table 6 Index-Decomposition by component of consumption, Brazil

Consumption Group	Consumption Share	Concentration	Contribution	Relative Contribution
Durable Goods	0.1365	0.5393	0.0736	0.1470
	(0.0011)	(0.0033)	(0.0007)	(0.0019)
Housing	0.3250	0.4982	0.1619	0.3232
	(0.0025)	(0.0062)	(0.0030)	(0.0046)
Education Health and Transportation	0.1468	0.7037	0.1033	0.2062
	(0.0021)	(0.0044)	(0.0019)	(0.0031)
Food	0.2178	0.3710	0.0808	0.1612
	(0.0019)	(0.0037)	(0.0011)	(0.0023)
Others	0.1739	0.4678	0.0814	0.1624
	(0.0013)	(0.0046)	(0.0011)	(0.0022)
Total	1.00	.	0.5010	1.00
	(0.0000)	.	(0.0037)	(0.0000)

Source: IBGE, Research Directory, Brazilian Family Expenditure Survey POF -2008-2009.

These data complement the graphical analysis of Concentration and Lorenz Curves made earlier, since although the knowledge of the concentration is extremely relevant for the composition of inequality, such information needs to be supplemented by the expenditure weight on the consumption aggregate. The group "Education, Health and Transport" as indicated in Table 6, is the most concentrated of all the components, and its concentration index reaches 0.7. However, its relative share in total consumption is small, 14.7%, making its relative contribution to inequality not the greatest.

2.4. Decomposition of inequality by population subgroup

This subsection gives continuity to the study of the decomposition of inequality by geographical area and by characteristics of the person responsible for the consumption unit: years of education, sex, and color or race. However, for the analysis of population subgroups, the Gini index was not used, since it is not decomposable by subgroups in a way that one gets only the interaction of inequality within each subgroup and among the subgroups studied.

Thus, the decomposition by subgroups is made based on the mean logarithmic deviation. This index belongs to the class of Generalized Entropy[37], closely associated with the Atkinson measure of inequality. In the case of the mean logarithmic deviation method ($ln\ (\mu/W_G)$), this can be described as the sum of inequality within each subgroup of the population, weighted by the share of each subgroup, plus the existing inequality between the subgroups.

As can be seen in Table 7, the inequality calculated by the mean logarithmic deviation for Geographical Areas presents results close to the level of Brazil (45.0%), being of 47.0% in the Metropolitan Region, 40.5% in Rural Areas, and 39.7% in Urban Areas. However, by having a greater number of inhabitants (53.0%), the Urban Area, even with a lower level of inequality among the Geographical Areas, has a greater relative contribution (46.7%). Concerning the Major Regions, the Southeast has the highest share of population and also the highest level of inequality (41.0%). It may be noted in this subgroup the cases of the Midwest and North regions which have the smallest population rates (7.3% and 8.0%, respectively), but a level of inequality rather high (40.3% and 37.8%, respectively).

[37] For further details on this index consult Lambert (2001) and Cowell (2000).

Regarding the subgroup color or race, whites are responsible for the higher relative incidence of inequality, 41.4%. Regarding the sex subgroup, the mean logarithmic deviation is very similar for men (45.0%) and women (44.8%), i.e., the sex of the person responsible for the consumption unit does not affect the consumption inequality. Therefore, the higher relative contribution of men to total inequality is determined by their greater participation (72.4%) on the total number of persons responsible for consumption units.

Table 7: Mean logarithmic deviation - decomposition by population subgroup

Subgroups	Population share	Mean logarithmic deviation	Contribution	Relative Contribution
Brazil	1.00	0.4503	0.4503	1.00
Geographical Area				
Metropolitan	0.3006	0.4703	0.1414	0.3140
	(0.0048)	(0.0145)	(0.0052)	(0.0086)
Urban	0.5298	0.3965	0.2101	0.4666
	(0.0048)	(0.0066)	(0.0038)	(0.0089)
Rural	0.1696	0.4048	0.0686	0.1524
	(0.0034)	(0.0096)	(0.0020)	(0.0047)
Within	.	.	0.4201	0.9330
Between	.	0.0302	0.0302	0.0670
Major Regions				
North	0.0808	0.3772	0.0305	0.0677
	(0.0019)	(0.0131)	(0.0013)	(0.0029)
Northeast	0.2815	0.4476	0.1260	0.2799
	(0.0038)	(0.0124)	(0.0040)	(0.0088)
Southeast	0.4200	0.4096	0.1720	0.3821
	(0.0051)	(0.0115)	(0.0053)	(0.0083)
South	0.1450	0.3307	0.0479	0.1065
	(0.0027)	(0.0089)	(0.0016)	(0.0037)
Midwest	0.0726	0.4033	0.0293	0.0651
	(0.0016)	(0.0151)	(0.0014)	(0.0031)
Within	.	.	0.4058	0.9012
Between	.	0.0445	0.0445	0.0988
Race / Color				
White	0.4608	0.4049	0.1866	0.4143
	(0.0044)	(0.0084)	(0.0044)	(0.0063)
Black	0.0919	0.3678	0.0338	0.0751
	(0.0024)	(0.0182)	(0.0019)	(0.0043)
Mixed	0.4336	0.3843	0.1666	0.3700
	(0.0041)	(0.0075)	(0.0035)	(0.0073)
Others	0.0137	0.5469	0.0075	0.0167
	(0.0010)	(0.0415)	(0.0008)	(0.0017)
Within	.	.	0.3945	0.8761
Between	.	0.0558	0.0558	0.1239

Subgroups	Population share	Mean logarithmic deviation	Contribution	Relative Contribution
Brazil	1.00	0.4503	0.4503	1.00
School Years				
Zero	0.1175	0.3157	0.0371	0.0824
	(0.0027)	(0.0106)	(0.0015)	(0.0034)
1-3	0.1614	0.3284	0.0530	0.1177
	(0.0028)	(0.0075)	(0.0015)	(0.0038)
4-7	0.2855	0.3216	0.0918	0.2039
	(0.0037)	(0.0066)	(0.0021)	(0.0050)
8-10	0.1331	0.2963	0.0394	0.0876
	(0.0027)	(0.0089)	(0.0014)	(0.0032)
11-14	0.2148	0.2976	0.0639	0.1419
	(0.0036)	(0.0077)	(0.0018)	(0.0041)
15+	0.0805	0.2599	0.0209	0.0465
	(0.0029)	(0.0122)	(0.0011)	(0.0020)
Unknow	0.0073	0.3050	0.0022	0.0050
	(0.0006)	(0.0313)	(0.0003)	(0.0006)
Within	.	.	0.3084	0.6849
Between	.	0.1419	0.1419	0.3151
Sex				
Woman	0.2761	0.4479	0.1237	0.2746
	(0.0039)	(0.0095)	(0.0030)	(0.0061)
Man	0.7239	0.4505	0.3261	0.7243
	(0.0039)	(0.0081)	(0.0061)	(0.0058)
Within	.	.	0.4498	0.9989
Between	.	0.0005	0.0005	0.0011

Source: Brazilian Family Expenditure Survey 2008-2009, IBGE.

