GUILHERME FONSECA TRAVASSOS

TWO ESSAYS ON CONSUMER DEMAND AND POPULATION AGING IN BRAZIL

Tese apresentada à Universidade Federal de Viçosa, como parte das exigências do Programa de Pós-Graduação em Economia Aplicada, para obtenção do título de *Doctor Scientiae*.

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APROVADA: 14 de março de 2018.

Leonardo Chaves Borges Cardoso

Bladimir Carrillo Bermudez

Alexandre Rodrigues Loures

Mary Paula Arends-Kuenning

Alexandre Bragança Coelho
(Orientador)

“A parte mais importante do progresso é o desejo de progredir”

Lucius Annaeus Seneca.

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CONTENTS

ABSTRACT

TRAVASSOS, Guilherme Fonseca, D.Sc., Universidade Federal de Viçosa, March, 2018. **Two essays on consumer demand and population aging in Brazil**. Advisor: Alexandre Bragança Coelho.

This thesis studies two topics on consumer demand and population aging using Brazilian data. We first present an introductory chapter about the situation of the elderly in Brazil addressing aspects such as the demographic transition, the profile of the Brazilian elderly, the socio-demographic conditions of this segment and, finally, the consequences and trends of population aging in Brazil. The intention of this introductory chapter is to guide the research problems related to the elderly population that will be presented in the next chapters. In the first essay, we analyze the level of well-being of the elderly people. Understanding such theme is important for the design of public policies and income transfer for the elderly, such as the calculation of poverty rates, life insurance and death pensions. However, little is known about this topic in developing countries and estimates from rich economies may have limited external validity to the developing world. Thus, this application becomes relevant in the Brazilian context, since the vast majority of the elderly survive from income transfer programs, such as death pensions and retirement. Results indicate that elderly individual's consumer preferences in Brazil are very similar by gender and both are more sensitive to changes in expenditure and price for Health care. The results indicate substantial economies of scale and a husband's share that is increasing in total expenditures. OECD scale underestimates poverty among elderly women in couples and overestimates poverty among elderly men in couples. In the case of widow and widowers, in most of the periods, OECD scale underestimates poverty rates. Finally, we find that the drop in material well-being following the wife's death is rather substantial for men and the opposite was observed for women. The second essay compares consumption expenditure patterns and demand, measure by price and income elasticities, of the elderly and adult-headed households, taking into account socio-economic factors associated to consumer behavior. Our study recognizes that differences between expenditure of the elderly and the adults are important in order to establish appropriate public policies to help elderly consumers. In the course of the aging process, elderly households will play an increasing role, but their behavior might

differ substantially from younger people. Again, little is known about this issue in developing countries, especially those in Latin America, and mainly in Brazil. The findings suggest that Brazilian elderly and adult-headed households have different consumption patterns. Adult-headed households were more sensitive to changes in expenditure for Food products, while households headed by the elderly showed more sensitivity for Health care. Demographic variables, mainly gender, education level and government transfers, influence the demand for most of the goods in Brazilian elderly headed households. Government transfers help elderly households to spend more on Housing and Health care. In relation to household composition variables, those formed only by the elderly demand less Food and more Housing; those households composed by the elderly with children demand more Clothing and Transportation products and less Habitation and Health care products; and those households composed by the elderly with relatives demand less Health care products. Together, the two essays contribute to a better understanding about consumer pattern, consumer demand and well-being of elderly using data from Brazil, a developing economy.

RESUMO

TRAVASSOS, Guilherme Fonseca, D.Sc., Universidade Federal de Viçosa, março de 2018. **Dois ensaios sobre a demanda do consumidor e o envelhecimento populacional no Brasil**. Orientador: Alexandre Bragança Coelho.

Esta tese estuda dois tópicos sobre a demanda do consumidor e o envelhecimento populacional usando dados do Brasil. Mas, em primeiro lugar, apresentamos um capítulo introdutório sobre a situação dos idosos no Brasil abordando aspectos como a transição demográfica, o perfil dos idosos brasileiros, as condições sócias demográficas deste segmento e, finalmente, as consequências e as tendências do envelhecimento da população no Brasil. A intenção deste capítulo é introduzir os problemas de pesquisa relacionados à população idosa que serão apresentados nos próximos capítulos. No primeiro ensaio, analisamos o nível de bem-estar dos idosos. Compreender esse tema é importante para a formulação de políticas públicas e de transferência de renda para os idosos, como o cálculo das taxas de pobreza, do seguro de vida e das pensões por morte. No entanto, este tema é pouco conhecido nos países em desenvolvimento e estimativas de economias ricas podem ter uma validade externa limitada em comparação àqueles países. Assim, essa aplicação torna-se relevante no contexto brasileiro, uma vez que a grande maioria dos idosos sobrevive de programas de transferência de renda, tais como pensões pós morte e aposentadoria. Os resultados indicaram que as preferências dos idosos no Brasil são muito similares por gênero e ambos são mais sensíveis às mudanças nas despesas e nos preços dos bens relacionados à saúde. Os resultados indicaram substanciais economias de escala e a participação do idoso aumentando à medida que as despesas totais cresciam. A escala da OCDE subestima a pobreza entre idosas em casais e superestima a pobreza entre idosos homens em casais. No caso das viúvas e dos viúvos, na maioria dos períodos, a escala da OCDE subestima as taxas de pobreza. Finalmente, encontramos que a queda no bem-estar material após a morte da esposa é bastante substancial para os idosos homens e o oposto foi observado para as idosas. O segundo ensaio compara os padrões de gastos de consumo e a demanda, medida por elasticidades preços e dispêndio, dos domicílios em que o idoso ou o adulto não-idoso são os responsáveis, levando em consideração os fatores socioeconômicos associados ao comportamento do consumidor. Nosso estudo reconhece que as diferenças entre as despesas dos idosos e adultos são importantes para estabelecer

políticas públicas adequadas para ajudar os consumidores idosos. No decurso do processo de envelhecimento, os agregados familiares idosos desempenharão um papel crescente, mas o seu comportamento pode diferir substancialmente das pessoas mais jovens. Novamente, pouco se sabe sobre essa questão nos países em desenvolvimento, especialmente na América Latina e principalmente no Brasil. Os resultados sugerem que os domicílios brasileiros chefiados por idosos e adultos não idosos têm diferentes padrões de consumo. Os domicílios chefiados por adultos são mais sensíveis às mudanças nas despesas com produtos alimentares, enquanto os domicílios chefiados pelos idosos apresentavam maior sensibilidade para os cuidados da saúde. Variáveis demográficas, principalmente gênero, nível educacional e transferências governamentais, influenciam a demanda pela maioria dos bens em famílias chefiadas por idosos no Brasil. As transferências governamentais ajudam as famílias idosas a gastar mais em Habitação, Alimentação e Saúde. Em relação às variáveis de composição domiciliar, os domicílios formados apenas pelos idosos demandam menos Alimentos e mais Habitação; os domicílios compostos por idosos com crianças demandam mais produtos relacionados a vestuário e transporte, e menos produtos de higiene e habitação; e os domicílios compostos por idosos com parentes exigem menos produtos de cuidados de saúde. Juntos, os dois ensaios contribuem para uma melhor compreensão sobre o padrão do consumo, a demanda dos consumidores e o bem-estar dos idosos usando dados do Brasil, uma economia em desenvolvimento.

BACKGROUND

A large literature on the economic consequences of population aging has prompted important debates regarding the possible causes on elderly poverty, aggregated consumer demand and possible policies to reduce the inequalities generated by the demographic transition. The understanding of the present situation is necessary to prevent and design cost-effective policies in the future. While the international literature has advanced, the understanding about economic consequences of population aging in developing countries is still lagging behind. As emphasized by Saad (2010) and Medici (2010), different from developed countries, the period of rapid population aging in Latin America countries – LAC - will pose new social and economic challenges to the society and require the implementation of public policies and programs in multiple areas in the present, including the provision of long-term health care and the financing of pensions for a progressively aging population. The social and economic circumstances of the aging population, such as late retirement, improvement of health and functional ability, and public and private policies that influence individual well-being are in a state of continuing evolution and transition. Understanding the complexities of this situation and the relationship among demographics, policy, social behavior, economics, poverty and consumer demand in the present is essential to improve the design of policies as well as to guarantee a better quality of life for the elderly in developing countries.

This thesis consists mainly of two empirical papers about consumer demand and population aging using Brazilian data. Despite being close to one another, they are independent and focus on distinct issues inside the universe of population aging. In addition, before presenting the two essays and after this background section, we present information about the situation of the elderly in Brazil, addressing aspects such as the demographic transition, the profile of the Brazilian elderly, the socio-demographic conditions of this segment and, finally, the consequences and trends of population aging in Brazil. The intention of this introductory chapter is to guide the research problems related to the elderly population that will be presented in the next chapters.

The first essay aims to analyze the level of well-being of the Brazilian elderly. Specifically we intend to: a) analyze which percentage of household expenses benefits the elderly women or the elderly men and if there are economies of scale when married; b) verify which variables rule the bargaining power in the elderly households; c)

compare the level of poverty among the elderly through a collective consumption model in relation to the OECD traditional approach; d) check how much income a widow(er) elder would need to get the same living standards as when she/he was married; and e) understand how is the sensitivity of consumption of the elderly in relation to expenditure and prices. The primary contribution of this essay is to analyze poverty among elderly using a collective consumption model in a developing country, based on a representative basket of consumption.

The second essay objective is to compare consumption expenditure patterns and demand, measure by price and income elasticities, of the elderly and adult-headed households, taking into account socio-economic factors associated to consumer behavior. The main contribution of this essay is to recognize that differences between expenditure of the elderly and the adults are important in order to establish appropriate public policies to help elderly consumers. In the course of the aging process, elderly households will play an increasing role, but their behavior might differ substantially from younger people. As a consequence, if they represent a bigger and bigger part of the population, this process might involve changes in the household's consumption structure and the economy might have to face a significant change in the national demand structure. If changes occur without being predicted and thus without appropriate public policies, shortages of goods and services needed by the elderly might occur and their prices rise to a point that needed commodities are unaffordable to them. The welfare of the adult consumer as well as the elderly consumer might decline.

Together, the two essays contribute to a better understanding about the consequences of population aging on poverty among elderly and consumer demand using data from Brazil, a developing country. In the first essay, we verify that Brazilian elderly individual's consumer preferences are similar by gender and both are more sensitive to changes in expenditure and price for Health care. Despite that, the results indicate substantial economies of scale and an elderly husband's share that is increasing in total expenditures in Brazil. OECD scale underestimates poverty among elderly women in couples and overestimates poverty among elderly men in couples. In the case of widow and widowers, in most of the periods, OECD scale underestimates poverty rates in Brazil. Finally, we find that the drop in material well-being following the wife's death is rather substantial for men and the opposite was observed for women. In turn, the second essay confirms that elderly and adult-headed households have different

consumption patterns in Brazil. Adult-headed households were more sensitive to changes in expenditure for Food products, while households headed by the elderly showed more sensitivity for Housing and Health care. Demographic variables, mainly gender, education level and government transfers, influence the demand for most of the goods in elderly headed households. Government transfers help elderly households to spend more on Housing and Health care. In relation to household composition variables, those formed only by the elderly demand less Food and more Housing; those households composed by the elderly with children demand more Clothing and Transportation products and less Habitation and Health care products; and those households composed by the elderly with relatives demand less Health care products. Collectively, the two essays indicate that a better understanding of the actual conditions of elderly well-being and the difference on consumer demand by households headed have positive long-run impacts on poverty rates and the national demand structure in Brazil.

CHAPTER 1 - THE ELDERLY IN BRAZIL

1.1. The demographic transition

The Brazilian population has undergone significant changes over the nineteenth and twentieth century. Among them one might highlight the reduction in mortality followed by the decline in fertility rates. Compared to European countries, the demographic transition from high rates of mortality and fertility to a stable population with low rates of mortality and fertility have happened in Brazil at a faster pace. This transition took about 200 years in some European countries; however in Brazil experts predict that the demographic transition will be completed in about 100 years around 2050 (BELTRÃO *et al*., 2004). According to the World Bank database (2018), the percentage of elderly population and the life expectancy at birth in 2018 in Brazil are the same as the Organization for Economic Co-opeation and Development - OECD countries had in 1960 and 1980, respectively.

Demographic transition is defined as the movement of the population from high to low levels of mortality and fertility associated with the process of technological development and modernization. Warren Thompson, a pioneer researcher on the demographic transition theory, says this passage occurs in four stages: the first (pre-industrial stage), when fertility and mortality are high (low population growth); the second (industrialization/urbanization stage), when mortality is reduced and fertility remains constant (rapid population growth); the third (industrial maturity stage), when fertility is reduced and mortality are low; and fourth (post-industrial stage), when fertility and mortality are low (low population growth) (ZUANAZZI; STAMPE, 2014).

According to Brazilian Institute of Geography and Statistics - *Instituto Brasileiro de Geografia e Estatística* IBGE (2017), the approximately 206 million inhabitants living in Brazil in 2016 are a result of population history that can be summarized in three basic periods. In the first, which extends from the middle of nineteenth century to about 1930, the Brazilian population had high mortality and fertility rates with moderate population growth rates below 2% per year on average, mainly due to rising international migration. This period can be characterized as the first phase of demographic transition in Brazil.

The second phase of the Brazilian population history starts from 1940 when death rates and international migration begin to decline. Thus the decline in mortality rates in all age groups coupled with the high fertility rates in the decades 1950 and 1960 caused the growth of the Brazilian population to reach its peak with growth rates of approximately 3% per year on average. Therefore the second phase of the Brazilian population history fits the so-called second stage of the demographic transition and extended until the end of the 1960s when fertility levels began to decline, offsetting the relative reduction in mortality, preventing the population growth rates from continuing to increase (IBGE, 2015).

In this context, the third period in the Brazilian population history began in the late 1960s characterized by a rapid reduction in population growth rate. From the rate of almost 3% per year observed between 1950 and 1970 this rate decreased to approximately 1.3% per year after 1990. Therefore, the main variables responsible for the demographic transition, the fertility and mortality rates, show that the Brazilian population has already reached the third stage of demographic transition (IBGE, 2015). Table 1 shows in detail further evidence of demographic transition with some indicators of age structure, fertility, and mortality in the 1950-2010 periods.

According to IBGE (2013), Brazil has been experiencing a rapid drop in fertility levels since the 1960s. While in the 1950s and 1960s the average number of children per woman was around 6.3, this number dropped to about 1.7 children per woman in 2013. The crude birth rate defined as the number of live births per thousand inhabitants also decreased significantly after the 1950s from 43.5 births to 16 births per thousand in 2010. According to IBGE (2009), the late 1960s and especially during the 1970s, the ongoing transformation of Brazilian society - strong migratory movements from the countryside to the city, leading to an intensification of urbanization; advances in the wage of the Brazilian economy and increasing women's participation in the labor market; the spread of an economic model focused on the consumption of durable goods associated with the spread of market relations and increase in family and social reproduction costs; the industrial production of contraceptive means and its acceptance by a significant portion of women - may explain the sharp decline in fertility rates after the 1970s. IBGE projections show that the fertility rate will continue to fall in the next years reaching 1.5 children per woman in 2030 (IBGE, 2013).

Table 1 - Age structure, fertility and mortality indicators in Brazil, 1960-2010

Indicadores	1960	1970	1980	1990	2000	2010
Population	70,070,457	93,139,067	119,002,706	146,825,475	169,799,170	190,755,799
Median age	18	19	20	22	25	27
Aging index[1]	11.2%	12.4%	15.9%	20.9%	28.9%	44.8%
Age dependency ratio[2]	90.0%	88.3%	79.5%	72.5%	61.7%	53.6%
Total fertility rate[3]	6.3	5.8	4.4	2.9	2.4	1.9
Crude birth rate[4]	44.0	37.7	31.8	23.7	21.1	16.0
Crude death rate[5]	15.0	9.4	8.9	7.3	6.9	6.1
Child mortality rate[6]	124.0	115.0	82.8	45.2	27.4	16.2
Life expectancy at birth	51.6	53.5	62.8	65.8	70.4	73.5
	1950-60	**1960-70**	**1970-80**	**1980-90**	**1990-00**	**2000-10**
Annual growth rate	3.0	2.9	2.5	1.9	1.6	1.2

Note: (1) Number of people of 60 and more years old, for every 100 people under 15 years; (2) The ratio of older dependents (people older than 64) to the working-age population (those ages 15-64); (3) The average number of children that would be born per woman if all women lived to the end of their childbearing years and bore children according to a given fertility rate at each age; (4) The number of live births per thousand inhabitants; (5) The number of deaths per thousand inhabitants; and (6) The death of infants and children under the age of five or between the age of one month to four years thousand inhabitants.
Source: Vasconcelos and Gomes (2012).

The mortality rates have also been decreasing steadily in Brazil. Thus, life expectancy at birth for both sexes which was under 50 in 1950 increased to 74.8 years by 2013. In the same period, infant mortality rates fell from 135 deaths per thousand live births in 1950 to only 15 deaths in 2013. The crude death rate defined as the number of deaths per thousand inhabitants also decreased significantly after the 1950s from 19.7 deaths to only 6.1 deaths per thousand inhabitants in 2010. According to IBGE (2009), while the causes that led to a reduction in mortality are not fully understood, public health systems, social security, urban infrastructure, and labor regulations in key regions of the country from the 1930s have played important roles. These institutional factors, along with technological advances in the chemical-pharmaceutical industry, contributed to the control and reduction of various diseases, especially infectious and pulmonary, which until then had high prevalence with high mortality rates. Projections of IBGE (2013) show that life expectancy at birth in Brazil should reach 75.3 years for men and 82 years for women in 2030.

As Alves (2008) indicates, the demographic transition is the result of different socio-economic and cultural determinants and there is ample literature in Brazil[1] that explains the causes of the reduction in mortality and fertility rates as a result of structural and institutional changes that have occurred both at the macro and micro levels, and that, in turn, have affected inter-generational and gender relations. The most visible effect of the demographic transition takes place with the acceleration and subsequent deceleration of population growth. The Brazilian population increased from about 10 million in 1870 to 204 million in 2015, and should stabilize according to United Nations – UN projections at about 250 million people by the year 2050.

However, the major effect for social and economic policies is the changing age structure of the population. The process of falling fertility and mortality rates and reduction in the percentage of children and youth of the population makes the age pyramid start a gradual process of aging. According to Wong and Carvalho (2006), this process is called Age Structural Transition - AST, which results in changes in the size of various age groups and modifies the proportional weight of various age groups of the population (ALVES, 2008). Thus, note that the age pyramid in Brazil in 1980 had a very wide base and a very narrow top (Figure 1). In 1980, the Brazilian age pyramid still had the shape of a pyramid, where each older group had fewer members than the previous group, although the bottom of the pyramid had been reduced in percentage terms. With the fall of fertility and mortality rates, the age pyramid in 2010 had three younger age groups with lower percentages than the group aged 15 to 19 years. Therefore, lower fertility and mortality rates transformed the age structure of the population, reducing the weight of children and young people and increasing, initially, the weight of the adult group and then the weight of the elderly group[2]. This is clear when observing the projected age pyramid in 2050, when the age structure of the population should have a rectangular shape and the percentage of elderly is expected to exceed the number of children, especially for women.

[1] Carvalho *et al*. (1981), Merrick and Berquó (1983), Faria (1989), Alves (1994), Martine (1996), Monteiro (1997), Carvalho and Wong (1998), Alves (2002), Beltrão *et al*. (2004), Carvalho and Brito (2005), Brito *et al*. (2007), Alves (2008), Castiglioni (2012) and Vasconcelos and Gomes (2012).

[2] The World Health Organization - WHO defines elderly people as people with age equal or greater than 60 years old (IBGE, 2009).

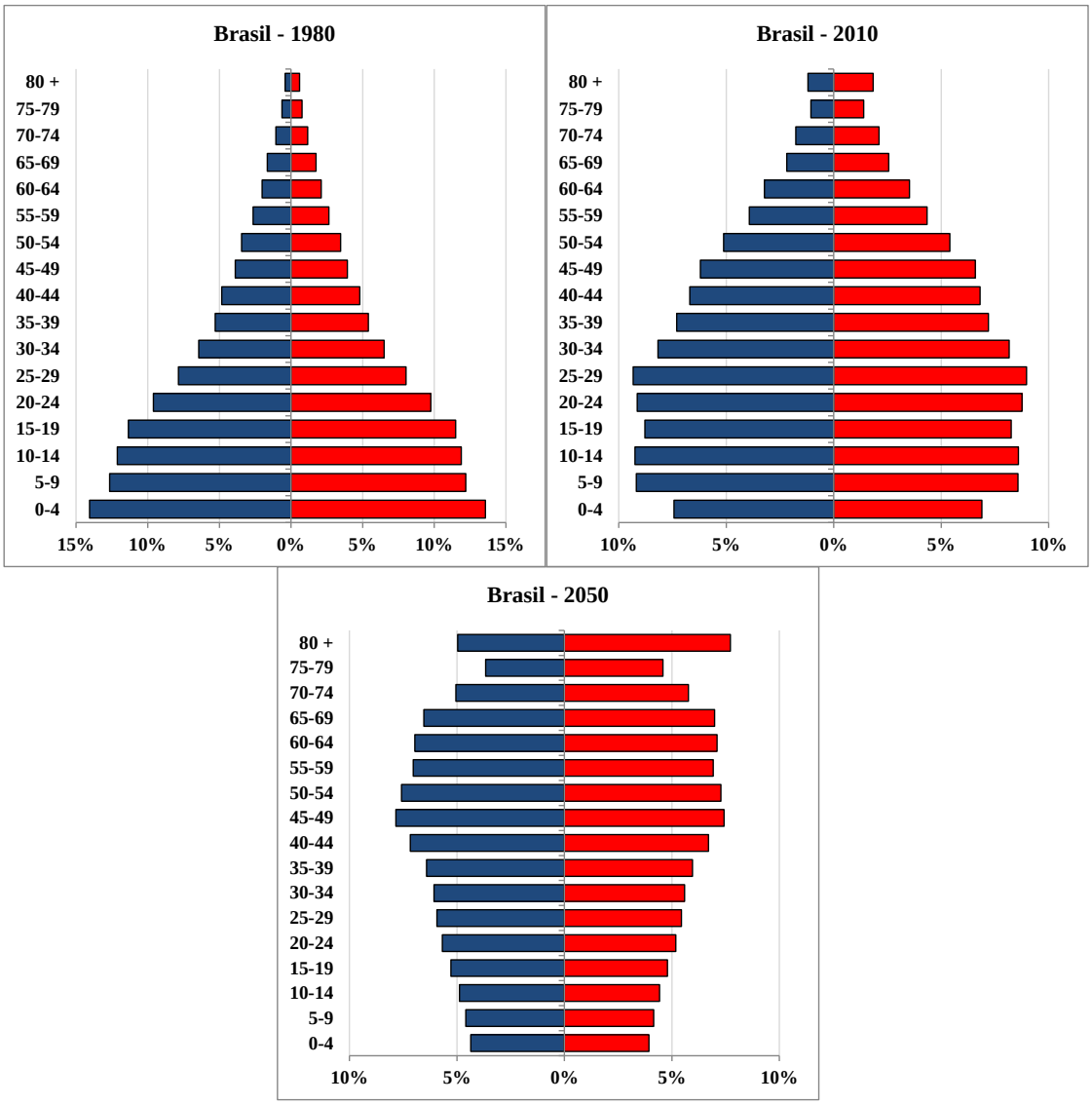

Figure 1 - Brazilian age pyramids: 1980, 2010 and 2050.
Source: IBGE (2017)
Note: Men and women are represented by blue and red color respectively.

Therefore, Brazil's population growth up until 2025 will be driven by increases in the older population, while the population of working age people (between 15 and 59 years old) will begin to decline. An interesting indicator that emerges from this statement is the ratio of total dependence, which relates the total population in potentially inactive age (under 15 and over 60) in relation to the population in potentially active age (15-59 years). This indicator reflects the weight or "economic burden" from the group of children, adolescents and the elderly on the segment of the population that is considered to be in the correct age to engage in productive activity. As seen in Table 1, the dependency ratio decreased from 90% in 1960 to 53.6% in 2010.

The trend of "economic burden" will decrease until it reaches a minimum in 2020 (50.9 inactive for every 100 people of working age) with the reversal of this trend from that date, mainly due to the increase in the number of elderly in both absolute and relative terms. By 2050, the ratio is projected to be 75 inactive people for every 100 of working age. Taking into account only the elderly, this quota will rise from 13.1 per 100 people in 2010 to 52.1 in 2050. Therefore, there is a growing increase in the aging index of the population (number of people of 60 and more years old, for every 100 people under 15 years), which rose from 11.2% in 1960 to 44.8% in 2010. Maintaining the forecasts of future declines in fertility and mortality rates, Brazilian population will have 226 elderly people for every 100 children and adolescents in 2050 (IBGE, 2009).

1.2. The Brazilian elderly profile

The elderly population in Brazil has grown significantly since 1950. According to IBGE (2015), the national population was composed in 1950 of 2.6 million seniors representing about 4.9% of the population. In 2010, with an annual growth of 3.4% compared to 2.2% of the population in general, the elderly were already 19.6 million representing about 10.2% of the population. IBGE estimates (2017) show that in the next 40 years this group will grow at a rate of 3.2% per year compared to 0.3% of the population, reaching 64 million people by 2050, which will be equivalent to 29.7% of the population. According to World Bank (2016), compared to other countries this percentage will be close to the current Japan, the country with the highest proportion of elderly in the world, and above the percentage of countries in Europe where the average proportion of this population group was 20% in 2013.

However, the distribution of the elderly in the national territory is not homogeneous, due to the characteristics of each region, the behavior of fertility and mortality rates, migration, socio-economic and political aspects (TORRES; SÁ, 2008). According to IBGE (2014), most of the population aged 60 or more is concentrated in the Southeast region (46.2%) and Northeast region (26.5%), followed by the South region (16%). The lower percentage of elderly is in the Midwest region (6%) and North region (5.3%). It is noteworthy that 70% of the population aged 60 or more are concentrated in the Southeast and Northeast regions. However, when analyzing the proportion of elderly in the population of each region, it appears that this segment is

more representative in the South region (14.5%) and Southeast region (14.2%) followed by the Northeast region (12.4 %) and Midwest region (11.1%) and, finally, the North region (8.8%). Therefore, it is clear that the Southeast region has the highest concentration of elderly in the country and the second highest proportion in relation to its population, and the Northern region has the lowest concentration and relative proportion of elderly.

As Cunha (2000) indicates, the highest concentration of elderly in the Southeast region can be explained by the attractiveness of their metropolitan areas, which in recent years have experienced significant economic growth, mainly due to the development of the industrial sector. However, as Otero (2001) explains, the concentration of elderly in the Northeast region results from the emigration of the young population to more developed regions in search of work. According to IBGE (2010), the low percentage of elderly in the North and Midwest region is due to the high levels of past fertility, although in recent years, the population in these regions has been aging. Wong and Carvalho (2006) explain that the extreme socio-economic and geographical inequalities have delayed the decline in fertility in the less developed regions of Brazil.

