WILMAN JAVIER IGLESIAS PINEDO

# INTRA-HOUSEHOLD INEQUALITY IN BRAZIL: USING A COLLECTIVE MODEL TO EVALUATE INDIVIDUAL POVERTY

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

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(Orientador)

*A Deus e a toda a minha família.*

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## BIOGRAFIA

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IGLESIAS PINEDO, Wilman Javier, M.Sc., Universidade Federal de Viçosa, fevereiro de 2016. **Desigualdade intra-familiar no Brasil: Uso de um modelo coletivo para avaliar a pobreza individual**. Orientador: Alexandre Bragança Coelho

A distribuição dos recursos nos domicílios é importante para a compreensão do bem-estar material de seus integrantes e para a formulação de políticas redistributivas. Apesar da aparente importância da dimensão intrafamiliar da desigualdade, muito pouco tem sido feito para entender o quanto dos recursos do domicílio são apropriados pelos indivíduos que o compõem, e assim, tentar avaliar a pobreza individual. De fato, a avaliação da pobreza e da desigualdade, muitas vezes, assume uma distribuição igualitária dos recursos entre os membros do agregado familiar. Além disso, as medidas de pobreza não apenas negligenciam a distribuição dos recursos dentro dos domicílios, mas também os ganhos decorrentes do consumo conjunto. No entanto, a parcela de recursos domésticos dedicados a cada membro da família é difícil de identificar porque o consumo é medido ao nível do domicílio e os bens podem certamente ser compartilhados. Esta pesquisa tentou analisar o grau de desigualdade dentro das famílias e sua contribuição para os níveis de pobreza no contexto brasileiro. Em particular, estimou-se o processo de alocação de recursos e as economias de escala nos domicílios do Brasil usando um modelo coletivo de consumo das famílias. Mais

especificamente, tentou-se analisar as parcelas de recursos de crianças e adultos e a relação com as economias de escala decorrentes do consumo conjunto e o processo de barganha dos pais, a fim de calcular uma medida direta da pobreza individual para o Brasil. A identificação da parcela de recursos dos membros do agregado familiar requer, além da observação de bens específicos dos adultos, a estimativa conjunta de curvas de Engel para domicílios de casais e solteiros. Esta estratégia de identificação difere do método tradicional de Rothbarth na medida em que é compatível com as economias de escala, bem como com o processo de barganha parental. A base de dados utilizada foi a Pesquisa de Orçamentos Familiares do Brasil (POF 2008-2009). Os principais resultados forneceram evidência de desigualdade e economias de escala dentro dos domicílios brasileiros, o que nos leva à rejeição do modelo unitário de consumo e da abordagem tradicional de Rothbarth no caso do Brasil, respectivamente. Os resultados também mostraram que a parcela dos gastos totais dos homens é ligeiramente maior do que as parcelas das mulheres para quase todas as estruturas familiares consideradas no presente trabalho. Por sua vez, a magnitude das parcelas das crianças, interpretadas como o custo dos filhos para os pais, é comparativamente menor. Outros resultados também mostraram como os recursos destinados a cada membro variam de acordo com o tamanho e a estrutura da família, e, em particular, como as medidas tradicionais de pobreza tendem a superestimar a incidência da pobreza infantil. Além disso, encontrou-se que a parcela de recursos dedicada às crianças aumenta com o número de crianças, mas a parcela média por cada criança tende a diminuir. Por outro lado, verificou-se que as economias de escala dos adultos são grandes e afetam as medidas de pobreza. Especificamente, a pobreza entre adultos é menor porque os pais são altamente compensados pelas economias de escala decorrentes do consumo conjunto. Apesar de os filhos comandarem uma parcela de recursos razoavelmente grande do agregado familiar, tal parcela não é suficiente para evitar que eles tenham taxas mais elevadas de pobreza do que os seus pais. Além disso, foi encontrado que as mães parecem contribuir com mais recursos para os filhos do que os pais, e por outro lado, não foram encontradas diferenças de gênero, mas sim diferenças etárias nas parcelas de recursos entre as crianças. Ainda, os resultados fornecem evidências indicando que o poder de barganha das mulheres dentro da família melhora com a idade, nível de educação e a participação no mercado de trabalho. No geral, a principal conclusão é que a desigualdade intrafamiliar é significativa. Uma consequência importante disso é que as medidas tradicionais *per capita* de pobreza, que, por construção, ignoram a desigualdade intrafamiliar, apresentam uma imagem enganosa da pobreza, em especial para as crianças. Finalmente,

essas estimativas são importantes para as intervenções de políticas redistributivas, porque constituem medidas mais precisas do bem-estar material relativo dos brasileiros em domicílios de diversas composições. Igualmente, o fato de que é plausível medir as parcelas de recursos de cada membro das famílias é um passo muito útil para medir a pobreza individual e, assim, informar de forma mais precisa aos formuladores de políticas que estão focados na redução da pobreza.

# ABSTRACT

IGLESIAS PINEDO, Wilman Javier, M.Sc., Universidade Federal de Viçosa, February, 2016. **Intra-household inequality in Brazil: Using a collective model to evaluate individual poverty**. Adviser: Alexandre Bragança Coelho

The distribution of resources within households is crucial to the understanding of its members' material well-being and for the design of redistributive policies. Although the apparent importance of the intra-household dimension of inequality, very little research has focused on how much of the family resources are dedicated to each member, and thereby attempting to assess individual poverty. In fact, the assessment of poverty and inequality often assumes an equal distribution of resources among household members. Moreover, poverty measures not only neglect the distribution of resources within families, but also the gains from joint consumption. However, the share of household resources devoted to each family member is hard to identify, because consumption is measured at the household level and goods can indeed be shared. This research attempted to analyze the extent of inequality within households and its contribution to levels of poverty in the Brazilian context. In particular, we estimated the process of resources allocation and economies of scale in households from Brazil using a collective model of household consumption. More specifically, we attempted to analyze the resource shares of children and adults in relation with the scale economies of joint

consumption and the parental bargaining in order to calculate a direct measure of individual poverty for Brazil. The identification of the household member's resource share requires the observation of adult-specific goods and a joint estimation on couples and singles. This identification strategy differs from the traditional Rothbarth method, in that it is compatible with economies of scale as well as with parents' bargaining. The database used was *Pesquisa de Orçamentos Familiares* (POF 2008-2009). The main results provide evidence of inequality and economies of scale within Brazilian households, which leads us to the rejection of the unitary model and the traditional Rothbarth approach for Brazil, respectively. Our findings also showed that men's share of total expenditures is slightly larger than women's shares for almost all the family structures considered here. The magnitude of children's shares, interpreted as the cost of children for the parents, is in turn comparatively smaller. We also showed how resources devoted to each household member vary by family size and structure, and we find that, particularly, standard poverty measures tend to overstate the incidence of child poverty. Furthermore, we found that the share of resources devoted to children rises with the number of children, but the average share per child tends to decrease. On the other hand, we found that adult's scale economies are large and affect poverty measures. Specifically, adult poverty is smaller because parents are highly compensated by the scale economies due to joint consumption. Despite that the children command a reasonably large share of household resources, such share is not enough to avoid having higher rates of poverty than their parents. In addition, we found that mothers seem to contribute more resources than fathers to children, and we do not find evidence of gender but age differences in children's resource shares. Also, results provide evidence indicating that women's bargaining power within the household improves with their age, level of education and participation in the labor market. Overall, our main finding is that there is substantial intra-household inequality. One important consequence of this is that standard per-capita poverty measures, which by construction ignore intra-household inequality, present a misleading picture of poverty, particularly for children. Finally, our estimates are important for redistributive policy interventions, because they constitute more accurate measures of the relative material welfare of Brazilians in households of varying composition. Furthermore, the fact that it is plausible to measure of each member's resource shares within households is a very useful step in measuring individual poverty, and thus informing in a more precise way to policy makers which are focused on poverty alleviation.

