

Appendix A.

1. Database

1.1. *The Household Expenditure Surveys (HES)*

Brazil has been collecting information on household expenditures since 1975, with its first survey and carried out four others HES between 1987 and 2008. The first three, applied in 1975, 1987–1988 and in 1995–1996, were restricted to the universe of nine metropolitan regions (RMs), the Federal District and the city of Goiânia. Starting in 2002–2003, the HES gained national scope, maintaining sample representativity for the area of the two surveys, urban areas of all the federal units (UFs) and the rural areas of the five major Brazilian regions. The institution responsible for the surveys is the Brazilian Geography and Statistics Institute, or IBGE in Portuguese [10].

The first Brazilian HES was restricted to the collection of monetary expenditures, not physical quantities, and the collection of the variables related to the conditions of the households and the main characteristics of the people (gender, race, schooling, etc.) [10].

The first HES dealing with quantities was in 1987–1988, calculated based on the expenses surveyed by IBGE and the prices collected for the determination of the price indices. In the subsequent HES, in 1995–1996, in addition to the expenses, the quantities of each food item were investigated. Another variable that had different treatment among HES was the appropriation of rental of owned or ceded households. In two occasions (1987–1988 and 2002–2003), information was collected on estimated rent for own and assigned households, an indicator not collected in the 1995–1996 POF. There is a relative consensus, at an international level, to consider the estimated rent in the measurement of household welfare. In 2002–2003, the IBGE restarted the collection of anthropometric measures and investigating the non-monetary expenditures and receipts of the population. These advances are said to allow a more accurate analysis of the nutritional status of the population, indigence situations and poverty of the families[69], as well as allowing a more adequate evaluation of the consumption profile of Brazilian families. For that reason, this study started consumption investigations with the 2002–2003 Brazilian HES.

The 2002–2003 Brazilian HES is divided into surveys. That year, the sample size was 48,470 households for a population size of 48,394,067 households in the country that year. For people, the sample size was 182,324 people for a population size of 175,835,904 inhabitants. Figure S1 shows a diagram representing the structure of the surveys and their main indicators. Since this research focuses on food consumption patterns and how they are affected by someone's living conditions, six surveys were helpful. First and second were Households and Life conditions, which contain information on house conditions (with or without electricity, with or without sewage), living conditions (minimum expenditures on food, perception on food availability and food quality, perception on environmental problems). Third, the People survey, with everyone's characteristics such as gender, age, race, schooling years, weight and height. Forth, the Expense account, which contained the information on food quantities obtained at the household level. Fifth, the Individual expenditures with the information on how much everyone spent on food items outside the household and, finally, the Income survey, with the information on income for each individual.

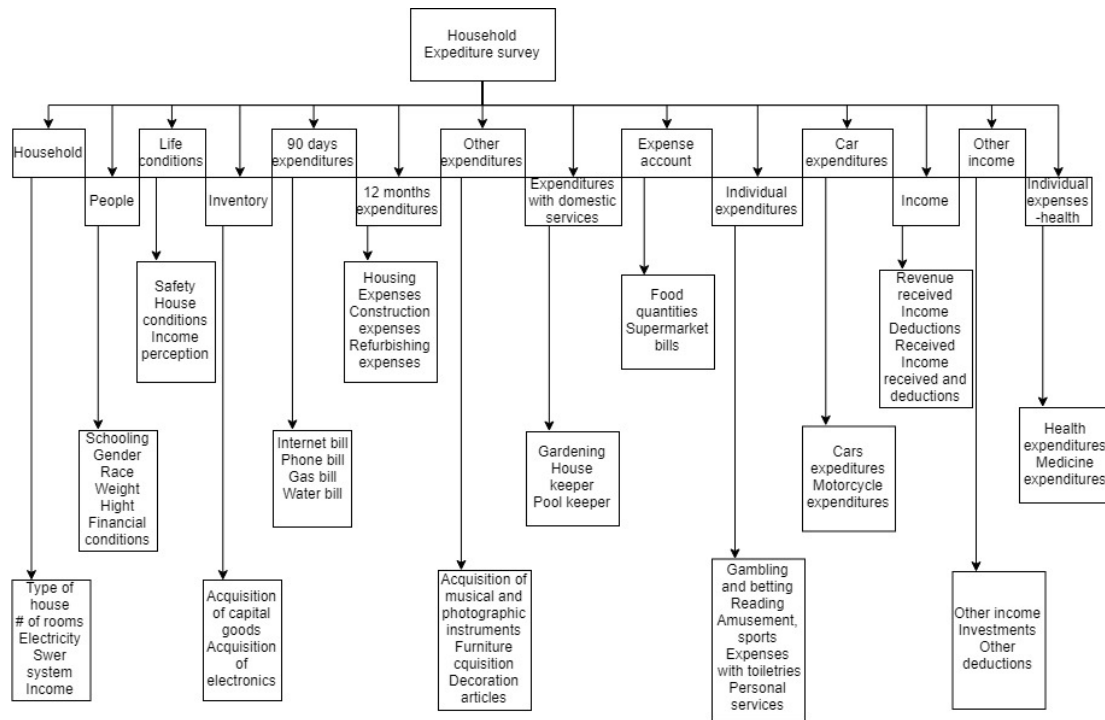


Figure S1. Layout of the 2002-2003 Brazilian Household Expenditure Survey. Source: IBGE[69].