Table 2 shows other differences among the elderly population in Brazil. According to the sex ratio, the number of women is higher than men in this segment. In 1980, women accounted for 52.7% of the elderly population, rising to 55.5% in 2013. By analyzing regional differences, the distribution by sex of the elderly is more pronounced in the Southeast region (56.7% women), followed by the South and Northeast regions (55.3% women), Midwest region (53% women) and, finally, the North region (50.5% females). This imbalance can be explained by differences in life expectancy among genders, which is a worldwide phenomenon, but these differences are larger in Brazil given that on average women live eight years longer than men (IBGE, 2014).

The urban-rural distribution of the elderly population also is related with the constant growing urbanization of the population. The proportion of elderly people living in rural areas decreased from 23.3% in 1990 to 16.5% in 2010. The urbanization of the elderly followed the trend of the total population, which was around 83.9% in 2013 (IBGE, 2014). According to Barbot-Coldevin (2000), demographic projections show that there is a trend towards greater urbanization along with the increasing size of the elderly population, with a higher proportion of elderly men in rural areas and elderly

women in urban areas. According to the authors, living in the city can benefit the elderly women, especially those who are widowed, who want to be close to family, health services and other facilitators.

Table 2 - Percentage distribution of seniors by gender, household situation and color or race, by Major Regions, 2013

Major Regions	Percentage distribution of 60 years or older people						
	Gender		Household situation		Ethnicity[1]		
	Man	Woman	Urban	Rural	White	African	
						Brown	Black
Brazil	44.5%	55.5%	83.9%	16.1%	53.4%	37.3%	8.3%
North	49.5%	50.5%	72.5%	27.5%	24.2%	65.0%	9.2%
Northeast	44.7%	55.3%	71.9%	28.1%	30.9%	57.8%	10.8%
Southeast	43.3%	56.7%	92.6%	7.4%	61.8%	28.5%	8.4%
South	44.7%	55.3%	80.9%	19.1%	79.5%	15.6%	3.7%
Midwest	46.5%	53.5%	88.3%	11.7%	46.2%	45.6%	7.4%

Note: (1) There aren't presented results for Asian or indigenous ethnicity.
Source: National Household Survey (2013) cited by IBGE (2014)

As for the distribution by race, the vast majority of the elderly population identified themselves as White (53.4%), followed by the African Brazilians, Mixed race - Brown (37.3%) and Black (8.3%). This proportion changes in parts in the North and Northeast regions, which have a higher percentage of seniors who reported being Brown, 65% and 57.8% respectively, over the other races. In the case of the South region, the distribution of the elderly also changes, but the vast majority identified themselves as White (79.5%) (IBGE, 2014).

Taking into account the condition of the elderly at home, 64.4% of the elderly were the household heads in 2013, observing an increase compared to 1991 when were 60.4%. The elderly spouses accounted for about 24.7% in 2013, which means that the vast majority (89.1%) of this population occupies a prominent role in the organization model of the Brazilian families. Among single person households, those inhabited by elderly men were about 15.1% and 17.8% for older women in 2013. It is noteworthy that in 1970 this ratio was approximately 5% for men and 8% for women elderly (IBGE, 2014). According to Berquó (1990) a justification for this phenomenon is that the greater number of elderly women determines the growth of single-parent families

and single-person households under the female responsibility. In addition, since widowers or divorced men remarry more frequently than women under the same conditions in Brazil, the differentiation of household arrangements significantly increases according to the gender and age of the person in household head.

Table 3 shows the distribution of elderly people living in private households by type of living arrangement and major regions in 2013. The most common type is still the household composed by couples with children and/or other relatives (40.4%), followed by households of couples without children (26.5%), single-person households (15.1%), living without children and with others (10.7%) and other (7.2 %). The distribution does not change for major regions, however the highest proportion of households consisting of elderly couple without children (33.5%) and single person households (16.9%) are found in the South region (IBGE, 2014).

Table 3 - Distribution of elderly people living in private households by type of living arrangement and major regions, 2013

Major Regions	Single person	Couple without children	Living without children and with others	Living with children and/or with others		Others
				With children under 25 years	All children aged 25 years or more	
Brazil	15.1%	26.5%	10.7%	9.8%	30.6%	7.2%
North	12.0%	19.3%	12.5%	16.9%	30.4%	8.8%
Northeast	13.2%	21.4%	13.0%	13.0%	32.6%	6.8%
Southeast	15.7%	27.7%	9.7%	7.9%	31.7%	7.3%
South	16.9%	33.5%	8.9%	8.4%	25.0%	7.3%
Midwest	16.2%	28.1%	11.5%	8.1%	29.0%	7.0%

Source: National Household Survey (2013) cited by IBGE (2014)
(1) Household with older people only on the condition of another relative and/or aggregate.

The educational levels of the elderly in Brazil can be considered one of the indicators characterizing the socio-economic profile of the population. In the case of the elderly population, literacy is considered an indicator of the Brazilian educational policies of the past. Thus, literacy is measured by the proportion of people who declared themselves as knowing how to read and write at least a simple note. The proportion of

literate elderly increased from 55.8% in 1991 to 71.6% in 2013. The average number of years of study of the elderly is very different among the major regions, ranging from 5.5 years in the Southeast region to 3.3 years in the Northeast region (IBGE, 2014) (Table 4).

Despite the increase in elderly literacy in recent years, the low balance of average education of this population is a reflection of unequal access due to restrictions of primary education to specific social groups in the 1930s to at least the 1950s. Looking at Table 4 and assuming a definition of "functional illiteracy" as the people with less than 4 years of study, approximately 45.5% of the elderly had not even obtained this minimum level of education. In the case of the Northeast and North regions this percentage is even higher, about 63.4% and 58.3%, respectively. The situation is better in the Southeast and South regions, where functional illiteracy affects about 35.6% and 38.6% of the elderly, respectively. However, there was a significant improvement in the number of illiterate elderly people, which represented 45% in 1991, compared to 28.4% in 2013, indicating greater access to education due to past improvements in access to education (IBGE, 2014).

Table 4 – Average years of study of the elderly and percentage distribution by groups of years of study, by Major Region, 2013

Major Regions	**Average years of study**	**Percentage distribution by groups of years of study**			
		No education and less than 1 year	**1 a 3 years**	**4 a 8 years**	**9 ou years**
Brazil	4.7	28.4%	17.1%	34.5%	19.9%
North	3.7	37.6%	20.7%	27.6%	14.0%
Northeast	3.3	46.9%	16.5%	22.0%	14.5%
Southeast	5.5	20.0%	15.6%	39.9%	24.4%
South	5.0	18.0%	20.6%	43.2%	18.2%
Midwest	4.6	30.8%	17.8%	30.9%	20.3%

Source: National Household Survey (2013) cited by IBGE (2014).

The average income of the elderly indicates the ability to purchase goods and services by this segment. Whereas the determination of the minimum wage value is based on the basic needs of individuals, it is possible to consider this variable as an

indicator of welfare and poverty. In this case, an improvement in recent decades was observed: while in 1991, more than half of the elderly (52.1%) had income less than the minimum wage, in 2013 this proportion fell to about 39.7%. However, regional differences are observed with most of the elderly on Northeast (53.2%) and North (51.1%) regions presenting income up to one minimum wage (Table 5) (IBGE, 2014).

Table 5 - Percentage distribution of the elderly by monthly income classes from all sources, by Major Region, 2013

Major Regions	Percentage distribution of the elderly by monthly income classes from all sources			
	Up to 1/2 minimum wage	More than 1/2 to 1 minimum wage	More than 1 to 2 minimum wages	More than 2 minimum wages
Brazil	1.4%	38.3%	23.9%	24.6%
North	2.5%	48.6%	23.2%	15.3%
Northeast	2.3%	51.9%	23.3%	14.0%
Southeast	0.9%	30.2%	23.8%	30.2%
South	1.0%	34.1%	26.5%	28.9%
Midwest	1.4%	41.0%	20.6%	25.2%

Source: National Household Survey (2013) cited by IBGE (2014).
Note: No results are displayed for people with monthly income from all sources, or with no monthly income statement from all sources.

While labor income is usually responsible for most household income, the database for the elderly income composition shows that labor income is not the major income share. In 2013, about 67.6% of the elderly's income came from retirement and/or pension, 28.3% from employment, and 4.1% from other sources. This difference is even greater in the Northeast and South regions, where the income derived from retirement and/or pension reached 71.5% and 69%, respectively (Table 6) (IBGE, 2014).

In summary, the profile of the elderly in Brazil has the following characteristics: the majority are women (55.5%), and the percentage of women varies across regions from 50.5% in the Northern region to 56.7% in the Southeast region ; most elderly identify themselves as White (53.4%), with this indicator reaching 79.5% of elderly people in the South region and only 24.4% in the North region; about 83.9% of the

elderly live in urban areas, especially in the Southeast region (92.6%); 41.6% of the elderly live in households in single-person arrangements or a couple without children, with the highest proportion in the South region (50.4%); 64.4% of the elderly were the household heads, mainly in the case of the men (80.3%); the elderly schooling average was 4.7 years, ranging from 3.3 years of schooling in the Northeast region to 5.5 years in the Southeast region; 28.4% had less than a year of study, and in the Northeast region this indicator reached 46.9%; and 48.4% of the elderly have income from all sources higher than a minimum salary wage.

Table 6 – Percentage distribution of elderly income by source of income, by Major Region, 2013

Major Regions	**Percentage of elderly income by source of income**		
	Labor	**Retirement and/or pension**	**Other sources**
Brazil	28,3%	67,6%	4,1%
North	29,2%	64,2%	6,6%
Northeast	22,8%	71,5%	5,7%
Southeast	30,5%	66,2%	3,3%
South	27,9%	69,0%	3,1%
Midwest	30,0%	65,0%	5,1%

Source: National Household Survey (2013) cited by IBGE (2014).

1.3. Socioeconomic condition of the elderly

The elderly are more vulnerable to falling into poverty than other age groups. The elderly have lower chances of recovering from a negative income shock and have difficulties in (re)entering the labor market, because characteristics such as productivity and employability decline with age from a certain time of life that often occurs around the age of 60 (HURD, 1991). Therefore, the difficulty of recovering from negative income shocks implies that poverty among older people tends to be more permanent than among other groups in society.

It is evident that a challenge to the State and Federal Government due to population aging relates to social security. Table 7 shows the percentage distribution of

the elderly retired[3] and/or pensioners[4] by gender in 2013, by major Brazilian regions. Of the elderly, 23.9% did not receive retirement or pension, whereas 7.8% of the elderly accumulated retirement and death pension. The retiree's ratio does not change much regionally, being higher in the Northeast (63.8%) and South regions (60.9%). The proportion of people receiving retirement and pension is also higher in the South (11.6%). However, the proportion of elderly who accumulated both was differentiated by gender: while only 2.6% of men received both benefits, about 11.9% of women were in this condition. The high proportion of elderly who did not receive retirement or pension plan (23.9%) may be related to greater inclusion thereof in the labor market, as the occupancy rate was 27.4% in this age range. However, for those who were not retired or pensioners, the occupancy rate was 45.1% (IBGE, 2014).

This vulnerability, or the difficulty of recovering from negative income shocks, depends directly on the state's role in ensuring income for the elderly. According to Turra and Rocha (2010), reducing the level of poverty among this segment in Brazil was mainly due to the increase in public spending on retirement and pensions after the 1988 Constitution. Over the past three decades, poverty rates in Brazil across all segments have been declining gradually. There were two distinct periods of poverty reduction: 1980-2000, characterized by a moderate reduction; and 2001-2015, when there was a significant acceleration in the reduction of poverty. According to Ferreira and Leite (2009), four factors contributed to this reduction during the first period: the non-contributory benefits established after the 1988 Constitution, providing income for retirees who failed to meet the contribution criteria; all the measures taken by the Brazilian government in the early 1990s that stabilized the economy, keeping inflation under control, with positive effects mainly on the real wages of the poorest; changes associated with the first and second phases of demographic transition, which reduced the size of families, and their dependence ratio, reducing poverty by increasing the relative number of adults; and finally, progress and steady increase in human capital, investment in health and education, as well as female participation in the workforce, helping to boost family income.

[3]Action to move away from work after completing a certain period of service (stipulated by law); or reached a certain age, or for health reasons, is put into inactivity and starts receiving an income.

[4] A monthly payment corresponding to the value of the remuneration or income of the server due to its dependents, from the date of their death. It may originate from the Armed Forces, the Social Security Plan or a Federal Social Security Institute (INSS), state or municipal, including FUNRURAL - Rural Workers' Assistance Fund.

Table 7 - Percentage of elderly who receive retirement and/or death pension by gender, by Major Region, 2013

Major Regions	Percentage of elderly income by source			
	Retirees	Pensioners	Retirees and Pensioners	Other
Total				
Brazil	59.0%	9.3%	7.8%	23.9%
North	58.7%	7.7%	4.0%	29.6%
Northeast	63.8%	6.6%	8.2%	21.4%
Southeast	56.2%	11.3%	6.9%	25.6%
South	60.9%	8.9%	11.6%	18.6%
Midwest	54.1%	9.4%	5.9%	30.7%
Elderly men				
Brazil	72.7%	1.4%	2.6%	23.3%
North	62.7%	2.3%	2.1%	32.9%
Northeast	73.2%	1.4%	3.4%	22.1%
Southeast	73.8%	1.1%	2.0%	23.0%
South	76.5%	1.5%	3.6%	18.3%
Midwest	63.7%	2.1%	1.5%	32.7%
Elderly women				
Brazil	48.0%	15.7%	11.9%	24.5%
North	54.7%	13.0%	5.8%	26.4%
Northeast	56.3%	10.8%	12.1%	20.9%
Southeast	42.7%	19.1%	10.6%	27.6%
South	48.4%	14.9%	18.0%	18.8%
Midwest	45.7%	15.7%	9.7%	28.9%

Source: National Household Survey (2013) cited by IBGE (2014).

As Barros *et al.* (2006) state, policies to reduce inequality have been the key to poverty reduction in the second period (2001-2015). Income transfer programs and the minimum wage policy explain much of the reduction of poverty and inequality in Brazil. Also according to the authors, counterfactual analyses reveal that 48% of the decline in income inequality between 2001 and 2005 was due to the creation of income transfer programs (especially the Bolsa Família Program) and the expansion of the non-contributory social security system. In addition, the minimum wage increases also favored workers with lower incomes and beneficiaries of the death pension system, helping to reduce levels of inequality and poverty.

Poverty reduction through income transfer has not been homogeneous among segments of the population. A large number of studies in Brazil [5] emphasize the importance of public transfers, particularly of social security benefits [6], in reducing poverty by age groups. Some of these studies use simple counterfactual analysis to compare poverty rates with and without the public benefits. Turra *et al*. (2008), among the most recent studies, uses 2005 data for households to show that the incidence of poverty among the elderly in Brazil would grow by 3.9% to 63.5% (if they did not receive government benefits. Coetlar and Tornarolli (2009) compared poverty rates with and without pensions for two major age groups - over 60 years and below 15 years - using 2008 data for several countries in Latin America. According to the authors, Brazil, Argentina, Chile and Uruguay are countries with large and generous pension systems, which have relatively greater impact on poverty rates among the elderly. Coetlar and Tornarolli (2010) confirm that the poverty rate among the elderly in Brazil in 2008 fell from 49.3% to 4.2% after taking into account income transfers.

To better understand the influences of public transfers in reducing poverty among the different age groups in Brazil, Turra and Rocha (2010) compared poverty rates by age in three years: 1981, 1995 and 2008. The authors estimated poverty rates based on the World Bank's poverty line of US$ 2.00 per day in purchasing power parity in 2005 with and without public transfers including contributory and non-contributory retirement benefits, as well as conditional cash transfers from the Bolsa Família program. Figure 2 shows the results reported in Turra and Rocha (2010).

Looking at the chart for the year 1981, before the Constitution of 1988 and the expansion of social welfare programs, on average 53% of the population lived in poverty, and the incidence varied little according to age, 65.2% for children under 15 years and 47.7% among the elderly. According to the authors, since the income transfer programs had not yet been established in 1981, these results were not surprising. The impact of excluding transfers was virtually zero for poverty rates among children, but about 25% of the elderly population had not received public pensions in 1981, so the

[5] Lavinas and Versanos (1997), Rocha (1998), Brant (2001), Silva (2002, 2003, 2004, 2005), Rocha (2005), Barreto (2005), Barros *et al*. (2006, 2007), Costa & Salvato (2008), Turra *et al*. (2008), Cotlear and Tornarolli (2010), Turra and Rocha (2010) e Marinho *et al*. (2011).

[6] Benefits that are intended to replace the remuneration of the activity in disease occurrences, disability, death, old age - the various types of retirement (age, contribution and special), aid (illness, imprisonment) and pensions (Rocha , 2005).

exclusion of social security benefits had a moderate effect on poverty of elderly, about 20% on average.

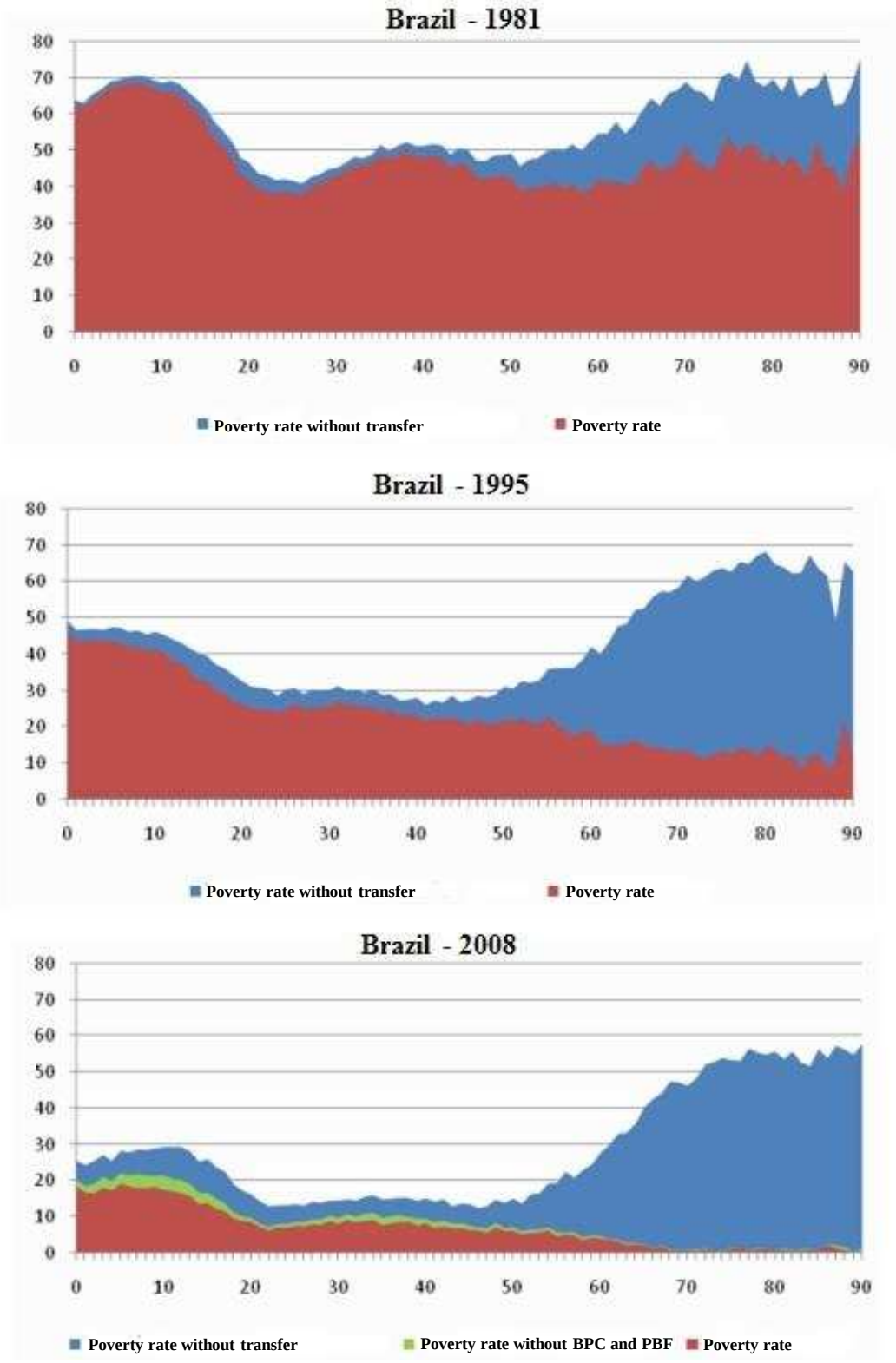

Figure 2 - Poverty rates by age with and without transfer (%), 1981, 1995 and 2008
Source: Turra and Rocha (2010).

In the 1995's chart, the incidence of poverty is much lower among the elderly (13.6%) than among children (40.8%). Thus, the results of Turra and Rocha (2010) confirm that the main factor in reducing poverty among the elderly has been the expansion of social security benefits. Finally, in the 2008 chart, poverty rates declined again for all ages. The development and expansion of the conditional cash transfer programs (Bolsa Família) reduced the percentage of children living in poverty. However, the impact of social protection to the elderly with increasing non-contributory benefits is even higher, and virtually eradicates poverty in the segment, according to the data. The authors conclude with the information that for every elderly person in poverty, there were almost 16 children in the same condition in 2008. Taking into account the study of Turra and Rocha (2010), it is important to note that public transfers in Brazil have been very effective in reducing poverty among the elderly.

Furthermore, the percentage of the elderly who have monthly income less than or equal to one minimum wage was reduced from 52.1% in 1991 to 39.7% in 2013; the income of the elderly from the retirement and/or pension accounts on average for 67.6% of the total income of the elderly and approximately 76.1% of the elderly receive retirement, pensions or both benefits. These information, coupled with recent studies by Turra et al. (2008), Coetlar and Tornarolli (2009) and Turra and Rocha (2010), which assessed the impact of cash transfers on the levels of poverty among the elderly, show that the vast majority of the elderly in Brazil receive government income transfer programs with a positive effect on poverty reduction in the segment.

These studies are very instructive, but they can be methodologically flawed if we take into account causal relationships, since they do not include behavioral effects. In the case of poverty rates, for example, the simulations ignore the possibility that a slower expansion of welfare programs could have created incentives for a greater supply of labor and savings. In addition, many counterfactual analyzes found in the literature are data-driven by an artificial generation and thus ignore the historical determinants of poverty trends that are related to period and generation changes. Despite that, it is important to note that public transfers in Brazil have been very effective in reducing poverty among the elderly. These studies show that poverty levels for this group are very low compared to international standards, while they would be very high in the absence of public transfers.

1.4. Consequences and trends of population aging

The rapid aging of the Brazilian population and elderly reliance on income transfer programs will have great impact on Brazil. The increase in the dependency ratio of the elderly and the fall of the pension support ratio[7] causes an increasing number of beneficiaries to depend on a decreasing number of workers. In addition, early retirement and informality in the labor market decrease the pension support ratio, making it difficult to project population distributions and predict the demographic dependency ratio. These developments make it difficult to make policies aimed to help the elderly avoid falling into poverty in the future (WORLD BANK, 2011). According to information from the IBGE (2017), the demographic situation is still favorable, because the number of potential contributors in 2015 is six times higher than the number of elderly. In 2050 the situation will be less favorable; the number of potential contributors will only be twice as large as the number of elderly people.

For the coming years, the share of the working-age population will grow until 2025, resulting in more people in the labor force, which means that everything else constant there will be an increase in the generation of resources. While it is expected that the mature fraction of the labor force (19-25 years) will continue to grow until the end of 2020, the future workforce (5-24 years) has started to slow. Since the mature workforce is responsible for most of the economic activity and consequently generates the most wealth, Brazil has the opportunity to increase growth, savings and government revenues. However, in the medium term, the expected changes in the age structure due to aging will pose challenges to economic growth. After 2015, the growth rate of the age group between 15 and 59 years became negative. To sustain economic growth, Brazil will need to encourage the participation of groups such as women, as well as productivity growth in the labor market, or encourage immigration, as it did in the early 20th century. Aging can bring negative effects on productivity, which can now affect the aggregate economy in the coming years when a large proportion of the workforce will be beyond their peak productivity.

International experience shows that specific training and improvement programs can be effective to soften or nullify the decreased ability to learn new skills related to age. Such programs may stabilize or even reverse declines of inductive reasoning and

[7] Ratio of the number of taxpayers by the number of beneficiaries.

spatial orientation. In addition, exercises for speed, reasoning and memory can improve the functional level (World Bank, 2007). The effectiveness of these programs depends crucially on the time and the quality of education that workers received when younger (Heckman *et al*., 2005). Therefore, the country's choice in terms of education, health and welfare at this stage will determine the country's ability to invest adequately in their youth.

As the World Bank (2011) discusses, economic behavior and macroeconomic indicators change both systematically and endogenously with aging. The impact of population aging on savings (and consequently on growth) is particularly important. It is traditionally believed that aging will reduce savings and thus growth, because of the decline in the share of savers in the population, as implied by life-cycle theory. However, under certain circumstances, Brazil cannot experience a reduction in savings and growth. In fact, if government policies are formulated appropriately, properly and in time, it is likely that strong capital accumulation and growth will increase permanent income and the wealth associated with it.

According to Turra and Holz (2009), the savings rates by age do not follow a conventional pattern in Brazil and do not diminish as people age, being stable after the age of 40 at low rates, below the OECD average. Moreover, developing countries often have high savings rates for the elderly. It is likely that the savings rate will increase in the future given the aging population and largely savings formed by workers and elderly with high savings. This result depends on the future structure of the pension system, which needs to ensure that a large part of the population contributes to it; whether public pensions remain relatively high, which does not encourage savings; and whether the State continues to promote the reduction of poverty and social inequality.

Based on the potential increase in savings rates in the future, a key growth factor is the accumulation of endogenous capital. Economic behavior related to consumption and savings over the life cycle is significantly affected by tax policies, transfers and issuing debt to postpone the fiscal costs to future generations. To understand the implications for capital accumulation and growth, it is crucial to take into account the financing options that the government has at its disposal to meet fiscal obligations related to aging. Using a general equilibrium model, Jorgensen (2011) sets out three scenarios, which are compared to the financing of the fiscal costs of aging: financing with tax, in which taxes increase to absorb the costs; financing benefits, in which social

security benefits decrease to accommodate the tax burden; and financing with debt, in which public debt increases so that the government can avoid changes in taxes or benefits. Financing with debt tends to reduce demographic fiscal costs; financing with taxes will keep them more or less constant; while a policy of maintaining constant taxes and debts and allowing adjustment to occur through the benefits (reduction) tends to promote fiscal costs. As a result, according to the author, there are two main findings: First, saving rates could increase and not necessarily fall as a consequence of aging in Brazil - thus contradicting conventional views. Second, lifetime wealth across generations could increase - as capital deepening generates a second demographic dividend. Two policy responses to aging are emphasized: First, a structural policy response of linking mandatory retirement (or entitlement) ages to increasing life expectancy would boost labor supply and reduce the fiscal costs of aging. Second, in terms of preferable parametric policy responses, the second demographic dividend will be promoted to the highest extent by keeping taxes and debt unchanged while allowing public pensions to adjust downward. Such a policy response would keep pensions from further crowding out private saving - thus balancing capital accumulation with intergenerational income distribution. In conclusion, according to Jorgensen (2011), Brazil will not necessarily experience a fall in saving and growth, but if government policies are appropriately, adequately, and timely formulated, population aging is likely to lead to substantial capital deepening and increases in lifetime income, wealth, and welfare.