# 1. INTRODUCTION

## 1.1 Context

The proper measure of individuals' welfare has been subject to debate for a long time in economic literature. Two of the most popular economic well-being indicators are inequality and poverty among households. In Brazil, poverty and income concentration across regions and families are striking[1]. Although the Brazilian poverty and income inequality rates have undergone an evident drop in 2000s, the income distribution pattern appears generally inequitable. In fact, Brazil is still well known for having one of the highest inequality rates in the world. In addition, regional differentials in income distribution and poverty in Brazil are some of the most notable cases of regional inequality and have attracted attention from economists from all over the world (LEFF, 1972; LOVELL, 2000; AZZONI; SERVO, 2002; DE MENEZES et al., 2012; among others). The aforementioned decline in poverty and

[1] According to figures of De Souza (2012, p. 7), Brazil's GINI Index of the household *per capita* income has slowly decreased from 0.594 in 2001 to 0.539 in 2009 indicating a rather significant problem of income disparity. Regarding poverty, from 2004 to 2009 the share of the population with less than a minimum wage per month decreased from 71% to 58%, yet in 2009 the extremely poor accounted for 4.7% of the population and the poor came to almost 9.4% of Brazilians and people vulnerable to poverty amounted to around 44% of the total population (OSORIO et al., 2011). According to more recent figures, in 2014, the Brazil's GINI Index was 0.494, and the rates of extreme poverty and poverty were 2.8% and 7.3% of the population, respectively. See Brazil (2015).

inequality has been attributed to factors such as economic growth, formal employment, decline in labor income inequality, and the impact of conditional cash transfer programs compensating poor households -*Bolsa Família* (literally, scholarship for the family), for instance- (ROCHA, 2006; BARROS et al., 2010, chap. 6; BERGOLO et al, 2011; LUSTIG et al., 2013) [2]. In particular, between 50% and 60% (depending on the poverty line used) of the drop in Brazilian extreme poverty can be attributed to the reduction in inequality during 2002–2009 (LUSTIG et al., 2013). Intuitively, focusing on the latter aspect, we note that there is an intrinsic relationship between poverty and inequality. Nevertheless, this argument is empirically controversial in Brazil and needs further investigation.

To investigate the causes of changes in inequality and poverty, it is important to identify which individuals are considered poor. In the most common measures, poverty is defined as a condition in which people are below a certain income threshold. However, many authors point out that income is both an indirect and rather imperfect measure of living standards (e.g., BRADSHAW; FINCH, 2003; KAGEYAMA; HOFFMAN, 2006). The seminal study by Deaton and Zaidi (2002) suggests that in a single-period analysis, there is no distinction between income and consumption to measure living standards. Despite of this, there is good evidence that consumption is not closely tied to short-term fluctuations in income, and so, consumption is smoother and less-unstable than income (DEATON; ZAIDI, 2002, p. 12). In related research, Rodrigues (2014) argues that income is an unreliable indicator of well-being because people tend to underestimate their income levels providing very inaccurate information about this aspect in surveys. The consumption expenditure is in turn a more realistic measure of economic welfare than the level of income because it represents the access or deprivation of goods and services as a more direct economic indicator of the living conditions. In practice, the information available on household consumption structure improves the calculations of economic well-being, which is very useful for poverty analysis (DEATON, 1997; DEATON; ZAIDI, 2002). Thus, a well-tested economic welfare indicator should be based on consumption data rather than income.

Despite the voluminous academic debate on inequality and poverty measures among households, there is still a relatively small body of attempts to estimate the distribution of resources within families, and to measure poverty at the individual level in this way. Ideally,

[2] It is worth noting that although the government transfers have reduced the percentage of families with several children in the extremely poor, the poverty condition of these types of families is significantly aggravated by the presence of additional children (OSORIO et al., 2011).

to assess the allocation process in households, individual consumption should be used, but empirically, consumption is typically measured at the household level[3]. Nonetheless, one possible solution to this problem is the use of a collective model of the household consumption to fill in the missing information about the within-household allocation of resources[4]. Menon et al. (2012) assert that given household-level data, useful measures of individual consumption expenditures are resource shares[5], which may reveal if there is intra-household inequality (so standard per-capita calculations are invalid measures of individual well-being). A number of early studies, including Becker (1965, 1981), Apps (1981, 1982), Apps and Jones (1986) and Chiappori (1988, 1992), and several recent studies, such as Lewbel and Pendakur (2008), Browning et al. (2013), Dunbar et al. (2013), Bargain and Donni (2012a; 2012b) and Bargain et al. (2014), rely on the identification of resource shares from household-level expenditure with different assumptions on the collective household model. The latter set of studies assumes that, in the absence of price variation, resource shares do not vary with household expenditures. For this reason the use of Engel curve data with no need for observed price variation and the ease of implementation of nearly linear econometric models are valuable features of these identification theorems (MENON et al., 2012). Moreover, empirical estimates of resource shares are useful for welfare and poverty analysis (e.g., DUNBAR et al., 2013, or BARGAIN et al., 2014) and social-level redistribution (e.g., LEWBEL, 2003).

As argued by Osorio et al. (2011), the current welfare and poverty measures in Brazil are still very rough due to (among others) the lack of comprehensive information on income, which hinders the identification and the study of effective strategies for overcoming poverty.

[3] Traditionally, microeconomic theory considers the households as single decision-making units. This so called unitary model only considers allocation among households and disregards questions concerning individual preferences and intra-household inequalities, which may lead to wrong welfare implications (HADDAD; KANBUR, 1990, 1992). Unitary model has been criticized both from a theoretical and an empirical perspective by several authors who have developed alternatives termed as collective approaches to household behavior (BOURGUIGNON; CHIAPPORI, 1992).

[4] The collective models of household consumption are those in which the household is described as a group of individuals, each of whom is characterized by particular preferences, and among whom an intra-household bargaining and a collective decision processes are assumed to take place (VERMEULEN, 2002). According to Xu (2007, p. 3), the collective framework explain phenomena that cannot be understood under the unitary approach and reshape policy instruments to make social welfare and individual development programs more efficient.