Next, a summary of the 2002-2003 HES will be given by type of information starting with households.

1.1.1. Households

In 2002 the minimum wage was BRL 200 [69]. Table S1 shows the average income per household, average inhabitants per household and personal income in BRL/capita/household. As the table shows, the Northeast region was the poorest that year, with the lowest income per capita being Maranhão state, followed by Piauí. The highest income per capita, on the other hand, is in the national Capital, Distrito Federal, reaching almost 1000 Brazilian Reais per capita per household per month.

Table S1. Average household income, inhabitants and personal income in 2002.

Region	State	Monthly average household income (BRL/Household) *	Average inhabitants/household	Monthly personal income (BRL/capita/household) *
North	Rondônia	1649.25	3.82	431.74
	Acre	1204.52	4.1	293.79
	Amazonas	1200.12	4.52	265.51
	Roraima	1329.9	4.31	308.56
	Pará	1228.58	4.52	271.81
	Amapá	1362.16	4.75	286.77
	Tocantins	1146.49	3.85	297.79
Northeast	Maranhão	830.16	4.49	184.89
	Piauí	955.5	4.06	235.34
	Ceará	1164.98	4.13	282.08
	Rio Grande do Norte	1148.56	3.91	293.75
	Paraíba	925.36	3.91	236.66
	Pernambuco	1102.42	3.86	285.60
	Alagoas	1116.66	4.12	271.03
	Sergipe	1026.06	3.96	259.11
Southeast	Bahia	1241.9	3.94	315.20
	Minas Gerais	1826.7	3.58	510.25
	Espírito Santo	1825.67	3.49	523.11
	Rio de Janeiro	2358.36	3.22	732.41
South	São Paulo	2424.51	3.45	702.76
	Paraná	1934.16	3.46	559.01
	Santa Catarina	1912.74	3.45	554.42
	Rio Grande do Sul	2027.98	3.18	637.73
Center-west	Mato Grosso do Sul	1501.97	3.47	432.84
	Mato Grosso	1401.83	3.7	378.87
	Goiás	1513.06	3.43	441.13
	Distrito Federal	3282.66	3.53	929.93
Total households			48,394,067	

Notes: * In BRL of 2002. Source: IBGE [69]

Table 2. Average household income, inhabitants and personal income in 2008.

Region	State	Monthly average household income (BRL/Household) *	Average inhabitants/household	Monthly personal income (BRL/capita/household) *
North	Rondônia	2552.72	3.32	768.61
	Acre	2041.59	3.82	534.51
	Amazonas	1948.65	4.04	481.95
	Roraima	1728.31	3.91	442.41
	Pará	2072.95	4.07	509.90
	Amapá	2645.35	4.01	659.05
	Tocantins	1931.24	3.61	535.51
Northeast	Maranhão	1537.06	3.86	398.02
	Piauí	1674.29	3.66	457.88
	Ceará	1546.72	3.67	421.28

	Rio Grande do Norte	1739.78	3.56	488.67
	Paraíba	1718.17	3.44	499.47
	Pernambuco	1980.63	3.33	595.32
	Alagoas	1431.43	3.66	391.59
	Sergipe	1839.34	3.60	510.30
	Bahia	1946.06	3.51	554.88
Southeast	Minas Gerais	2736.33	3.26	840.07
	Espírito Santo	2608.07	3.17	821.67
	Rio de Janeiro	3547.24	3.03	1171.65
	São Paulo	3634.42	3.14	1158.20
South	Paraná	2904.11	3.22	901.89
	Santa Catarina	3343.29	3.10	1078.48
	Rio Grande do Sul	3045.25	3.02	1008.06
Center-west	Mato Grosso do Sul	2756.83	3.19	863.54
	Mato Grosso	2112.40	3.11	679.18
	Goiás	2485.21	3.14	791.57
	Distrito Federal	4602.82	3.26	1411.49
	Total households		57,691,781	

Notes: * In BRL of 2008. Source: IBGE [10].

Region wise, the North follows the Northeast as the second poorest region. The Center-west has its average income raised by the existence of the National Capital. The south and Southeast, income wise, are the wealthiest regions in the country. The regional difference is very clear, with the wealthiest state having an average income 5 times higher than the poorest state. The households are also divided into their living conditions and given their average income and their share of total households in Brazil.