Through investigation of the results of the subgroup's years of study, it is clear that there is an inverse association between the number of years of study with the level of inequality, and for the grades 8-10 years and 11-14 years, the mean logarithmic deviation is stable, and falls back to people with 15 years or more of study.

Another way to examine the results of the mean logarithmic deviation is to look at the interaction of inequality of subgroups with their weight in the population and the total inequality in the country. As shown in Table 7 the main contribution to inequality in Brazil comes from within each subgroup. That is, although there is a Generalized Lorenz dominance of the Metropolitan Area over the Urban and Rural Areas (see Subsection 2.1), 93.3% of Brazil's inequality is

explained by inequality within these subgroups. The same can be observed for subgroups of the Major Regions (90.1%), color or race (87.6%) and sex (99.9%).

In the case of the subgroup years of study there is a peculiarity. Both the inequality between (31.5%) and the inequality within (68.5%) the subgroup grades is significant in explaining the total inequality of Brazil.

3. Analysis of poverty and vulnerability based on aggregated consumption

In this section the consumption units are analised by Geographical Areas and subgroups of population regarding poverty. In this sense poverty measures that belong to the FGT (Foster, Greer e Thorbecke, 1984) class are used with focus on severity to poverty (FGT(2)). In order to estimate the probability of a consumption unit becoming poor in a future period of time, a vulnerability analysis based on Chaudhuri *et al* (2002) methodology adapted to incorporate cluster effects was done.

3.1. *Poverty Severity*

The consumption aggregate can also be used in studies of poverty from a monetary perspective. Following this perspective, different dimensions (food, housing, education, health, transport, leisure etc.) were combined considering available prices and expenditure type as described in previous sections. After calculating the consumption, two extra exercises were necessary in order to evaluate poverty, the Identification and Aggregation exercises, emphasized by Sen (1976)[38]. The Identification itemizes the poor and the non-poor, while the Aggregation enables the combination of information about poverty in an index.

In general, the poor identification is based on some poverty line (z) that marks a limit to the welfare indicator (in this case, consumption). The poor are expressed by the welfare indicator (consumption) that is below the line. The non-poor are expressed by the indicator (consumption) that is higher or equal regarding the poverty line[39]. In this work, two absolute lines were adopted based on minimum wage. Consumption units with *per capita* income next to half of minimum wage (between R$ 202.50 and R$ 212.50) and a quarter of a minimum wage (between R$ 101.25 and R$ 106.25) were adopted. Then, the median *per capita* consumption of these two groups was calculated resulting in two poverty lines based in consumption: R$ 185.00 and R$ 117.00.

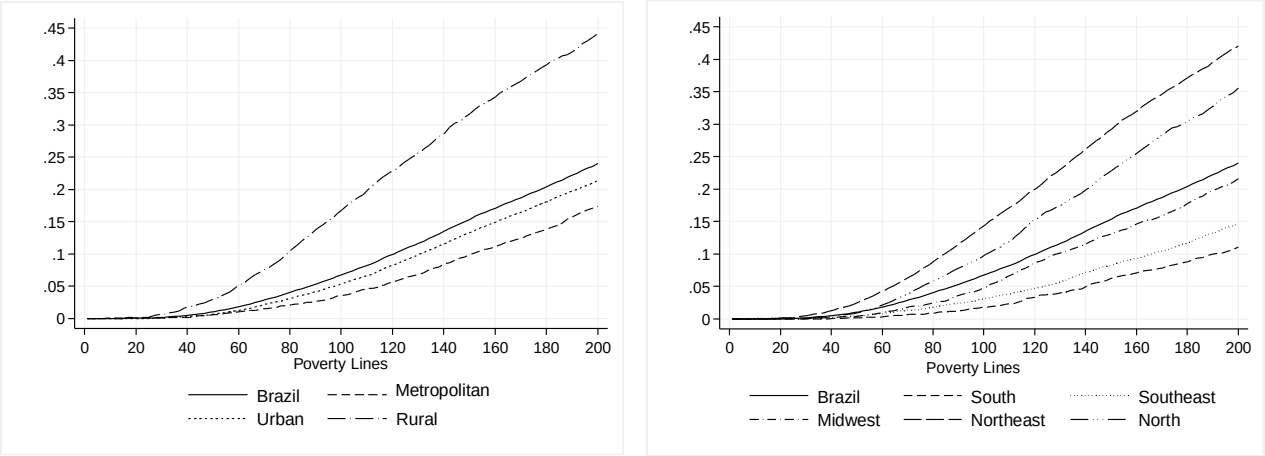
In Figure 4, the proportions of the poor in Brazil are shown for the Geographical Areas and Major Regions according to different poverty lines (R$ 1.00 $\leq$ z $\leq$ R$ 200.00). This helps one visualize how sensible the Identification exercise (of the poor) is towards the chosen lines. The inclination of these curves around the lines R$ 185.00 and R$117.00 indicates this sensibility. As it can be seen, the sensibility is higher in the Rural Area, and in the North and Northeast regions. Even so, around these two lines, we can see a clear hierarchy within the Geographical Areas and

[38] Besides the emphasis on these exercises, Sen's article comments the limitation concerning the most used poverty measures at the time (insensible to inequality among the poor) and stimulates axiomatic approach in which measures concerning poverty are generated and evaluated to attend some properties.

[39] Further details about different methodologies, definitions and interpretations regarding absolute, relative and subjective poverty lines can be seen in Ravallion (2001), Soares (2008) and Atkinson *et al* (2002).

within the Major Regions. That is to say that for an extensive set of lines next to R$ 185.00 and R$117.00, the proportion of the poor is higher in the Rural Area followed by the Urban Area. Similarly, for an extensive set of lines of poverty next to R$ 185.00 and R$117.00, a bigger proportion of the population is classified as poor in the North and Northeast and a smaller proportion in the South and Southeast.

Figure 4: Poverty curves by Geographical Area and Major Regions



Source: Brazilian Family Expenditure Survey 2008-2009, IBGE.

Once the lines are selected, we move to the exercise of Aggregation in which the information about the poor is combined to analyze poverty in society. Three measures of family FGT (Foster, Geer and Thorbecke, 1984) are used to study poverty: the proportion or incidence of the poor [FGT (α=0)], poverty intensity [FGT(α=1)], and poverty severity [FGT (α=2)], as defined on the expression below:

$$FGT(\alpha) = \frac{1}{n}\sum_{i=1}^{n}\left[\frac{(z - y_i)}{z}\right]^{\alpha} S_i \qquad (9)$$

where z is the poverty line value and S_i is a variable that indicates that it is equal to 1 if i-th individual is below poverty line and 0, otherwise. The bigger the coefficient α is, the bigger the poverty gap is. The values of these measures for Brazil and Geographical Areas are presented in Appendix 3.

Among the three measures presented, only the one concerning poverty severity is sensible to inequality in terms of consumption among the poor. That is to say, the more heterogeneous the poor population is, the bigger is the value of the indicator FGT(2). That being said, this is the most appropriated poverty measurement, and that will be analyzed in of Table 8.