The impact of population aging becomes quickly apparent when examining projections of public expenditure on education, health and welfare. These costs depend on the average generosity of these benefits received by each individual and the age structure of the population. The fraction of economic output directed to education, health, welfare and the public sector can be broken down into two multiplicative components. First, the demographic factor measures the size of the demand for a specific benefit (education, health and security) by the working age population. Second, the economic factor measures the average benefit received by the beneficiary. Regarding the benefit levels, public sector spending on education and welfare in Brazil resembles that of the OECD countries (as a percentage of GDP), but the age structure of its population is much younger (high demographic factor). This results in a significantly lower public investment in education of young people (9.8% of average wages in Brazil

vs. 15.5% in the OECD) and average retirement benefits and public pensions significantly higher (66.5% of average wages in Brazil vs. 30.4% of the average wage in OECD). Public health aggregate expenditures in Brazil are far below the OECD average - and average health benefits are somewhat smaller (low economic factor) (WORLD BANK, 2011).

Also according to World Bank (2011), while each sector faces different challenges and opportunities with population aging, the projection of all three trajectories of spending through a comparable methodology provides an understanding of the interconnections and choices available to Brazilian policies formulators. Very often, political reforms of the social security system, health system, and education systems are discussed, analyzed and implemented separately without considering relationships among the three systems. The changes in the age structure of the population projected for the next four decades will cause additional fiscal pressures on the social security and health systems financed by the government.

So what policies could be adopted to help mitigate the inevitable strain on the growing social spending caused by rapid population aging in Brazil? First, with respect to education, the accelerated reduction of school-age population provides a unique opportunity to increase investment per student to OECD levels without adding much weight to public finances. Some of the resources saved in primary education could support the expansion of day-care centers and preschools, and help in financing the expansion of better quality and full-time education to the secondary and high school level. After that, the share of GDP allocated for education would decline gradually according to the reduction of the school-age population - while maintaining levels of investment per student at the levels of OECD countries (WORLD BANK, 2011).

Second, health care tends to emerge as a major fiscal challenge in the coming decades. There are two main forces behind the need for increased health spending with population aging: the growing proportion of elderly in the population and the increasing use of health care among the elderly. According to World Bank (2011), it is urgent that the health care system adapt to the different demographic and epidemiological profiles of the growing old age population in Brazil, because the magnitude of the increase in health spending associated with an older population will depend crucially on whether the more years of life will be healthy ones or ones afflicted with disease and addiction.

So preventing and delaying disease and disability, maintaining health, independence and mobility in an aging population will continue to be greatest challenges to Brazil.

In some OECD countries, 40-50% of health care expenditures are targeted to the elderly and the per capita cost of those over 65 is three to five times higher than in other age groups (Jacobzone; Oxley, 2002). In Brazil, although there is no estimate of total public health care expenditure by age group, in the supplementary/private health sector, the average annual expenditure on health services for beneficiaries of self-management private health plans over 59 years is R$ 5,460.25, according to information of the União Nacional das Instituições de Autogestão em Saúde (UNIDAS, 2011). This value represents 7.5 times the average expenditure for the first age group (0 to 18 years), which is R$ 723.88 (a proportion well above the OECD average).

The increase in life expectancy also causes a change in the profile of diseases that affect the elderly, which has an effect on the type of service used. As aging is a natural process of gradually decreasing the adaptive responses of the elderly body to the environment, with advancing age, chronic diseases become more prevalent in the population (SAAD, 1990). In addition, these diseases often require continuous treatment and may usually be accompanied by dysfunctions and/or some level of dependence (NASRI, 2008). In the United States, for example, almost 35% of people over the age of 65 have some activity limitation, while for people aged 14-44 this percentage is 6% (MARTINO; MOORE, 2006). In addition, 85% of older Americans suffer from at least one chronic illness and in Canada this proportion is 76% of the elderly (CANADIAN INSTITUTE FOR HEALTH INFORMATION, 2011). This evidence shows that aging will have increasing effects on long-term care spending, but little effect on acute or short-term care (SPILLMAN; LUBITZ, 2000). Observing elderly beneficiaries of the Medicare program in the United States, Manton *et al*. (2006) found that, in the period from 1994 to 2004, while spending on the elderly in long-term care institutions increased, the total expenditure on health care for the elderly population decreased, suggesting a shift from acute care to chronic care. The changes in the patterns of health services for the elderly, which have occurred all over the world, are motivated by the need to meet increasing demand while maintaining quality and, at the same time, to consider rising health costs.

Finally, in terms of public security, without recent reforms (1999 and 2003), spending on pensions would have increased from 10% of GDP in 2005 to an impressive

37% of GDP because of the mere increase in the number of retirees and eligible pensioners due to aging. However, the problem of sustainability of social security expenditure has not been resolved, with the projection that spending on social security will double to 22.4% of GDP in 2050 (World Bank, 2011). According to Tafner *et al*. (2015), retirement, pension and old-age care expenses will at least double in real terms over the next 20 years, reflecting the effect of aging populations combined with poorly-enforced benefits rules. It is estimated that this spending will increase from R$ 338 billion in 2015 to R$ 725 billion in 2025 and reach at least R$ 1 trillion in 2050, at today's values, not counting the retirement of public servants. The authors do not consider the formulas 85/95 years for women/men to retire by contribution time[8].

After this review, we verified that the Brazilian demographic transition has been occurring dynamically with a growing and progressive aging of the Brazilian population. First, we examined the profile of the Brazilian elderly population considering the differences in gender, income, geographical characteristics and household structure. Then we found that the great majority of the income of the elderly comes from public social security programs, which are considered directly responsible for the reduction of poverty in this segment in recent years. Finally, there have been some natural consequences and trends of population aging, noting that the government will need to devote efforts to adjust mainly health and social security spending, which will be in high demand due to the country's demographic change. Therefore, this review chapter served to guide the research problems related to the elderly population that will be presented in the next chapters.

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CHAPTER 2 – POVERTY AMONG THE ELDERLY: AN APPLICATION OF A COLLECTIVE CONSUMPTION MODEL IN BRAZIL

Abstract: *We applied the collective consumption model of Browning et al. (2013) to analyze the level of well-being of elderly in Brazil based on last three Brazilian Household Budget Surveys (POF 1995/96, POF 2002/03 and POF 2008/09). Our results indicate substantial economies of scale and a husband's share that is increasing in total expenditures. We further calculated two kinds of poverty rates: the first based on the collective consumption model and the other based on the OECD traditional approach. OECD scale underestimates poverty among elderly women in couples and overestimates poverty among elderly men in couples. In the case of widow and widowers, in most of the periods, OECD scale underestimates poverty rates. Finally, we find that the drop in material well-being following the wife's death is rather substantial for men and the opposite was observed for women.*

Keywords: Elderly in Brazil**,** Collective consumption, intra-household allocation model, poverty.

JEL classification: D11, D12, D13, D63, I31.

Resumo: O modelo de consumo coletivo de Browning *et al.* (2013) foi aplicado para analisar o nível de bem-estar do idoso no Brasil com base nas últimas três Pesquisas de Orçamento Familiar (POF 1995/96, POF 2002/03 e POF 2008/09). Os resultados indicaram economias de escala substanciais com a participação crescente do marido à medida que as despesas totais aumentavam. Calcularam-se ainda dois tipos de taxas de pobreza: a primeira baseada no modelo de consumo coletivo e outra baseada na abordagem tradicional da OCDE. A escala da OCDE subestima a pobreza entre mulheres idosas em casais e superestima a pobreza entre homens idosos em casais. No caso das viúvas e viúvos, na maioria dos períodos, a escala da OCDE subestima as taxas de pobreza. Finalmente, verificou-se que a queda no bem-estar material após a morte da esposa é bastante substancial para os homens e o oposto foi observado para as mulheres.

Palavras-chave: Idosos no Brasil, consumo coletivo, modelo de alocação intra-domiciliar, pobreza.

2.1. INTRODUCTION

The population ageing process all over the world is a well-acknowledged fact. Whereas the demographic transition lasted over a century in developed countries, these changes are occurring much more quickly in LAC – Latin America and Caribbean countries. This is due the controlling of fertility and the reducing of mortality rates. According to Kinsella and He (2009), France had 115 years to duplicate its elderly population from 7 percent to 14 percent; this relatively slow process was common in

other European nations and in North America. Japan, the oldest country today, was unusual case in that this same transition took place in only 26 years, from 1970 to 1996. According to the authors, most of developing countries are aging in the same rate or even faster than Japan. In LAC, Chile is transitioning at the same pace as Japan; Brazil is projected to do it in 21 years; and Colombia in 19 years. In LAC the share of the elderly in the population increased from around 6% in 1950 to more than 8% in 2000, while it is expected to reach 24% at the end of this century. This ageing process implies an estimate of around 200 million people older than 60 in LAC by 2050.

In addition to the increase in the number of elderly people in LAC, the composition of households in this segment of the population has also changed. There is a big increase in the number of elderly people living alone, especially among women. According to Gasparini *et al.* (2007), elderly people tend to live in households of smaller size than younger people. On average in LAC, the elderly live in households with 1.5 persons less than the rest of the population. This gap varies from 1 person in Colombia and Venezuela to around 2 in Guatemala, Argentina and Bolivia. According to data from the IBGE (2014), the proportion of Brazilian elderly people living alone in 2013 was 15.1% for men and 17.8% for women. It should be noted that in 1970 this proportion was approximately 5% for men and 8% for women. This phenomenon in LAC, due to improved health and greater independence of the population, tends to increase in the coming decades.

Both the growth of the elderly and the changes in the household composition raise important questions regarding the level of well-being of elderly in developing countries, like Brazil. There is great concern about their vulnerability, their potential state of poverty and the possible permanence in a low level of economic well-being by the elderly. This is justified because older people are generally less likely to recover from a decrease in income and have difficulties to (re)enter the labor market, since characteristics such as productivity and employability decline with age from a certain moment of life that often occurs around the age of 60. Therefore, the difficulty of recovering from negative income shocks implies that poverty among the elderly tends to be more permanent than in other groups of society (HURD, 1991).

This poverty and vulnerability framework depends directly on the role of the Government in guaranteeing income to the elderly. Cotlear and Tornarolli (2010) state that, despite demographic and household composition similarities, the average poverty

among elderly in LAC is 10 to 20 percent lower than the overall poverty rate on the same countries. This result, however, is the average of three different groups of countries. According to the authors, there is a group where the aging are significantly better off than the rest of the population; these are the countries with the largest and most generous pension systems in LAC—Argentina, Brazil, Chile and Uruguay. At the other hand, there are three countries where poverty among the elderly is significantly higher than among the rest of the population - Colombia, Costa Rica and Mexico. For the rest of the countries, elderly have poverty levels similar to the national average.

However, database used in most studies that tried to understand poverty among elderly people in LAC did not consider the distribution of resources within the household. The understanding of how individual preferences on private and public consumption behave, as well as who holds greater power over intra-household consumption, is crucial in analyzing the implications of welfare policy reforms and understanding issues such as poverty among the elderly. Although common, the use of the unitary consumption model [9] may underestimate poverty in some cases and overestimate in others, depending on issues such as household composition, sharing of goods, and bargaining power within household.

Traditional analyzes of poverty often ignore the question of intra-household distribution of resources, assuming that all household members consume the same amount of goods. While there is an extensive literature on poverty in many household settings, the intra-household implications of poverty have received little attention. Thus, the present study will be related to a growing empirical literature on collective consumption model, intra-household distribution and individual poverty measures. Based on the collective consumption model, it is possible to analyze poverty among the elderly, taking into account the potential difference in the distribution of resources between an elderly couple and an elderly person living alone, an approach ignored in the traditional analysis of poverty among this segment in LAC. Thus, it is essential to reach estimates that show an alternative approach to traditional welfare and poverty analysis among elderly.

This alternative approach is the so-called collective consumption model, whose definition would be that a household is formed by a group of individuals, each of them having a well-defined utility function, and interacting to generate decisions in

[9] The so-called unitary consumption model is the one that considers the household as the unit of decision, not taking into account the allocation within the household (HADDAD, KANBUR, 1990).

household level. In these models, household consumption data is used to retrieve information about family members (BECKER, 1991). We must emphasize that the international literature on intra-household allocation clearly shows that resources are not equally shared within families[10], justifying the use of the collective consumption model.

According to Deaton and Paxson (1998), the transition from the household welfare analysis to the individual welfare analysis requires assumptions about intra-household allocation of resources, including concepts such as sharing of goods and bargaining power among household members, economies of scale and indifference scales, concepts that help clarify the issues raised previously. According to Browning *et al.* (2013), the sharing rule represents a measure of relative resource allocation among household members, and is considered a measure of bargaining power within the household[11]. The concept of economies of scale[12] in consumption is related to the sharing and joint consumption of goods within the household. Finally, the indifference scales allow us to compare the economic well-being of an individual in different household arrangements, without any interpersonal comparisons of utility.

Therefore, the application of a collective consumption model will allow answering a number of important questions related to the poverty analysis such as: on average, how much income an elderly person living alone would need to get the same living standards as when he was married? What is the percentage of the couple's expenses that benefits the elderly men or the elderly women? How much money does an elderly couple save on consumption by living together compared to being in a single arrangement? These issues are fundamental to analyze the economic well-being and poverty among the elderly.

Despite the relevance of the analysis of welfare by collective consumption model, the studies on poverty in Brazil [Rocha (2000), Quintães *et al*. (2006), World Bank (2006), Figueiredo *et al*. (2007) and Rodrigues (2014)], as well as in many LAC, usually establish a level of income, below which people are classified as poor. However,

[10] For more details on the general collective consumption model, see Browning *et al*. (1994), Lundberg et al. (1997) and Vermeulen (2002).

[11] In a household consisting of an elderly couple, if the value of the sharing rule is higher for the elderly women, it means that she receives more than half of the household resources, having greater bargaining power within the household.

[12] According to Deaton and Paxson (1998), the concept of economies of scale applied to the consumption can be exemplified as follows: when two households composed of an individual start to live together while maintaining their respective constant incomes, the average per capita income of new household is the same as the average of the two previous households, but the individuals in the new household composition may consume everything they used to consume and a little more due to the sharing of goods and joint consumption within the household.

according to several authors, income is a rather imperfect measure of living conditions[13]. Therefore, according to Quintães *et al*. (2006),consumption may be a more adequate source for the study of well-being and poverty in household arrangements compared to income. The authors argue that consumer spending reflects not only what a household is capable of doing with its income, but also access to credit markets. In addition, it should be noted that consumption is a better measure of well-being in the long term, since income presents greater variations in the short and medium term.

Although few studies have analyzed poverty among the elderly in Brazil, internationally several recent studies have been carried out to analyze the well-being and poverty among this segment in developed countries (Engelhardt and Gruber (2004), Weir *et al*. (2004), McGarry and Schoeni (2005), Zaidi *et al*., (2006) and Cherchye *et al*. (2012)). Some of these studies use household consumption databases to identify individuals living in poverty situations. Among them, we can highlight the study by Cherchye *et al*. (2012), which followed the model of Browning *et al*. (2013) to analyze well-being and poverty among the elderly in the Netherlands. Results indicated substantial economies of scale, with women's share of spending increasing relative to total expenditures. Two sets of poverty rates were calculated: one based on the collective consumption model and another based on the traditional approach, with a standard equivalence scale. The authors concluded that poverty among widowers is underestimated by the traditional approach. Finally, the authors analyzed the impact of becoming a widower, concluding that the decline in material well-being after the husband's death is quite significant for women.

As previously pointed out, despite the relevance of the application of the collective consumption model and the use of indifference scales for the welfare analysis, there aren't any studies that used this methodology in developing or LAC countries like Brazil, evidencing the importance of the present paper. We will try to follow closely Cherchye *et al*. (2012) analysis to Netherlands data and adapt it to the Brazilian case, giving that the demographic, economic and social characteristics of both countries are very different. Due to its characteristics, the collective consumption model of Browning *et al*. (2013) is able to analyze important themes for the formulation of public policies and income transfer for the elderly in Brazil, such as the calculation of life insurance and death pensions. One possible result of this work, for example, is to

[13] For more details on the problems of using income as a measure of well-being and poverty, see Rodrigues (2014).

show how much a widow(er) should receive to be as well (materially) as she(he) was when married. Thus, this application becomes relevant in the Brazilian context, since the vast majority of the elderly survive from income transfer programs, such as death pensions and retirement, for example. In addition, the above model will provide poverty rates different from those used by traditional analysis, allowing a comparison with those used by the World Bank. Such an approach highlights the importance of the theme for both the public sphere and economic agents. We must emphasize that the present work is the first to analyze poverty among elderly using a collective consumption model in a developing country, and uses a different and more representative basket of consumption than that used in Cherchye *et al*. (2012).

Therefore, the main purpose of this study is to analyze the level of well-being of elderly in a developing country based on last three Brazilian Household Budget Surveys (POF 1995/96, POF 2002/03 and POF 2008/09). Specifically we intend to: a) analyze which percentage of household expenses benefits the elderly women or the elderly men and if there are economies of scale when married; b) verify which variables are important in the sharing rule of goods in the households; c) compare the level of poverty among the elderly through a collective consumption model in relation to the OECD traditional approach; d) check how much income a widow(er) elder would need to get the same living standards as when she/he was married; and e) understand how is the sensitivity of consumption of the elderly in relation to expenditure and prices behaves.

This study is divided into five sections, including this introduction. In the second section, we present the theoretical framework used in this study. In the third section we introduce the methodology and database. In the fourth section we present the results for individuals demand system, couples demand system with consumption technology and sharing rule, the poverty rates and economy of well-being among the elderly in Brazil. The fifth and final section we present the conclusions of the study.

2.2. THEORETICAL FRAMEWORK

The collective consumption model recognizes that each member has his individual preferences and the result of the allocation decision is made by the

individuals who compose the household. Following many authors[14], the unitary consumer model of household will initially be presented. It will be used in the case of single person households. Next, the collective consumption model and analytical concepts of well-being that emerge from this model will be presented.

2.2.1. Unitary consumption model

Following Cherchye *et al.* (2012) and Browning *et al.* (2013), we will use the unitary model of consumption for a household with only one individual k, where $k = m$ if the household consists of an elderly man, while $k = w$ if the individual is an elderly woman. We assume that a total expenditure x^k is spent for a given household over a period of time with n goods. These can be purchased in non-negative quantities (q_i^k) with fixed prices (p_i). The budget constraint can be written as follows:

$$x^k = p_i q_i^k, \tag{2.1}$$

By using the equal sign we assumed that the consumers in the household will always reach the upper limit of its range of possibilities, implying no satiation. In addition, the above equation assumes that the expenditure x^k is determined separately from the decision to purchase.

The unitary consumption model can be constructed by optimizing the utility function, subject to the budget constraint (DEATON; MUELLBAUER, 1980a). Preferences are represented by a two-times differentiable direct utility function, strictly increasing and strictly quasi-concave as $U^k(q_i^k)$. Therefore, the individual k faces the following problem:

$$\max_{q_i^k} U^k(q_i^k) \text{ subject a } p_i q_i^k = x^k, \tag{2.2}$$

where $U^k(q_i^k)$ is the utility function; $p_i q_i^k = x^k$, the budget constraint; p_i, the price of good i, $\forall$ i $= 1,2, \ldots,$ n; q_i^k, the amount consumed of good i; e x^k, the total expenditure.

[14] Cherchye and Vermeulen (2008), Lewbel and Pendakur (2008), Cherchye *et al*. (2009), Bargain and Donni (2012a; 2012b), Cherchye *et al*. (2012), Browning *et al.* (2013), Dunbar *et al*. (2013) and Bargain *et al.* (2014).

The solution of the first order condition will result in the Marshallian or non-compensated demands for each good:

$$q_i^k = g_i^k(p_i/x^k), \tag{2.3}$$

2.2.2. Collective consumption model

Unlike the traditional unitary consumption model that describes the behavior of households, the collective consumption model explicitly recognizes that a household is composed of several members do not necessarily behave as a single decision maker. In other words, the collective consumption model recognizes that each member has his individual preferences and the result of the allocation decision within the household is Pareto efficient. Thus, considering a household consisting of two elderly (m e w)[15] where both individuals do not participate in the labor market, it is possible to write Pareto efficiency decisions of the couple as a constrained maximization of a weighted sum (CHERCHYE *et al*., 2012) :

$$\widetilde{U} = \mu(p'/x, s)U^w(q_i^w) + U^m(q_i^m), \tag{2.4}$$

where $\mu(p'/x, s)$ is the Pareto efficient weight; and $U^w(q_i^w)$ and $U^h(q_i^m)$ are the elderly individual utility functions, twice continuously differentiable, strictly increasing and strictly quasi-concave. This equation can be interpreted as the welfare function of the household, although the relative effect of individual utility function of household members may vary according to price and distribution factors (s). Alternatively, equation (2.4) may result from a bargaining model (Nash's model of bargaining, for example), in which distribution factors affect individual decisions. Efficient Pareto weight μ is defined as the spouse bargaining power and can generally depend on the prices, total expenditure and distribution factors vector s, defined as variables without direct impact on preferences, consumer technology or budget constraint, but that can influence the decision-making process by affecting the bargaining power in the

[15] For simplicity, we will use the words "married" and "spouse", but individuals who make up the household does not necessarily need to be married. In addition, we will not consider households composed by other people beside the elderly due to the need to identify the individual demands in the collective consumption model.

household. The model assumes that households do not suffer from money illusion. Possible examples of distribution factors include individual salary (BROWNING et al., 1994), or income outside work (THOMAS, 1990), or individual benefits provided by relatives such as inheritance (RUBALCAVA; TOMAS, 2000). Therefore, if $\mu(p'/x, s)$ increases due to a distribution factor s, then the wife's bargaining position improves following this increase in s. This implies that the wife is able to request greater share of utility than before by an intra-household allocation that is more favorable to her.

According to Browning *et al*. (2013), the economies of scale of living as a couple should be considered in a collective consumption model. Consequently, the aggregate consumption of the elderly couple $q = q^w + q^m$ will not necessarily be equal to the basket of goods purchased by the household z. In this context, according to Vermeulen (2002), some goods are purely private and other purely public, with the added generality that some goods may be public and private. Following Cherchye *et al.* (2012), examples of goods that may have a public nature are rent or heating: consumption of it by one of the spouses does not reduce the supply available for the other spouse, while no individual can be excluded from consuming it. On the other hand, goods like beverages are purely private: every bottle of coke drunk by one of the members cannot be drunk by the other one. However, in reality, the distinction is not necessarily that easy. For example, a car driven alone or in couple could be modeled as two separate goods, purely private ($q = q_j^w + q_j^m$) or purely public ($q = x_j/2$ with an additional restriction that $x_j^w = x_j^m$). As the examples show, many goods will have both a private and a public component[16].

Following Browning *et al*. (2013), we assume that a couple is characterized by a consumption technology that transforms the household's purchased quantity vector z into two individual vectors of private good equivalents q_i^w and q_i^m. Often the linear consumption technology used is mathematically identical to Gorman's linear techniques[17] (1976), except that we apply in the context of a collective consumption model. For simplicity, the consumer technology will be restricted to a simple Barten-type:

[16] See Browning and Chiappori (1998) and Cherchye *et al*. (2007) for collective consumption models that explicitly account for different uses (private, public or both) of the purchased consumption bundle.

[17] The Gorman's linear technology demand model of consumption (1976) can be specified as follows: $F(z) = Ah^B\left(\frac{A'p}{x-a'p}\right) + a$. Barten (1964) is the Gorman's model (1976) with $a = 0$ and A as a diagonal matrix.

$$z = Aq, \tag{2.5}$$

where the technology matrix A is a diagonal *n* by *n* matrix, with entries that are between 0.5 and 1. Diagonal elements associated with purely private goods are equal to 1, while entries associated with purely public goods are equal to 0.5. Remark, however, that purely public goods also imply that $q_j^w = q_j^m$, which is not imposed here. Goods that have both a public and a private component are associated with an entry that is between 0.5 and 1. As discussed by Browning *et al*. (2013), the above consumption technology is similar to Becker's (1965) household production model. The crucial difference is that the goods purchased at the market serve as inputs to produce a greater quantity of the same goods via sharing, and thus are not inputs to produce household goods as in a Beckerian model.

Taking into account that the couple faces a budget constraint $x = p'z$, the elderly couple's consumption behavior is different from the elderly behavior in a one-person household (the unitary consumption model is distinct from the collective consumption model). Given all this, the couple's optimization program can be formulated. This program boils down to the assumption that the spouses maximize the weighted sum of utilities subject to the consumption technology and the household's budget constraint:

$$\max_{q_i^w, q_i^h, z} \mu(p'/x, s)U^w(q_i^w) + U^m(q_i^m) \text{ subject to, } z = Aq, p'z = x, \tag{2.6}$$

The optimization program results in a set of n household demand functions and two sets of n private good equivalent demand functions:

$$z = g_i^k(p, x), \tag{2.7}$$

$$q_i^w = h_i^w(p, x), \tag{2.8}$$

$$q_i^m = h_i^m(p, x), \tag{2.9}$$

Browning *et al*. (2013) also derived a dual representation of the household's optimization program. This dual representation summarizes into a two-stage budgeting process: in a first stage, household members divide the household's aggregate resources

among each other. In the second stage, each individual maximizes her/his own utility function subject to the resulting shares and taking account the personalized prices. Following Cherchye *et al.* (2012), in a collective model with only private consumption, these personalized prices are equal to observed market prices. In a context with public consumption, personalized prices are a vector of Lindahl prices; at these prices and the individual's fraction of the household's aggregate resources, each individual is willing to consume her/his vector of private good equivalents. Hence, the Lindahl type vector of personalized prices are:

$$\pi(p/x) = \frac{A\prime p}{x}, \tag{2.10}$$

Given these personalized prices and a sharing rule $\eta(p/x, s)$, constrained between 0 and 1, we have:

$$q_i^w = h_i^w(p, x) = g_i^w(\frac{\pi(p/x)}{\eta(p/x,s)}), \tag{2.11}$$

$$q_i^m = h_i^m(p, x) = g_i^m(\frac{\pi(p/x)}{1-\eta(p/x,s)}), \tag{2.12}$$

$$z = g_i^k(p, x) = Ag_i^w(\frac{\pi(p/x)}{\eta(p/x,s)}) + Ag_i^m(\frac{\pi(p/x)}{1-\eta(p/x,s)}), \tag{2.13}$$

The Lindahl type vector of personalized prices are normalized such that the household's aggregate resources are equal to $\pi'(q^w + q^m) = 1$, whereas the shares η e (1 – η) of the household's resources that are allocated to the wife and husband are respectively equal to $\pi' q^w$ and $\pi' q^m$. Similar to the Pareto weight μ, the sharing rule η is a measure of the wife's weight in the household's decision making process. *Ceteris paribus*, the higher the share η, the higher the utility that will be attained by the wife by means of a higher private consumption q^w[18].