[5] Resource shares are defined as each member's share of total household consumption expenditures. Collective household models posit that each household member has access to a fraction of the household budget (a resource share), which defines the shadow budget faced by a household member and that jointly with the within-household shadow price vector determines the material well-being of the household member (MENON et al., 2012).

Furthermore, poverty is a multidimensional phenomenon that is better understood by the development of a poverty profile rather than by a multidimensional indicator that flatten the diversity of situations in a single number (OSORIO et al., 2011). Hence identifying a more realistic profile of poverty of individuals is an empirical endeavor. In this scenario, the question of poverty intensity becomes relevant. More specifically, it is crucial to assess whether all household members are equally poor or whether some persons are disproportionately poor. Thus, ignoring resource allocation behavior within the household can lead to failure in targeting the population group of concern in policy and social program designs. With regard to this latter aspect, collective models are useful because they encompass the analysis of the interaction between heterogeneous preferences and the distribution of resources and power among household members.

## 1.2 Problem statement and significance of the study

While a broad literature on inequality and poverty exists, the intra-household implications in this field have received little attention and should be object of research. A related concern with this issue is addressed in the present study which is associated with a growing empirical literature on collective models, intra-household distribution and poverty measures at individual level. Most immediately, this research builds on Bargain et al. (2014). In that paper, an approach is developed in order to retrieve the intra-household resource allocation and a measure of individual poverty. In general, empirical analysis of collective models not just tackles with the fact that individual allocation within families are practically unobserved, but also with the appropriate inclusion of joint consumption[6] in the household to measure individual's welfare. Indeed, poverty and inequality indicators often ignore both the distribution of resources within households and the gains from joint consumption. Alternatively, using anthropometric information as measure of individual welfare, some studies have revealed a significant level of intra-household inequality (e.g, HADDAD; KANBUR, 1990) and significant impacts of economic policy on child poverty (e.g,

[6] Joint consumption is the shared use of commodities in multi-person households, i.e. collective enjoyment of goods, like housing, which are in the nature of ‘public goods’ to the family and by which ‘scale economies' take place. In family economics, household consumption can be divided into private or collective (public) depending on the type of good being shared among the household members. This applies to household goods such as furniture, housing, family car, home heating/cooling, etc.

THOMAS et al., 1996). In particular, Sahn and Younger (2009) use individuals' body mass index (BMI) as the indicator of well-being to examine the relationship between level of welfare and inequality at inter-country and intra-household levels. They find that about half of total BMI inequality at the country level is within households. Therefore, standard measures of inequality that use household-level data may drastically understate true inequality. In the economic literature, researchers must often rely on strong assumptions to retrieve the intra-household sharing process, that is, the resource shares. Yet, applications of collective models and the analysis of how resources are allocated within households on data from a developing country are relatively rare (BARGAIN et al., 2014).

Following a promising line of research (BARGAIN;DONNI, 2012a, BARGAIN et al., 2014, and the references therein) and using data from Brazil, the present study attempts to examine the mechanisms by which resources are allocated among household members and assess the implications of these decisions on individual poverty levels. On the other hand, there is evidence that parent-specific characteristics as well as the resulting pattern of household decision-making power sharing can play an important role on the welfare of other members of the household, particularly children (e.g., DOSS, 2013). Based on this observation, we estimate a measure of resource allocation in a multi-person model with consumption economies of scale and parental bargaining[7]. Specifically, we focus on the share of total expenditure accruing to children and adults and on a measure of poverty based on individual resources. As far as we know, this study is the first that uses Brazilian data for the stated purpose.

We carry out this research within the microeconomic framework of the collective model of household consumption consistent with economies of scale and parental bargaining. This approach, recently developed by Bargain and Donni (2012a), is a generalization of the conventional Rothbarth-Gronau method[8]. In the context of developing countries, the Rothbarth-Gronau method has been used to measure the cost of children and the level of

[7] Parental bargaining is a process of negotiation within the household between parents aimed at reaching agreements about the control over household resources or the sharing rule by which total household resources are distributed among family members. Much of the empirical work using bargaining models concludes that there exists some sort of bargaining process within the household (MAITRA, 2004; VERMEULEN, 2002).

[8] As clearly explained in Bargain et al. (2014), the Rothbarth approach "… is a method that allows retrieving how household resources are allocated between parents and children. It consists in examining the extent to which the presence of children depresses the household consumption of adult-specific goods" (see, particularly, p. 262, and the references therein).

gender discrimination among children[9]. However, according to Bargain et al. (2014), the disadvantage of this method is that it considers consumption as a purely private activity. But the consumption of some goods and services is an activity partially, or completely collective (in the case of household public goods) that generates economies of scale in multi-person households[10]. Against this background, Bargain et al. (2014) constructed a model of household decision-making grounded in the collective model framework that accounts for the existence of scale economies and for the possibly diverging opinions of the parents, and allows estimating indifference scales in Lewbel (2003)'s sense[11]. The identification strategy relies on the existence of adult goods in the data (adult clothing, specifically) and on a joint estimation on couples. Perhaps most essentially, the model deals with the fact that datasets typically contain total purchases at household levels but not the allocation of goods between household members. The Brazilian dataset that we use is not an exception. Therefore, with all these valuable features of the approach that guides our empirical analysis, we can construct more precise measures of inequality and poverty in order to reveal a more accurate economic profile of these phenomena in Brazil. To the best of our knowledge, the present research is the first attempt in estimate a more precise measure of individual poverty in Brazil using a collective model. Other results are associated with an original description of intra-household inequality in Brazil on the basis of aforementioned new model in the economic literature. Thereby, we attempt to contribute to the debate about the sources of the persistence of a high level of inequality in Brazil.

[9] See Deaton (1989, 1997), Rose (1999) and Dunbar et al. (2013) for recent discussions.

[10] There are gains from joint consumption in multi-person households as compared to single-person consumption. Such gains lie in the economies of scale or in the cost savings due to an increasing scope of household consumption. For instance, sharing the fixed payment for renting a house (or investment of a house) among household members is cheaper than paying the rent alone (or having individual houses per member). Another example of gains from the consumption of household public goods is television, fridge, furniture or utilities whose use and acquisition can be shared. Even some shareable consumer goods (such as groceries) when are bought in larger quantities tend to be less expensive per unit than when bought in smaller quantities due to volume discounts, and hence such goods allow to reap scale economies in consumption. On the other hand, there is evidence that these scale economies may affect poverty measures. In particular, when the gains from joint consumption are accounted for, poverty of married adults decreases very substantially (BARGAIN et al., 2014).

[11] An equivalence scale is a measure of the cost of living in a household of a given size and demographic composition, relative to the cost of living in a reference household (usually a single adult), when both households attain the same level of utility or living standard (BROWNING et al., 2013). One further refined measure which is related to equivalence scales is that of indifference scales. In the Lewbel (2003)'s sense, an indifference scale is a scalar that equates the utility of a person living alone to the utility of the same individual if he or she lived with a partner. More generally, an indifference scale represents the income adjustment applied to person when living in a multi-person household (with or without children) for her/him to reach the same indifference curve as when living alone.