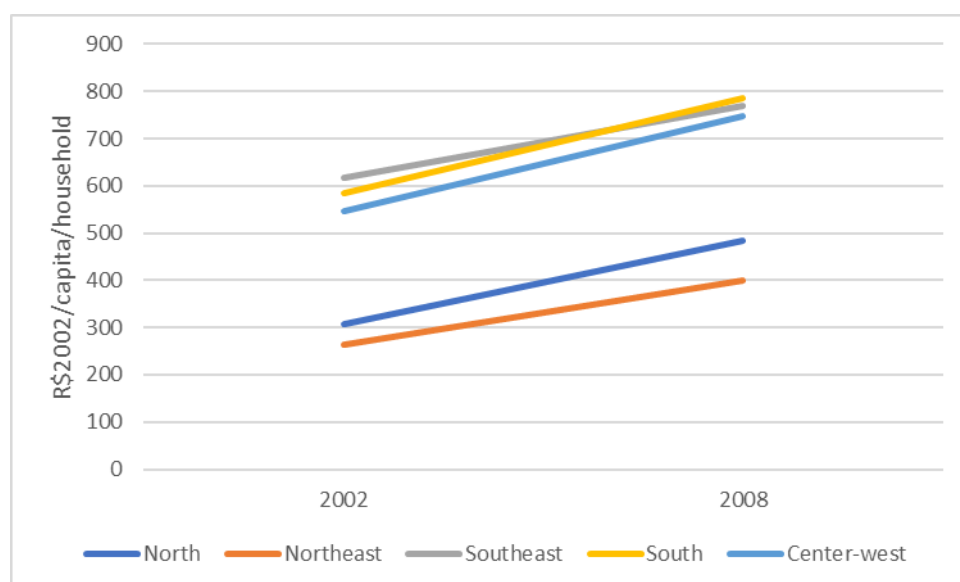


Figure S2. Monthly personal income (BRL/capita/household in BRL of 2002) in 2002 and in 2008.
Source: IBGE [10,69].

Table S3 shows the life conditions of Brazilian households, their income and share.

Table S3. Life conditions, income and share of each type of household in 2002.

	Monthly average household income (BRL/Household)*	Share of total households (%)
Type of household		100
Non-rustic house	1596.17	85.5
Rustic house	843.47	4.8
Apartment	4568.86	8.8
Single room	401.7	0.5
Documented contract?		100
Yes	2268.34	7.6
No	1052.24	7.7
non-applicable	1845.61	84.7
Pavement on the street?		100
Yes	2305.14	62.3
No	1011.49	37.7
Type of floor		100
Ceramics	2205.16	44.2
Board Wood	3084.89	14.4
Cement	786.23	34.5
Exposed soil	463.81	3.0
Others	2236.28	3.9
House ownership		100
Paid house	1899.26	65.9
Under payment	2824.15	5.7
Rented	1658.76	15.3
Borrowed	1169.83	11.6

Other	1175.54	1.5
Type of sewage connection		100
General sewage network or rainwater	2474.45	49.6
Septic tank	1651.04	16.7
Rudimentary tank	1028.34	21.9
Ditch	899.88	2.2
River, lake or sea	1211.16	2.6
Other Shed	960.1	0.5
None	493.25	6.5

Notes: *In BRL of 2002; Source: IBGE [69].

Table S4. Life conditions, income and share of each type of household in 2008.

	Monthly average household income (BRL/Household)	Share of total households (%)
Type of household		100
House	2401.09	88.4
Apartment	5917.03	10.8
Single room	860.24	0.8
Documented contract?		100
Verbal contract	1738.97	9.2
Realter contract	4560.78	3.7
Other source	2860.74	3.6
non-applicable	2799.41	83.4
Pavement on the street?		100
Yes	3315.76	68.9
No	1557.61	31.1
Type of floor		100
Carpet	5340.13	0.9
Ceramics	3246.76	58.5
Board Wood	4300.03	9.7
Cement	1203.69	27.4
Reused wood	3575.52	0.7
Exposed soil	709.40	2.0
Others	4461.94	.8
House ownership		100
Paid house	2884.38	67.4
Under payment	4027.99	5.4
Rented	2618.92	16.6
Borrowed	1656.59	9.8
Other	1531.21	0.9
Type of sewage connection		100
General sewage network or rainwater	3575.83	52.4
Septic tank	2507.81	16.9
Rudimentary tank	1671.36	22.3
Ditch	1291.63	1.8
River, lake or sea	1688.93	2.7
Other Shed	1397.71	0.4
None	748.08	3.6

Notes: *In BRL of 2008; Source: IBGE [10].

The information in Table S3 and A4 shows that Brazilian households still have room for improvements regarding their conditions. In 2002, 85% of Brazilians lived in non-rustic houses and only 49% of them had any connection with the general sewage network. Pavement was absent in 37% of households and 65% of the houses were settled.

The income is also related to house conditions. Higher income is found in floors with board wood and ceramics and the lowest incomes are in houses without any coating (exposed soil) and cement. In sewage systems, houses without any connection have the lowest income by any group

by households, except single rooms. Families with lower income also live in borrowed or rented houses and also lower income families live in streets with no pavement on the streets.