[18] After these definitions, we present at the Appendix how to identify the individual demand functions, the sharing rule, the consumer technology and the shadow prices, given the observed household demand function.

2.2.2.1. Analytical concepts of well-being

Once the above collective consumption model is identified, three useful welfare-analytical concepts can be derived. They are potential analytical tools of the collective consumption model, in addition to the traditional tools of demand models, such as price and income elasticities.

2.2.2.1.1. Bargaining power among the elderly

One of this paper's objectives is the analysis of the resource alocation among the elderly and the possible bargaining power within the household. The tool offered by the collective consumption model to make this analysis is the sharing rule $\eta(p/x, s)$, a direct measurement of the intra-household bargaining power. If all goods are considered private, without economies of scale or scope in consumption (if $q^w + q^m = z$), then η would be exactly equal to that part of x that was used to buy the basket consumed by the husband q^h. Browning and Chiappori (1998), using only household data, showed that this measure of bargaining power can only be identified in very specific situations. In contrast, according to Browning *et al.* (2013), as described above, by combining the household demand function and individual demand function of the elderly, η sharing rule is completely identified.

The Pareto weight μ is a less tangible measure of bargaining power compared to sharing rule η, because μ depends on a cardinalization of an unobservable individual utility function of household members, while η is recoverable by the observed demand function. However, if the cardinalization is known, then $\mu(p/x)$ can be calculated and used in the model.

2.2.2.1.2. Economy of scale in consumption

Another important analytical concept of well-being that emerges after the identification of the collective consumption model is measure of the economies of scale in consumption within the household. Following Browning et al. (2013), a global measure of economies of scale from living together within the household can be defined as:

$$e = \frac{p\prime(q_i^w + q_i^m)}{x} - 1 = \frac{p\prime\left(g_i^w(\frac{\pi(p/x)}{\eta(p/x,s)}) + g_i^m(\frac{\pi(p/x)}{1-\eta(p/x,s)})\right)}{x} - 1\ , \qquad (2.14)$$

where given the estimated vector of private good equivalents of the model $q_i = q_i^w + q_i^m$, x is what the household spends to acquire z and $p'(q_i^w + q_i^m)$ is the cost of purchasing the private good equivalents z. In other words, the above equation compares the expenditure required to finance the aggregate private consumption if both individuals lived alone rather than forming a couple, given the expenditure required for the consumption bundle z. It is clear that the more sharing inside the household, the higher economies of scale will also be.

Following Cherchye *et al* (2012), two extreme cases can be distinguished. Firstly, if all consumption would be purely private, then aggregate private consumption q would be equal to the observed couple's consumption bundle z (see the consumption technology function in (2.5)). In that case, the measure for the economies of scale *e* would be equal to zero and would reach its minimum. Secondly, if all consumption would be purely public, then aggregate private consumption would be equal to two times the couple's consumption bundle z. In this case, the measure for the economies of scale *e* would be equal to 1 and would reach its maximum.

It is also possible calculate the economies of scale of consumption corresponding to each good separately. This value can be interpreted as a measure of "publicness" or "privacyness" of each item. For a purely private good, the economy of scale measure is equal to zero, whereas for a purely public good this measure is equal to one.

2.2.2.1.3. Indifference scales

It should be stressed that the measure for the economies of scale assumes that there is no shift in the individual consumption pattern when both spouses would live alone rather than in a couple. As soon as individuals live alone, they are confronted with market prices instead of the individual shadow prices. As soon as both sets of prices do not coincide (as expected), the optimal consumption pattern can be different. Following the application of the collective consumption model of Cherchye *et al* (2012), the indifference scale for the wife and husband in a household composed only by an elderly couple are respectively defined by:

$$S^w = \frac{\min_{q^{w*}}\left(p'q^{w*} | U^w(q^{w*}) = U^w(q^w)\right)}{x}, \tag{2.15}$$

$$S^m = \frac{\min_{q^{m*}}\left(p'q^{m*} | U^h(q^{m*}) = U^h(q^m)\right)}{x}, \tag{2.16}$$

The numerators of the equations above represents the minimum expenditure required for an elderly living alone to achieve the same indifference curve as living as a couple, and get the same vector of private good equivalents q^w e q^m, respectively. The denominator is equal to the couple's total expenditure x which is used to finance household consumption z. Thus, the definition of $S^i(p/x, \eta)$ depends only on the representation of the ordinal value, the household resources and the degree of which the consumption is shared within the household. So the indifference of scale can be identified without any cardinalization of utility function or assumptions related to interpersonal comparability.

Therefore, the indifference scales $S^i(p/x, \eta)$ can be used to measure poverty among the elderly, and for the calculation of life insurance or pension for death. For example, in the case life insurance or pension for death, the wife require a $S^i(p/x, \eta(p/x))x$ income to achieve the same standard of living without her husband, and then she will be in the same situation (materially speaking) in the household with this husband and an income x. This calculation would consider part of household resources $\eta(p/x)$ that she consumed and would be just enough to offset the loss of economies of scale by sharing resources, but not to compensate the husband consumption, or the mourning, the company's loss, or other components of the utility function assumed to be separable from the consumer goods. The calculation also not compensate for any change in preference for goods that could occur as the result of her husband's death

According to Browning *et al.* (2013), this discussion illustrates an important quality of the model: the ability to separately evaluate the preferences of the individuals inside the household, the intra-household allocation and resources control. It also shows the ability to include in the analysis of economies of scale due to sharing and consumption together, beyond indifference scales, fundamental concepts for the welfare analysis of the elderly.

2.3. EMPIRICAL APPLICATION

2.3.1. Empirical specification

The demand of the single-person elderly households will be estimated by the traditional unitary consumption model. At the same time, assuming equality of preferences, we will estimate individual preferences of the couple via collective consumption model, where the other components of the structural model (specifically the sharing rule and the Barten scale) are identified. Finally, we present the information about the database and the construction of the price index.

2.3.1.1. Individual's demand system

Deaton and Muellbauer (1980b) pioneered the estimation of flexible functional forms through a demand system called the *Almost Ideal Demand System* (AIDS), derived from any expenditure function that would represent consumer preferences. The AIDS model brings together almost all the properties theoretically and empirically desirable: it is an arbitrary first order approximation for any demand system; satisfies the axioms of choice; perfectly integrates consumers while still allowing non-linear Engel curves; and the properties of homogeneity and symmetry can be tested and imposed by simple constraints on the parameters. Therefore, the individual indirect utility function is assumed to be of the following form ($k = w, m$):

$$V^k = \left\{ \left[\frac{\ln x^k - \ln a^k(p)}{b^k(p)} \right]^{-1} \right\}^{-1}, \tag{3.1}$$

where:

$$\ln a^k(p) = \alpha_0^k + \sum_{i=1}^{n} \alpha_i^k \ln p_i + \frac{1}{2} \sum_{i=1}^{n} \sum_{j=1}^{n} \tau_{ij}^k \ln p_i \ln p_j, \tag{3.2}$$

$$b^k(p) = \prod_{i=1}^{n} p_i^{\beta_i^k}, \tag{3.3}$$

Applying Roy's identity to equation (3.1), we obtain the AIDS budget share equations for commodity i ($i = 1, \dots, n$) and individual ($k = w, m$):

$$w_i^k = \sum_j \theta_{ij}^k D_{ij} + \alpha_i^k + \sum_j \tau_{ij}^k \, lnp_j + \beta_i^k \ln\left(\frac{x^k}{a^k(p)}\right), \tag{3.4}$$

where w_i^k is the budget share of the elderly k with the good i[19]; x^k is the total expenditure of the elderly k with all goods; p_j is the price of good j; D_{ij} is a vector of demographic characteristics[20]; and α_i^k, τ_{ij}^k, β_i^k and θ_{ij}^k are the parameters to be estimated.

As seen in the previous section, the microeconomic theory and in particular the hypothesis of consumer utility maximization imposes some restrictions on the coefficients. One of the reasons that Deaton and Muellbauer call this system of AIDS is that the theoretical constraints of demand (Adding-up, Homogeneity, and Symmetry) depend only on unknown parameters and therefore are easy to impose or test. The constraints derived from the theoretical properties of demand are as follows: Adding-up requires that $\sum_i \alpha_i^k = 1$, $\sum_i \tau_{ij}^k = 0$ and $\sum_i \beta_i^k = 0$; Homogeneity is satisfied if $\sum_j \tau_{ij}^k = 0$; and Symmetry requires that $\tau_{ij}^k = \tau_{ji}^k$ ($\forall\, ij$) (DEATON; MUELLBAUER, 1980b).

In order to obtain the expenditure elasticities, price elasticities and cross-price elasticities, first differentiate equation (3.4) with respect to the logarithm of expenditure and prices, respectively, generating the following terms (DEATON; MUELLBAUER, 1980b):

$$\mu_i^k \equiv \frac{\partial w_i^k}{\partial \ln x^k} = \beta_i^k, \tag{3.5}$$

[19] We decided to select the goods according to the large groups of consumer expenses used by POF, such as: food, housing, clothing, transportation, health care and other expenses. For more details, see pages 28 and 29 in IBGE (2010).

[20] According to Su and Yen (2000), it is possible to measure the impact of the demographic variables present in vector D_k by varying the quantity demanded when the dummy variable in question oscillates from zero to one. Thus, this impact can be considered as the intensive effect, or the direct impact of the quantity acquired. This impact can be calculated as follows (LAZARIDIS, 2004): $e_{i,z} = \frac{\theta_{ij}^k D_{ij}}{\overline{w_i^k}}$, where $e_{i,z}$ is the marginal effect of the i-th good in relation to the demographic variable; θ_{ik} are the estimated parameters demographic variables; D_{ij} is the vector of demographic variables; and $\overline{w_i}$ is the expenditure share at the midpoint.

$$\mu_{ij}^{k} \equiv \frac{\partial w_i^k}{\partial lnp_j} = \tau_{ij}^{k} - \beta_i^k \left[w_j^k - \beta_j^k \ln\left(\frac{x^k}{a^k(p)}\right) \right], \quad (3.6)$$

The expenditure elasticities (e_i) and Marshallian price elasticities (e_{ij}^u) can be written as:

$$e_i = \frac{\mu_i}{w_i} + 1, \quad (3.7)$$

$$e_{ij}^u = \frac{\mu_{ij}}{w_i} - \delta_{ij}, \quad (3.8)$$

where δ_{ij} is called Delta Kronecker, whose assumed values are:

$$\delta_{ij} = \begin{cases} 1 \; se \; i = j \\ 0 \; \; se \; i \neq j \end{cases} \quad (3.9)$$

The compensated price elasticities (Hickisian) (e_{ij}^c) can be calculated by the Slutsky equation $\left(e_{ij}^c = e_{ij}^u + e_i w_j\right)$, and are used to classify the goods as substitutes or complements.

The parameters of the AIDS demand systems were estimated by the programming routine for STATA described in Poi (2008). Due to limited degrees of freedom and thus to improve the efficiency of our estimates the demand restrictions are imposed. The adding up constraint was imposed by treating one of the goods as "residual" and the demand systems were estimated for $n-1$ goods, and the homogeneity and symmetry constraints were imposed on the demand systems by parameter restrictions (YEN *et al.*, 2003). The residual good chosen was "Other expenses", because despite its representativeness (around 10% of the household basket), it is the good of lesser interest in the estimation. Using the adding up restriction, it is possible to retrieve the parameters and calculate the elasticities for that good. The demand equations were estimated by a seemingly unrelated nonlinear regression system (SUR), according to STATA's NLSUR command. The method used was IFGNLS (Iterated feasible generalized non-linear least squares), with results similar to the Maximum Likelihood estimates. Thus, in order to make statistical inference about the

values of the elasticities, the so-called "delta method"[21] is applied, which allows to transform the variance-covariance matrix of the estimated parameters into the variance-covariance matrix of the parameters of interest (DURHAM; EALES, 2010).

Finally, as in Cherchye *et al.* (2012), we will assume that preferences of widows and widowers are equal to the preferences of respectively female and male elderly individuals. Therefore, the parameters α_i^k, τ_{ij}^k, β_i^k and θ_{ij}^k will be the same across both types of female and male individuals, but real expenditures and prices appearing in the demand equations will differ between widow(er)s and individuals in couples, as we will illustrate next.

2.3.1.2. Consumption technology

Now we will turn attention to the structural model components that are only associated with elderly couples. As we said earlier, we will assume a Barten type linear consumption technology function. Consequently, given a basket of consumer goods z observed by the couples and the set of private goods equivalents for the two elderly (q^w e q^m), the consumer technology function is given by:

$$z = A_i(q^w + q^m), \tag{3.10}$$

where A_i is the corresponding diagonal of matrix A (see equation (2.5)). In the empirical application, A_i will be restricted between 0.5 and 1 (which are respectively purely public and purely private consumption cases), assuming the following functional specification for A_i ($i = 1, \ldots, n$):

$$A_i = \frac{1+\frac{\exp(a_i)}{1+\exp(a_i)}}{2}, \tag{3.11}$$

where a_i is the parameter to be estimated simultaneously in the demand system.

Therefore, the demand system for couples will have the shadow prices according to this equation:

[21] See Deaton (1997) for a detailed description of the Delta method.

$$\pi_i = \frac{A_i p_i}{x}, \quad (3.12)$$

in which the elderly couple faces the price p_i and a total expenditure x.

2.3.1.3. Sharing rule

As we discussed earlier, the sharing rule (η) is a measure of the wife's weight in the household's decision making process, or a direct measurement of intra-household bargaining power. *Ceteris paribus*, the higher the share η, the higher the utility that will be attained by the wife by means of a higher private consumption q^w. In our empirical application, the sharing rule among elderly will depend on the following distribution factors: the real expenditure of couple (s_1); a dummy variable that indicates whether the female has a strictly higher income than the male (s_2); the education level of the female (s_3); and a dummy variable that indicates if both individuals' contribute to the household income (s_4).

By the definition, we can see that the sharing rule is restricted between 0 and 1. Therefore, we use the following functional specification:

$$\eta = \frac{exp(\delta_0+\delta_1 s_1+\delta_2 s_2+\delta_3 s_3+\delta_4 s_4)}{1+exp(\delta_0+\delta_1 s_1+\delta_2 s_2+\delta_3 s_3+\delta_4 s_4)}, \quad (3.13)$$

where s_i $(i = 1, 2\ 3, 4)$ are the respectively household specific distribution factors and δ_i $(i = 0, 1, 2\ 3, 4)$ are the parameters to be estimated.

2.3.1.4. Couple's demand system

By the definition of the Barten type linear consumption technology function (3.11), the shadow prices (3.12) and the sharing rule (3.13), we can define the equation of the elderly couples' demand system in the collective consumption model. Thus, for the individual preferences represented by the AIDS model, the portion of the budget of the equation (2.26) applied to a household k with two elderly people is as follows:

$$w_i^k = \eta \left\{ \sum_j \theta_{ij}^w D_{ij} + \alpha_i^w + \sum_j \tau_{ij}^w \, ln \, \pi_j + \beta_i^w \ln \left(\frac{\eta}{a^m(\pi)} \right) \right\} + (1 - \eta) \left\{ \sum_j \theta_{ij}^m D_{ij} + \alpha_i^m + \sum_j \tau_{ij}^m \, ln \, \pi_j + \beta_i^m \ln \left(\frac{\eta}{a^h(\pi)} \right) \right\}, \quad (3.14)$$

This equation shows that the budget shares of the couple are equal to a weighted average of the budget shares of its members, with weights given by the income sharing rule η and $1 - \eta$. Therefore, the parameter η represents both the fraction of resources controlled by the wife and the extent to which the household's demand resemble her demand, evaluated at shadow prices.

We emphasize that the parameters of the collective consumption model consist of all parameters of the AIDS model of both the single's budget shares, w_i^w and w_i^m; the Barten scale, A_i; and the parameters of the sharing rule, η. We will use a two-stage procedure to estimate the complete system, where the individual preference parameters are first estimated and then used in equation (3.14) to estimate the parameters of the Barten scale and the sharing rule. This strategy has the virtue of simplicity of estimation depending on the household arrangement (for example, in a household consisting of a couple, it is enough to estimate two traditional AIDS systems and then a joint system). Therefore, both stages were estimated by SUR, according to STATA's NLSUR command. The method used was IFGNLS.

2.3.2. Brazilian Household Budget Survey – POF

We used the microdata of the Brazilian Household Budget Survey - Pesquisa de Orçamentos Familiares (POF) conducted by the Brazilian Institute of Geography and Statistics - Instituto Brasileiro de Geografia e Estatística (IBGE) in 1995/96, 2002/03 and 2008/09, which collected households' expenditure on consumption goods/services from 11 metropolitan areas, in the case of POF 1995/96, and all Brazilian territory, in the case of the last two researches, POF 2002/03 and POF 2008/09. The POFs are a cross sectional national surveys which gathers information on household expenditures, incomes and sociodemographic information (IBGE, 1997, 2004 and 2010).

Since the sample of POF 1995/96 was restricted to Brazilian main cities, we restricted our sample accordingly, gathering data from 11 metropolitan areas: 1. Rio de Janeiro; 2. Porto Alegre; 3. Belo Horizonte; 4. Recife; 5. São Paulo; 6. Municipality of

Brasília-DF; 7. Belém; 8. Fortaleza; 9. Salvador; 10. Curitiba; and 11. Municipality of Goiânia[22]. For simplicity, we will call all of them metropolitan areas. We also select our sample with only single elderly men and women who are aged 60+ and for couples with no one else in the household and where each individual is aged 60+. This results in a sample that consists of 772 widows, 292 widowers and 680 couples.

Family level monthly expenditures on various detailed commodity groups are available in the POFs surveys. We aggregate them into six broad categories: 1. Food; 2. Housing; 3. Clothing; 4. Transportation; 5. Health care; and 6. Other expenses. Because POF surveys present very disaggregated data with several subdivisions per product, it was necessary to aggregate the various subtypes in order to obtain the desired six categories. Thus, the products considered in the aggregated demand system are presented in Table A1 in the Appendix.

The system estimation comprises 5 share equations (3.14). The residual good chosen was "Other expenses". We included 5 demographic variables inside the vector D_k described on Table 1. All demographic variables are allowed to affect both the preferences of each single's budget shares. Following Asano and Fiúza (2001), price indexes were constructed for the six categories as described on the next section. The price indexes allow for comparisons both across-time and across-region.

According to equations (3.4) and (3.14), since the demand systems will be composed of 5 goods and 5 demographic variables, the AIDS model of individual demand for the elderly will have a total of 50 parameters ($\theta_{ij}^{m} = 5\ x\ 5 = 25$; $\alpha_i^m = 6$; $\tau_{ij}^{m} = 6\ x\ 6 = 36$; e $\beta_i^m = 6$). We derive 23 parameters from each individual demand system due to the symmetry, homogeneity and adding-up demand restrictions. In addition to the 100 parameters, there are 12 parameters referring to the Barten scale ($a_i = 6\ e\ A_i = 6$), 5 parameters regarding the distribution factors of the sharing rule

[22] According to POF 2008/09 data, there were 12,905,981 households headed by elderly people in Brazil, where 10,744,628 belonged to urban areas (83.3% of all households), 4,539,422 to metropolitan areas (35.2% of all households and 42.3% of urban households) and 4,033,494 to the eleven metropolitan regions analyzed (31.3% of all households, 37.6% of urban households and 88.9% of metropolitan households). In addition, there were 41,620,280 adult-headed households in Brazil, where 35,236,113 belonged to urban areas (84.6% of all households), 15,547,667 to metropolitan regions (37.4% of all households and 44.1% of urban households) and 13,364,201 to the respective metropolitan areas (32.1% of all households, 37.9% of urban households and 86% of metropolitan households). These information shows that the eleven metropolitan areas covered in the study are relevant in relation to the total households, to those located in urban areas and to those located in the metropolitan regions as a whole in Brazil.

($\delta_i = 5$) and 1 parameter referring to the sharing rule itself ($\eta = 1$), resulting in a total of 118 parameters of the AIDS model to analyze the well-being of the elderly.

Variable	Description
Household head characteristics	
Age	Age of the household head
Education	Education of the household head
Government transfers[1]	Dummy if the household head receives government transfers
Time characteristics[2]	
POF 1995/96	Dummy if household belongs to POF 1996/96
POF 2002/03	Dummy if household belongs to POF 2002/03

Note: 1- Includes all possible government transfers including: retirement and pensions; federal social programs; and other transfers, such as scholarships and grants. 2 - The default variables for the time characteristics were POF 2008/09.
Table 1 - Variables present in vector D_k.

2.3.3. Price Index System[23]

Until the paper of Asano and Fiúza (2001), the only source of a cost-of-living[24] difference estimates across regions in Brazil was a Staple Food Basket collected by Dieese, a research institute supported by labor unions, in 16 state capitals. The need of a more comprehensive and up to date household basket of goods and services for estimating a system of consumption demand equations led those authors to construct a new set of Regional Price Difference Indexes (RPDI) based on a combination of the existing price variations at subitem level, released monthly by IBGE, with special tabulations of nominal prices provided by the same source.

Following Asano and Fiúza (2001), price indexes were constructed for the six categories. The price indexes allow comparisons both across-time and across-region. The authors named this Price index as Regional Price Difference Indexes (RPDI) based on a combination of the existing price variations at subitem level, released monthly by IBGE – the IPCA – *Índice Nacional de Preços ao Consumidor Amplo*[25], with special tabulations of nominal prices provided by the same source.

[23] For more details about the Price Index System, see Asano and Fiúza (2001).
[24] The ratio of the minimum expenditures required to attain a particular indifference curve under two price regimes (POLLAK; WALES, 1979).
[25] Broadened Consumer Price Index in Brazil.

In order to calculate RPDI Index we used a set of nominal prices released by IBGE. Neither of the prices are contemporaneous: food prices had been released earlier by IBGE, for September 1996. The delivered non-food nominal prices referred to September 1999[26]. We calculated RPDI for three instants in time: September 1996, January 2003 and January 2009, respectively the reference dates of POF 1995/96, POF 2002/03 and POF 2008/09. The equation that expresses RPDI is:

$$P_{rt} = \sum_j w_{j00} \frac{P_{jrt}}{P_{j00}}, \tag{3.15}$$

where:

P_{rt} is the Index for metropolitan area r at time t;

P_{jrt} is price of good j in metropolitan area r at time t;

P_{j00} is average price of good j in all metropolitan areas where weight greater than zero is observed in the reference date; and

w_{j00} is the subitem j average national weight at reference period that is, the average share of the subitem expenditure in total (or group or subgroup or item) household expenditure over all metropolitan areas.

We divided the process to calculate RPDI into six steps:

1. Organize the prices of each subitem of the aggregate by metropolitan region. Therefore, the prices for each subitem were organized into the six aggregates of goods: food, housing, clothing, transportation, health care and other expenses, according to the POF classification;
2. Tabulate all the IPCA variations for each metropolitan area from September 1996 until January 2009;
3. Use the IPCA variation to calculate the real prices of all subitems for the periods of September 1996, January 2003 and January 2009 on each metropolitan areas;
4. Tabulate the average share of the subitem expenditure in total household expenditure for all metropolitan areas. We decided to use January 2009 as the reference weight period for P_{j00} in the three instants time;

[26] We would like to thank Professor Alexandre Nunes de Almeida from the Economy, Administration and Sociology Department of *Escola Superior de Agricultura Luiz de Queiroz – Esalq/USP* for providing IBGE nominal prices.

5. Identify the products that we had prices, but not weights at the reference periods, and the products that we had weights, but not prices. We did this process for the three periods. An interesting fact was that despite prices being from September 1996 and 1999, goods that presented prices and weights in the reference periods represented on average about 80% of the basket of goods used to calculate the IPCA at the three periods; and finally,
6. Redistribute the remaining subitems weights (20% on average) within each item that matched for prices and weights.

At this point, we already had the real price of all goods in metropolitan areas for all three periods (P_{rt}); the average price of all goods in all metropolitan areas where weight greater than zero is observed in January 2009 (P_{j00}); and the subitem j average national weight for all periods (w_{j00}). Than we calculate the RPDI for the six goods in the eleven metropolitan areas for the three periods of time as shown in Table A2, A3 and A4 in the Appendix.

Asano and Fiúza (2001) pointed some limitations of Brazilian data for calculating RPDI. Brazilian National Consumer Price Index System (SNIPC)[27] products vary from region to region, such that very few subitems are completely comparable across all metropolitan areas. Another limitation for constructing the RPDI is that we would need a minimum set of standardized products present in all metropolitan areas with their weights provided by a regular (yearly if possible) household expenditure survey. To circumvent this heterogeneity, we use different products across areas within each aggregate. A problem is that, since subitem price variations are computed over all products of the subitem, using them to chain RPDI is likely to bias regional comparisons along time. To deal with this problem we use the price variation by individual products provided by IPCA along time. Finally, expenditures on domestic servants or vehicle, for example, which amount to a high share in the personal service and transportation subgroup, are treated by IBGE as if no regional difference existed, because it uses the official minimum wage as parameter, which is unique in the whole country. Those are the limitations from the Brazilian database when using the RPDI.

[27] The National Consumer Price Index System (SNIPC) was created in 1979 and the first national index was released in 1980, based on nine metropolitan areas and the Federal capital, Brasília (in 1989 another city, Goiânia, was added to the sample). It comprises two main sets of indices: the National Consumer Price Index (INPC) and the Broadened Consumer Price Index (IPCA) (ASANO; FIUZA, 2001).

2.4. EMPIRICAL RESULTS

2.4.1. Descriptive statistics

First, we discuss the main descriptive statistics from our database. Table 2 provides summary statistics from our sample by household type. We can see that the average age is practically the same in the different households, around 70 years, and the average age of elderly couple households is the highest, 71.1 years. The average education level is higher for elderly couple household type, 6.10 years, in view of 4.87 and 5.88 years in widower and widow household type, respectively. The level of education is still relatively low for these household types, since an individual with 6 years of schooling did not complete Elementary School[28].

Another important statistic is related to Government transfers. Most of the elderly household types receive some kind of government benefit. We can highlight the elderly women households and elderly couple households that almost 84% and 85% of them respectively receive some kind of government transfer. This information can be justified by the increase in the Federal Social Programs at the beginning of the 21st century in Brazil, mainly the benefit called *Benefício de Prestação Continuada (BPC)*, a government social assistance benefit that aims to provide a minimum wage for all elderly of 65 years or older and disabled people who are not entitled to social security, cannot work or lead an independent life and receive up to ¼ of the minimum wage as per capita family income (BRASIL, 2006).

In relation to the monthly income, we can see that households composed only by elderly men have on average higher income than households composed only by elderly women, $1,031.91 and $643.15 respectively, that is, there is still an income inequality between genders in Brazil. This inequality in the distribution of income has a direct influence on the consumption of goods and services, since elderly with higher income have greater purchasing power, which may influence their life quality. As expected, income in couple's elderly households was higher than individual's elderly households.