Some studies on Brazil were concerned with the intra-household resource allocation[12]. But these studies have focus primarily on child work, gender bias and the unequal distribution within households. Rangel (2006) indicates that more decision power in the hands of women impacts hours worked by female adults and investments in the education of children. This author suggests that policy and models on household decision-making should take intra-household heterogeneity of preferences into account. Emerson and Souza (2007) estimated the impact of each parent's education on the labor market participation and school attendance of their sons and daughters. They found (among other results) that for schooling decisions, the mother's education has a greater positive impact than the father's education on daughters' school attendance, but fathers have a greater positive impact on sons' school attendance than on daughters'[13]. Polato e Fava and Arends-Kuenning (2013) pointed out that decisions about durable goods ownership are the outcomes of bargaining processes between husbands and wives. In this case, wives have a relative preference for household production durable goods over entertainment durable goods compared to their husbands. Other studies have used random experiments to explore the existence of gender differences in intra-household allocation decisions in Brazil. Contrary to the existing literature, Braido et al. (2012) results do not support the existence of gender-specific effects on household decisions.

The prominent advantage of the method developed in Bargain et al. (2014) is that it allows testing directly for this type of discrimination, or the effect of other characteristics, like children's age, on child resources and boy–girl inequality[14]. Therefore, using such approach makes possible to conciliate new evidence with the existing literature on intra-household inequality and poverty in Brazil and more generally in developing countries. An understanding of the mechanisms by which resources are allocated among household members is critical for informing policy which effectively targets households in appropriate ways which maximize the impacts on childhood poverty. Alderman et al. (1995) argue that

[12] See Thomas (1990), Rangel (2006) and Emerson and Souza (2007) on the inequality of resource allocation within the household in Brazil.

[13] In this respect, Bargain et al. (2014) find that men's and women's shares of household total expenditure are positively related to spouses' education and that children receive a slightly larger share of the household resources when their mothers control a larger fraction of family resources.

[14] Bargain et al. (2014) found no evidence of child gender bias in the overall treatment of boys and girls in Côte d'Ivoire. The same conclusion is reached by Lundberg and Rose (2004) in USA, Bhalotra and Attfield (1998) in Pakistan, and Deaton (1989) in Côte d'Ivoire and Thailand. Evidence of discrimination between boys and girls can be found in Rose (1999) for India and Dunbar et al. (2013) for Malawi. The presence of child gender bias in these latter studies is attributed to the cultural context of such countries. On the other hand, evidence of gender discrimination among children in developing countries often pertains to long-term expenditure on children, especially 'productive' investments on children's education and health (Sen, 1981). However, the literature on differences in education and health expenditures is extensive and beyond the scope of our study.

more effective policy instruments will emerge from analyzing the processes by which households balance the diverse interests of their members.

According to Haddad and Kanbur (1990), taking the distribution of welfare within a household into account may drastically change the level of poverty or inequality. The knowledge of the intra-household allocation of resources may be important, especially in programs that target individuals in certain more vulnerable groups (e.g., women or children[15]). In particular, Maitra (2004) pointed out that the woman's status (bargaining power) within the household affects individual and household expenditure patterns, children's health and education. In turn, Lundberg et al. (1997) argued that when the allowance scheme of government transfers puts more resource under the control of the mother, children's welfare improves significantly. Thus, the understanding of the intra-household distribution of resources and the implications of this process on individual poverty levels can improve the accuracy and effectiveness of social welfare and human development policies and programs.

On the other hand, a measure of individual poverty allows creating a profile that describes the specific characteristics of the poor and the particular magnitude of him/her deprivation. This profile represents the most pressing problems of poverty, allowing the definition of a hierarchy of priorities for public policy. Overall, this knowledge can help policy makers to distinguish programs and actions that contribute to increasing welfare.

## 1.3 Hypothesis

- ✓ Individual measures of poverty show that parents are highly compensated by the scale economies due to joint consumption.
- ✓ There is no evidence of discrimination against girls compared to boys in the household.
- ✓ Women command a smaller share of resources compared to their husbands.
- ✓ Mothers' bargaining power improves their own share of resources and their children's one.

[15] In Brazil, children continue to be the most represented age group in poverty and extreme poverty (see OSORIO et al., 2011 for figures on individual poverty).

## 1.4 Objetives

### 1.4.1 General Objetive

Examine the intra-household resource distribution process and poverty at individual level in Brazil.

### 1.4.2 Specific Objetives

- ✓ Estimate the share of total expenditure accruing to children and adults in Brazil consistent with economies of scale and parental bargaining;
- ✓ Compute a direct measure of poverty at individual level and define a new poverty profile for Brazil;
- ✓ Estimate and use indifference scales taking into account adult scale economies in order to reassess individual poverty among adults.

# 2. THEORETICAL FRAMEWORK

## 2.1 Collective decisions, preferences and consumption technology

We follow closely the theoretical framework of Bargain and Donni (2012a) and Bargain et al. (2014). The model assumes three types of households consisting of $n = 1$ for single adults, $n = 2$ for childless couples, and $n = 3$ for couples with children. Let superscripts $k = 1,\ldots,K$ refer to goods and subscripts $i$ refer to household members, with $i = m$ indicating men, $i = w$ women and $i = c$ the children. Let $x$ denotes the log household expenditure and let $\mathbf{p}$ be the vector of log prices. For each individual $i$ living in a household of type $n$, there is a set of utility functions, a set of sharing functions, and a set of scaling functions. In particular, individual log resources for single-person households ($n = 1$) is the same as the household log expenditure $x$ whereas multi-person households ($n > 1$) individual log resources ($x_{i,n}$)[16] is assumed to have the following structure:

$$x + \log \eta_{i,n}(\mathbf{p}, \mathbf{z}) - \log s_{i,n}(\mathbf{p}, \mathbf{z}) \qquad (2.1)$$

[16] The level of individual expenditure for each person $i$ living in a household of type $n > 1$ can be represented by the fraction of total household expenditure [$\exp(x_{i,n}) = \eta_{i,n} \cdot \exp(x)$]. So the individual resources (which are adjusted for the scale economies) can be denoted 'in level' as

$$\frac{\eta_{i,n} \cdot \exp(x)}{s_{i,n}}$$

or in logarithmic form as

$$x + \log \eta_{i,n} - \log s_{i,n}$$

where the deflator $s_{i,n}$ measures the cost savings experienced by person $i$ resulting from scale economies in the multi-person household.

where log $\boldsymbol{\eta}_{i,n} > 0$ is the logarithm of the share of total expenditure accruing to individual *i* in household *n*, log $s_{i,n} > 0$ represent the logarithm of the economies of scale associated to this individual's consumption[17], and **z** is a vector of individual and household characteristics (such as age, education or region of residence). As shown in Bargain et al. (2014), the utility of individual *i* living in a household of type *n* can be characterized by a well-behaved (i.e., monotonic, strictly quasi-convex, and three times continuously differentiable) indirect utility function that takes the form:

$$v_i(x + \log \eta_{i,n}(\mathbf{p},\mathbf{z}) - \log s_{i,n}(\mathbf{p},\mathbf{z}), \mathbf{p}, \mathbf{z}_i) \qquad (2.2)$$

where $\mathbf{z}_i$ is a vector of individual characteristics, with $\boldsymbol{\eta}_{i,n}(\boldsymbol{p},\boldsymbol{z}) = s_{i,n}(\boldsymbol{p},\boldsymbol{z}) = 1$ if $n = 1$ by convention. In the next sections, the indirect utility, the sharing and the scaling functions will be examined in more detail.