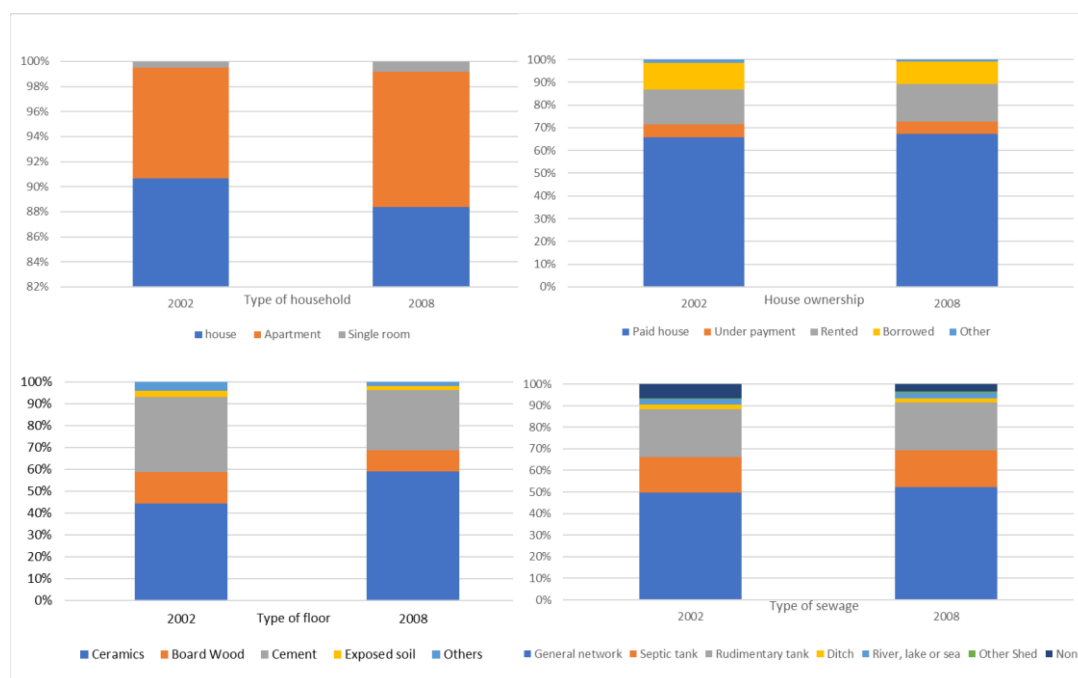


Figure S3. Percent of households per type of household, ownership, type of floor and sewage connection.

1.1.2. People or Individuals

The individuals considered by the 2002 Brazilian HES were any person who had the household as the sole or main residence and who was not separated from it for a period exceeding 12 months. The survey collects information on race, gender, religion, instruction level, financial information (health insurance and credit card), weight and height. Table S5 shows the average income for each group of people and their share of total population.

Table S5. Average individual income by group of people and their share of total population in 2002.

Socioeconomic group	Average individual income per month (BRL/month)*	Share of people (%)
Gender		100
Male	1024.41	49.2
Female	648.23	50.8
Ethnicity		100
caucasian	1135.98	51.1
African-Brazilian	607.83	7.0
Asian-Brazilian	2621.13	0.6
Mixed race	546.35	40.9
Indigenous	800.93	0.3
Ignored	832.3	0.2
School years		100
No instruction	300.60	14.4
4th grade	350.49	5.7
8th grade	507.44	52.7
high school	849.99	19.0
Undergraduation	2734.65	5.8
Postgraduation	4551.73	0.7
Ignored	1659.12	1.7

Health insurance?		100
No	568.42	87.1
Yes	2413.26	12.8

Notes: *In Reais of 2002. Source: (IBGE, 2004).

Table S6. Average individual income by group of people and their share of total population in 2008.

Socioeconomic group	Average individual income per month (BRL/month)*	Share of people (%)
Gender		100
Male	2172.46	49.0
Female	1361.73	51.0
Ethnicity		100
caucasian	2329.78	47.5
African-Brazilian	1219.26	7.7
Asian-Brazilian	3700.37	0.5
Mixed race	1232.43	43.5
Indigenous	1921.12	0.4
Ignored	1507.26	0.3
School years		100
No instruction	641.29	19.0
4th grade	616.66	25.3
8th grade	1346.9	22.23
high school	1368.26	24.28
Undergraduation	3342.83	7.4
Postgraduation	8530.98	1.2
Ignored	1451.0	0.5
Health insurance?		100
No	1074.66	74.6
Yes	3200.71	25.4

Notes: *In Reais of 2008. Source: IBGE [10].

Table S5 shows that women earned 60% less than men and represent 50.8% of total population. The 2002 HES also divides women into pregnant and non-pregnant and, within this classification, pregnant women's average income is BRL 400 per month. There is considerable inequality regarding race in Brazil as well. The poorest group, or brown, earn only 20% of what the wealthiest group, yellow, makes.

1.2. Food and Agriculture Organization Data (FAOSTAT)

The food and Agriculture Organization (FAO) offers to the public the Food Balance Sheet (FBS), which presents a comprehensive picture of the pattern of a country's food supply during a specified reference period [2]. The food balance sheet shows for each food item the sources of supply and its utilization. The total quantity of foodstuffs produced in a country added to the total quantity imported and adjusted to any change in stocks that may have occurred since the beginning of the reference period gives the supply available during that period [2]. On the utilization side, a distinction is made between the quantities exported, fed to livestock, used for seed, put to manufacture for food use and non-food uses, losses during storage and transportation, and food supplies available for human consumption, which is the main variable of interest in this project. The per capita supply of food is then obtained by dividing the respective quantity by the population living in that year. Food Balance Sheets (FBS) are compiled every year by FAO [2], mainly with country-level data on the production and trade of food commodities. Using these data and the available information on seed rates, waste coefficients, stock changes and types of utilization (feed, food, processing and other utilization), a supply/utilization account is prepared for each commodity in weight terms, as explained in FAO's website. Besides commodity-by-commodity information, the FAO FBS also provide total food availability estimates by aggregating the food component of all commodities including fishery products.

From these values and the available population estimates, the per-person dietary energy and protein and fat supplies are derived and expressed daily [2].

The resulting historical available kilocalorie per capita per day in Brazil is shown in Figure S4 with the consumption of meat also in kilocalories per capita per day. From 1970 to 2013, the Brazilian average consumption of total calories raised 35%, while meat intake increased 159% in the same period, jumping from 13% to 25% of total consumption. In 2002, FAO estimated an average of total consumption of 2.827 kcal/capita/day, with 22% coming from meat products.