Taking into consideration poverty severity by Geographical Area for the line R$ 185.00, it is noticeable that poverty is more severe in the Rural Area (8.4%). However, the Urban Area presents the biggest relative contribution, because of the weight of its population. When the same evaluation is done with the line R$ 117.00, it is noticeable that the biggest contribution in terms of severity comes from the Rural Area (45.2%), and the Urban Area is 39,1%.

When severity to poverty is analyzed by Major Regions taking the two lines of studies into account, the Northeast presents the biggest poverty level, followed by the North. However, when

one observes the relative contribution concerning poverty severity, the North still has the biggest participation. But, the Southeast appears in second place in terms of relative participation.

In the subgroup related to color or race, it is recognizable that the black or mixed population subgroups are the ones that most contribute to the poverty severity, followed by the white subgroup.

Table 8: Poverty severity and relative contribution by consumption lines, according to Geographical Areas, Major Regions and the Population subgroups (Part 1)

Subgroup	Population Share	Poverty Line = R$185			Poverty Line = R$117		
		FGT (α=2)	Contribution	Relative Contribution	FGT (α=2)	Contribution	Relative contribution
Brazil	1.00	0.0359	0.0359	1.00	0.0121	0.0121	1.00
Geographical Area							
Metropolitan	0.3006	0.0206	0.0062	0.1725	0.0063	0.0019	0.1578
	(0.0048)	(0.0018)	(0.0006)	(0.0142)	(0.0010)	(0.0003)	(0.0221)
Urban	0.5298	0.0291	0.0154	0.4294	0.0089	0.0047	0.3907
	(0.0048)	(0.0009)	(0.0005)	(0.0134)	(0.0004)	(0.0002)	(0.0196)
Rural	0.1696	0.0843	0.0143	0.3981	0.0321	0.0054	0.4515
	(0.0034)	(0.0033)	(0.0006)	(0.0140)	(0.0020)	(0.0004)	(0.0219)
Major Regions							
North	0.0808	0.0516	0.0042	0.1161	0.0157	0.0013	0.1053
	(0.0019)	(0.0030)	(0.0003)	(0.0076)	(0.0014)	(0.0001)	(0.0099)
Northeast	0.2815	0.0738	0.0208	0.5786	0.0269	0.0076	0.6294
	(0.0038)	(0.0022)	(0.0007)	(0.0144)	(0.0013)	(0.0004)	(0.0222)
Southeast	0.4200	0.0176	0.0074	0.2055	0.0055	0.0023	0.1915
	(0.0051)	(0.0014)	(0.0006)	(0.0146)	(0.0008)	(0.0003)	(0.0228)
South	0.1450	0.0111	0.0016	0.0448	0.0026	0.0004	0.0310
	(0.0027)	(0.0011)	(0.0002)	(0.0045)	(0.0004)	(0.0001)	(0.0053)
Midwest	0.0726	0.0272	0.0020	0.0551	0.0071	0.0005	0.0429
	(0.0016)	(0.0020)	(0.0002)	(0.0046)	(0.0007)	(0.0001)	(0.0049)

The results in Table 8 also show that the poverty is more severe for people with no school education or with only few years of study (0-7 years); having a relative contribution of 87.2% (referring to line R$ 185.00) and 88.7% (referring to line R$117.00) concerning poverty severity. In relation to sex there are not any observed differences concerning poverty severity: referring to line R$ 185.00 women have the index of 3.7% while men have 3.6%; refereeing to line R$ 117.00 the value is 1.3% and 1.2 %, in the same order.

Table 8: Poverty severity and relative contribution by consumption lines, according to the population subgroups (Part 2)

School Years							
Zero	0.1175	0.0891	0.0105	0.2915	0.0340	0.0040	0.3318
	(0.0027)	(0.0036)	(0.0005)	(0.0114)	(0.0023)	(0.0003)	(0.0186)
1-3	0.1614	0.0647	0.0104	0.2908	0.0226	0.0036	0.3027
	(0.0028)	(0.0024)	(0.0004)	(0.0105)	(0.0013)	(0.0002)	(0.0171)
4-7	0.2855	0.0364	0.0104	0.2895	0.0107	0.0030	0.2523
	(0.0037)	(0.0015)	(0.0004)	(0.0094)	(0.0008)	(0.0002)	(0.0146)
8-10	0.1331	0.0203	0.0027	0.0752	0.0061	0.0008	0.0672
	(0.0027)	(0.0020)	(0.0003)	(0.0072)	(0.0011)	(0.0002)	(0.0122)
11-14	0.2148	0.0076	0.0016	0.0452	0.0022	0.0005	0.0391
	(0.0036)	(0.0009)	(0.0002)	(0.0052)	(0.0006)	(0.0001)	(0.0097)
15+	0.0805	0.0008	0.0001	0.0018	0.0002	0.0000	0.0016
	(0.0029)	(0.0004)	(0.0000)	(0.0008)	(0.0001)	(0.0000)	(0.0010)
Unknow	0.0073	0.0297	0.0002	0.0061	0.0087	0.0001	0.0053
	(0.0006)	(0.0092)	(0.0001)	(0.0019)	(0.0051)	(0.0000)	(0.0031)
Sex							
Woman	0.2761	0.0368	0.0102	0.2829	0.0126	0.0035	0.2880
	(0.0039)	(0.0016)	(0.0005)	(0.0108)	(0.0010)	(0.0003)	(0.0175)
Man	0.7239	0.0356	0.0258	0.7171	0.0119	0.0086	0.7120
	(0.0039)	(0.0011)	(0.0008)	(0.0108)	(0.0006)	(0.0004)	(0.0175)
Race / Color							
White	0.4608	0.0161	0.0074	0.2059	0.0047	0.0022	0.1790
	(0.0044)	(0.0010)	(0.0005)	(0.0111)	(0.0005)	(0.0002)	(0.0161)
Black	0.0919	0.0524	0.0048	0.1340	0.0197	0.0018	0.1504
	(0.0024)	(0.0039)	(0.0004)	(0.0098)	(0.0024)	(0.0002)	(0.0167)
Mixed	0.4336	0.0536	0.0232	0.6471	0.0183	0.0079	0.6576
	(0.0041)	(0.0016)	(0.0007)	(0.0130)	(0.0009)	(0.0004)	(0.0204)
Others	0.0137	0.0340	0.0005	0.0130	0.0115	0.0002	0.0130
	(0.0010)	(0.0056)	(0.0001)	(0.0024)	(0.0027)	(0.0000)	(0.0032)

Source: Brazilian Family Expenditure Survey 2008-2009, IBGE.

3.2. Poverty vulnerability

Recent studies have emphasized the analysis of poverty vulnerability, understood as the chance of the welfare indicator to present a value below the poverty line[40]. It is important to highlight that the data set that has a panel form is the most appropriated way to study vulnerability. However, Chaudhuri *et al* (2002) and Jonathan and Haughton (2009) recommend the evaluation of vulnerability even in the absence of data panels on consumption. In those cases they suggest the use of regressions and estimators of generalized minimum squares to model the consumption distribution and the chance of a consumption unit falling into poverty. In this section, the procedures of Chaudhuri *et al* (2002) are adapted to include area effects (clusters). Thus, a methodology similar to the one used in the Poverty Map will be applied (Elbers *et al*, 2002; IBGE, 2008)[41].