[28] Elementary education is the name given to one of the stages of basic education in Brazil. It lasts for nine years, and enrollment is compulsory for all people between the ages of 6 and 14.

Table 2 - Summary statistics of the sample, by household type in Brazil

Household type	Elderly women	Elderly men	Elderly couple
Budget shares			
Food	0.241	0.280	0.246
Housing	0.433	0.409	0.382
Clothing	0.038	0.031	0.029
Transportation	0.046	0.089	0.099
Health care	0.176	0.106	0.163
Other expensives	0.066	0.085	0.081
Expenditure (montly in BRL)			
Food	155.00	237.28	290.71
Housing	485.39	545.88	749.17
Clothing	32.64	32.53	60.08
Transportation	75.85	208.97	354.92
Health care	173.41	154.31	273.77
Other expensives	76.76	135.57	150.48
Total	999.05	1314.54	1879.13
Household charactersitcs			
Age	71.05	70.00	71.17
Education (years of education)	4.87	5.88	6.10
Governement transfer	0.841	0.767	0.854
POF 95/96	0.434	0.373	0.193
POF 02/03	0.201	0.199	0.601
POF 08/09	0.365	0.428	0.207
Income (montly in BRL)	1,483.52	2,380.26	2,814.27
Income (montly in USD)	643.15	1,031.91	1,220.07
Sample size	292	772	680

Source: Research results.

Data reveals that the expenditure on Housing is the main item on the elderly household representing about 43.3% and 38.2% of the budget shares in elderly women and elderly couple household types, respectively. All the budget shares are similar in the elderly household types, with the exception of Transportation - where the share is lower in elderly women households (4.6%) compared to elderly men (8.9%) and elderly couples households (9.9%) - and Health care - in which the share is lower in elderly men households (10.6%) compared to elderly women (17.6%) and elderly couples households (16.3%). In general, elderly household types in Brazil seems to prefer consuming Habitation, Food and Health care, compared to Transportation, Clothing and Other expenses. There are some studies that confirmed that elderly households spend more of their income on housing, food, and healthcare—the three most important items

in their total consumption — and less on clothing and transportation (Chen and Chu (1982); Chung and Magrabi (1990); Lee e*t al.* (1997); and Lee, Sohn and Rhee (2014)).

2.4.2. Individual's demand results

It is rather hard to evaluate results based upon the original parameters in the estimation of demand systems. So we display the estimates of the parameters from the individuals demand systems in Tables A5 and A6 at the Appendix. Here, we will only examine results based upon the estimates of the price and expenditure elasticities, important parameters in projecting demand. Expenditure elasticity and own- price elasticity by individual household type are presented on Tables 3 and 4.

Table 3 – Individual expenditure elasticities by household type in Brazil

Goods	Elderly women households			Elderly men households		
	Expenditure elasticity	95% Conf. Interval		Expenditure elasticity	95% Conf. Interval	
		Limit Inferior	Limit Superior		Limit Inferior	Limit Superior
Food	0.960*	0.892	1.028	0.912*	0.801	1.023
Housing	0.936*	0.891	0.981	0.917*	0.852	0.983
Clothing	0.980*	0.805	1.155	0.830*	0.555	1.105
Transportation	1.253*	1.143	1.364	1.780*	1.542	2.019
Health care	1.021*	0.917	1.126	1.009*	0.899	1.119
Other expensives	1.197*	1.096	1.297	1.029*	0.798	1.261

Source: Research results.
Note: *$p < 0.01$.

Table 4 – Individual own-price elasticities by household type in Brazil

Goods	Elderly women households			Elderly men households		
	Own-price elasticity	95% Conf. Interval		Own-price elasticity	95% Conf. Interval	
		Limit Inferior	Limit Superior		Limit Inferior	Limit Superior
Food	-0.765*	-0.924	-0.606	-0.764*	-1.009	-0.520
Housing	-0.960*	-1.116	-0.805	-1.047*	-1.287	-0.808
Clothing	-0.953*	-0.989	-0.918	-0.985*	-1.052	-0.919
Transportation	-1.030*	-1.085	-0.976	-0.848*	-1.032	-0.664
Health care	-1.198*	-1.305	-1.090	-1.055*	-1.202	-0.908
Other expensives	-0.980*	-1.027	-0.933	-0.982*	-1.104	-0.861

Source: Research results.
Note: *$p < 0.01$.

In general, the results for expenditure elasticities were significant and positive, as expected theoretically, for all goods on both household types, and we find statistical difference only for Transportation, in which households composed by elderly men are more sensitive to changes in income compared to households composed by elderly women. Comparing the results, both household types are more sensitive to changes in expenditure for Transportation, Other expenses and Health care, so we can consider these goods to be luxuries for elderly households. If we consider the 95% confidence interval, Food and Clothing can also be considered luxury goods in Brazilian elderly households. We did not expect this result for Food products; however, in this aggregate we have food away from home, which could explain this elasticity. Housing was considered a necessity for both household types. Comparing our results with the finding in Cherchye *et al*. (2012) for individual elderly households in Netherland, we have that Transportation was also considered a luxury good in both household types, mainly in elderly men households (1.88); Food was considered a necessity good for both elderly households too; and Clothing was considered a necessity only for elderly women households (0.96). Otherwise, the authors found that Housing was considered a luxury good in both Netherlands individual elderly households.

Regarding the results for own-price elasticities, they were significant and negative, as expected theoretically, for all goods on both household types too, and we cannot find any statistical difference among them. Comparing the results, both household types are more sensitive to changes in price for Health care, so we can consider this good elastic for elderly households. However, elderly women households were more sensitive to price changes in Transportation (-1.030) and Health care (-1.198), while elderly men households were more sensitive to changes in price for Housing (-1.047). If we consider the 95% confidence interval, Housing, Transportation, Health care and Other expenses can be considered elastic goods. Food was considered inelastic for both household types. Comparing again with the results found by Cherchye *et al.* (2012), only Transportation was considered price elastic for elderly women households, and Food was considered inelastic for both elderly households. Otherwise, Clothing and Housing were considered inelastic goods in both Netherlands individual elderly households.

Therefore, we can consider that both individual elderly households were sensitive to changes in expenditure (luxury) and price (elastic) for Health care, and if we

consider the confidence interval, to Transportation and Other expenses too. This result shows that the elderly households in Brazil are not able to spend what they would like with these goods. In the specific case of Health care, this result show that, in the case of expenditure elasticity, with the degeneration of health with age, the needs of older people tend to be generally large. In the case of price elasticity, results might show that, with an increase in prices, Brazilian elderly tend to greatly reduce their consumption of health-related goods, which could happen by seeking the public health system (*Sistema Único de Saúde – SUS*) and/or decreasing or interrupting the use of medicines, which can be detrimental to health.

2.4.3. Couple's demand results

Now we focus our attention on the estimation results with respect to the parameters in the elderly couple model: the sharing rule, distribution factors and consumption technology parameters. The main results for our elderly couple model are displayed in Table 5.

The first part of Table 5 shows the estimated parameters for distribution factors ($\boldsymbol{s_i}$). C*eteris paribus*, higher real expenditures imply a higher share for females. This result is in line with earlier findings in the literature (see Cherchye *et al*. (2012) and Browning *et al*. (2013)). If elderly women in couple have more income than elderly men, this will also contribute to a higher share for females. This result may indicate a greater bargaining power in households where the elderly woman has a higher income than the elderly man, benefiting more the private consumption of the elderly woman. On the other hand, all else equal, the share that is shifted to the woman is slightly lower when she has a higher education level than her husband and if both elderly contribute to the household income. The first result was found in Cherchye *et al.* (2012) too, and the second one can indicate that husbands tend to control the income inside household. To confirm this, we show the results of the sharing rule (η). The average share was close to 0.43 with a minimum of 0.27 and a maximum of 0.58. This implies that the average couple's consumption pattern is more in line with that of husbands, but there is quite some heterogeneity across couples. The sharing rule estimated in Cherchye *et al.* (2012) for Netherland elderly couples was 0.63 with a minimum of 0.54 and a maximum of 0.73, which implies that, unlike in Brazilian elderly households, the couple's

consumption pattern in Netherlands elderly households are more in line with that of wives. Browning *et al*. (2013) on Canadian data of prime age employed individuals obtained a share of 0.63 at the mean of their data (with minimum and maximum shares of respectively 0.47 and 0.75). However, our estimation results are very similar to the shares calculated by Gómes (2017), which used a micro-level dataset from POF 2008/2009 of Brazilian traditional families (married couples with zero to three children). He found a higher resource share for men in all household compositions[29].

Table 5 – Sharing rule and consumption technology parameters in Brazil

Distribution factors	**Sharing rule**	
	Estimate (s_i)	**Std. Error**
Constant	-0.624	0.340
Real expenditures	0.0002	0.000
Income difference	1.247	0.487
Education difference	-0.090	0.034
Income contribution	-0.556	0.285
Sharing rule (η)	0.429	0.079
Consumption technology parameters	**Consumption technology**	
	Estimate (a_i)	**Std. Error**
Food	-0.232	0.219
Housing	0.695	0.549
Clothing	28.822	.
Transportation	-151.628	.
Health care	-1.271	0.344
Other expensives	0.665	0.413
Diagonal of matrix A	**Consumption technology**	
	Estimate (A_i)	**Std. Error**
Food	0.721	0.027
Housing	0.834	0.061
Clothing	1.000	.
Transportation	0.500	.
Health care	0.610	0.029
Other expensives	0.830	0.046

Source: Research results.

[29] Gomes (2017) found a mean value for men resources shares of 0.53 in childless couple's households, 0.41 in couples with one child, 0.38 in couples with two children and 0.36 in couples with three children. On the other hand, the author found woman resources shares of 0.47 in childless couple's households, 0.406 in couples with one child, 0.35 in couples with two children and 0.34 in couples with three children.

The estimation results with respect to the consumption technology are presented in the second and third part of Table 5. The second part of the table shows the consumption technology parameters a_i, while the third part shows the implied entries of the diagonal technology matrix A_i. It turns out that Housing and Other expenses are close to being purely private goods, while Health care are close to be a public good. Food is somewhere in between and, Transportation and Clothing although presented missing standard errors[30], were considered purely public and purely private goods, respectively. With the exception of Housing, our results were very intuitive and agrees with those found in Cherchye *et al.* (2012).

Another useful tool to interpret the couples' demand results is the measure for the economies of scale of living in a couple (see Eq. (2.11)). We calculate this measure at de mean point in the sample and the result was 0.33, with a minimum value of 0.27 and a maximum value of 0.40. The interpretation of this value is simple: a scale close to zero would refer to a case where most of the consumption is purely private, while a scale close to one would be associated with a case where most of the consumption is purely public. So our model suggest that a large part of elderly couples' consumption has a private nature. This result was close to the one found in Cherchye *et al.* (2012), which found a measure equal to 0.38.

2.4.4. Poverty among the elderly in Brazil

In this section, we will follow the application of Cherchye *el al.* (2012) to analyze poverty among elderly people in Brazil using the methodology of the collective consumption model. The idea of this section is to illustrate the impact of choosing a different methodology to calculate poverty indexes, comparing our results with those obtained by the traditional analysis based on the OECD modified equivalence scale. Therefore, the difference between our approach and the OECD will be the fact that the collective consumption model allows for household members that have different preferences, unequal sharing of resources in couples and the economies of scale of living in a couple.

[30] Missing standard errors are usually produced by nearly singular variance covariance matrices. This is usually associated to database and/or model specification issues. We tried to test several model specifications with several estimation procedures, but the results continued to present missing standard errors for these parameters. Therefore, we conclude that this result is due to limitations of the database.

2.4.4.1. OECD versus collective poverty analysis

In Table 6 we present the results for the evolution of poverty rates for individuals, elderly in couples and elderly in total and poverty values in Brazil using the OECD modified and collective consumption approach. The OECD poverty is calculated in three steps: first, equivalent expenditures were calculated by dividing household expenditures by the modified OECD equivalence scale - household expenditures are either divided by 1 (single individuals) or by 1.5 (couples)[31]; second, the resulting equivalent expenditures of elderly women, elderly men and individuals in elderly couples are used to obtain the median of the equivalent expenditures for the three periods; and third, the elderly is considered to be poor if the equivalent expenditures are lower than 60 percent of the time period specific median equivalent expenditures (CHERCHYE *et al.*, 2012). The collective consumption poverty is different from the OECD poverty rate: first, we must calculate the expenditures on private good equivalent consumption that may differ across spouses and, as discussed earlier, depend on the economies of scale associated with living in a couple and on the sharing rule; second and third steps are the same as in OECD poverty rate, but using the private good equivalent consumption for individual elderly in couples.

Table 6 demonstrates that the poverty rates for the different elderly groups in Brazil are relatively high between 1995 and 2009. However, the rates in both approaches were declining for all elderly groups if we compare the first and the last period of analysis. In general, if we compare our results to those found in Cherchye *et al.* (2012) for elderly in Netherlands, our poverty rates are more than ten times higher, except for Elderly men in couples. This result is quite worrying, because if you look for the Elderly in total group in our last period, despite in better situation than the elderly in 1995/96, almost 25% of them are still below the poverty line. Our results agree in part with those found in Turra *et al*. (2008), Coetlar and Tornarolli (2009) and Turra and Rocha (2010). These authors state that income transfer programs (especially the *Bolsa Família* Program) and the expansions of the non-contributory social security system explain much of the reduction of poverty and inequality in Brazil during the last years, and we can confirm this poverty reduction using the collective consumption

[31] It is important to remark that modified OECD scale complies with economies of scale measure of 0.33, which is actually the same to the average economies of scale measure for our estimated collective model.

methodology. However, the magnitude of this reduction is much greater in those papers than in our results. For example, Coetlar and Tornarolli (2009) state that the poverty rate among the elderly in Brazil in 2008 fell from 49.3% to 4.2% after taking into account income transfers. Turra and Rocha (2010) confirm that, considering public transfers, less than 5% of elderly in Brazil can be considered poor using the World Bank's poverty line[32].

Table 6 – OECD and collective poverty rates and values in Brazil

	POF 1995/96	POF 2002/03	POF 2008/09
Elderly women in couples			
Collective poverty approach	31.8%	40.8%	29.9%
OECD poverty approach	26.9%	30.0%	23.0%
Elderly women			
Collective poverty approach	42.4%	22.6%	26.2%
OECD poverty approach	40.9%	22.6%	26.6%
Elderly men in couples			
Collective poverty approach	22.0%	22.5%	16.4%
OECD poverty approach	26.9%	30.0%	23.0%
Elderly men			
Collective poverty approach	41.3%	39.7%	27.2%
OECD poverty approach	39.4%	37.9%	27.2%
Elderly in total			
Collective poverty approach	33.6%	29.6%	24.6%
OECD poverty approach	32.9%	28.5%	24.6%
Collective poverty monthly value (R$)	132.68	491.06	609.79
OECD poverty monthly value (R$)	126.70	488.85	612.86
Collective poverty monthly value ($)	129.96	142.85	264.36
OECD poverty monthly value ($)	124.11	142.21	265.70

Source: Research results.
Note: The exchange rate is $1 = 1,02 BRL Brazilian real in September 1996; $1 = 3,44 BRL Brazilian real in January 2003; and $1 = 2,31 BRL Brazilian real in January 2009.

If we look for the different groups, poverty was higher in the Elderly women (42.4% and 40.9%) and men (41.3% and 39.4%) groups respectively in both approaches in the first period of analysis. In the last period, the poverty rates were similar on the groups, but Elderly men (27.2% for both) and women (26.2% and 26.6%) were still poorer. However, in the last period, the highest poverty rate was in Elderly women in couples using the collective approach (29.9%), as well of for the period of POF 2002/03

[32] Turra and Rocha (2010) estimated poverty rates based on the World Bank's poverty line of US$ 2.00 per day in purchasing power parity in 2005 with and without public transfers including contributory and non-contributory retirement benefits, as well as conditional cash transfers from the Bolsa Família program.

(40.8%). This result can be explained by the fact that an important part of the household's budget is spent on public consumption and that the sharing rule for our collective model is more favorable to men. Therefore, elderly men in couples are able to attract a relatively higher share of private good equivalents, with the obvious consequence that they are less likely to be labelled as poor (and vice versa for women) when households have increasing financial means, as is the case in our data. These results show that much of the poverty among the elderly in Brazil comes from the issue of inequality in the intra-household distribution of resources. Therefore, disregarding this question means greatly underestimating the poverty of the elderly. Lise and Seitz (2011) already showed that traditional measures of consumption inequality only reflect inequality at the household level, when it is assumed that there is no intra-household inequality.

We conclude from our above results that, as well as in Cherchye *et al.* (2012), although OECD and collective poverty rates are of the same magnitude on average, the OECD approach underestimates most of the poverty rates (6 of 12, and the results of 2 of 12 were the same) in the periods and population groups in the analysis, mainly in the case for Elderly women in couples. This difference happens because the OECD poverty measure does not take into account intra-household allocation of resources, unequal sharing of resources in couples and the economies of scale of living in a couple.

2.4.4.2. Economic consequences of being alone (widow(er)hood)

This subsection reveals another important policy issue that can emerge in the collective consumption model: the economic consequences of being alone, either by having become a widow(er) or divorcee[33]. As emphasized in Cherchye *et al.* (2012), we must make two considerations about the results presented here: first, we only look at the impact on the expenditures on private good equivalents (material goods) of being alone and don't concern about the emotional impact of this event on the indifference curves; and second, the results we show are based on a time series of cross-sections, so we are

[33] We have to be cautious here, because in our database the elderly in individual households, referred here as widows and widowers, are not observed as women or men who are living in couples before the death or being divorced of their partner. However, to interpret the results in Table 8 and 9, we use the assumption that widow(er)s are comparable to individuals in couples who are situated in the same expenditure quartile.

not able to analyses the impact of being alone on an individual specific basis. Results are presented in Table 7 and 8.

Table 7 shows, for individuals in elderly couples, the average minimum expenditures needed when living alone to reach the same indifference curve as when living in a couple (see the numerator of Eq. (2.12) and Eq. (2.13)). These expenditures are calculated for the four different quartiles of the distribution of total household expenditures from the couple's households. This table also shows, for elderly women and men living alone, the observed household expenditures. Table 8 further shows the corresponding average indifference scales for elderly women and men in couples (see Eq. (2.15) and Eq. (2.16)). By definition, the indifference scale for elderly living alone equals 1.

Table 7 – Economic of well-being in elderly household in Brazil

	POF 1995/96	**POF 2002/03**	**POF 2008/09**
Elderly women in couples			
First quartile	86.03	319.95	472.09
Second quartile	169.44	474.63	735.95
Third quartile	304.95	891.63	1,079.50
Fourth quartile	671.00	1,579.42	2,281.96
Elderly women			
First quartile	70.41	457.97	532.84
Second quartile	124.71	754.91	809.04
Third quartile	209.55	1,073.62	1,187.46
Fourth quartile	501.51	1,795.01	2,046.72
Elderly men in couples			
First quartile	118.81	441.84	651.93
Second quartile	233.98	655.43	1,016.31
Third quartile	421.12	1,231.31	1,490.74
Fourth quartile	926.62	2,181.11	3,151.27
Elderly men			
First quartile	67.88	365.67	501.32
Second quartile	127.25	500.89	784.73
Third quartile	296.08	897.91	1,207.97
Fourth quartile	829.60	2,050.72	2,419.47

Source: Research results.

Table 8 – Indifference scales in elderly households in Brazil

	POF 1995/96	POF 2002/03	POF 2008/09	Average IS
Women in couples				
First quartile	0.583	0.565	0.554	0.562
Second quartile	0.594	0.575	0.562	0.575
Third quartile	0.605	0.585	0.568	0.588
Fourth quartile	0.616	0.594	0.582	0.603
Men in couples				
First quartile	0.805	0.781	0.764	0.776
Second quartile	0.820	0.794	0.776	0.794
Third quartile	0.835	0.808	0.785	0.812
Fourth quartile	0.851	0.820	0.803	0.832

Source: Research results.

If we look for the results on Table 7, it is possible to compare the individual household expenditure (Elderly men and women) with the minimum expenditures needed when living alone to reach the same indifference curve as when living in a couple (Elderly women or men in couples), to conclude about the material impact of an individual being alone (or become widow(er) or divorced). For a given expenditure quartile and POF period, the material impact to become a widow(er) corresponds to the difference between the actually observed expenditures for elderly men or women and the minimally required expenditures of individuals in couples to be materially equally well off when living as a single (in case a widow(er) or divorced). So the results on Table 7 suggests that men in all expenditures quartiles are materially better off when living in couple than when living alone in each period of POF database. The reverse pattern was observe for women: on average, with the exception of the POF 1995/96 period and fourth quartile in POF 2008/09 period, women are materially better off when living as a widow than when living in a couple. Therefore, these results follow our previous subsection suggesting the prevalence of economies of scale and a sharing rule more favorable to men. Cherchye *et al.* (2012) found similar results, but the difference was that elderly women in Netherlands are more favored by the intra-household bargaining power.

Finally, we focus on the average indifference scales by POF periods and quartiles presented on Table 8. Results show that the indifference scales depend on total household expenditures given the time period. Therefore, men in couples that are situated in the first expenditure quartile need 77% of the couple's expenditure to be

equally well off as being alone (widower) as when living in a couple. Women in elderly couples in the same quartile need about 56% of the couple's total expenditures. When we look for the fourth expenditure quartile, men need on average 83% of the couple's resources to achieve the same indifference curve as a widower or divorced man, while women only would need about 60%. So, again these results follow our previous subsection result suggesting the prevalence of economies of scale and a sharing rule more favorable to men and, because of this, they need more resources than women to be as well of when they become widower or divorced.

2.5. CONCLUSIONS

The proportion of elderly in LAC and especially in Brazil is increasing and most of elderly are living until an advanced age. Besides that, elderly people are more vulnerable to falling into poverty than other age groups. So it is evident that a challenge to the State and Federal Government due to population aging relates to social security. Despite that, most of the studies for Brazil acknowledge that poverty among the elderly has been decreasing and reaching levels that are relatively low in relation to the other age groups of population.

In this context, we applied the collective consumption model of Browning *et al*. (2013) and Cherchye *et* al. (2012) to analyze poverty among the elderly in Brazil. Besides being the first study that uses the methodology to a developing and LAC country, the collective consumption model is particularly useful because it starts with individual elderly preference, while accounting for consumption technology to understand the economies of scales of elderly living in a couple and sharing rule that controls the intra-household allocation of resources. Therefore, the purpose of this study was to analyze consumption expenditure patterns and demand, measure by price and income elasticities, in elderly households, intra-household bargaining power in elderly couples households using the tools providing by the collective model, consumption technology and the sharing rule, and finally, understand the poverty among the elderly and the material impact of being an elderly widow(er) in Brazil.

Our empirical results for the collective consumption model indicate substantial economies of scale associated with living in a couple, and a husband's share that is increasing in the couple's real expenditures. Next, we calculated collective consumption

model poverty rates and put in contrast to traditional poverty rates, which are based on OECD modified equivalent scales for expenditure. Collective poverty rates explicitly take into account the different intra-household distribution of resources. For most of the time periods in our analysis, collective poverty rates turn out to be higher than traditional poverty rates that are based on the modified OECD equivalence scale. So the economies of scale of living in elderly couples for most of the periods are above those incorporated in the OECD modified equivalence scale. Besides that, OECD scale underestimates poverty among elderly women in couples and overestimates poverty among elderly men in couples. In the case of widow and widowers, in most of the periods, OECD scale underestimates poverty rates. The permanence in poverty of the elderly women can be explained by the fact that the male's share of the household's resources is increasing in the couple's real expenditures. The increase in real expenditures over time induced an intra-household allocation of resources that is more favorable towards men in couples. Thus, there are differences in poverty rates among the elderly genders in Brazil.

Our last conclusion arise in the analysis of the economic (material) impact of become a widow(er) or being divorced. Our results indicate a substantial drop in material well-being following the wife's death for men. The opposite conclusion holds for women. After becoming a widow, Brazilian women are generally materially better off than when living in a couple and these result can be explained by the economies of scale of living in a couple, in combination with a sharing rule that is favorable to men.

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2.6. APPENDIX

2.6.1. Identification of the household demand function

According to Browning *et al.* (2013) and Cherchye *et al.* (2012), the household demand function $g(p/x)$ can be easily identified by observing the prices p, total expenditure x and the basket acquired by household z. That is, variations in p and x allow the estimation of the couples' demand functions. The identification of the elderly individual demand functions g^w and g^m is not immediate, but can be obtained by different means. If individual preferences do not change when the elderly form the couples' household, then g^w and g^m can be estimated (and then identified) using demand data on observed prices, total expenditure, and quantities purchased individually by the elderly when they live alone, that is, by observing the individual demand of the elderly. Generally, g^w and g^m can be identified immediately if preferences change after couples' household formation, provided that these changes can be observed using individual data, joint data, and knowledge of changes (estimated parameters that change their values after couples' household formation) to retrieve g^w and g^m.

Cherchyl *et al*. (2012) argue that the assumption that individual preferences remain the same after becoming a widow(er) may be subject to criticism. For example, it can be argued that becoming a widow(er) affects the marginal rate of substitution of the surviving individual for different assets due its new state of mental health. However, if the data do not allow such observations (such as POF), then an empirical analysis of the results can be allowed. Another issue is a potential non-random selection for individual households. For example, if a spouse has a serious health problem, then this condition can have an impact on the technology function, such that the elderly will be worse off. Therefore, care must be taken in interpreting the empirical results obtained by the assumption of equal preferences in a context without any information on observable health.

An alternative way to identify the parameters of the collective consumption model is to directly observe the consumption of goods of each individual within the household under different prices and expenditure regimes. Thus, this alternative directly provides the observations of the functions h^w and h^m, together with $g(p/x)$, which can

be used to retrieve g^w and g^m. In other words, g^w and g^m will be identified if the goods are individually assigned.

In practice, the first estimation strategy mentioned above will be used on this paper. In this case, g^w and g^m will be identified by the estimation of the combination of individuals' and couples' demand functions.

2.6.2. Identification of the other parameters

According to Browning et al. (2013), if the number of goods in the demand system is $n \geq 3$, then the functions $\pi(p/x)$, $\eta(p/x, s)$, $h^w(p/x)$ and $h^m(p/x)$ and the parameters of the consumption technology function represented by A are all generically identified. The identification of these parameters is only generic if there are more equations than unknown parameters in the estimated demand system. According to Browning et al. (2013), the problem of identification arises when one uses "very simple" (eg, linear) functional forms for the functions of demand or functions of technology and, disappears for functional forms sufficiently complex for the functions of demand, since the nonlinearity in functional forms tends to eliminate the linear dependencies between the equations[34].

However, according to Cherchye *et al*. (2012), another alternative approach to identify the functions $\pi(p/x)$, $\eta(p/x, s)$, $h^w(p/x)$ and $h^m(p/x)$ is by the individuals demands g^w and g^m, that is, the observed household demand equation $g(p, x)$ together with variations in p, x and s. This is the strategy to be used here.