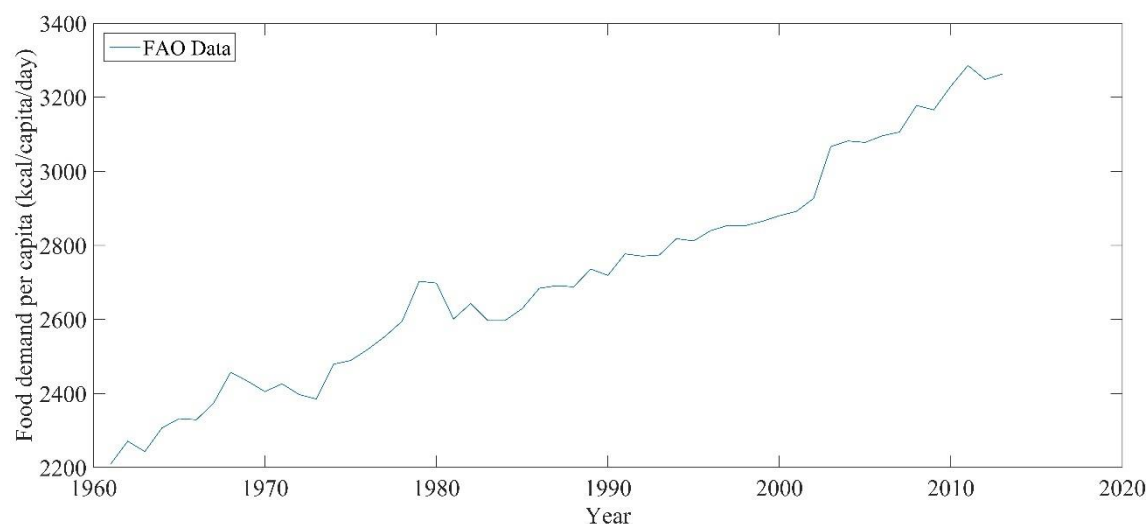


Figure S4. Average kilocalorie consumption per capita (kcal/capita) from 1970 to 2013. Source: FAO [2].

Table S7. Resulting regional consumption in 2002.

Region	Average Household Income per capita (BRL/capita/Household) *	Average daily household kilocalorie consumption per capita (kcal/capita/household/day)	Share of meat consumption (%)
North	409.65	2899.47	25
Northeast	342.5	2467.75	2
Southeast	784.12	3398.95	24
South	744.19	3489.98	27
Center-west	633.08	3074.65	27
Brazil	522	2913.2	23

Notes: * In BRL of 2002.

Table S8. Resulting regional consumption in 2008.

Region	Average Household Income per capita (BRL/capita/Household)*	Average daily household kilocalorie consumption per capita (kcal/capita/household/day)	Share of meat consumption (%)
North	472.52	3150.92	26
Northeast	397.34	2612.91	23
Southeast	758.94	3639.24	22
South	779.60	3719.77	23
Center-west	688.39	3177.70	22
Brazil	581.09	3147.67	23

Notes: * In BRL of 2002.

2. Clustering of Household Consumption

Figure S5 shows an exemplification of relationship among variables used for clustering, crossing income per household per capita with food consumption per household per capita.

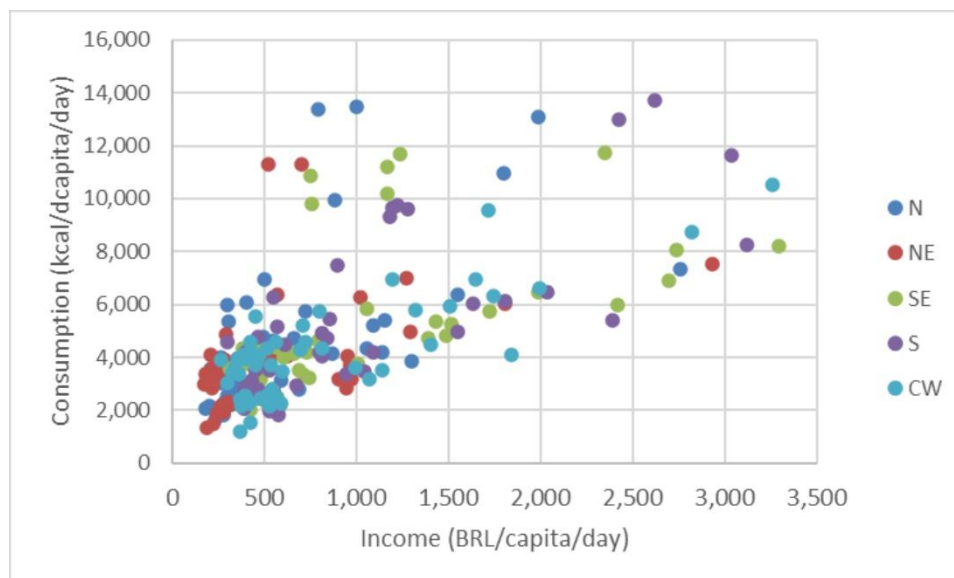


Figure S5. Resulting clusters divided by region, crossing income and consumption.