More specifically, the vulnerability of a consumption unit *j* to poverty in time *t* is defined as the probability of the *per capita* consumption of that unit in time *t +1* being below poverty line *z*:

[40] Examples of this analysis can be found in Lopes-Calvas and Ortiz-Juarez (2011), Ferreira *et al* (2013), SAE's Report (uses it for the definition of middle class), Ribas (2007), and Calvo and Dercon (2008).
[41] Another possibility that might be explored in the future is the use of pseudo-panels as suggested by Bourguignon *et al* (2006) and Dang and Lanjouw (2013).

$$v_{jt} = P(c_{j,t+1} < z) \tag{10}$$

meaning $c_{j,t+1}$ is the *per capita* consumption of the consumption unit *j* in time *t+1* and *z* is the poverty line calculated from the consumption aggregate.

One defines y_{dj} as a welfare variable function that being the logarithm of the *per capita* consumption aggregate, of consumption unit *j* in the enumeration area *d*. The model can be written as follows:

$$y_{dj} = x'_{dj}\beta + \eta_{dj}, \eta_{dj} \sim F(0, \Sigma) \tag{11}$$

meaning *F* is a distribution with a vector of average **0** and variance-covariance matrix Σ and x_{dj} is the vector of explanatory variables of the sample survey, regarding the consumption unit *j* of enumeration area *d*, $j = 1,\ldots,N_d$ and $d = 1,\ldots,D$. It is possible to introduce indicators on geographical levels that are more aggregated in order to control the localization effect whenever it is not entirely explained through regressors. Such indicators can be obtained in other data bases.

The model error may have two components: (i) unit effect associated with consumption unit and; (ii) area effect associated with the enumeration area where this unit is placed. Thus, η_{dj} can be written as:

$$\eta_{dj} = u_d + e_{dj} \tag{12}$$

meaning u_d and e_{dj} are independent, from $u_d \sim N(0, \sigma_u^2)$ and $e_{dj} \sim N(0, \sigma_{e_{dj}}^2)$.

Assuming that the errors of the domestic level e_{dj} are heterocedastics, Elbers *et al* (2002) suggest estimating the logistic regression:

$$\ln\left(\frac{e_{dj}^2}{A - e_{dj}^2}\right) = z'_{dj}\alpha + r_{dj} \tag{13}$$

and they estimate the variance on consumption unit level according to the formula:

$$\hat{\sigma}_{e_{dj}}^2 \approx \left[\frac{AB}{1+B}\right] + \frac{1}{2} var(r)\left[\frac{AB(1-B)}{(1+B)^3}\right] \tag{14}$$

where $A = 1.05 max(e_{dj}^2)$, $B = \exp(z'_{dj}\hat{\alpha})$, *var(r)* is the quadratic error of the estimated logistic regression's residual and z_{dj} is a vector of explanatory variables.

Assuming that u_d and e_{dj} have a normal distribution, Elbert *et al* (2002) derived an estimate of the area effect variance u_d:

$$var(\hat{\sigma}_u^2) \approx \sum_d 2\left\{a_d^2[(\hat{\sigma}_u^2)^2 + (\hat{\tau}_d^2)^2 + 2\hat{\sigma}_u^2\hat{\tau}_d^2] + b_d^2 \frac{(\hat{\tau}_d^2)^2}{n_d - 1}\right\} \tag{15}$$

where $\hat{\tau}_d^2 = \frac{1}{n_d(n_d-1)}\sum_j (e_{dj} - e_{d.})^2$, $e_{d.} = \frac{1}{n_d}\sum_j e_{dj}$, $a_d = \frac{w_d}{\sum_j w_j(1-w_j)}$, $b_d = \frac{w_d(1-w_d)}{\sum_j w_j(1-w_j)}$, $\hat{\sigma}_u^2 = \sum_d a_d \eta_{d.}^2 - \sum_d b_d \hat{\tau}_d^2$, $\eta_{d.}^2 = u_d + e_{d.}$, $w_d = \sum_j \frac{w_{dj}}{n_d}$ and n_d it is the total number of people associated to the enumeration area *d* and w_j is the survey expansion factor of the consumption unit *j*.

From the estimates found for the modeling procedure parameters, it is estimated the welfare

variable and the vulnerability of each consumption unit according to the equation:

$$\hat{v}_{dj} = \Phi\left(\frac{\ln z - \hat{y}_{dj}}{\sqrt{\hat{\sigma}^2_{u_d} + \hat{\sigma}^2_{e_{dj}}}}\right) \quad (16)$$

Once the methodology is defined, the following step is the estimation of the consumption units (and their components) vulnerability. As explanatory variables, data regarding consumption units extracted from POF was used, such as logarithm of available *per capita* monetary income, density of resident per room, indicator of illiterate consumption unit responsible, logarithm of total residents, indicator of bathroom, indicator of the consumption unit responsible occupation, indicator of the consumption unit responsible years of study, indicator of the geographical context, enumeration area data such as proportion of consumption units which the responsible name is on healthcare insurance contract, proportion of responsible with high level education and data on a municipal level from other sources of data, for instance, the logarithm of 2010 *per capita* GDP and the proportion of people who received *Bolsa Família* in 2010. The significance level concerning the choice of the variables was 0.05[42].

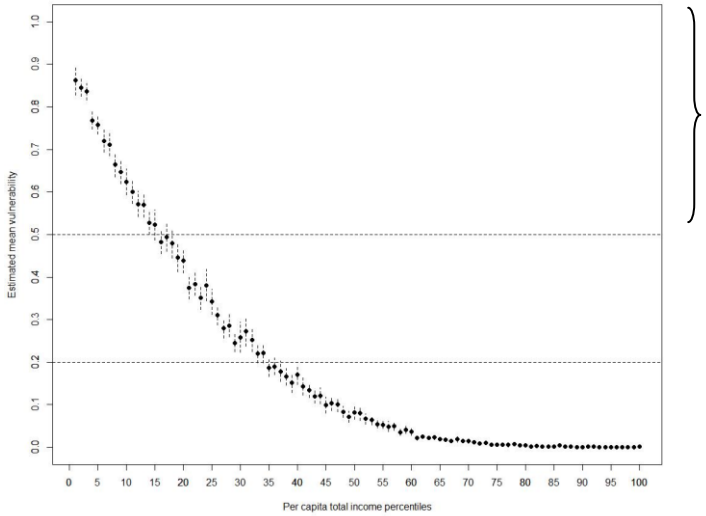
It is important to mention that the variables selection aim was to select a model with good predictive power, wihtouth the pretension of presenting causal effects. The model adjustment (equation 11) resulted in a R^2 of 0.75.