### 2.1.1 Utility functions $v_i(\cdot, \mathbf{p}, \mathbf{z}_i)$

Collective household models posit that each household member has a utility function. Following the same arguments as in Bargain et al. (2014), there are two important points that we must to make. First of all, the utility function of each family member does not depend on the type *n* of the household once we controlled for the sharing of total expenditure and the existence of joint consumption. Thus, scaling and sharing functions can explain the differences in expenditure patterns between a person living alone and an individual living with other people. This assumption implies that the individual preferences across household types are stable, as in the Rothbarth method (GRONAU, 1988, 1991; BARGAIN et al., 2014). On the other hand, preferences of children in the household are aggregated into a unique index, which could then be used to represent the indirect utility function of the children living in the household. This latter procedure avoids issues of lack of parsimony and does not imply the strong assumption that the resource shares are equally distributed among children. In fact, the total share of children are allowed to depend on demographic characteristics (**z**) which includes (among others) the age of children and the number of boys versus girls in order to test for potential gender discrimination among children in household expenditure.

[17] We shall go back to these functions, namely $\eta_{i,n}$ and $s_{i,n}$, below (see, particularly, the Section 2.1.2. and the Section 2.1.3. for additional details on sharing and scaling functions, respectively).

### 2.1.2 Sharing functions $\eta_{i,n}(\mathbf{p},\mathbf{z})$

The set of sharing functions allows identifying the intra-household allocation and control of resources among household members. We employ a two-stage budgeting decision process based on Browning et al. (1994)'s collective approach (see Bargain et al., 2014). This process is compatible with the potential sharing rule or social norm that guides the distribution pattern of total resources among household members in order to retrieve individual shares. Specifically, household resources are supposed to be allocated between household members according to some sharing rule at the first stage. This implies that individual $i$ living in household of type $n > 1$ receives a share $\eta_{i,n}(\mathbf{p},\mathbf{z})$ of total expenditure $\exp(x)$. At the second stage, each member $i$ maximizes their own utility function subject to an individual budget constraint given by the fraction of $\boldsymbol{\eta}_{i,n}(\mathbf{p},\mathbf{z}) \cdot \exp(x)$, choosing in this way consumption expenditure vectors. The basic assumption here is that sharing function is independent of household total expenditure, so that the resource shares depend on the socio-demographic variables (e.g., age, education, and region of residence) and, possibly, variables that capture the relative bargaining position of the parents.[18] In consequence, changes in the level of expenditures on all goods do not affect the sharing functions. Since we are interested in retrieving resource shares from household-level consumption data, the assumption that resource shares are independent of expenditure is made for the sake of identification (LEWBEL; PENDAKUR, 2008; BARGAIN; DONNI, 2012a; DUNBAR et al., 2013; BARGAIN al., 2014). Although this assumption is potentially strong, it fortunately can be tested empirically and tends to be supported by recent evidence, and consequently, identification of sharing functions on the basis of this restriction may be valid (MENON et al., 2012; BARGAIN al., 2014).[19]

[18] In the literature on equivalence scales, this restriction that resource shares are independent of expenditure is known as 'independent of base' (IB) scaling of consumption (BLACKORBY; DONALDSON, 1993; LEWBEL, 1991). IB is a function, independent of total expenditure –and, hence, of the utility level – at which it is evaluated, which scales the expenditure of each individual in the household and represents the economies from joint consumption (LEWBEL; PENDAKUR, 2008; BARGAIN et al., 2014).

[19] According to Bargain et al. (2014, p. 265), although the identification is still possible without this restriction (but with additional strong parametric restrictions instead), such restriction can also be mitigated by including measures of household wealth (e.g., urban residency, house ownership or the woman's participation in the labor market) other than total expenditure in individual shares. In the present research, we have not only included these measures but also tested the restriction that resource shares are independent of total expenditures (see the Section 3).

### 2.1.3 Scaling functions $s_{i,n}(\mathbf{p},\mathbf{z})$

The set of scaling functions $s_{i,n}(\mathbf{p},\mathbf{z})$ characterizes the adult economies of scale and scope in consumption. This functions must be individual-specific, i.e., depend on all the individual characteristics of the persons living in the household and on the vector of prices[20]. It is in this sense that the economies of scale may differ between individuals within the same household, depending on how they value the good which is jointly consumed (BARGAIN et al., 2014). Overall, the household model presented here is consistent because of the inclusion of the consumption technology function which represents the degree of public consumption achieved by the household and the corresponding economies of scale. Following Lewbel and Pendakur (2008) and Bargain et al. (2014), we assume that the 'value' of total expenditure is inflated by the presence of several persons in the household (e.g., a married couple that always rides together in a car 'will consume' gasoline twice) and that economies of scale have a pure wealth effect. More precisely, we assume that scale economies generated by joint consumption of certain goods in the household can be represented by the price-dependent deflator $s_{i,n}(\mathbf{p},\mathbf{z})$. As explained previously, the scale $s_{i,n}(\mathbf{p},\mathbf{z}) < 1$ is then interpreted as a measure of the cost savings experienced by person $i$ as a result of scale economies in the household[21]. In this case, the 'independent of the base' (IB) assumption concerns individual utility functions rather than aggregated household utility functions. Consumption decisions in families may also be characterized by positive or negative externalities of joint consumption, i.e. the level of publicness in household consumption (e.g., parents may change consumption patterns after the birth of a child). To capture economies of scale in consumption, Bargain et al. (2014) suppose that these changes in the consumption technology function that characterizes the intra-household publicness of goods consumption can be approximated by a variation of prices in the IB scales.

[20] See Bargain and Donni (2012a) and Lewbel and Pendakur (2008) for recent discussions in detail on this intuition.

[21] The existence of public goods (or goods jointly consumed) within household generates economies of scale in consumption. Consumption by one household member (or by shared expenses) does not reduce the amount available, and can indeed benefit the other household member. For example, the joint consumption of household operations (such as heating and lighting in the house), carpets, furniture, shared automobile trips, or the living space of the house itself can be interpreted as cost savings of household members implicitly compensated by scale economies originated by cohabitation or sharing of resources.