3. Income Neural Network

Figure S6 shows the confusion matrix for each step of the income network

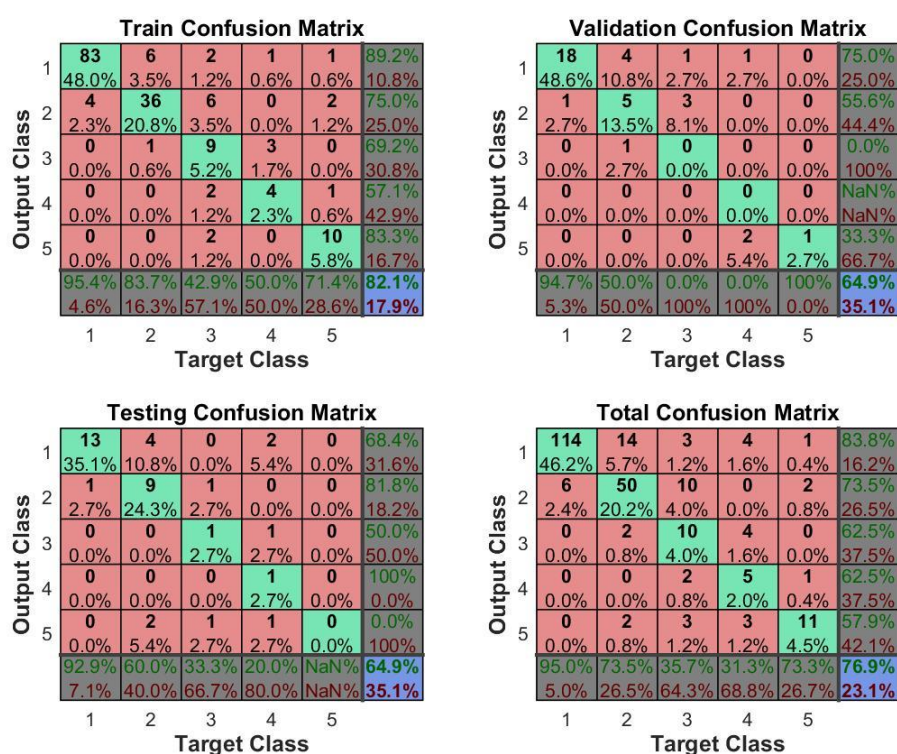


Figure S6. Confusion matrix for the best neural network.

4. Food Consumption Neural Network

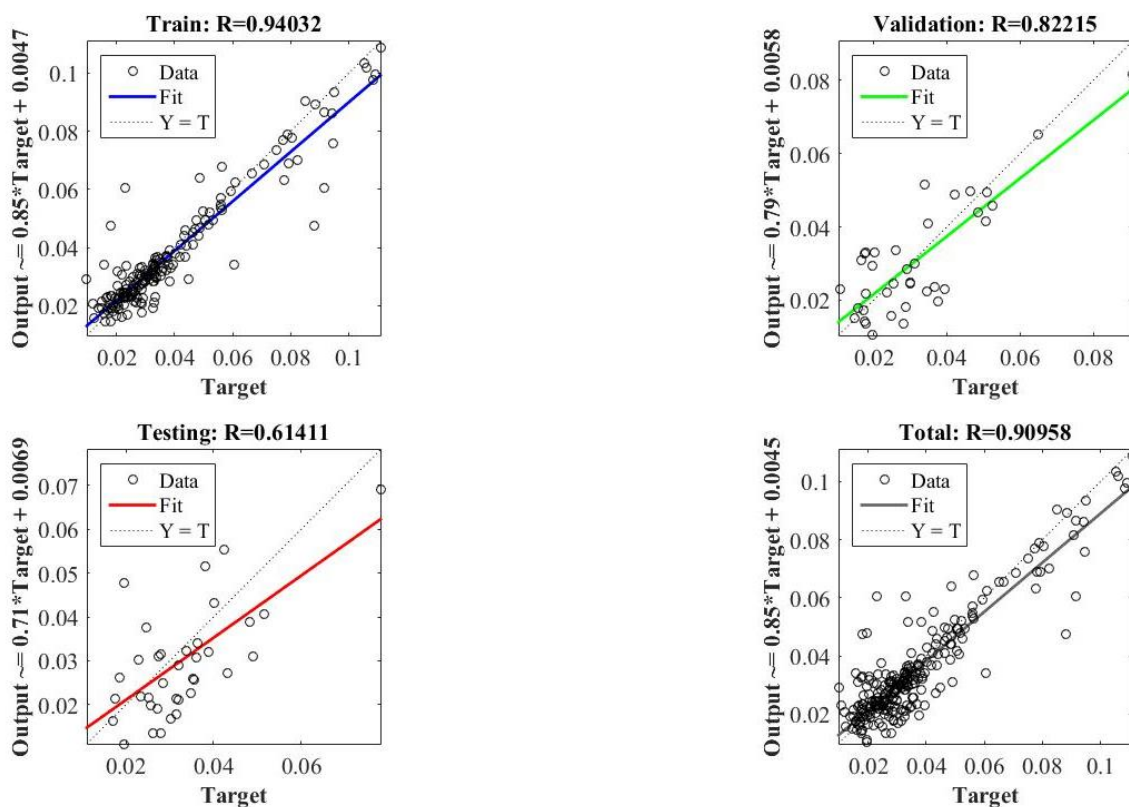


Figure S7. The relationship between neurons and the regression R between targets and outputs.