According to Chaudhuri *et al* (2002), the consumption units with vulnerability index higher than 0.5 were considered highly vulnerable. The estimated consumption of these consumption units and their components are below poverty line. It is possible that these consumption units end up suffer from chronic poverty. The consumption units (and their components) with probabilities between 0.2 and 0.5 were classified as vulnerable due to the fact that they present estimated consumption above the poverty line, but they still have big chances of falling into poverty. It is possible that these consumption units may suffer from transitory poverty[43].

The Figure 5 indicates the relation between income and consumption vulnerability in a synthetic way. More specifically, it indicates the average vulnerability (of *per capita* consumption) by percentiles of *per capita* income and their respective confidence intervals of 95.0%. A strict relation is observable between these incomes and the consumption units' vulnerability. Around 16.0% of the population presents average vulnerability higher than 0.5 and *per capita* income bellow R$ 181.70. Thus, a rather low *per capita* income (less than R$ 181.70), also indicates high vulnerability (of consumption). Similarly, *per capita* incomes between R$181.70 and R$ 327.24 can be consider as a sign of vulnerability (between 0.2 and 0.5). People who present estimated vulnerability between 0.2 and 0.5 may face a situation of transitory poverty; they represent 19% of the Brazilian population.

[42] See Appendix 4: Explanatory variables of the model.
[43] A more appropriated explanation concerning chronic poverty as well as transitory would also need data panels. See for example Ravallion and Jalan (2000), Addison (2009) and the Journal of Economic Inequality 10 (2012)

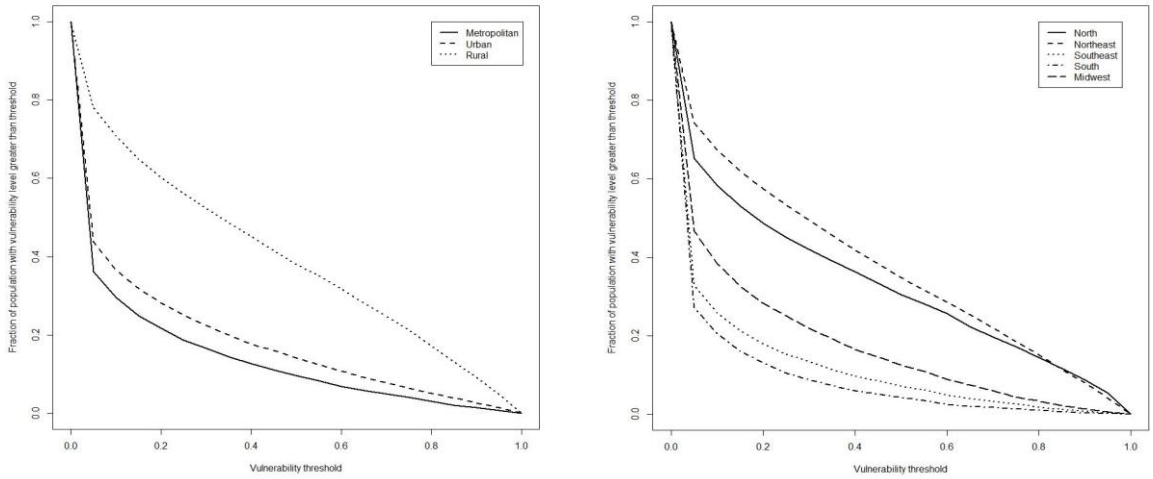
Figure 5: Estimated average vulnerability by percentiles of *per capita* income regarding consumption units and their respective confidence intervals of 95%



Source: Brazilian Family Expenditure Survey 2008-2009, IBGE.

The Figure 6 indicates the estimated fraction of vulnerable people concerning poverty according to vulnerability levels established between zero and one relating to (a) Metropolitan, Urban and Rural Areas and (b) Major Regions. Among all levels of vulnerability, the North and the Northeast present bigger estimated fractions of vulnerable people, as it is in the Rural Area. The South line decay is more accentuated than the other regions.

Figure 6: Estimated fraction of vulnerable people concerning poverty according to vulnerability levels established between 0 and 1.



(a) Metropolitans, Urban and Rural Areas (b) Major Regions

Source: Brazilian Family Expenditure Survey 2008-2009, IBGE.

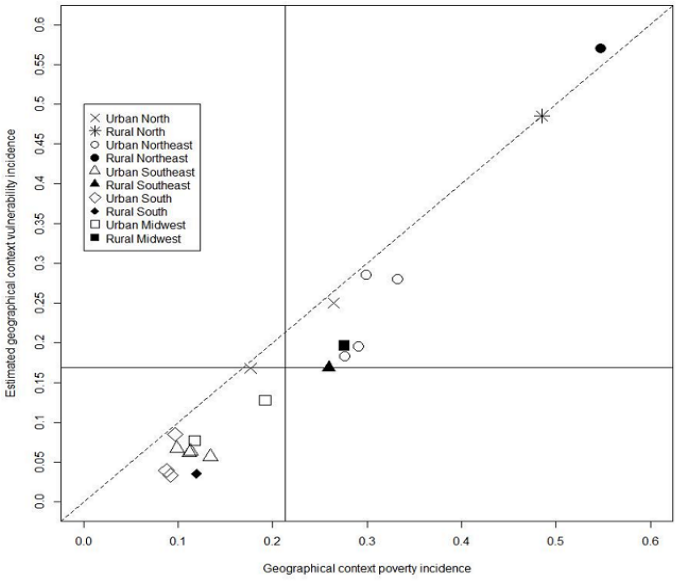
In conclusion to the regional analysis, the Figure 7 indicates the estimated fractions of vulnerable people concerning poverty versus the estimated proportions of the poor estimated directly in POF for the 20 geographical contexts which they take part in Geographical Areas and in the Major Regions. The figure 7-a focuses on highly vulnerable people (vulnerability above 0.5), while Figure 7-b focuses on vulnerable people (vulnerability between 0.2 and 0.5). In 7-a we can observe that the contexts in the North and Northeast region present proportions of highly vulnerable

people higher than Brazil's (horizontal line), except for the Belem metropolitan region (represented in one of the Urban Area contexts of the North region). The same occurs with the estimated proportion of poor people in Brazil (vertical line). It is highlighted that, among Rural Areas, the South is the only region that has a fraction of people highly vulnerable lower than Brazil's. The same tendency can be seen in (b), therefore, in conclusion, people from the South and from Urban Areas of Southeast and Midwest are less vulnerable to poverty than people from the North and from the Northeast.