As demonstrated by Chiappori and Ekeland (2009), this identification cannot be expected if the researcher has only data of elderly couples in a context without assignable goods. The information contained in the individual demand of the elderly along with the assumption of equality of preferences is sufficient to identify the couple's individual preferences, while the informations contained in the demand of the elderly couple are generally sufficient to identify the other components (specifically the sharing rule and consumer technology) of the structural model.

[34] For further details on the non-parametric identification differences of the parameters of linear and nonlinear demand model equations, see appendix of Browning *et al*. (2013).

1 - Food
1.1 - Cereals, legumes and oilseeds
1.2 - Flours, starches and pasta
1.3 - Tubers and roots
1.4 - Sugars and derivatives
1.5 - Vegetables and greens
1.6 - Fruits
1.7 - Meat, offal and fish
1.8 - Poultry and eggs
1.9 - Milk and dairy products
1.10 - Breads
1.11 - Oil and lard
1.12 - Beverages and infusions
1.13 - Canned and preserved food
1.14 - Salt and seasonings
1.15 - Prepared foods
1.16 - Other foods
1.17 - Food outside the home
2 - Housing
2.1 - Rental
2.2 – Condominium fee
2.3 - Services and rates
2.4 - Home maintenance
2.5 - Cleaning products
2.6 - Furniture and household articles
2.7 - Home appliances
2.8 - Repair of household articles
3 - Clothing
3.1 - Man's clothes
3.2 - Woman's clothes
3.3 - Children clothes
3.4 - Footwear and accessories
3.5 - Jewelery and costume jewelery
3.6 - Fabrics and haberdashery
4 - Transportation
4.1 - Public
4.2 - Gasoline - Own vehicle
4.3 - Ethanol - Own vehicle
4.4 - Maintenance and accessories
4.5 - Vehicle acquisition
4.6 - Sporadic trips
4.7 - Others

5 – Health care
5.1 - Medicines
5.2 - Health insurance/plan
5.3 - Consultation and dental treatment
5.4 - Medical appointment
5.5 - Medical and outpatient treatment
5.6 - Surgery services
5.7 - Hospitalization
5.8 - Miscellaneous Examinations
5.9 - Treatment material
5.10 - Others
6 - Other expenses
6.1 - Hygiene and personal care
6.1.1 - Perfume
6.1.2 - Hair products
6.1.3 - Soap
6.1.4 - Instruments and personal products
6.2 - Education
6.2.1 - Regular courses
6.2.2 - Undergraduate courses
6.2.3 - Other courses and activities
6.2.4 - Textbooks and technical journals
6.2.5 - School supplies
6.2.6 - Others
6.3 - Recreation and culture
6.3.1 - Toys & games
6.3.2 - Cell phones & accessories
6.3.3 - Periodicals, non-textbooks and journals
6.3.4 - Recreation and sports
6.3.5 - Others
6.4 - Smoke
6.5 - Personal services
6.5.1 - Hairdressing
6.5.2 - Manicure and pedicure
6.5.3 - Repair of personal items
6.5.4 - Others
6.6 - Miscellaneous expenses
6.6.1 - Games and betting
6.6.2 - Communication
6.6.3 - Ceremonies and celebrations
6.6.4 - Professional Services
6.6.5 - Real estate for occasional use
6.6.6 - Others

Table A1 – Products considered in the demand system.

Table A2- Regional Price Difference Index for metropolitan areas at September 1996.

Metropolitan areas	Food	Habitation	Clothing	Transportation	Health care	Other expensives
Rio de Janeiro	0.482	0.377	0.539	0.356	0.550	0.430
Porto Alegre	0.392	0.301	0.513	0.425	0.444	0.462
Belo Horizonte	0.392	0.344	0.585	0.430	0.517	0.438
Recife	0.414	0.322	0.511	0.379	0.456	0.392
São Paulo	0.365	0.352	0.302	0.404	0.469	0.343
Distrito Federal	0.412	0.552	0.600	0.419	0.455	0.530
Belém	0.382	0.392	0.479	0.296	0.479	0.428
Fortaleza	0.459	0.331	0.522	0.396	0.573	0.448
Salvador	0.478	0.354	0.503	0.358	0.452	0.596
Curitiba	0.426	0.379	0.534	0.405	0.564	0.410
Goiânia	0.390	0.426	0.579	0.398	0.306	0.405

Source: Research results.

Table A3 - Regional Price Difference Index for metropolitan areas at January 2003.

Metropolitan areas	Food	Habitation	Clothing	Transportation	Health care	Other expensives
Rio de Janeiro	0.788	0.757	0.620	0.681	0.745	0.680
Porto Alegre	0.673	0.689	0.687	0.830	0.714	0.662
Belo Horizonte	0.644	0.661	0.660	0.812	0.697	0.641
Recife	0.679	0.569	0.610	0.695	0.684	0.520
São Paulo	0.638	0.799	0.625	0.799	0.770	0.869
Distrito Federal	0.661	0.853	0.781	0.836	0.661	0.804
Belém	0.626	0.766	0.554	0.620	0.603	0.594
Fortaleza	0.710	0.597	0.591	0.691	0.745	0.601
Salvador	0.732	0.669	0.623	0.724	0.670	0.721
Curitiba	0.663	0.673	0.675	0.782	0.818	0.705
Goiânia	0.675	0.752	0.783	0.755	0.844	0.650

Source: Research results.

Table A4 - Regional Price Difference Index for metropolitan areas at January 2009.

Metropolitan areas	Food	Habitation	Clothing	Transportation	Health care	Other expensives
Rio de Janeiro	1.130	1.067	0.994	0.943	0.980	0.985
Porto Alegre	0.945	0.930	1.111	1.175	0.948	1.016
Belo Horizonte	0.955	1.053	1.021	1.203	0.950	0.957
Recife	0.962	0.872	0.965	0.927	0.971	0.771
São Paulo	0.953	1.057	0.940	1.006	1.059	1.291
Distrito Federal	1.006	1.302	1.172	1.118	0.962	1.222
Belém	0.954	1.047	0.789	0.905	0.845	0.901
Fortaleza	1.005	0.868	0.883	0.845	1.063	0.912
Salvador	1.040	0.926	0.916	1.028	0.976	1.034
Curitiba	0.925	0.923	0.986	0.984	1.129	1.021
Goiânia	1.002	1.077	1.387	0.961	1.200	0.969

Source: Research results.

Table A5 - Estimated parameters of the elderly women demand system Brazil

Groups	Food	Habitation	Clothing	Transportation	Health care	Other expenses
Intercept	0.351	0.537	0.096	0.047	-0.038	0.007
	0.083	0.090	0.029	0.040	0.082	0.038
Prices in logarithmic form						
Food	0.222	-0.145	-0.023	-0.014	-0.020	-0.020
	0.082	0.062	0.026	0.033	0.053	0.031
Habitation	-0.145	0.003	-0.015	0.016	0.148	-0.007
	0.062	0.077	0.024	0.033	0.048	0.033
Clothing	-0.023	-0.015	0.046	0.017	0.002	-0.026
	0.026	0.024	0.018	0.016	0.019	0.014
Transportation	-0.014	0.016	0.017	-0.040	0.025	-0.004
	0.033	0.033	0.016	0.028	0.026	0.018
Health care	-0.020	0.148	0.002	0.025	-0.195	0.040
	0.053	0.048	0.019	0.026	0.055	0.024
Other expenses	-0.020	-0.007	-0.026	-0.004	0.040	0.017
	0.031	0.033	0.014	0.018	0.024	0.024
Ln (total expenditure)	-0.010	-0.026	-0.001	0.019	0.003	0.015
	0.009	0.009	0.003	0.004	0.008	0.004
Age	-0.001	0.003	-0.001	-0.002	0.002	-
	0.001	0.001	0.000	0.000	0.001	-
Education level	-0.009	0.003	0.000	0.003	-0.001	-
	0.002	0.002	0.001	0.001	0.002	-
Governement transfers	0.006	-0.014	0.000	0.008	0.002	-
	0.020	0.021	0.007	0.009	0.019	-
POF 1995/1996	0.131	-0.371	0.003	0.033	0.151	-
	0.022	0.024	0.008	0.011	0.021	-
POF 2002/2003	-0.004	-0.067	-0.008	0.003	0.092	-
	0.020	0.021	0.007	0.010	0.019	-

Note: Values below estimated parameters are standard errors.
Source: Research results.

Table A6 - Estimated parameters of the elderly men demand system Brazil

Groups	Food	Habitation	Clothing	Transportation	Health care	Other expenses
Intercept	0.419	0.389	0.090	-0.086	0.010	0.177
	0.128	0.124	0.042	0.082	0.081	0.081
Prices in logarithmic form						
Food	0.202	-0.063	-0.035	-0.028	0.061	-0.137
	0.126	0.093	0.042	0.064	0.078	0.064
Habitation	-0.063	-0.098	0.009	0.144	-0.043	0.051
	0.093	0.119	0.040	0.064	0.067	0.069
Clothing	-0.035	0.009	0.003	0.036	-0.011	-0.002
	0.042	0.040	0.031	0.029	0.033	0.029
Transportation	-0.028	0.144	0.036	-0.059	-0.058	-0.036
	0.064	0.064	0.029	0.063	0.048	0.044
Health care	0.061	-0.043	-0.011	-0.058	-0.053	0.104
	0.078	0.067	0.033	0.048	0.074	0.048
Other expenses	-0.137	0.051	-0.002	-0.036	0.104	0.019
	0.064	0.069	0.029	0.044	0.048	0.061
Ln (total expenditure)	-0.022	-0.034	-0.006	0.058	0.001	0.002
	0.014	0.014	0.005	0.009	0.009	0.009
Age	-0.001	0.005	0.000	-0.003	0.001	-
	0.002	0.002	0.001	0.001	0.001	-
Education level	-0.007	0.003	0.000	0.001	0.002	-
	0.003	0.003	0.001	0.002	0.002	-
Governement transfers	-0.002	-0.020	-0.014	0.002	0.011	-
	0.030	0.029	0.010	0.020	0.019	-
POF 1995/1996	0.112	-0.309	0.002	0.104	0.021	-
	0.036	0.035	0.014	0.024	0.026	-
POF 2002/2003	0.010	-0.048	-0.018	0.034	0.023	-
	0.034	0.033	0.012	0.022	0.022	-

Note: Values below estimated parameters are standard errors.
Source: Research results.

CHAPTER 3 - CONSUMPTION PATTERNS AND DEMAND IN HOUSEHOLDS HEADED BY THE ELDERLY: EVIDENCE FROM BRAZIL

Abstract: *The purpose of this study was to analyze consumption expenditure patterns and demand of elderly headed households based on the last three Brazilian Household Surveys. The Quadratic Almost Ideal Demand System (QUAIDS) augmented with household head characteristics and household composition variables was applied. Results point that elderly and adult-headed households have different consumption patterns. Adult-headed households were more sensitive to changes in expenditure for Food products, while households headed by the elderly showed more sensitivity for Health care. Household head demographic variables influence the demand for most of the goods in elderly headed households. Government transfers support elderly households to spend more on Housing, Food, and Health care. In relation to household composition variables, those formed only by elderly demand less Food and more Housing, those households composed by children demand more Clothing and Transportation products and less Habitation and Health care products, and those households composed by relatives demand less Health care products.*

Keywords: Consumption pattern, demand analysis, population aging.

JEL classification: J14, D12, J11.

Resumo: O objetivo deste estudo foi analisar os padrões de dispêndio de consumo e a demanda em domicílios chefiados por idosos com base nas últimas três Pesquisas de Orçamento Familiar. Foi utilizado o modelo *QUAIDS* com variáveis relacionadas a características do chefe, composição domiciliar e variáveis relacionadas ao tempo. Os resultados apontaram que os domicílios chefiados por idosos e adultos têm diferentes padrões de consumo. Domicílios chefiados por adultos foram mais sensíveis às mudanças nas despesas com Alimentos, enquanto os chefiados por idosos apresentaram maior sensibilidade para os bens relacionados a cuidados de saúde. As variáveis demográficas relacionadas às características do idoso responsável pelo domicílio influenciaram a demanda pela maioria dos bens. As transferências governamentais ajudam as famílias idosas a gastar mais em Habitação, Alimentação e Saúde. Em relação às variáveis de composição doméstica, aquelas formadas apenas por idosos demandam menos Alimentos e mais Habitação, as famílias compostas por crianças demandam mais Roupas e Transportes e menos produtos de Habitação e Saúde, e as famílias compostas por parentes exigem menos produtos de Saúde.

Palavras-chave: Padrão de consumo, análise da demanda, envelhecimento da população.

3.1. INTRODUCTION

The Brazilian population has undergone significant changes over the twentieth century. Among them one might highlight the reduction in mortality followed by the decline in fertility rates. Compared to European countries, this demographic transition

from high rates of mortality and fertility to a stable population with low rates of mortality and fertility happened in Brazil at a faster pace. This transition took about 200 years in some European countries; however, in Brazil experts predict that the demographic transition will be completed in about 100 years around 2050 (BELTRÃO *et al*., 2004).

The elderly population is increasing not only in absolute numbers, but as a share of the total population in Brazil since 1950. According to Brazilian Institute of Geography and Statistics - *Instituto Brasileiro de Geografia e Estatística* - IBGE (2015), the national population was composed in 1950 of 2.6 million seniors [35] representing about 4.9% of the population. In 2010, with an annual growth of 3.4% compared to 2.2% of the population in general, the elderly were already 19.6 million representing about 10.2% of the population. IBGE estimates (2017) show that in the next 50 years this group will grow at a rate of 2.6% per year compared to 0.2% of the population, reaching 73.5 million people by 2060, which will be equivalent to 33.7% of the population. According to World Bank (2016), compared to other countries this percentage will be close to the current Japan, the country with the highest proportion of elderly people in the world, and above the percentage of countries in Europe where the average proportion of this population group was 20% in 2013. This process already allows us to alert to the challenges ahead in the field of social protection policies (health, welfare and assistance) and the need for Brazil to prepare for it.

The process of population aging entails a series of implications in the most distinct spheres of society, such as economic, social and political organization, among others. Unlike in developed countries, population aging in Brazil, as in many other developing countries, occurs in an unfavorable socioeconomic context due to high levels of social inequality; high rates of illiteracy; problems with sanitation, housing and poverty; and, lack of properly consolidated institutions (GUIMARÃES, 2006). In addition, population aging can affect the demand of goods, because changes in age distribution can alter the composition of household consumption among types of goods and services and preferences usually vary along life-cycle. It is necessary to reorganize the supply of goods to face these significant changes in the aggregated demand composition (DENTON AND SPENCER, 1999).

[35] The World Health Organization - WHO defines elderly people as people with age equal or greater than 60 years old (IBGE, 2009).

Besides the significant growth of the elderly population and implications of these changes, the Brazilian elderly have access to a higher income in relation to the last decades, and the effect of population aging on consumption is becoming an increasingly important area of concern to economists and public policy makers. According to IBGE (2014), while in 1991, more than half of the elderly (52.1%) had income less than the minimum wage, in 2013 this proportion fell to about 39.7%. According to Osório and Pinto (2007), this increase in the income of the elderly and their greater purchasing power, previously ignored by business firms and society in general, causes it to become a group that attracts the individual and collective interest of business owners. In addition, the elderly in Brazil have income from pensions and retirements, which does not occur with the younger population, and this income is less sensitive to fluctuations.

In addition, according to Camarano and Pasinato (2004), the increase in the elderly-headed households and the reduction in the proportion of elderly people living in relatives' homes has been a growing trend in Brazil. The importance of the elderly in the household as a provider of stable income from retirement or pension or even the continuation of economic activity is often ignored. However, while labor income is usually responsible for most household income, according to IBGE (2014), the elderly income composition show that labor income is not the majority share of the total. In 2013, about 67.6% of the elderly's income came from retirement and/or pension, 28.3% from employment, and 4.1% from other sources.

The income distribution in Brazil is changing, and some of the changes favored the elderly, who have experienced a higher rate of increase in real household income, adjusted for family size, than other age groups; thus the elderly today are, on average, at least as well off as other age groups (ALMEIDA; FREITAS, 2007). Therefore, if consumption patterns of the elderly differ from those of the young and their resources do not decline relative to other age groups, the demographic transition of the population and the continuous increasing of the elderly income are likely to result in a significant change in demand of Brazilian population as a whole. The relative share of expenditure by elderly consumers will also increase due to the fact that the proportion of elderly consumers will increase.

To effectively understand the consumer needs of this large and growing segment of the Brazilian population, both government policymakers and business interests must be informed about the consumption patterns and the demand of the different elderly-

headed household's compositions. In the international literature, the first papers who investigate these aspects emerged in the late 1970s [36] (HURD, 1989). However, international studies continue to analyze the pattern of consumption of the elderly in different countries, like Fuchs (2001); Tomassini *et al.* (2004); Luhrmann (2005); Butrica and Mermin (2006); Dewhurst (2006); Lefèbvre (2006); Ying and Yao (2006); Copeland (2007); Butrica, Johnson and Mermin (2009); De Nardi, French and Jones (2010) and Banerjee (2012). In Brazil, the emergence of scientific works about the demographic transition focused on elderly occurred in the late 1980s and early 1990s[37]. But there are also several more recent studies that investigate social and economic variables of the Brazilian elderly, especially Camarano *et al.* (1999); Goldani (1999); Neri, Carvalho and Nascimento (1999); Wajnman *et al.* (1999); Schor and Afonso (2001); Almeida and Kassouf (2004); Neri *et al.* (2004); Guimarães (2006); Almeida and Freitas (2007); Camargos, Machado and Rodrigues (2007); Sievert and Taíse (2007); Marques (2009); Pedrazzi *et al.* (2010); Rodrigues (2011); Mello *et al.* (2014); Melo, Ferreira and Teixeira (2014); and Melo *et al.* (2016).

Among these studies, it is worth mentioning Almeida and Kassouf (2004) and Almeida and Freitas (2007). The first one analyzes the family consumption behavior of elderly-headed households over 60 years old in the most important metropolitan Brazilian regions, Federal District and Goiânia using the 1995/96 Brazilian Household Budget Survey (POF) from IBGE. The second study produced the same results as the first, but using the 2002/03 POF from IBGE. Both studies verified that the presence of the elderly in the family, thanks to their more stable income, allows the increase of purchasing power; and the percentages spent on medicines and health services in families with the elderly were higher than the expenditures of families without the elderly. The authors also observed that the presence of the elderly in the families does not modify the consumption habits of the young people who live with them. In families with the elderly and without the elderly, individuals in the working life stage, between 30 and 50 years, have similar consumption habits.

Despite that, there is still a great lack of studies that analyzes the consumption pattern and the demand of different elderly-headed household's composition. Although

[36] Druker (1979); Fareed and Riggs (1982); Chen and Chu (1982); Axelson and Penfield (1983); Heslop (1986); Junk, Jones and Kessel (1988); Chung and Magrabi (1990); Koelln, Rubin and Picard (1995); Tsakloglou (1996); Lee et al. (1997); and Xia, Malroutu and Yuh (1999).

[37] Baeta and Cruz (1988), Prata (1990), Saad (1990), Yazaki (1990), Melo (1990); Yazaki, (1992); and Valéry and Paiva (1994)

informative, these Brazilian studies have typically used descriptive statistics, employed limited controls for sociodemographic and time differences among the elderly and did not use a demand system according to economic theory to identify such behavior in households headed by the elderly. Therefore, the contributions of this study are: a) Perform an aggregate analysis using the main household consumption groups[38] and the last three POF's database (POF 1995/96, POF 2002/03 and POF 2008/09). The studies already developed in Brazil only use one POF to analyze the consumption pattern in households composed by elderly people; b) Use a demand system (*Quadratic Almost Ideal Demand System - QUAIDS*) that is in agreement with the Economic Theory and with estimation that takes into account the relationship between the products (*Seemingly unrelated regressions - SUR*). None of the studies highlighted above has made such analysis; c) Compare the differences in demand elasticities with respect to income and prices in households headed by the elderly and adults[39]. None of the studies estimates price or income elasticities focused on this kind of households; and finally d) Analyze the impact of socio demographic variables as households characteristics, family composition and time variables, on the demand in households headed by the elderly. None of the studies measure the direct impact of socio demographic variables on the demand in elderly-headed households, much less the difference in demand by family compositions in which the elderly are the household head.

Our study recognizes that differences between expenditure of the elderly and the adults are important in order to establish appropriate public policies to help elderly consumers. In the course of the aging process, elderly households will play an increasing role, but their behavior might differ substantially from younger people. As a consequence, if they represent a bigger and bigger part of the population, this process might involve changes in the household's consumption structure and the economy might have to face a significant change in the national demand structure. If changes occur without being predicted and thus without appropriate public policies, shortages of goods and services needed by the elderly might occur and their prices rise to a point that needed commodities are unaffordable to them. The welfare of the adult consumer as well as the elderly consumer might decline. This study may also contribute to business companies to better understand this new public that is emerging, taking into account the

[38] We aggregate consumption goods into six broad categories: 1. Food; 2. Housing; 3. Clothing; 4. Transportation; 5. Health care; and 6. Other expenses.
[39] We define adult people as people with age between 18 and 59 years old (IBGE, 2009).

fact that this is a group that is constantly growing and should be seen as a promising consumer group, mainly due to its purchasing power, availability of time and concern for their health and well-being. Therefore, the purpose of this study is to compare consumption expenditure patterns and demand, measure by price and income elasticities, of the elderly and adult-headed households, taking into account other socio-economic factors associated to consumer behavior based on last three POF's database (POF 1995/96, POF 2002/03 and POF 2008/09).

This study is divided into five sections, including this introduction. In the second section, we present the methodology used in this study. In the third section we introduce the database and the methodology to get the price variables. In the fourth section we present the differences in consumption patterns and price and income elasticities in households headed by adults and elderly, the impact of demographic variables on households headed by the elderly, and the effect of the aging of the Brazilian population on consumption. The fifth and final section we present the conclusions of the study.

3.2. METHODOLOGY

3.2.1. The QUAIDS model: Functional specification

The main objective of the theory of consumer behavior is to explain how a rational consumer makes decisions on what to consume when confronted with different prices and a limited budget constraint. At this level of generality, the usefulness of this theory for empirical purposes is that it establishes a set of constraints that the demand parameters must satisfy, thus limiting the number of independent parameters to be estimated and ensuring consistency in the results obtained. Several demand systems have been commonly used in literature to the estimation of demand equation parameters such as the Linear Expenditure System (LES) (Stone, 1954), the Rotterdam model (Barten, 1964), the Indirect Translog System (ITS) (Christensen, Jorgenson and Lau, 1975), the Almost Ideal Demand System (AIDS) (Deaton and Muellbauer, 1980) and the Quadratic Almost Ideal Demand System (QUAIDS) developed by Banks *et al.* (1997).

Deaton and Muellbauer (1980) were pioneers in the estimation of flexible functional forms of demand systems. They developed the Almost Ideal Demand System

(AIDS) derived from any expenditure function that would represent consumer preferences. However, Blundell *et al.* (1993) and Banks *et al.* (1997) found that the nonlinearity of Engel's curves is quite likely empirically. This fact suggests that Engel curves require quadratic terms in the logarithm of total expenditure, which was not incorporated in the AIDS model. Thus, the authors derived a similar system with the same degree of flexibility, but with the ability to incorporate the non-linear effects of expenditure into their specification. The Quadratic Almost Ideal Demand System - QUAIDS model is obtained by the specification:

$$w_i = \alpha_i + \sum_j \gamma_{ij} \, lnp_j + \beta_i \ln\left(\frac{x}{a(p)}\right) + \frac{\lambda_i}{b(p)} \left\{\ln\left(\frac{x}{a(p)}\right)\right\}^2, \tag{2.1}$$

where $w_i = \frac{p_i q_i}{\sum_{i=1}^{n} p_i q_i}$ is the expenditure share with the product i ; x is the total expenditure on all goods; p_j is the price with the product j; and α_i, γ_{ij}, β_i e λ_i are the parameters to be estimated. The latter is the parameter required for the quadratic term of the expenditure.

Some constraints must be imposed on the parameters of QUAIDS share equation to guarantee consistency with Demand Theory. These theoretical constraints depend only on unknown parameters, which facilitate their imposition or testing[40]. The adding up, homogeneity and symmetry restrictions are satisfied, respectively, by:

$$\sum_i \alpha_i = 1; \; \sum_i \beta_i = 0; \sum_i \gamma_{ij} = 0; \sum_i \lambda_i = 0, \tag{2.2}$$

$$\sum_j \gamma_{ij} = 0, \tag{2.3}$$

$$\gamma_{ij} = \gamma_{ji}, \forall \, i \neq j, \tag{2.4}$$

Provided that equations (2.2), (2.3), and (2.4) hold, the estimated demand functions add up to the total expenditure, are homogenous of degree zero in prices and income, and satisfy the Slutsky symmetry.

[40] Only the negativity constraint is not testable, dependent only on the data. The denomination “almost” in the AIDS stems from this fact (COELHO, 2006).

The expenditure elasticities, price elasticities and cross-price elasticities of demand can be found by differentiating equation (2.1) with respect to the logarithm of expenditure ($ln\ x$) and the logarithm of prices (($ln\ p_j$) respectively:

$$\mu_i \equiv \frac{\partial w_i}{\partial \ln x} = \beta_i + \frac{2\lambda_i}{b(p)}\{ln\left(\frac{x}{a(p)}\right)\}, \tag{2.5}$$

$$\mu_{ij} \equiv \frac{\partial w_i}{\partial ln p_j} = \gamma_{ij} - \mu_i\left(\alpha_i + \sum_j \gamma_{ij}\, lnp_j\right) - \frac{\lambda_i \gamma_i}{b(p)}\{\ln\left(\frac{x}{a(p)}\right)\}^2, \tag{2.6}$$

The expenditure elasticities (e_i) and Marshallian price elasticities (e_{ij}^u) can be written as:

$$e_i = \frac{\mu_i}{w_i} + 1, \tag{2.7}$$

$$e_{ij}^u = \frac{\mu_{ij}}{w_i} - \delta_{ij}, \tag{2.8}$$

where δ_{ij} is called Delta Kronecker, whose assumed values are:

$$\delta_{ij} = \begin{cases} 1\ se\ i = j \\ 0\ \ se\ i \neq j \end{cases} \tag{2.9}$$

Finally, the compensated price elasticities (Hickisian) (e_{ij}^c) can be calculated by the Slutsky equation. This equation is given by:

$$e_{ij}^c = e_{ij}^u + e_i w_j, \tag{2.10}$$

The AIDS model is a particular case of the QUAIDS model if $\lambda_i = 0$ on equation (2.1). The QUAIDS model preserves all the qualities of the AIDS model such as flexibility, ease of estimation and consistency in consumer aggregation, and allows to capture more accurately the effects of total expenditure or income on the demands of each product. Moreover, according to Banks et al. (1997), unlike the AIDS model, the quadratic term allows us to capture different behaviors along the distribution of total

expenditure, so that a good can be a luxury at a low level of expenditure and a normal good at a higher level. This is a common pattern in household budget research.