5. Extrapolations

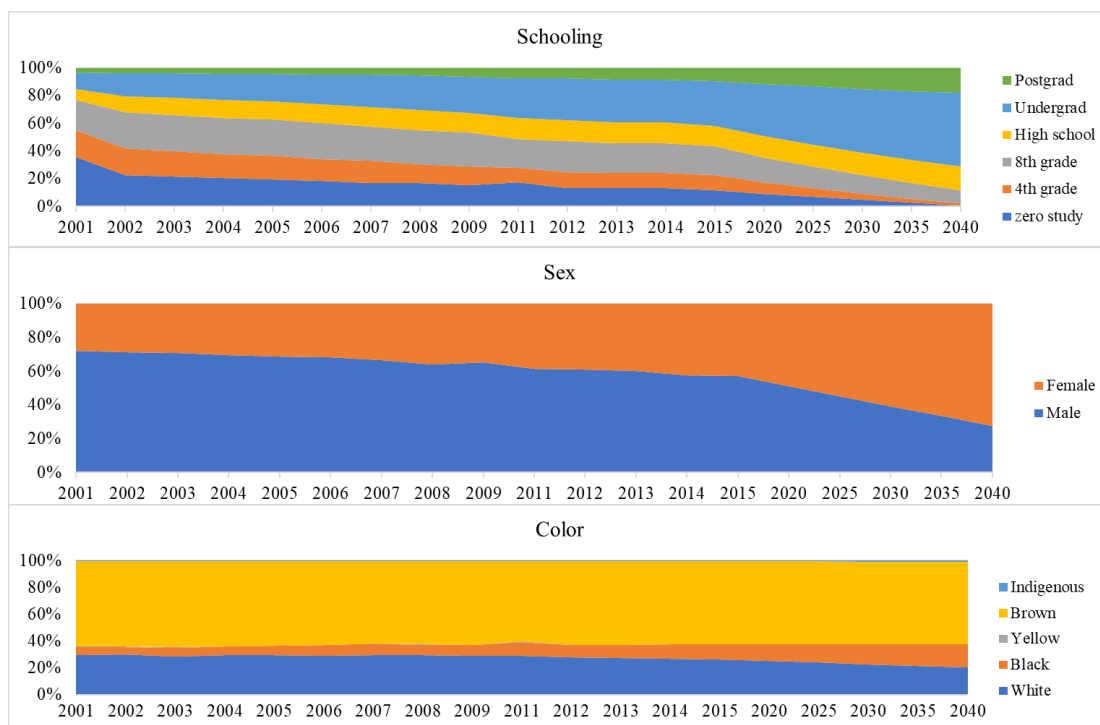


Figure S8. Shares extrapolation of schooling, sex and color for the person of reference of households until 2040 for the Northeast region.

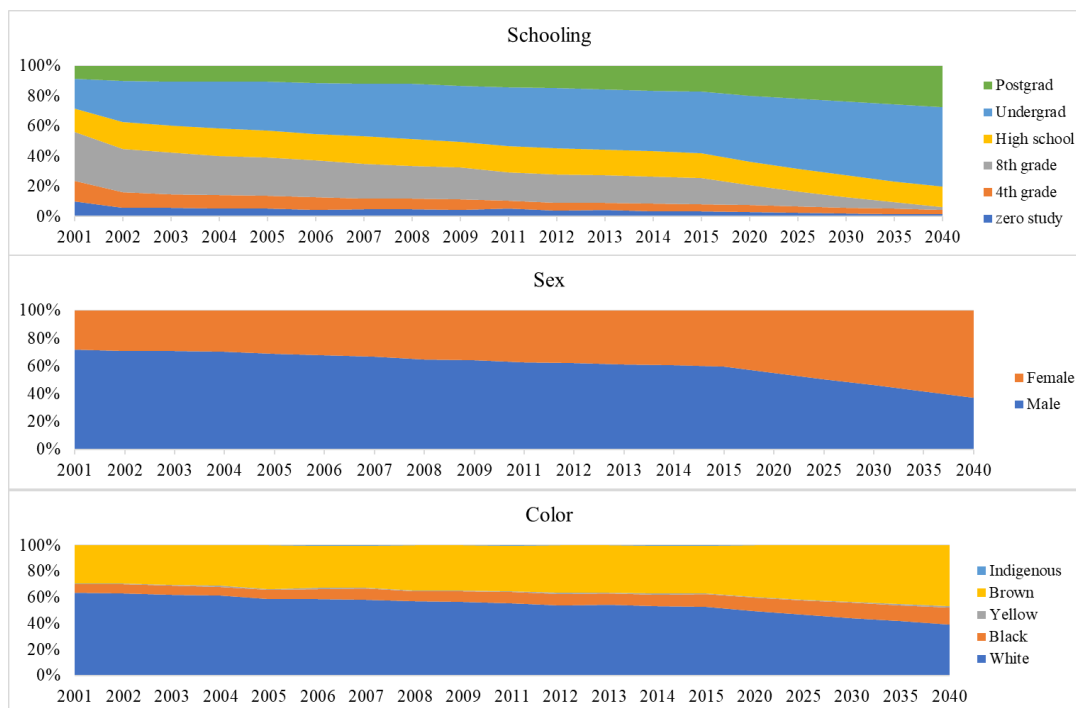


Figure S9. Shares extrapolation of schooling, sex and color for the person of reference of households until 2040 for the Southeast region.