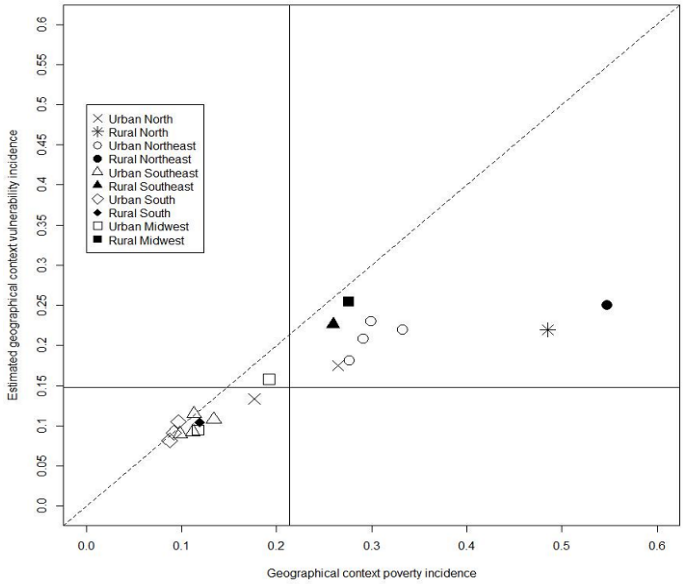
Two other remarkable factors are related to 45º straight line in these figures. As it is observable, the proportion of highly vulnerable people is (fairly always) a little smaller than the proportion of the poor, although these two measures behave in the same way. This can be explained because of the fact that the proportion of the poor is a measurement of vulnerability (not conditioned) of society. In Figure 7-b, the biggest differences can be seen since an increase of the proportion of poor is not always followed by a similar increase of vulnerability proportion[44].

Figure 7: Estimated fractions of vulnerable people concerning poverty versus the estimated proportions of the poor calculated directly from POF regarding the 20 geographical contexts which take part in Geographical Areas, and in Major Regions

(a) Level above 0.5



(b) Level between 0.2 e 0.5



Source: Brazilian Family Expenditure Survey 2008-2009, IBGE.

4. Final considerations

The present article is proposed to examine the well-being, inequality, poverty and vulnerability to poverty of Brazilian families from the perspective of the consumption. This issue is commonly addressed through the income perspective. However the consumption pattern is brought as the most suitable for these studies, since it presents a better response to seasonal fluctuations, demonstrating how families behave according to their budget availability, and thus better capturing their living conditions.

[44] See Appendix 5: Estimated fractions of vulnerable people concerning poverty versus the estimated proportions of the poor calculated directly from POF regarding the 20 geographical contexts which take part in Geographical Areas, and in Major Regions.

The Brazilian Family Expenditure Survey (POF), conducted by IBGE, is the research that raises the information expenses of a range sufficient to determine the consumption pattern of Brazilian families. However, the use of information from POF to conduct analysis on well-being, inequality, poverty and vulnerability to poverty is still little known. Therefore, we selected costs and expenses not sporadic most likely to represent welfare gains, and assigned values to the consumption of durable goods by an estimate of the service value. The last step of consumption aggregate consisted in the correction of the values obtained by means of a spatial price deflator. Thus, we verified in this paper that through the construction of a consumption aggregate, which reflects multiple dimensions of the families consumption choices, such as food, housing, durable goods, health, education and transport and other non-food items, it is possible to perform these studies with POF data.

Once defined the consumption aggregate, we followed with measurement of well-being, poverty, inequality and vulnerability. For this, we examined the behavior of Generalized Lorenz Curve, two functions of social welfare (abbreviated), we calculated Gini and Atkinson measures of inequality and mean logarithmic deviation, then we decompose inequality by components and by population subgroup. To measure poverty, we analyzed the sensitivity of the exercise of identification to the different poverty lines, and then we presented the results for the poverty severity for geographic areas and different population subgroups. Finally, we assessed the vulnerability to poverty, including area effects (clusters), based on the work of Chaudhuri *et al* (2002) and Elbers *et al* (2002).

The results obtained during the analyses presented here were consistent and as expected, and indicates the adequacy of the consumption aggregate for the studies of well-being and inequality, and also of poverty and vulnerability.

We emphasize that the present article is part of a larger work of poverty studies based on POF data. Possible extensions of this study are, among other exercises, to apply the evaluation measures and analyzis presented here in other geographical divisions, the comparison of indicators over time (2002-2003 and 2008-2009), the creation of pseudo panels to improve the measurement of vulnerability and, further study on the poverty lines.

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Appendix 1: Service value of durable goods by Federative Units (R$ annual number)