3.2.2. Estimation procedure

The demand systems[41] we have estimated, in addition to include prices and expenditure, will also include variables related to demographic characteristics of the household head, household composition and time periods. The incorporation of these variables into the demand system is done through linear demographic translation (POLLAK; WALLES, 1981). Therefore, the demand systems estimated in the paper can be expressed as follows:

$$w_{ik} = \sum_k \theta_{ik} D_{ik} + \alpha_i + \sum_j \gamma_{ij}\, log p_j + \beta_i\, log\left(\frac{x_r}{a(p)}\right) + \frac{\lambda_i}{b(p)}\left\{log\left(\frac{x_r}{a(p)}\right)\right\}^2 + \vartheta_{ik}, \qquad (2.11)$$

where D_{ik} is a vector of variables that characterize the k-th household; θ_{ik} are the estimated parameters for each of these variables; $b(p) = \prod_n p_k^{\beta_\lambda}$ is a Cobb-Douglas price aggregator; and ϑ_{ik} is the random error with mean zero. For the estimation of the demand systems in the present paper, we used the Laspeyers price index[42]:

$$\log a(p) = \log P = \sum_j w_j^0 \ln p_j, \qquad (2.12)$$

where w_j^0 is the average expenditure shares in the base period with the *j-th* good.

As described in section 2.1, in order to obtain the expenditure elasticities, price elasticities and cross-price elasticities, first differentiate equation (2.11) with respect to the logarithm of expenditure and prices, respectively, generating the following terms (BANKS *et al*., 1997):

[41] For a complete analysis, we will estimate two demand systems: one only with households headed by elderly; and the other one only with adults-headed households. More details in the following section.

[42] The standard price index of the AIDS model is not linear in the parameters, so Deaton and Muellbauer (1980) suggest the Stone index, aiming to linearize the model. This facilitates estimation and convergence of results. However, Moschini (1995) proves that such index is not invariant in relation to price and quantity changes, suggesting as substitutes the Laspeyres index.

$$\mu_i \equiv \frac{\partial w_i}{\partial \ln x} = \beta_i + \frac{2\lambda_i}{b(p)} (\log x_r - \log P), \tag{2.13}$$

$$\mu_{ij} \equiv \frac{\partial w_i}{\partial ln p_j} = \gamma_{ij} - \left[\beta_i + \frac{2\lambda_i}{b(p)} (\log x_r - \log P)\right] \left(w_j^0\right) - \frac{\lambda_i \gamma_i}{b(p)} [\log x_r - \log P]^2, \tag{2.14}$$

The expenditure elasticities (e_i) and Marshallian price elasticities (e_{ij}^u) can be written as:

$$e_i = \frac{\mu_i}{w_i} + 1, \tag{2.15}$$

$$e_{ij}^u = \frac{\mu_{ij}}{w_i} - \delta_{ij}, \tag{2.16}$$

The compensated price elasticities (Hickisian) (e_{ij}^c) can be calculated by the Slutsky equation $\left(e_{ij}^c = e_{ij}^u + e_i w_j\right)$, and are used to classify the goods as substitutes or complements.

According to Su and Yen (2000), it is possible to measure the impact of the demographic variables present in vector D_k by varying the quantity demanded when the dummy variable in question oscillates from zero to one. Thus, this impact can be considered as the intensive effect, or the direct impact of the quantity acquired. This impact can be calculated as follows (LAZARIDIS, 2004):

$$e_{i,z} = \frac{\theta_{ik} D_{ik}}{\overline{w_i}}, \tag{2.17}$$

where $e_{i,z}$ is the marginal effect of the i-th good in relation to the demographic variable Z_{ik}; θ_{ik} are the estimated parameters demographic variables; D_{ik} is the vector of demographic variables; and $\overline{w_i}$ is the expenditure share at the midpoint.

Thus, the elasticities are in function of the estimated parameters and the variable in the midpoint, in the case of continuous variables, or the variable in the unit point, in the case of the dummies variables. In order to make statistical inference about the values of the elasticities, the so-called "delta method"[43] is applied, which allows to transform

[43] See Deaton (1997) for a detailed description of the Delta method.

the variance-covariance matrix of the estimated parameters into the variance-covariance matrix of the parameters of interest (DURHAM; EALES, 2010).

The parameters of the QUAIDS demand systems were estimated by the programming routine for STATA described in Poi (2008). Due to limited degrees of freedom and thus to improve the efficiency of our estimates the demand restrictions are imposed. The adding up constraint was imposed by treating one of the goods as "residual" and the demand systems were estimated for $n-1$ goods, and the homogeneity and symmetry constraints were imposed on the demand systems by parameter restrictions (YEN *et al.*, 2003). The residual good chosen was "Other expenses", because despite its representativeness, it is the good of lesser interest in the estimation. Through the adding up restriction, it is possible to retrieve the parameters and calculate the elasticities for that good. Although a linear price index is applied, the QUAIDS model is still nonlinear due to the term $b(p)$. As a consequence of this characteristic, the demand equations (2.11) were estimated by an apparently unrelated nonlinear regression system (SUR), according to STATA's NLSUR command. The method used was IFGNLS (Iterated feasible generalized non-linear least squares), with results similar to the Maximum Likelihood estimates.

3.3. DATABASE

3.3.1. Brazilian Household Budget Survey – POF

The data sources for expenditures come from the microdata of the Brazilian Household Budget Survey - *Pesquisa de Orçamentos Familiares* (POF) conducted by the Brazilian Institute of Geography and Statistics - *Instituto Brasileiro de Geografia e Estatística* (IBGE) in 1995/96, 2002/03 and 2008/09, which collected households' expenditure on consumption goods/services from 11 metropolitan areas, in the case of POF 1995/96, and all Brazilian territory, in the case of POF 2002/03 and POF 2008/09. The POFs are a cross sectional national surveys which gathers information on household expenditures, incomes and sociodemographics (IBGE, 1997, 2004 and 2010).

Since the sample of POF 1995/96 was restricted to Brazilian main cities, we restricted our sample accordingly, gathering data from 11 metropolitan areas: 1. Rio de Janeiro; 2. Porto Alegre; 3. Belo Horizonte; 4. Recife; 5. São Paulo; 6. Municipality of Brasília-DF; 7. Belém; 8. Fortaleza; 9. Salvador; 10. Curitiba; and 11. Municipality of

Goiânia[44]. For simplicity, we will call all of them metropolitan areas. We also selected our sample by age of the household head. We divided the entire sample in two subsamples: only households headed by elderly with more than 60 years old composed the first one; and adults aged between 18 and 59 years old composed the second subsample. The final samples are composed of 5,697 households headed by elderly and 23,253 households headed by adults.

Family level monthly expenditures on various detailed commodity groups are available in the POFs surveys. We aggregate them into six broad categories: 1. Food; 2. Housing; 3. Clothing; 4. Transportation; 5. Health care; and 6. Other expenses. Because POF surveys present very disaggregated data with several subdivisions per product, it was necessary to aggregate the various subtypes in order to obtain the desired six categories. Thus, the products considered in the aggregated demand system are presented in Table A1 in Appendix. The system estimation comprises 5 share equations. The residual good chosen was "Other expenses". We included 9 demographic variables inside the vector D_k described on Table 1: three household head characteristics and six household composition characteristics. All demographic variables are allowed to affect both the preferences of each household headed by elderly person or adult. In order to delineate the socioeconomic profile of the different living arrangements, an exploratory analysis of the data was carried out, which consists of characterizing the population under study with clarity and precision, so that the group characteristics can be discovered. The Brazilian National Survey by Household Sample – *Pesquisa Nacional por Amostra de Domicílios* (PNAD) of 2009 brings a classification of living arrangements, however it is restricted to the study in question, not bringing, for example, living alone arrangement. Thus, it was decided to carry out a new classification for living arrangements. This empirical classification, which corresponds mainly to the possibilities and imitations provided by the database, were the following: living alone; living with another relative; living with spouse only; living with spouse

[44] According to POF 2008/09 data, there were 12,905,981 households headed by elderly people in Brazil, where 10,744,628 belonged to urban areas (83.3% of all households), 4,539,422 to metropolitan areas (35.2% of all households and 42.3% of urban households) and 4,033,494 to the eleven metropolitan regions analyzed (31.3% of all households, 37.6% of urban households and 88.9% of metropolitan households). In addition, there were 41,620,280 adult-headed households in Brazil, where 35,236,113 belonged to urban areas (84.6% of all households), 15,547,667 to metropolitan regions (37.4% of all households and 44.1% of urban households) and 13,364,201 to the respective metropolitan areas (32.1% of all households, 37.9% of urban households and 86% of metropolitan households). These information show that the eleven metropolitan areas covered in the study are relevant in relation to the total households, those located in urban areas and in the metropolitan regions as a whole in Brazil.

and child; living with spouse and relative; living with spouse, child and relative; and living with child and/or relative.

Variable	Description
Household head characteristics	
Education level	Household head Education in years
Gender	Dummy=1 if the household head is a woman.
Government transfers[1]	Dummy=1 if the household head receives any government transfer
Household compostion characteristics	
Living arrangement 01	Dummy=1 if elderly or adult living alone
Living arrangement 02	Dummy=1 if elderly or adult living with another relative
Living arrangement 03	Dummy=1 if elderly or adult living with spouse
Living arrangement 04	Dummy=1 if elderly or adult living with spouse and child
Living arrangement 06	Dummy=1 if elderly or adult living with spouse, child and relative
Living arrangement 07	Dummy=1 if elderly or adult living with child and/or relative

Note: [1]Within this variable we consider all possible government transfers including: retirement and pensions; federal social programs; and other transfers, such as scholarships and grants. The default variables for the household composition characteristics were Living arrangement 05, which the household-head lives with spouse and relative.
Table 2 - Variables present in vector D_k.

3.3.2. Price Index System[45]

Until the paper of Asano and Fiúza (2001), the only source of a cost-of-living[46] difference estimates across regions in Brazil was a Staple Food Basket collected by Dieese, a research institute supported by labor unions, in 16 state capitals. The need of a more comprehensive and up to date household basket of goods and services for estimating a system of consumption demand equations led those authors to construct a new set of Regional Price Difference Indexes (RPDI) based on a combination of the existing price variations at subitem level, released monthly by Brazilian Geographical and Statistical Institute (IBGE), with special tabulations of nominal prices provided by the same source.

Following Asano and Fiúza (2001), price indexes were constructed for the six categories. The price indexes allow comparisons both across-time and across-region. The authors named this Price index as Regional Price Difference Indexes (RPDI) based on a combination of the existing price variations at subitem level, released monthly by IBGE

[45] For more details about the Price Index System, see Asano and Fiúza (2001).
[46] The ratio of the minimum expenditures required to attain a particular indifference curve under two price regimes (POLLAK, 1989).

– the IPCA – *Índice Nacional de Preços ao Consumidor Amplo*[47], with special tabulations of nominal prices provided by the same source.

In order to calculate RPDI we used a set of nominal prices released by IBGE. Neither of the prices are contemporaneous: food prices had been released earlier by IBGE, for September 1996. The delivered non-food nominal prices referred to September 1999. We calculated RPDI for three instants in time: September 1996, January 2003 and January 2009, respectively the reference dates of POF 1995/96, POF 2002/03 and POF 2008/09. The equation that expresses RPDI is:

$$P_{rt} = \sum_j w_{j00} \frac{P_{jrt}}{P_{j00}}, \quad (3.1)$$

where:

P_{rt} is the Index for metropolitan area r at time t;

P_{jrt} is price of good j in metropolitan area r at time t;

P_{j00} is average price of good j in all metropolitan areas where weight greater than zero is observed in the reference date; and

w_{j00} is the subitem j average national weight at reference period that is, the average share of the subitem expenditure in total (or group or subgroup or item) household expenditure over all metropolitan areas.

We divided the process to calculate RPDI into six steps:

1. Organize the prices of each subitem of the aggregate by metropolitan region. Therefore, the prices for each subitem were organized into the six aggregates of goods: food, housing, clothing, transportation, health care and other expenses, according to the POF classification;
2. Tabulate all the IPCA variations for each metropolitan area from September 1996 until January 2009;
3. Use the IPCA variation to calculate the real prices of all subitems for the periods of September 1996, January 2003 and January 2009 on each metropolitan areas;
4. Tabulate the average share of the subitem expenditure in total household expenditure for all metropolitan areas. We decided to use January 2009 as the reference weight period for P_{j00} in the three instants time;

[47] Broadened Consumer Price Index in Brazil.

5. Identify the products that we had prices, but not weights at the reference periods, and the products that we had weights, but not prices. We did this process for the three periods. An interesting fact was that despite prices being from September 1996 and 1999, goods that presented prices and weights in the reference periods represented on average about 80% of the basket of goods used to calculate the IPCA at the three periods; and finally,
6. Redistribute the remaining subitems weights (20% on average) within each item that matched for prices and weights.

At this point, we already had the real price of all goods in metropolitan areas for all three periods (P_{rt}); the average price of all goods in all metropolitan areas where weight greater than zero is observed in January 2009 (P_{j00}); and the subitem j average national weight for all periods (w_{j00}). Than we calculate the RPDI for the six goods in the eleven metropolitan areas for the three periods of time as shown in Table A2, A3 and A4 in the Appendix.

Asano and Fiúza (2001) pointed some limitations of Brazilian data for calculating RPDI. Brazilian National Consumer Price Index System (SNIPC)[48] products vary from region to region, such that very few subitems are completely comparable across all metropolitan areas. Another limitation for constructing the RPDI is that we would need a minimum set of standardized products present in all metropolitan areas with their weights provided by a regular (yearly if possible) household expenditure survey. To circumvent this heterogeneity, we use different products across areas within each aggregate. A problem is that, since subitem price variations are computed over all products of the subitem, using them to chain RPDI is likely to bias regional comparisons along time. To deal with this problem we use the price variation by individual products provided by IPCA along time. Finally, expenditures on domestic servants or vehicle, for example, which amount to a high share in the personal service and transportation subgroup, are treated by IBGE as if no regional difference existed, because it uses the official minimum wage as parameter, which is unique in the whole country. Those are the limitations from the Brazilian database when using the RPDI.

[48] The National Consumer Price Index System (SNIPC) was created in 1979 and the first national index was released in 1980, based on nine metropolitan areas and the Federal capital, Brasília (in 1989 another city, Goiânia, was added to the sample). It comprises two main sets of indices: the National Consumer Price Index (INPC) and the Broadened Consumer Price Index (IPCA) (ASANO; FIUZA, 2001).

3.4. EMPIRICAL RESULTS

3.4.1. Descriptive statistics – Consumption patterns by household head

In this section, we discuss the main descriptive statistics from our database. Table 2 provides summary statistics from our sample by household head and by the three periods of POF. We can see that the average age in elderly-headed households across POF's are close to 69 years old, and in adult-headed household ranges from 39.8 in POF 1995/96 to 41 years old in POF 2008/09. The average education level was higher for the adult-headed households across all the POFs, and higher for both elderly and adult-headed household on POF 2008/09, 5.9 and 8.6 respectively. In general, most of the households are headed by elderly and adult males, but the proportion of woman-headed household are growing across time, ranging between 43% to 48% in elderly-headed households and 23.8% to 33.9% in adult-headed households.

Another important statistic is related to Government transfers. Most of the elderly-headed households receive some kind of government benefit, unlike the adult-headed households. In the period of POF 1995/96 almost 70% of the elderly-headed household received any kind of Government transfers, reaching 90% in the period of POF 2002/03. This information can be justified by the increase in the Federal Social Programs at the beginning of the 21st century, mainly the benefit called *Benefício de Prestação Continuada (BPC),* a government social assistance benefit that aims to provide a minimum wage for all elderly of 65 years or older and disabled people who are not entitled to social security, cannot work or lead an independent life and receive up to ¼ of the minimum wage as per capita family income (BRASIL, 2006).

Data reveals that the most common arrangement in 2008/09 in elderly-headed households is Living arrangement 7 - Elderly living with child and/or relative (39.4%), followed by Living arrangement 1 - Elderly living alone (22.2%) and Living arrangement 3 – Elderly living with spouse only (14.9%), though the percentage of Living arrangement 7 is decreasing across time, unlike the Living arrangements 1 and 3 that are increasing across time. Regarding the adult-headed households the most common is Living arrangement 4 – Adult living with spouse and child (46.4%), followed by Living arrangement 7 – Adult living with child and/or relative (19.4%) and Living arrangement 3 – Adult living with spouse only (11%). The percentage of Living arrangement 4 is

decreasing across time, unlike the Living arrangements 7 and 3 that are increasing their percentage across time. According to Camarano (2007), the largest growth in living arrangements since 1990 were those of adults/elderly living alone and single-parent families, caused mainly by the reduction of mortality at the advanced ages.

Table 2 - Summary statistics of the sample, by household head

	Elderly-headed household				Adult-headed household			
	POF 95/96	POF 02/03	POF 08/09	Full data	POF 95/96	POF 02/03	POF 08/09	Full data
Budget shares								
Food	0.357	0.203	0.188	0.273	0.310	0.212	0.216	0.262
Habitation	0.201	0.409	0.487	0.333	0.203	0.361	0.408	0.296
Clothing	0.067	0.040	0.042	0.054	0.086	0.058	0.059	0.072
Transportation	0.121	0.083	0.095	0.105	0.174	0.135	0.153	0.160
Health care	0.119	0.182	0.102	0.126	0.065	0.123	0.049	0.073
Other expensives	0.134	0.083	0.086	0.109	0.161	0.112	0.115	0.137
Expenditure (montly in BRL)								
Food	221.24	324.07	423.89	305.97	224.16	334.70	445.00	310.69
Habitation	164.84	688.13	1,113.31	569.37	196.64	623.45	861.84	478.08
Clothing	53.64	78.94	107.19	75.68	73.19	101.00	138.36	97.66
Transportation	181.85	262.70	393.10	265.18	243.12	342.27	489.61	334.34
Health care	84.78	399.93	301.32	214.24	59.53	269.85	133.00	126.75
Other expensives	129.31	196.20	280.66	190.72	173.79	256.66	318.66	232.85
Total	835.67	1,949.97	2,619.48	1,621.16	970.42	1,927.93	2,386.47	1,580.38
Household charactersitcs								
Age (years)	69.1	69.4	69.4	69.3	39.8	40.1	41.0	40.2
Education (years of education)	4.62	4.57	5.90	5.81	7.33	7.63	8.66	8.59
Gender	0.437	0.465	0.480	0.456	0.238	0.300	0.339	0.280
Governement transfer	0.697	0.903	0.883	0.796	0.202	0.361	0.326	0.272
Arrangement 01	0.160	0.197	0.222	0.187	0.054	0.088	0.100	0.074
Arrangement 02	0.088	0.076	0.064	0.078	0.049	0.046	0.043	0.047
Arrangement 03	0.103	0.111	0.149	0.119	0.077	0.083	0.110	0.088
Arrangement 04	0.098	0.103	0.088	0.096	0.502	0.486	0.464	0.488
Arrangement 05	0.028	0.028	0.024	0.027	0.013	0.018	0.015	0.015
Arrangement 06	0.088	0.084	0.058	0.078	0.128	0.096	0.074	0.106
Arrangement 07	0.434	0.401	0.394	0.415	0.176	0.182	0.194	0.183
Income (montly in BRL)	1,296.92	2,292.00	3,858.35	2,310.15	1,271.02	2,213.17	3,108.63	1,996.03
Income (montly in USD)	1,270.37	666.75	1,672.71	-	1,244.99	643.82	1,347.68	-
Sample size	2,783	1,080	1,834	5,697	11,619	5,172	6,562	23,353

Source: Research results.

Note: (1) Elderly or adult living alone; (2) Elderly or adult living with another relative; (3) Elderly or adult living with spouse only; (4) Elderly or adult living with spouse and child; (5) Elderly and adult living with spouse and relative; (6) Elderly or adult living with spouse, child and relative; (7) Elderly or adult living with child and/or relative; and (8) The exchange rate is $1 = 1,02 BRL Brazilian real in September 1996; $1 = 3,44 BRL Brazilian real in January 2003; and $1 = 2,31 BRL Brazilian real in January 2009.

Budget shares, in turn, show that expenditure on foods was the main item on the elderly and adult-headed household in the period of POF 1995-96. However, spending on housing became more and more relevant, being the main expenditure in the period of POF 2008/09, representing about 48.7% and 40.8% of the budget shares in elderly and adult-headed households, respectively. In general, all the others budget shares had lost importance in the most recent POF periods. Comparatively, the budget shares percentage related to Food, Housing and Clothing are similar between households headed by adults and elderly. However, the budget shares of Transportation, Health Care and Other expenses are different. The budget share on Health care was greater in elderly-headed households, 10.2%, and only 4.9% in adult-headed households in the period of POF 2008/09. Instead, the budget share on Transportation was greater in adult-headed households, 15.3%, compared with only 9.5% in elderly-headed households in the period of POF 2008/09. There are some studies that confirmed that older households spend more of their income on basic needs than younger households. Compared with adults, the elderly spend more on housing, food, and healthcare—the three most important items in their total consumption — and less on clothing and transportation (Chen and Chu (1982); Chung and Magrabi (1990); Lee e*t al.* (1997); and Lee, Sohn and Rhee (2014)).

Figure 1 depicts the allocation of total consumption expenditures on the six goods by age of the household head over the period of POF 1995/96 and POF 2008/09. It shows that the share of Food stays roughly constant across years old. Health expenditures gain an increasing weight in total spending from age 60 onwards. Its share roughly doubles between 60 and 80. A very similar pattern can be seen for Housing expenditure shares with an increasing weight in total spending from age 60. The expenditure shares of Clothing, Transportation and Other expenses, on the contrary, are highest at young ages and decline after age 60. However, Figure 1 does not enable us to distinguish the sources of differences: age, year and generation. Thus, it only serves as a descriptive starting point for the analysis.

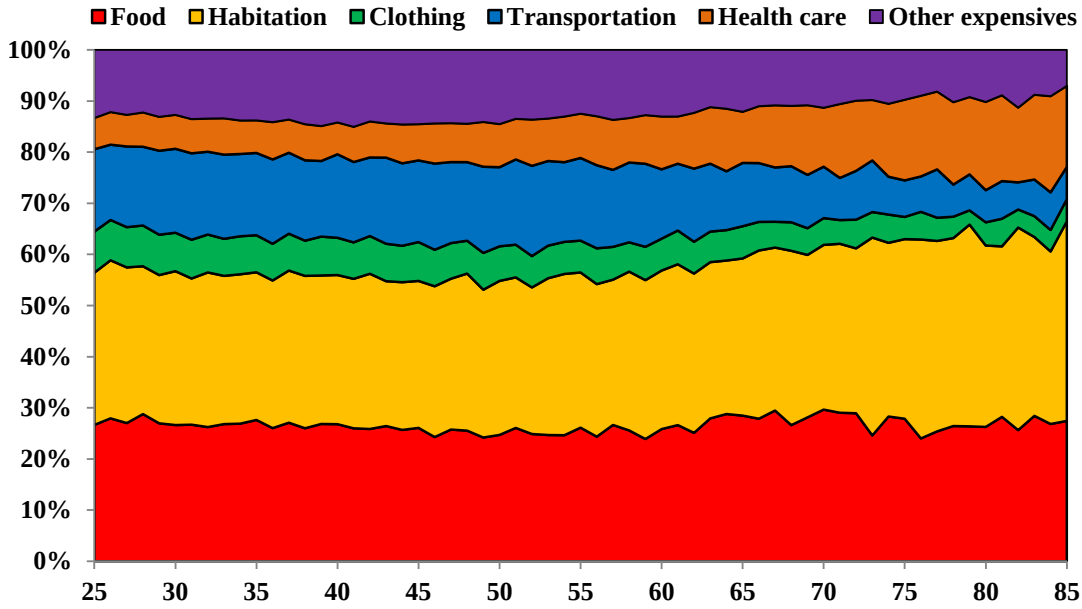

Figure 1 – Share of each demand in total consumption (%) by age.
Source: Research results.

We will now consider the Life-cycle and Permanent-income hypothesis[49] on the variation in consumption and income when household head age changes. Generally, the total expenditure and income of the elderly-headed households in all periods are close to the adult-headed households. However, the total expenditure was higher in elderly-headed households in the periods of POFs 2002/03 and 2008/09, and the income was higher in all the three periods in elderly-headed households. Most of the studies[50] applied to other countries support that consumption expenditures of elderly-headed households declined as they retire, finding little support for the formulations of the Life-Cycle/Permanent-income hypothesis. According to them, most of the retired elderly people do not dissave as quickly as has been said in the Life-cycle model. If we subtract total consumption expenditures from total income in households headed by adults and elderly (Table 3), we can see that the remaining income or apparent savings is still higher for all the three periods in elderly-headed households. So the elderly are cautious about unpredictable expenses and made precautionary saving for the probable event of

[49] The life-cycle hypothesis implies that individuals both plan their consumption and savings behavior over the long-term and intend to keep their consumption levels approximately the same in every period. Permanent income hypothesis on the other hand, states people maintain a fairly constant standard of living even though their incomes may vary considerably from year to year. As a result, increases and decreases in income that people see as temporary have little effect on their consumption spending (Browning and Crossley, 2001).

[50] Bernheim, Skinner, and Weinberg (2001), Haider and Stephens (2003), Miniaci, Monfardini, and Weber (2003), Aguiar and Hurst (2004) and Smith (2004).

living longer than expected or the possibility of ill-health and huge medical expenses. These probable events make the elderly-headed households in Brazil save more than adult-headed households, but in average they still have more income too.

3.4.2. Demand elasticities by household head

It is rather hard to evaluate results based upon the original parameters in the estimation of demand systems. So we display the estimates of the parameters from the elderly-headed households and adult-headed households in Tables A5 and A6 at the Appendix. Here, we will only examine results based upon the estimates of the price and expenditure elasticities, important parameters in projecting demand. Expenditure elasticity and own- price elasticity by household head are presented on Tables 3 and 4.

Table 3 – Expenditure elasticities by household head

Goods	Elderly-headed households			Adult-headed households		
	Expenditure elasticity	95% Conf. Interval		Expenditure elasticity	95% Conf. Interval	
		Limit Inferior	Limit Superior		Limit Inferior	Limit Superior
Food	1.057*	0.966	1.147	1.415*	1.358	1.471
Housing	1.225*	1.139	1.311	1.059*	1.005	1.114
Clothing	1.194*	1.014	1.373	1.099*	1.006	1.192
Transportation	0.190*	0.010	0.371	0.286*	0.238	0.335
Health care	0.839*	0.671	1.007	0.559*	0.469	0.649
Other expensives	1.040*	0.899	1.180	1.093*	1.026	1.159

Source: Research results.
Note: *$p < 0.01$.

Table 4 – Own-price elasticities by household head

Goods	Elderly-headed households			Adult-headed households		
	Own-price elasticity	95% Conf. Interval		Own-price elasticity	95% Conf. Interval	
		Limit Inferior	Limit Superior		Limit Inferior	Limit Superior
Food	-0.541*	-0.720	-0.362	-0.407*	-0.486	-0.329
Housing	-0.349*	-0.495	-0.204	-0.400*	-0.470	-0.330
Clothing	-0.288*	-0.467	-0.110	-0.334*	-0.403	-0.265
Transportation	-1.345*	-1.586	-1.104	-1.069*	-1.163	-0.975
Health care	-1.744*	-1.946	-1.542	-1.575*	-1.694	-1.456
Other expensives	-1.686*	-1.864	-1.508	-1.581*	-1.652	-1.510

Source: Research results.
Note: *$p < 0.01$.