## 2.2 The budget share equations

The general budget constraint to which the individual consumption behavior is subject can be calculated if the Roy's identity is applied to equation (2.2). In addition, assume that households face constant prices, then, the individual budget share equation for good *k* of person *i* living in household *n* can be obtained as[22]:

$$w_{i,n}^{k}(x,\mathbf{z}) = \varepsilon_{i,n}^{k}(\mathbf{z}) + \omega_{i}^{k}(x + \log\eta_{i,n}(\mathbf{z}) - \log s_{i,n}(\mathbf{z}), \mathbf{z}_{i}) \qquad (2.3)$$

for $i = w, m, c$, $n = 1, 2, 3$, and $k = 1,\ldots, K$,

where $w_{i,n}^{k}(x,\mathbf{z})$ represents the 'reduced-form' budget share on good *k* of person *i* in household of type *n* as a function of household (log) expenditure *x* and household characteristics **z** and $\varepsilon_{i,n}^{k}(\mathbf{z}) = \partial \log s_{i,n} / \partial p_{k}$ is a elasticity of the scaling function $s_{i,n}$ with respect to the *k*th price, following the explanation provided in Lewbel and Pendakure (2008)[23]. By using a basic budget share equation $\omega_{i}^{k}(\cdot, \mathbf{z}_{i})$ which is the same for all the types of household, the structure of this budget share on the right-hand side is associated with the IB restriction. This is analogous to the shape-invariance restriction implied by IB equivalence scales as in Pendakure (1999). In other words, an important implication of the IB assumption in the present context is that the budget share equations of an individual ($\omega_{i,n}^{k}$) when living in a multi-person household ($n>1$) differ from when living alone ($n=1$) only in that they are translated over by $\varepsilon_{i,n}^{k}$ while log household expenditures ($x$) are translated over by the expression $\log\eta_{i,n} - \log s_{i,n}$. Meanwhile, household expenditures on each good *k* can be

[22] We show in the Appendix A how the equation (2.3) can be obtained from the equation (2.2) and the Roy's identity.

[23] The price elasticity $\varepsilon_{i,n}^{k}$ is a translation function specific to good *k* and it is related to the differences that may exist between goods with respect to the possibility of joint consumption. Bargain and Donni (2012a, p. 797) point out that scale economies may have a wealth effect and a substitution effect represented by $\log s_{i,n}$ and $\varepsilon_{i,n}^{k}$, respectively. This latter effect can be positive or negative depending on the nature of good *k*, i.e. if good *k* is essentially public or private. In addition, Lewbel and Pendakure (2008) explain that the budget-shares of an individual as a function of log total household expenditures ($x$) have the same shape when evaluated at a vector of (logged) market prices **p** or at a vector of (logged) shadow-prices (e.g., **a** + **p**). That is, such functions differ only in that they are translated over log-expenditure *x* by $\log s_{i,n}$ and over each $w_{i,n}^{k}$ by $\varepsilon_{i,n}^{k}$. See Lewbel and Pendakure (2008, p. 353) for a more detailed explanation of this issue.

written as the sum of individual expenditures on that good. Then, according to Bargain et al. (2014) dividing this identity by the total expenditure exp(***x***), we obtain the household budget share function for households of any type *n* as follows:

$$W_n^k(x,\mathbf{z}) = \sum_{i\in\varphi_n} \eta_{i,n}(\mathbf{z}) \cdot \left(\varepsilon_{i,n}^k(\mathbf{z}) + \omega_i^k\left(x + \log \eta_{i,n}(\mathbf{z}) - \log s_{i,n}(\mathbf{z}), (\mathbf{z}_i)\right)\right) \qquad (2.4)$$

for any good *k*, with $\varphi_n$ the set of indices for all the persons living in a type-*n* household.

Two important concepts must be clarified, namely *indifference scales* and joint consumption. First, $I_{i,n}(\mathbf{z}) = \eta_{i,n}(\mathbf{z})/s_{i,n}(\mathbf{z})$ indicates *indifference scales*, i.e. the adjustment (applied to total expenditure) which allows a person living in a multi-person household to reach the same indifference curve as if living alone. These scales can be used to compare the welfare of the same individual in two different situations and are particularly useful to measure poverty at the individual level. Second, the level of the scale $s_{i,n}(\mathbf{z})$ cannot be interpreted directly; it must be compared to the level of the corresponding share $\eta_{i,n}(\mathbf{z})$, i.e. the fraction of total expenditure which is consumed by individual *i*. Thus, a normalized indicator of the 'individual' scale economies for each person living in a household of type $n \geq 2$ is defined as:

$$\sigma_{i,n}(\mathbf{z}) = \frac{\eta_{i,n}(\mathbf{z})\left(1 - s_{i,n}(\mathbf{z})\right)}{s_{i,n}(\mathbf{z})\left(1 - \eta_{i,n}(\mathbf{z})\right)}, \qquad (2.5)$$

which is equal to 0 in the purely private case and to 1 in the purely public case. The purpose here is to identify the main structural components of the model, $s_{i,n}(\mathbf{z})$ and $\eta_{i,n}(\mathbf{z})$, for $i = w,m,c$ and $n = 1,2,3$, from the knowledge of the deterministic components $W_n^k(x,\mathbf{z})$. Finally, the fact that young children are never observed living alone (i.e., they are always observed living with their parents) implies that the terms representing economies of scale in the budget share equations of children are meaningless in our analysis. That is why the factors corresponding to scale economies for children are normalized: $\varepsilon_{c,3}^k(\mathbf{z}) = 0$ and $s_{c,3}(\mathbf{z}) = 1$ for any good *k*.

## 2.3 Identification

The main identification result arises from the fact that we observe at least one adult-specific good for each adult living in the household and utility functions of all the children are aggregated into a single representative index. Furthermore, under some regularity conditions (including the non linearity of budget share equations with respect to $x$ and the constant prices) and normalization, the resource sharing functions $\eta_{i,n}(\mathbf{z})$ and the scaling functions $s_{i,n}(\mathbf{z})$, for $i = m$, $w$ or $c$ and $n = 1,2,3$, can be identified from the estimation of the budget share equations $W_n^{k_i}(x, \mathbf{z})$.

We specify a collective household model which captures both the scale economies in household consumption and unequal allocation of resources within the household. As stated previously, identification is based on how to retrieve the structural components of the model (the sharing functions and the scaling functions) from demand data and the existence of adult-specific goods. To account for unobserved factors, we add error terms to the household budget shares:

$$\tilde{W}_n^k(x, \mathbf{z}) = W_n^k(x, \mathbf{z}) + e_n^k \qquad (2.6)$$

for $n$=1, 2, 3 and $k$=1, …, K

where $\tilde{W}_n^k(\cdot)$ is the stochastic extension of the deterministic component $W_n^k(\cdot)$; $e_n^k$ can be interpreted as optimization or measurement errors. Alternatively, the stochastic component of the budget shares could be seen as resulting from unobservable heterogeneity in the individual budget share equations, in the scales or in the resource shares (BARGAIN; DONNI, 2012a). The main identification result is summarized in the following proposition and assumptions.