Item Description	Rondônia	Acre	Amazonas	Roraima	Pará	Amapá	Tocantins	Maranhão	Piauí	Ceará	Rio Grande do Norte	Minas Gerais	Espírito Santo	Rio de Janeiro	São Paulo	Paraná	Santa Catarina	Rio Grande do Sul	Mato Grasso do Sul	Mato Grosso	Goiás	Distrito Federal
Stove	48.27	38.84	38.11	37.02	38.87	43.19	46.44	42.62	41.77	42.62	33.39	51.83	52.64	53.95	57.09	68.65	57.8	61.48	52.26	56.93	50.79	86.94
Freezer	108.25	127.58	127.4	127.4	134.33	132.71	156.63	264.6	117.74	200.16	161.98	138.45	127.3	283.47	150.78	128.07	140.1	127.17	157.83	142.71	140.3	146.24
Fridge	113.76	103.65	90.13	88.73	112.67	112.55	124.63	115.31	120.03	101.3	100.25	119.33	135.78	151.21	138.4	155.29	158.8	148.02	135.48	183.08	149.18	124.57
Shower with hot water	4.45	4.45	4.45	6.23	4.53	8.9	5.02	67.22	11.56	7,00	6.65	3.95	3.75	3.75	4.31	4.14	5.92	4.09	4.39	4.92	3.95	4.07
Blender	13.12	15.13	13.38	16.14	15.38	14.53	15.44	15.17	15.42	11.91	13.74	13.57	15.66	12.92	17.17	16.55	16.98	15.37	16.7	15.89	14.55	13.52
Food processor	41.37	21.06	29.19	29.19	29.19	226.68	32.14	32.27	35.18	39.16	108.09	27.47	33.28	23.58	12.74	80.01	42.09	16.61	24.81	20.93	24.65	24.17
Grill	11.05	14.02	12.87	9.1	8.97	9.01	8.54	8.57	13.1	6.06	5.95	9.49	8.07	8.29	14.5	11.92	11.14	7.03	7.38	11.85	8.77	21.78
Vacuum cleaner	52.96	54.83	55.37	55.93	27.78	124.7	60.49	70.01	30.04	98.12	54.77	35.83	38.57	28.63	29.82	38.78	44.61	38.6	57.89	57.89	48.35	59.04
Electric oven	41.6	47.54	41.6	41.6	41.6	41.6	27.06	21.18	11.77	21.18	11.91	30.04	25.56	28.68	23.51	47.92	43.91	37.56	41.39	74.4	53.44	19.38
Electric iron	6.71	5.92	5.27	6.04	6.26	6.32	7.41	6.99	6.99	6.27	6.2	7.23	6.49	6.41	8.56	8.81	8.28	6.77	8.24	8.52	7.05	7.36
Washing machine	43.71	82.37	70.04	45.44	50.94	36.79	141.35	54.63	52.2	135.28	99.51	131.34	89.9	133.33	160.25	103.65	148.96	118.86	105.08	58.87	162.29	202.69
Color tv	55.1	52.11	49.54	55.05	59.45	55.05	66.28	66.73	58.36	53.38	52.88	75.52	72.7	81.81	91.99	73.29	76.45	74.87	66.98	79.54	77.02	86.63
Black and white tv set	13.98	13.98	13.98	13.98	13.98	13.98	15.67	13.66	16,00	16,00	16,00	9.63	7.57	15.47	16.52	11.95	11.01	12.32	0,00	0,00	0,00	0,00
Sound equipment	14.74	9.31	14.08	11.28	22.11	35.01	46.78	15.58	20.32	19.88	15.58	24.23	19.42	40.03	19.4	17.06	17.92	21.24	16.86	27.56	33.38	19.95
Radio	15.93	6.38	8.49	10.8	4.38	4.2	7.75	3.71	5.76	2.94	4.5	11.07	9.49	9.68	8.51	11.63	6.83	9.15	5.84	11.45	9.87	9.18
Air conditioner	116.29	156.9	90.18	94.22	123.44	131.9	147.91	117.55	180.84	195.31	122.97	90.2	107.66	170.14	299.99	161.65	98.93	158.62	100.28	133.38	92.44	185.68
Fan /air circulator	9.41	7.83	8.57	11.21	9.79	7.83	12.34	10.43	11.29	9.03	9.03	10.16	10.02	9.98	11.32	9.73	9.55	9.17	7.77	10.87	9.32	11.85
Sewing machine	32.88	101.62	221.96	131.53	110.74	137.8	55.38	108.54	108.54	93.13	109.61	90.04	44.38	69.63	74.26	128.05	138.28	50.59	77.97	90.97	92.89	92.88
Water filter	3.27	4.81	2.56	6.07	4,00	6.94	5.88	3.45	3.42	3.15	2.03	3.67	5.2	3.58	4.56	14.16	20.1	8.87	6.6	5.74	3.45	6.06
Automobile	1215.28	1535.91	4615.49	4861.13	4958.35	6341.45	5786.36	3172.66	6720.26	4614.77	1874.75	4299.2	5432.65	3802.85	4730.62	5209.97	4726.11	3712.62	4720.45	4523.83	4152.76	5576.01
Bicycle	45.4	46.69	46.69	50.52	41.68	47.05	48.22	45.47	38.27	37.9	30.24	44.68	52.84	35.58	41.61	46.61	47.26	36.85	44.51	41.61	38.56	34.79
Motorcycle	430.42	942.64	731.36	267.7	742.65	1046.63	836.74	1102.02	856.36	692.01	631.46	1036.75	1025.84	658.33	655.9	1229.69	733.36	1270.83	426.82	1037.55	1045.92	274.18
Microcomputer	279.78	220.76	268.24	279.78	266.51	318.42	306.98	312.54	299.65	357.26	265.82	318.15	293.51	342.7	296.59	312.98	355.31	314.53	253.01	379.93	312.66	282.4
Water purifier	41.81	68.99	62.72	39.72	39.72	8.15	43.5	11.16	66.97	16.71	8.75	49.82	61.99	119.09	13.71	40.69	39.78	17.8	20.7	148.87	92.81	65.93
Microwave oven	44.21	55.61	53.35	36.33	51.32	51.32	46.99	65.36	53.63	45.78	51.21	54.31	52.44	44.37	51.58	53.28	52.34	48.89	52.63	54.27	62.69	40.45
Satellite dish	46.42	54.74	52,00	94.81	51.68	57.48	64.33	73.03	60.53	50.78	47.12	54.03	45.12	60,00	66.1	55.57	57.55	61.19	61.88	56.43	60.46	71.24
Dvd set	17.6	15.88	15.98	18.55	18.45	17.95	20.84	24.51	23.63	22.05	18.55	22.91	19.94	21.71	25.23	20.78	20.66	19.52	20.2	22.46	20.84	24.44
Drying machine	76.17	80.93	80.93	80.93	105.68	80.93	87.55	245.65	67.28	67.28	67.28	148.52	145.84	145.84	1007.79	77.32	77.9	88.78	98.51	80.59	375.21	93.64
Column mixer	11.4	11.18	14.82	9.3	10.96	12.3	9.32	12.4	10.08	7.38	7.99	9.5	9.48	8.04	10.32	11.59	9.98	8.72	10.55	14.93	8.13	14.27
Hair dryer	7.85	8.46	9.06	11.96	9.33	9.66	13.72	10.36	8.81	8.14	6.91	10.08	8.86	8.48	10.32	9.49	7.89	7.63	10.35	11.08	8.48	12.76
Dishwasher	178.39	178.39	178.39	178.39	178.39	178.39	200.87	35.64	35.64	35.64	35.64	105.58	189.66	189.66	203.02	207.85	192.85	190.96	82.87	82.87	82.87	83.1

Source: IBGE, Research Directory, Brazilian Family Expenditure Survey POF -2008-2009.

Appendix 2 - Price Deflator by Geographical Context

Geographical Context	Price Deflator
Metropolitan urban area of Belém	0.93
Urban North excluding metropolitan urban areas	0.94
Rural North	0.89
Metropolitan urban area of Fortaleza	0.90
Metropolitan urban area of Recife	0.89
Metropolitan urban area of Salvador	0.98
Urban Northeast excluding metropolitan urban areas	0.90
Rural Northeast	0.86
Metropolitan urban area of Belo Horizonte	1.03
Metropolitan urban area of Rio de Janeiro	0.96
Metropolitan urban area of São Paulo	1.00
Urban Southeast excluding metropolitan urban areas	0.96
Rural Southeast	0.92
Metropolitan urban area of Curitiba	0.95
Metropolitan urban area of Porto Alegre	1.00
Urban South excluding metropolitan urban areas	0.95
Rural South	0.82
Brasília (FD)	1.02
Urban Midwest excluding Brasília	1.01
Rural Midwest excluding Brasília	0.95

Source: IBGE, Research Directory, Brazilian Family Expenditure Survey POF -2008-2009.

Appendix 3 - FGT class of poverty measures

Geographic Areas and Major Regions	Poverty Line = R$185			Poverty Line = R$117		
	FGT(0)	FGT(1)	FGT(2)	FGT(0)	FGT(1)	FGT(2)
Metropolitan	0.1460	0.0456	0.0206	0.0528	0.0147	0.0063
	(0.0078)	(0.0032)	(0.0018)	(0.0046)	(0.0017)	(0.0010)
Urban	0.1900	0.0628	0.0291	0.0781	0.0216	0.0089
	(0.0042)	(0.0017)	(0.0009)	(0.0027)	(0.0009)	(0.0004)
Rural	0.4053	0.1612	0.0843	0.2209	0.0709	0.0321
	(0.0093)	(0.0050)	(0.0033)	(0.0079)	(0.0034)	(0.0020)
North	0.3144	0.1095	0.0516	0.1436	0.0390	0.0157
	(0.0111)	(0.0052)	(0.0030)	(0.0085)	(0.0029)	(0.0014)
Northeast	0.3841	0.1454	0.0738	0.1922	0.0602	0.0269
	(0.0066)	(0.0034)	(0.0022)	(0.0055)	(0.0023)	(0.0013)
Southeast	0.1249	0.0386	0.0176	0.0447	0.0128	0.0055
	(0.0063)	(0.0025)	(0.0014)	(0.0035)	(0.0014)	(0.0008)
South	0.0941	0.0269	0.0111	0.0309	0.0069	0.0026
	(0.0064)	(0.0022)	(0.0011)	(0.0035)	(0.0009)	(0.0004)
Midwest	0.1877	0.0607	0.0272	0.0790	0.0190	0.0071
	(0.0094)	(0.0038)	(0.0020)	(0.0068)	(0.0017)	(0.0007)
Brazil	0.2133	0.0743	0.0359	0.0947	0.0279	0.0121
	(0.0037)	(0.0016)	(0.0009)	(0.0024)	(0.0009)	(0.0005)

Source: IBGE, Research Directory, Brazilian Family Expenditure Survey POF -2008-2009.