Comparing the results found for expenditure elasticities in households headed by the elderly and adults considering the 95% confidence interval, adult-headed households were more sensitive to changes in expenditure for Food products, while households headed by the elderly showed more sensitivity for Health care. This result shows that the elderly-headed households in Brazil are not able to spend what they would like with Health care in comparison to adult-headed households. We can confirm that with the degeneration of health with age, the needs of older people tend to be generally be larger than young people. The expenditure elasticities for other products were similar for both household heads. According to Lee, Sohn and Rhee (2014), previous studies on how the elderly allocate their expenditures internationally have repeatedly confirmed that older households spend more of their income on basic needs than do younger households. Compared with the nonelderly, the elderly spend more on housing, food, and healthcare - the three most important items in their total consumption, as we found here for Brazil - and less on clothing and transportation. So we may justify why the elderly-headed households increase less their Food, Housing and Health care consumption compared to other products (Clothing and Other expenses) when their total expenditure rises. Particularly in Brazil, the increase in total expenditure leads to a more than proportional increase in Clothing expenditure. Comparing the results found for own-price elasticities in households headed by the elderly and adults, we cannot find any statistical difference among them.

In general, the results for expenditure elasticities were significantly and positive, as expected theoretically, for all goods on both databases. Expenditure elasticities indicate that Transportation and Health Care are necessities for both elderly and adult-headed households, whereas Food, Housing, Clothing and Other expenses are found to be luxuries. In relation to Housing, we found results very similar to those of Asano and Fiúza (2001), who found expenditure elasticities for Housing and Furniture of 0.818 and 1.316 respectively for POF 1995/96. Pinto-Payeras (2009), who estimate price-elasticities, cross-elasticities and expenditure elasticities for 27 groups of products using POF 2002-2003 microdata, found expenditure elasticity for Housing and Home appliances close to unity. Clothing products in most of the studies in Brazil was considering luxury goods. Asano and Fiúza (2001) found expenditure elasticities of 1.184 for Clothing products. However, most recent studies like Pinto-Payeras (2009) and Almeida (2011) found expenditure elasticities for Clothing below unity, 0.92 and

0.95 respectively. In relation to Transportation, most of studies for Brazilian population considered Public transportation as a necessity, while Private transportation was considered a luxury. As the proposal of the work was to analyze the Transportation in aggregate form, we expected expenditure elasticities for this good to be higher than what we found. Health care products are commonly considered luxury goods in most of Brazilian studies, but we need to point out the difference between the expenditure elasticities for this product, probably because the proportion and need for Health care expenditures in elderly-headed households is much higher than in adult-headed households, as evidenced in the previous section, making those households more sensitive to income changes. However, the study of Hoffmann (2010), who uses data from POF 2008-09 to estimate income elasticities for several types of consumer incomes (food consumption at home and away from home, education, transportation, health care, etc.), found income elasticity for Health Care product of 0.907 on average, and 0.780 and 0.762 for low and high income stratum, respectively.

Finally, we didn't expect that Food was considered a luxury good, although within this category are included the food away from home, traditionally considered a luxury good in Brazil. As showed in Hoffmann (2010) and Almeida (2011), food demand is more responsive to changes in income for beverages, meat, fish, eggs and dairy products, compared to foods that trend to constitute basic diets (e.g. cereals, legumes and nuts and vegetables, fats and oils, tubers). However, Coelho, Aguiar and Eales (2010), that estimate a demand system including eighteen food products using data from POF 2002/2003 and a uses a close methodology, found that most of the expenditure elasticities for food products were close to unity. In some cases, basic diets products like Sugar (1.898), Bananas (1.135) and Potatoes (1.043), and the traditional Powdered Milk (1.076) and Cheese products (1.130), were considered luxury goods in Brazil.

The results for own price elasticities were significantly and negative, as expected theoretically, for all goods on both databases. Own-price elasticities indicate that most of the goods - Food, Housing and Clothing – were considering inelastic in Brazil for elderly and adult-headed households, whereas Transportation, Health care and Other expenses was considered elastic for both elderly and adult-headed households. Health care are found to be elastic to own-price variation for both groups. This result shows that when the price of Health care increases, Brazilian consumers tend to seek the public

health system (*Sistema Único de Saúde – SUS*) and/or decrease or interrupt the use of medicine, which can be detrimental to health. According to Dieleman *et al*. (2017), who projected health investment up to 2040 in 184 countries, the health public investment in Brazil will be equivalent to 56% of the total expenditure in 2040. All the rest will be spent privately, banked by citizens and businesses. In developed countries like France and the United Kingdom, about 80% of spending on health is public expenditure today and will be continue like this in 2040. Therefore, the Brazilian private health system must grow and become efficient so that this growing demand for Health care is supplied.

Exploring further results from national studies on own price elasticities, Asano and Fiúza (2001) found that Food, Housing and Furniture, Transportation and Other expenses were inelastic to own-price variation as we found. The same authors found that Clothing (-1.112) and Health care (-1.004) were elastic to own-price variations. A more recent study using a different methodology, Pinto-Payeras (2009) found that most of the Food products were considering inelastic to own-price variation. The same author found own-price elasticities for Housing, Clothing and Public Transportation products close but above unity. Unlike us, Pinto-Payeras (2009) found own-price elasticities for Health below unity or inelastic to price variation, as well as he found that own-price elasticities for Private transportation were higher than one. Almeida (2011) results are close to ours too, as most of the products he considered were inelastic to own-price variation, except private transportation related products like Automotive gasoline (-1.03) and Automobiles, Trucks and commercial vehicles (-1.06). Health care own-price elasticity was close to unity (-0.93) in Almeida (2011) paper.

3.4.3. Impact of demographic variables in elderly-headed households

One of the main objectives of this study is to analyze the impact of demographic characteristics on the consumption pattern in the elderly-headed households. Among these features, we included characteristics of the household head and the household composition. According to Koelln, Rubin and Picard (2005), a significant variation in expenditures has been reported among older households - a variation due to differences in income, place of residence (rural versus urban), education level, race, and marital status. Therefore in this section we present the impact of demographic variables on the

demand in households headed by the elderly (Table 5). As we can see, most of the parameters (60%) were significant at $p < 0.1$.

Table 5 – Impact of demographic variables on the demand by elderly-headed households

Demographics	Food	Housing	Clothing	Transportation	Health care
Education	-0.107***	0.094***	-0.086***	-0.025	-0.033*
Gender	-0.108***	0.117***	-0.037	-0.186***	0.163***
Government transfers	-0.091***	0.128***	-0.156***	-0.142***	0.088**
Living arrangement 01[A]	-0.139**	0.154***	-0.157	0.015	0.024
Living arrangement 02[B]	0.008	-0.042	0.162	0.090	-0.178*
Living arrangement 03[C]	-0.118**	0.105**	-0.302***	0.073	0.152
Living arrangement 04[D]	0.008	-0.065	0.059	0.191*	-0.102
Living arrangement 06[E]	0.015	-0.107**	0.348***	0.113	-0.188*
Living arrangement 07[F]	-0.011	-0.111**	0.378***	0.300***	-0.368***

Source: Research results.

Note: ***$p < 0.01$, ** $p < 0.05$ and * $p < 0.1$. (A) Elderly or adult living alone; (B) Elderly living with another relative; (C) Elderly living with spouse only; (D) Elderly living with spouse and child; (E) Elderly living with spouse, child and relative; (F) Elderly living with child and/or relative. The default variables for the household composition characteristics were Living arrangement 05, which the elderly household-head lives with spouse and relative.

The demographic variable related to the education of the elderly household head was significant for most of the goods, except for Transportation. The results show that a year of increase in schooling impacted positively the demand for Housing (9.4%) and negatively the demand for Food (-10.7%), Clothing (-8.6%) and Health care (-3.3%). Higher education is related to a better socioeconomic level and, therefore, greater consumption capacity. However, only one aggregate good in the elderly households grew in demand as the education level of the household head increased. Despite that, Food and Health care are among the most consumed good by elderly-headed households, so the increase in schooling can lead to a more rational and balanced consumption of these goods. Therefore, the assertion by Almeida and Kassouf (2004) that the increase in household-head education increases the probability of spending of the majority of the consumption aggregates, or that a higher level of purchasing power is a reflection of the greater schooling and, therefore, more likely to consume, haven't been confirmed here.

If the gender of the elderly-headed household was female, the impact of demand was positive for Housing (11.7%) and Health care (16.3%), and negative for Food (-10.8%) and Transportation (-18.6%). We found results close to Melo *et al*. (2014), who

pointed that Brazilian families headed by elderly women spend proportionately more on Housing, Clothing, Health care, Education, Culture and Personal services, while men-headed households spend more on Transportation, Food and Other current expenses. One of the secondary objectives of this paper was to analyses the impact of Government transfers in the demand by elderly-headed households, since about 80% receive some kind of benefit. The impact of Government transfers was significant for all goods with increasing demand for Housing (12.8%) and Health care (8.8%), indicating that elderly-headed households with this benefit tend to consume more of these goods, and decreasing demand for Food (-9.1%) and Clothing (-15.6%) if the elderly-household head receive any kind of Government transfer. Therefore, it is partly confirmed that Government transfers help older households to spend more on Housing, Food, and Health care - the three most important items in their total consumption - and less on Clothing and Transportation.

Finally, another specific objective of this paper was to analyze the consumption pattern among the different elderly-headed family composition. All the results presented here are compared to Living arrangement 05, where which *Elderly household-head lives with spouse and relative*. Unfortunately, most of the parameters here were not significant at $* p < 0.1$, indicating some resemblance among the different kind of elderly-headed households composition. However, we were able to find some consumption patterns in the results. For example, if we analyze the results related with households formed mostly by elderly (Living arrangements 01 and 03), we can see that they demand less Food (-13.9% and -11.8%, respectively) and more Housing (15.4% and 10.5%). So we can confirm that majority elderly households demand more comfort inside the house and less food products. Another pattern arises when we analyze households composed by children (Living arrangements 04, 06 and 07). If we look only for Living arrangements 06 and 07, we can see that they demand more Clothing (34.8% and 37.8%, respectively) and less Habitation (-10.7% and -11.1%) and Health care (-18.8% and -36.8%). In contract, if we look for Living arrangements 04 and 07, we can see that they demand more Transportation (19.1% and 30%, respectively). So we can confirm that households with children demand more Clothing and Transportation products, and less Habitation and Health care products. Other pattern we can found in households with relatives (Living arrangements 02, 06 and 07), with a tendency of less demand for Health care products (-17.8%, -18.8% and -36.8%, respectively). This result

arise perhaps because the elderly need to financial support these relatives or because they help the elderly to spend less on Health care than in another household composition.

3.5. SUMMARY AND CONCLUSIONS

The proportion of elderly and households headed by elderly in Brazil is increasing and most of elderly are living until an advanced age. Given that the demographic transition happened in Brazil at a faster pace, it is important to recognize differences between expenditure of the elderly and the adults in order to establish appropriate public policies to help elderly consumers. This study might also contribute to business companies to better understand this new public that is emerging, taking into account the fact that this is a group that is constantly growing and should be seen as a very promising group of consumers, mainly due to its purchasing power, availability of time and concern for their health and well-being.

Most of previous studies in Brazil carry out analyzes of the consumption pattern and the demand of different elderly-headed household's composition. Although informative, these Brazilian studies have typically used descriptive statistics, employed limited controls for sociodemographic and time differences among the elderly and did not use a demand system according to economic theory to identify such behavior in households headed by the elderly. Therefore, the purpose of this study was to compare consumption expenditure patterns and demand, measure by price and income elasticities, of elderly and adult-headed households, taking into account other socio-economic factors associated with consumer behavior based on last three POF's database (POF 1995/96, POF 2002/03 and POF 2008/09), and project changes in the aggregate consumption induced by population aging.

The findings of this study indicate that elderly consumers in Brazil are different from young consumers and there is an age effect in the consumption composition pattern in Brazilian households. In the course of the life cycle, households change the structure of their consumption and Health care and housing expenditures become more important components of the total consumption when people become older. Calculation of expenditure elasticities indicated that a one percent increase in total expenditures would likely result in a greater than one percent increase in expenditures on Food,

Clothing and Other expense by either age groups. However, adult-headed households were more sensitive to changes in expenditure for Food products, while households headed by the elderly showed more sensitivity for Health care. The expenditure elasticities for other products were considered statistically equal for both household heads. Results for own-price elasticities indicated that a one percent increase in prices would likely result in a greater than one percent increase in expenditures on Health care by either age groups. Comparing the results found for own-price elasticities in households headed by the elderly and adults, we can't find any statistical difference among them.

Considering the impact of demographic characteristics on the demand in the elderly-headed households, we found that: year of increase in schooling impacted positively the demand for Housing and negatively the demand for Food, Clothing and Health care; if gender of the elderly-headed household was female, the impact of demand was positive for Housing and Health care, and negative for Food and Transportation; government transfers increasing demand for Housing and Health care and decreasing demand for Food and Clothing; and finally, in relation to household composition variables, those formed only by elderly demand less Food and more Housing, those households composed by children demand more Clothing and Transportation products and less Habitation and Health care products, and those households composed by relatives demand less Health care products.

To establish appropriate consumer policies to promote the well-being of consumers in Brazil, policy makers need to know the differing patterns of consumption expenditure of elderly and adult consumers, and the effects of income, price and socio-economic and demographic factors on demand among the elderly and the adults. The findings of this study suggest that welfare economic policies should not be uniform for elderly and adult consumers, but should be diversified to accommodate the different consumption patterns of the elderly and the adult-headed households.

Therefore, recognizing that spending patterns differences between adults and the elderly related to goods as Food, Housing, Transportation and Health care, and that an increasing income in households headed by the elderly showed more impact on Health care expenditure compared to adult-headed households, can facilitate the development of useful public policy and programs by government or community agencies. For example, the relatively higher spending on healthcare by the elderly suggests programs

which focus on effective and economical healthcare will become increasingly important as the population ages.

Business firms can use the results of this study as a guide for market segmentation in areas such as Food, Housing, Clothing and Healthcare. As the elderly-headed households spend relatively more and are more sensitive to income and price variation for Housing and Health care, businesses that effectively target the segment of the elderly may increase their market share. Also, opportunity exists for new project development. Recognizing diversity among the population, business firms can develop new goods and services and adapt existing goods and services to better meet the differing needs of adults and elderly-headed households.

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APPENDIX – Chapter 3

1 - Food
1.1 - Cereals, legumes and oilseeds
1.2 - Flours, starches and pasta
1.3 - Tubers and roots
1.4 - Sugars and derivatives
1.5 - Vegetables and greens
1.6 - Fruits
1.7 - Meat, offal and fish
1.8 - Poultry and eggs
1.9 - Milk and dairy products
1.10 - Breads
1.11 - Oil and lard
1.12 - Beverages and infusions
1.13 - Canned and preserved food
1.14 - Salt and seasonings
1.15 - Prepared foods
1.16 - Other foods
1.17 - Food outside the home
2 - Housing
2.1 - Rental
2.2 – Condominium fee
2.3 - Services and rates
2.4 - Home maintenance
2.5 - Cleaning products
2.6 - Furniture and household articles
2.7 - Home appliances
2.8 - Repair of household articles
3 - Clothing
3.1 - Man's clothes
3.2 - Woman's clothes
3.3 - Children clothes
3.4 - Footwear and accessories
3.5 - Jewelery and costume jewelery
3.6 - Fabrics and haberdashery
4 - Transportation
4.1 - Public
4.2 - Gasoline - Own vehicle
4.3 - Ethanol - Own vehicle
4.4 - Maintenance and accessories
4.5 - Vehicle acquisition
4.6 - Sporadic trips
4.7 - Others

5 – Health care
5.1 - Medicines
5.2 - Health insurance/plan
5.3 - Consultation and dental treatment
5.4 - Medical appointment
5.5 - Medical and outpatient treatment
5.6 - Surgery services
5.7 - Hospitalization
5.8 - Miscellaneous Examinations
5.9 - Treatment material
5.10 - Others
6 - Other expenses
6.1 - Hygiene and personal care
6.1.1 - Perfume
6.1.2 - Hair products
6.1.3 - Soap
6.1.4 - Instruments and personal products
6.2 - Education
6.2.1 - Regular courses
6.2.2 - Undergraduate courses
6.2.3 - Other courses and activities
6.2.4 - Textbooks and technical journals
6.2.5 - School supplies
6.2.6 - Others
6.3 - Recreation and culture
6.3.1 - Toys & games
6.3.2 - Cell phones & accessories
6.3.3 - Periodicals, non-textbooks and journals
6.3.4 - Recreation and sports
6.3.5 - Others
6.4 - Smoke
6.5 - Personal services
6.5.1 - Hairdressing
6.5.2 - Manicure and pedicure
6.5.3 - Repair of personal items
6.5.4 - Others
6.6 - Miscellaneous expenses
6.6.1 - Games and betting
6.6.2 - Communication
6.6.3 - Ceremonies and celebrations
6.6.4 - Professional Services
6.6.5 - Real estate for occasional use
6.6.6 - Others

Table A1 – Products considered in the demand system.

Table A2- Regional Price Difference Index for metropolitan areas at September 1996.

Metropolitan areas	Food	Habitation	Clothing	Transportation	Health care	Other expensives
Rio de Janeiro	0.482	0.377	0.539	0.356	0.550	0.430
Porto Alegre	0.392	0.301	0.513	0.425	0.444	0.462
Belo Horizonte	0.392	0.344	0.585	0.430	0.517	0.438
Recife	0.414	0.322	0.511	0.379	0.456	0.392
São Paulo	0.365	0.352	0.302	0.404	0.469	0.343
Distrito Federal	0.412	0.552	0.600	0.419	0.455	0.530
Belém	0.382	0.392	0.479	0.296	0.479	0.428
Fortaleza	0.459	0.331	0.522	0.396	0.573	0.448
Salvador	0.478	0.354	0.503	0.358	0.452	0.596
Curitiba	0.426	0.379	0.534	0.405	0.564	0.410
Goiânia	0.390	0.426	0.579	0.398	0.306	0.405

Source: Research results.

Table A3 - Regional Price Difference Index for metropolitan areas at January 2003.

Metropolitan areas	Food	Habitation	Clothing	Transportation	Health care	Other expensives
Rio de Janeiro	0.788	0.757	0.620	0.681	0.745	0.680
Porto Alegre	0.673	0.689	0.687	0.830	0.714	0.662
Belo Horizonte	0.644	0.661	0.660	0.812	0.697	0.641
Recife	0.679	0.569	0.610	0.695	0.684	0.520
São Paulo	0.638	0.799	0.625	0.799	0.770	0.869
Distrito Federal	0.661	0.853	0.781	0.836	0.661	0.804
Belém	0.626	0.766	0.554	0.620	0.603	0.594
Fortaleza	0.710	0.597	0.591	0.691	0.745	0.601
Salvador	0.732	0.669	0.623	0.724	0.670	0.721
Curitiba	0.663	0.673	0.675	0.782	0.818	0.705
Goiânia	0.675	0.752	0.783	0.755	0.844	0.650

Source: Research results.

Table A4 - Regional Price Difference Index for metropolitan areas at January 2009.

Metropolitan areas	Food	Habitation	Clothing	Transportation	Health care	Other expensives
Rio de Janeiro	1.130	1.067	0.994	0.943	0.980	0.985
Porto Alegre	0.945	0.930	1.111	1.175	0.948	1.016
Belo Horizonte	0.955	1.053	1.021	1.203	0.950	0.957
Recife	0.962	0.872	0.965	0.927	0.971	0.771
São Paulo	0.953	1.057	0.940	1.006	1.059	1.291
Distrito Federal	1.006	1.302	1.172	1.118	0.962	1.222
Belém	0.954	1.047	0.789	0.905	0.845	0.901
Fortaleza	1.005	0.868	0.883	0.845	1.063	0.912
Salvador	1.040	0.926	0.916	1.028	0.976	1.034
Curitiba	0.925	0.923	0.986	0.984	1.129	1.021
Goiânia	1.002	1.077	1.387	0.961	1.200	0.969

Source: Research results.

Table A5 – Estimated parameters of the elderly-headed demand system Brazil

Groups	Food	Habitation	Clothing	Transportation	Health care	Other expenses
Intercept	0.3587	0.3520	0.0836	0.1554	-0.0336	0.0840
	0.03	0.03	0.01	0.02	0.02	0.02
Prices in logarithmic form						
Food	0.1301	-0.0420	-0.0145	-0.0746	0.0363	-0.0353
	0.02	0.02	0.01	0.01	0.02	0.01
Habitation	-0.0420	0.0550	-0.0070	0.0246	-0.0222	-0.0084
	0.02	0.02	0.01	0.01	0.01	0.01
Clothing	-0.0145	-0.0070	0.0199	0.0114	0.0045	-0.0143
	0.01	0.01	0.01	0.01	0.01	0.01
Transportation	-0.0746	0.0246	0.0114	-0.0100	0.0384	0.0102
	0.01	0.01	0.01	0.01	0.01	0.01
Health care	0.0363	-0.0222	0.0045	0.0384	-0.0933	0.0365
	0.02	0.01	0.01	0.01	0.01	0.01
Other expenses	-0.0353	-0.0084	-0.0143	0.0102	0.0365	0.0113
	0.01	0.01	0.01	0.01	0.01	0.01
Ln (total expenditure)	-0.0076	-0.0260	0.0059	0.0110	0.0009	0.0159
	0.00	0.00	0.00	0.00	0.00	0.00
Ln (total expenditure)²	-0.0073	-0.0034	-0.0011	0.0111	0.0008	-0.0001
	0.00	0.00	0.00	0.00	0.00	0.00
Age	-0.0007	0.0023	-0.0007	-0.0020	0.0018	-
	0.00	0.00	0.00	0.00	0.00	-
Education level	-0.0061	0.0063	-0.0010	-0.0013	0.0005	-
	0.00	0.00	0.00	0.00	0.00	-
Gender	-0.0251	0.0270	-0.0007	-0.0163	0.0210	-
	0.01	0.01	0.00	0.00	0.00	-
Governement transfers	-0.0043	-0.0019	-0.0018	-0.0038	0.0102	-
	0.01	0.01	0.00	0.00	0.00	-
Arrangement 01	-0.0321	0.0380	-0.0073	0.0018	0.0091	-
	0.02	0.02	0.01	0.01	0.01	-
Arrangement 02	-0.0025	-0.0009	0.0070	0.0065	-0.0236	-
	0.02	0.02	0.01	0.01	0.01	-
Arrangement 03	-0.0297	0.0257	-0.0145	0.0074	0.0264	-
	0.02	0.02	0.01	0.01	0.01	-
Arrangement 04	-0.0005	-0.0147	0.0021	0.0164	-0.0095	-
	0.02	0.02	0.01	0.01	0.01	-
Arrangement 06	0.0001	-0.0245	0.0166	0.0084	-0.0234	-
	0.02	0.02	0.01	0.01	0.01	-
Arrangement 07	-0.0077	-0.0233	0.0172	0.0223	-0.0384	-
	0.01	0.01	0.01	0.01	0.01	-
POF 1995/1996	0.1253	0.0386	0.0163	0.0386	0.0498	-
	0.01	0.01	0.00	0.01	0.01	-
POF 2002/2003	0.0046	-0.0624	-0.0043	-0.0182	0.0871	-
	0.01	0.01	0.00	0.00	0.01	-

Note: Values below estimated parameters are standard errors.
Source: Research results.

Table A6 – Estimated parameters of the adult-headed demand system Brazil

Groups	Food	Habitation	Clothing	Transportation	Health care	Other expenses
Intercept	0.3264	0.4186	0.0822	0.1193	0.0242	0.0292
	0.01	0.01	0.00	0.01	0.01	0.01
Prices in logarithmic form						
Food	0.1749	-0.0740	0.0031	-0.0910	0.0068	-0.0198
	0.01	0.01	0.00	0.01	0.01	0.01
Habitation	-0.0740	0.0778	-0.0218	0.0242	0.0007	-0.0069
	0.01	0.01	0.00	0.01	0.00	0.01
Clothing	0.0031	-0.0218	0.0173	0.0060	-0.0047	0.0001
	0.00	0.00	0.00	0.00	0.00	0.00
Transportation	-0.0910	0.0242	0.0060	0.0140	0.0274	0.0194
	0.01	0.01	0.00	0.01	0.00	0.00
Health care	0.0068	0.0007	-0.0047	0.0274	-0.0450	0.0149
	0.01	0.00	0.00	0.00	0.00	0.00
Other expenses	-0.0198	-0.0069	0.0001	0.0194	0.0149	-0.0078
	0.01	0.01	0.00	0.00	0.00	0.01
Ln (total expenditure)	0.0215	-0.0367	0.0017	0.0027	-0.0077	0.0184
	0.00	0.00	0.00	0.00	0.00	0.00
Ln (total expenditure)²	-0.0135	0.0000	-0.0014	0.0135	0.0020	-0.0006
	0.00	0.00	0.00	0.00	0.00	0.00
Age	-0.0005	0.0005	-0.0005	-0.0004	0.0008	-
	0.00	0.00	0.00	0.00	0.00	-
Education level	-0.0063	0.0042	-0.0001	-0.0017	0.0004	-
	0.00	0.00	0.00	0.00	0.00	-
Gender	-0.0155	-0.0155	0.0059	-0.0150	0.0069	-
	0.00	0.00	0.00	0.00	0.00	-
Governement transfers	0.0034	0.0034	0.0011	-0.0182	0.0194	-
	0.00	0.00	0.00	0.00	0.00	-
Arrangement 01	-0.0206	-0.0206	-0.0121	-0.0001	-0.0209	-
	0.01	0.01	0.00	0.01	0.01	-
Arrangement 02	-0.0125	-0.0125	0.0002	0.0000	-0.0003	-
	0.01	0.01	0.00	0.01	0.01	-
Arrangement 03	-0.0286	-0.0286	-0.0086	0.0229	-0.0035	-
	0.01	0.01	0.00	0.01	0.01	-
Arrangement 04	-0.0026	-0.0026	0.0012	0.0024	-0.0107	-
	0.01	0.01	0.00	0.01	0.00	-
Arrangement 06	0.0005	0.0005	0.0087	-0.0043	-0.0070	-
	0.01	0.01	0.00	0.01	0.01	-
Arrangement 07	-0.0084	-0.0084	0.0082	-0.0048	-0.0179	-
	0.01	0.01	0.00	0.01	0.01	-
POF 1995/1996	0.0668	0.0668	0.0206	0.0247	0.0322	-
	0.00	0.00	0.00	0.00	0.00	-
POF 2002/2003	-0.0033	-0.0033	-0.0006	-0.0297	0.0756	-
	0.00	0.00	0.00	0.00	0.00	-

Note: Values below estimated parameters are standard errors.
Source: Research results.