**Assumption 1.** Each individual $i$ has preferences represented by a traditional indirect utility function that is three times continuously differentiable and independent of the household demographic structure $n$.

**Assumption 2.** The shares of total expenditure are differentiable functions that do not depend on total expenditure $x$, i.e., $\eta_{i,n}(x,\mathbf{z}) = \eta_{i,n}(\mathbf{z})$ for $i = m,w,c$ and $n = 2,3$.

**Assumption 3** (Independent of the base). For each person *i* living in a household of type $n > 1$ there exists a scalar-valued, differentiable function $s_{i,n}(\mathbf{z})$ such that the indifference curves of individual i satisfy the condition:

$$u_i = v_i\left(x + \log \eta_{i,n}(\mathbf{z}) - \log s_{i,n}(\mathbf{z}), \mathbf{z}_i\right), \qquad (2.7)$$

for any level of log individual expenditure $x + \log \eta_{i,n}(\mathbf{z})$. Thus, scale economies are assumed to be independent of the base expenditure, and consequently utility, level at which they are evaluated.

**Assumption 4** (Normalization assumption). For single persons: $\eta_{i,1}(\mathbf{z}) = 1$, $\varepsilon_{i,1}(\mathbf{z}) = 0$, and $\boldsymbol{s}_{i,1}(\mathbf{z}) = 1$ for any *k*.

**Assumption 5** (Normalization assumption). For children: $\varepsilon_{c,3}(\mathbf{z}) = 0$, and $s_{c,3}(\mathbf{z}) = 0$ for any *k*.

**Proposition 1** (*Bargain and Donni*, 2012a). Given the assumptions 1-5 and the conjectures that prices are constant, assume that there exists at least one adult-specific good for each adult in the household. Assume also that $\nabla_x w_i^{k_i}(\cdot, \mathbf{z}_i) \neq 0$ and $\nabla_{xx} w_i^{k_i}(\cdot, \mathbf{z}_i) \neq 0$ almost everywhere for $i=m,w$ and the functions $\Delta_i^{k_i}(\cdot, \mathbf{z}_i) \equiv \nabla_x w_i^{k_i}(\cdot, \mathbf{z}_i) \cdot [\nabla_{xx} w_i^{k_i}(\cdot, \mathbf{z}_i)]^{-1}$ are not periodic in their first argument. Therefore, it is plausible that the sharing functions $\eta_{i,n}(\mathbf{z})$ and the scaling functions $s_{i,n}(\mathbf{z})$ for $i=m,w,c$ and $n=1,2,3$, can be identified from the estimation of the budget share equations $W_n^{k_i}(x, \mathbf{z})$ on the adult-specific goods.

In particular, the identification strategy consists of three steps:

*Step* 1. The basic budget share equations can be identified from a sample of single women and another of single men since preferences are stable across household types *n*. That is, the differences in consumption between singles and couples with or without children are assumed to be solely due to resource sharing, joint consumption and changes in total resources. Hence, identification of the functions $w_i^k(\cdot)$ can be obtained from a sample of single (male and female) individuals: $W_1^k(x, \mathbf{z}) = w_i^k(x, \mathbf{z})$ for any *k* and $i=m,w$.

*Step* 2. Once these functions are recovered, the sharing functions and scaling functions for $n$ = 2 can themselves be identified from a sample of couples without children:

$$W_2^{k_i}(x,\mathbf{z}) = \eta_{i,2}(\mathbf{z}) \cdot [\varepsilon_{i,2}^{k_i}(\mathbf{z}) + w_i^{k_i}(x - \log I_{i,2}(\mathbf{z}), \mathbf{z}_i)], \tag{2.8}$$

Note that $W_2^{k_i}(\cdot)$ are the household budget share equations for adult-specific good $k_i$ for $i$=$m$,$w$. For the sake of simplicity, we compute the first-order derivative of the equation (2.8) with respect to $x$ in order to eliminate $\varepsilon_{i,2}^{k_i}(\mathbf{z})$ and we have

$$\nabla_x W_2^{k_i}(x,\mathbf{z}) = \eta_{i,2}(\mathbf{z}) \nabla_x w_i^{k_i}(x - \log I_{i,2}(\mathbf{z}), \mathbf{z}_i), \tag{2.9}$$

where the left-hand side of this expression is identified. The simplification is achieved by differentiating the equation (2.9), again with respect to $x$, and taking the ratio of (2.9) and this second-order derivative as follows

$$\frac{\nabla_x W_2^{k_i}(x,\mathbf{z})}{\nabla_{xx} W_2^{k_i}(x,\mathbf{z})} = \frac{\nabla_x w_i^{k_i}(x - \log I_{i,2}(\mathbf{z}), \mathbf{z}_i)}{\nabla_{xx} w_i^{k_i}(x - \log I_{i,2}(\mathbf{z}), \mathbf{z}_i)} = \Delta_i^{k_i}(x - \log I_{i,2}(\mathbf{z}), \mathbf{z}_i), \tag{2.10}$$

where the left-hand side of the first equality are identified and the function $\Delta_i^{k_i}(\cdot,\mathbf{z})$ are known from step 1. If $\Delta_i^{k_i}(\cdot,\mathbf{z})$ is not periodic in its first argument[24], then equation (2.10) allows to identify the indifference scales $I_{i,2}(\mathbf{z})$ for $i$=$m$,$w$. The sharing functions $\eta_{i,2}(\mathbf{z})$ can be obtained for $i$=$m$,$w$ from (2.9) and translation functions $\varepsilon_{i,2}^{k_i}(\mathbf{z})$ from (2.8). Finally, identification of scaling functions follows from the definition of $I_{i,2}(\mathbf{z})$.

*Step* 3. Using expenditure on adult-specific goods, the adults' sharing and scaling functions for $n$ = 3 can also be identified with the same method as in step 2 from a sample of couples with children. This latter identification is possible because the budget share equations for adult-specific goods have exactly the same structure as above, that is $W_3^{k_i}(x,\mathbf{z}) = \eta_{i,3}(\mathbf{z}) \cdot [\varepsilon_{i,3}^{k_i}(\mathbf{z}) + w_i^{k_i}(x - \log I_{i,3}(\mathbf{z}), \mathbf{z}_i)]$ for $i$ = $m$, $w$.

[24] Identification requires that the second-order derivative of the basic budget share equations with respect to log total expenditure ($x$) be different from zero. In other words, the budget share equations for adult-specific goods must be non-linear in log total expenditure (BARGAIN; DONNI, 2012a). However, as Banks et al. (1997) point out, it is assumed that budget share equations are generally non-linear. Accordingly, it may be not necessary to impose the restriction of non-linearity on the budget share equations. But, as Bargain and Donni (2012a) state, the functional form of the budget shares must be sufficiently flexible to account for non-linearity because the regularity conditions in Proposition 1 may be violated for some specific goods. Hence, this issue must be checked in a preliminary inspection of the data for the sake of analytical convenience.