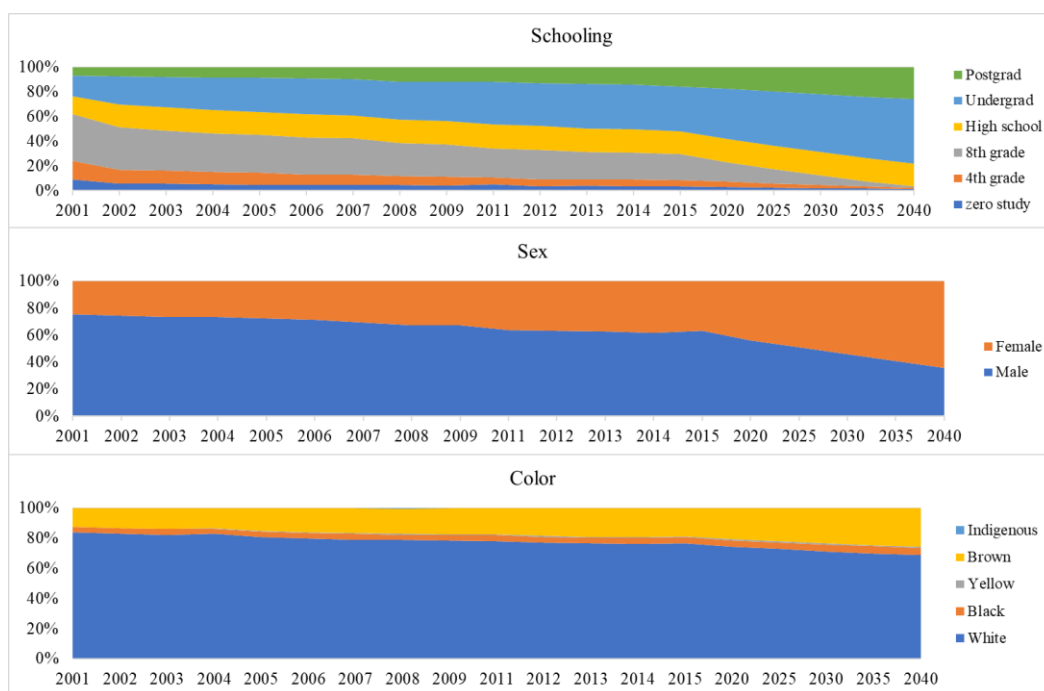


Figure S10. Shares extrapolation of schooling, sex and color for the person of reference of households until 2040 for the South region.

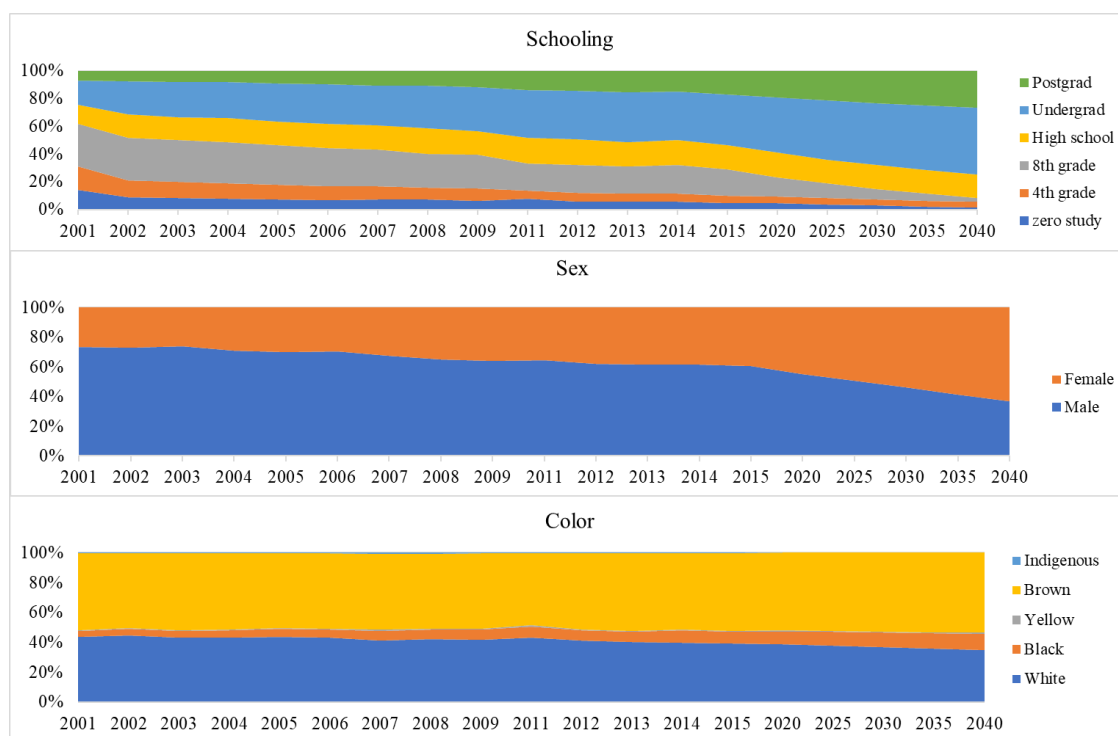


Figure S11. Shares extrapolation of schooling, sex and color for the person of reference of households until 2040 for the Center-west region.