Appendix 4 – Explanatory variables of the model

Variables	Coefficients	Standard Error	t Value	Pr > |t|
Intercept	0.4205	0.406	10.360	<.0001
If the household is in the metropolitan urban area of Belém	0.073	0.024	2.980	0.0029
If the household is in the urban North, excluding metropolitan urban areas	0.060	0.014	4.290	<.0001
If the household is in the rural North	0.163	0.027	6.120	<.0001
If the household is in the metropolitan urban area of Fortaleza	-0.122	0.032	-3.850	0.0001
If the household is in the metropolitan urban area of Recife	-0.098	0.021	-4.580	<.0001
If the household is in the metropolitan urban area of Salvador	-0.060	0.024	-2.540	0.011
If the household is in the rural Northeast	0.044	0.019	2.310	0.0207
If the household is in the metropolitan urban area of Belo Horizonte	-0.085	0.020	-4.250	<.0001
If the household is in the metropolitan urban area of Rio de Janeiro	-0.059	0.025	-2.360	0.0181
If the household is in the rural Southeast	0.039	0.021	1.850	0.0638
If the household is in the metropolitan urban area of Curitiba	-0.108	0.032	-3.410	0.0007
If the household is in the metropolitan urban area of Porto Alegre	0.077	0.022	3.450	0.0006
If the household is in the urban South, excluding metropolitan urban areas	0.055	0.013	4.220	<.0001
If the household is in the rural South	0.219	0.028	7.950	<.0001
If the household is in the urban Midwest, excluding Distrito Federal	-0.092	0.013	-7.130	<.0001
If the household has piped water in at least one room	0.075	0.017	4.410	<.0001
If the household head holds health plan	0.088	0.009	9.890	<.0001
If the household head has 7 years and less of school completed	-0.078	0.010	-7.920	<.0001
Existe pavimentação na rua em que se localiza o domicílio	0.061	0.009	6.640	<.0001
Literate household head	0.142	0.010	14.850	<.0001
If the household is rented	-0.124	0.009	-13.660	<.0001
If the household head is white	0.067	0.007	9.640	<.0001
Householder attendence: public school, college	0.139	0.021	6.610	<.0001
No bathroom in the household	-0.364	0.028	-12.860	<.0001
One bathroom in the household	-0.326	0.017	-19.750	<.0001
Two bathrooms in the household	-0.121	0.016	-7.650	<.0001
Uncoated mud with wall household	-0.179	0.032	-5.60	<.0001
Type of family: husband-wife household having children	0.061	0.008	7.260	<.0001
If the household head has 11 to 14 years of school completed	0.054	0.011	4.990	<.0001
If the household head has 15 years and over of school completed	0.182	0.016	11.260	<.0001
If the household head is an employer	0.254	0.018	14.000	<.0001
If the household head is an own account	0.083	0.008	10.180	<.0001
Members of household per room	-0.194	0.013	-14.700	<.0001
If the household is in the last decile of the the per capita disposable monetary income distribution	-0.060	0.015	-3.990	<.0001
Logarithm of the total of adult members in the household	0.179	0.019	9.350	<.0001
Logarithm of the household head age	0.517	0.210	2.460	0.0139
Squared logarithm of the household head age	-0.064	0.029	-2.220	0.0262
Logarithm of the total of elderly members in the household	-0.079	0.014	-5.670	<.0001
Logarithm of the total of household members, excluding private household workers and household lodgers	-0.427	0.016	-27.030	<.0001
Logarithm of *per capita* disposable monetary income	-0.128	0.022	-5.750	<.0001
Squared logarithm of *per capita* disposable monetary income	0.044	0.002	20.400	<.0001
Logarithm of the ratio between the *per capita* disposable monetary income of the household and the median of geographical context	-0.085	0.018	-4.680	<.0001
Logarithm of gross domestic product *per capita*	0.042	0.009	4.740	<.0001
Total of children under 7 years old in the household	-0.032	0.006	-5.230	<.0001
Proportion of people in municipality receiving Bolsa Família in 2010	-1.02	0.163	-6.240	<.0001
Proportion of people with complete college in the enumeration area	0.155	0.027	5.770	<.0001
Proportion of household head who holds health plan in the enumeration area	0.136	0.03	4.510	<.0001
R^2		0.75		
Observations		56091		

Source: IBGE, Research Directory, Brazilian Family Expenditure Survey POF -2008-2009.

Appendix 5 – Estimated fractions of vulnerable people concerning poverty versus the estimated proportions of the poor calculated directly from POF regarding the 20 geographical contexts which take part Geographical Areas and in Major Regions

Geographical context	Poverty incidence	Vulnerability incidence	
	POF	Threshold > 0.5	0.2 < Threshold < 0.5
Metropolitan urban area of Belém	0,177	0,168	0,133
Urban North excluding metropolitan urban areas	0,265	0,250	0,175
Rural North	0,485	0,485	0,219
Metropolitan urban area of Fortaleza	0,300	0,285	0,230
Metropolitan urban area of Recife	0,291	0,195	0,208
Metropolitan urban area of Salvador	0,277	0,183	0,181
Urban Northeast excluding metropolitan urban areas	0,333	0,280	0,219
Rural Northeast	0,548	0,570	0,250
Metropolitan urban area of Belo Horizonte	0,113	0,064	0,115
Metropolitan urban area of Rio de Janeiro	0,134	0,057	0,108
Metropolitan urban area of São Paulo	0,099	0,067	0,090
Urban Southeast excluding metropolitan urban areas	0,112	0,062	0,092
Rural Southeast	0,259	0,169	0,226
Metropolitan urban area of Curitiba	0,097	0,085	0,105
Metropolitan urban area of Porto Alegre	0,092	0,033	0,091
Urban South excluding metropolitan urban areas	0,087	0,039	0,082
Rural South	0,119	0,036	0,104
Distrito Federal	0,117	0,077	0,094
Urban Midwest excluding Distrito Federal	0,192	0,128	0,158
Rural Midwest excluding Distrito Federal	0,276	0,196	0,255
Brazil	0,213	0,168	0,147

Source: IBGE, Research Directory, Brazilian Family Expenditure Survey POF -2008-2009.