However, since the basic budget share equations of children are unknown, the adding-up condition of sharing functions, given by $\sum_i \eta_{i,n}(\mathbf{z}) = 1$, has to be exploited to identify the children's share. In this light, the share of total expenditure devoted to the child is then obtained as $\eta_{c,3}(\mathbf{z}) = 1 - \sum_i \eta_{i,n}(\mathbf{z})$ where $i=m,w$ and the function $s_{c,3}(\mathbf{z})$ is given by Assumption 5.

## 3. EMPIRICAL STRATEGY AND DATA

The goal of this section is to present the empirical strategy used for obtaining the results. The primary phase of the empirical strategy is devoted to preliminary inspections of the data. In a first step, we want to perform a test of the endogeneity of log total expenditure and for the non-linearity of budget share equations in log expenditure. To do so, we perform reduced-form estimations on the subsamples of households. The subsequent step is the estimation a simple three-equation model that consists of the budget share equations for the assignable goods. In this regard, our purpose is to conduct several exercises to check the robustness of our benchmark results. The second phase of the empirical strategy is aimed to the identification of the main structural components of the model. For this purpose, we consider a more complete model including additional budget share equations and a completely general specification. Some restrictions are tested[25] in the empirical section for the sake of identification. We also provide additional results[26] aimed at checking the sensitivity of our

[25] These restrictions are the stability assumption (according to which individual preferences over goods are stable or do not change across household compositions); the hypothesis according to which the parameters for singles and couples are similar; and the IB assumption which refer to the fact that the sharing functions are independent of log total expenditure.

[26] These results include the estimates of four specifications or variations of the model described in the previous section and estimates of two additional models: the first one exploits information on the budget shares for the assignable goods and the second one exploits information on the other goods only. This is explained in the remainder of the text.

estimates to alternative specifications. Finally, our empirical strategy accounts for inequality within the household and poverty at the individual level.

## 3.1 Empirical approach

### 3.1.1 Functional forms

For our empirical application, we introduce an index *h* for households observed in the data. The specification of the model therefore includes the basic budget share equation as a first component, which appears in the specification of the different demographic groups. The individual preferences are assumed to be consistent with a generalization of the PIGLOG indirect utility functions, proposed by Banks et al. (1997). In particular, the specification adopted is:

$$\omega_{i,h,n}^{k}(x_{i,n,h},\mathbf{z}_{i,h}) = a_i^k + b_i^k\mathbf{z}_{i,h} + c_i^k\cdot(x_{i,n,h}-\mu_i\mathbf{z}_{i,h}) + d_i^k\cdot(x_{i,n,h}-\mu_i\mathbf{z}_{i,h})^2, \qquad (3.1)$$

where $x_{i,n,h} = x_h + log\eta_{i,n,h} - logs_{i,n,h}$ represents the log resources for individual *i* in household *h* of type *n*; $a_i^k$ $b_i^k$ $c_i^k$ $d_i^k$, and $\mu_i$ are parameters and $\mathbf{z_{i,h}}$ are socio-demographic variables. Specifically, the socio-demographics variables include, in the adults' case, age and level of education and dummies for house ownership, women's work participation and urban and regional residency, and in the children's case, the number of children in the household, their average age, the proportion of boys and dummies for home ownership, urban resident and state of residence. Following Bargain et al. (2014), the socio-demographic variables enter the specification through the translation of budget share equations, i.e., coefficient vector $b_i^k$, and through the translation of log resources, i.e., coefficient vector $\mu_i$.

The household budget share equations, for single male and female adults, coincide with the basic budget share equations specified above plus an additive error term. In the case of multi-person households $n \geq 2$, and non-adult-specific goods, the household budget share equations is expressed as

$$W_{n,h}^{k}(x,\mathbf{z}) = \sum_{i\in\varphi_n}\eta_{i,h,n}\left[\varepsilon_{i,n,h}^{k} + \omega_i^k\left(x_h + \log\eta_{i,n,h} - \log s_{i,n,h},\mathbf{z}_{i,h}\right)\right] + e_{n,h}^{k}, \qquad (3.2)$$

where $e^k_{n,h}$ is the error term, $\omega^k_i(\cdot,\mathbf{z_{i,h}})$ individual functions as already specified and three other components that are defined as follows. First, the *sharing functions* are specified using the logistic form:

$$\eta_{i,n,h} = \frac{\exp\left(\alpha^\eta_i + \beta^\eta_i \mathbf{z}^\eta_{i,h}\right)}{\sum_{j\in\varphi_{n,h}} \exp\left(\alpha^\eta_j + \beta^\eta_j \mathbf{z}^\eta_{j,h}\right)}, \qquad \text{for } i = m,w,c, \qquad (3.3)$$

where $\alpha^\eta_i$ and $\beta^\eta_i$ represent parameters and $\mathbf{z}^\eta_{i,h}$ denotes socio-demographic variables. These latter consist of all the variables in $\mathbf{z}_{i,h}$ for adults. In the children's case, socio-demographic variables comprise all the variables in $\mathbf{z}_{i,h}$ plus a dummy for mother's work participation. For the constants and the parameters of the variables that enter several individual indices of the logistic function, normalization is required and the corresponding coefficients are simply set to zero. On the other hand, we want to restrict $s_{i,n}$ as much as possible while retaining its essential nature as a scale economy parameter. To do so, we specify $\sigma_{i,n}$ rather than $s_{i,n}$ and suppose that it does not depend on socio-demographic variables, as justified above. From the inversion of Eq. (2.5) in the previous section, the log scaling functions that translate expenditure within the basic budget shares are specified as:

$$s_{i,n,h} = \frac{\eta_{i,n,h}}{\sigma_{i,n,h} + \eta_{i,n,h} - \sigma_{i,n,h}\eta_{i,n,h}}, \qquad \text{with } \sigma_{i,n,h} = \alpha^\sigma_i + \beta^\sigma_i \mathbf{z}^\sigma_{i,h} \qquad \text{for } i = m,w, \qquad (3.4)$$

where $\alpha^\sigma_i$ and $\beta^\sigma_i$ are parameters and $\mathbf{z}^\sigma_{i,h}$ are socio-demographic variables (here, they include only the number of children, with the restriction that $\sigma_{i,n,h} \in [0,1]$). The function that translates the basic budget shares $\varepsilon^k_{i,n,h}$ is price elasticity. In order to attempt measuring price effects and their interaction with demographics, we restrict the derivative of $\sigma_{i,n}$ with respect to log price of good $k$ to be a constant and that of $\eta_{i,n}$ to be zero. We then compute $\varepsilon^k_{i,n,h}$ as the derivative of the log of $s_{i,n}$ with respect to $p_k$.

### 3.1.2 Estimation method

Our estimation method corresponds to the iterated Seemingly unrelated regressions (SUR) method. In order to account for the likely correlation between the error terms $e_{n,h}^{k}$ in each budget share function and the log total expenditure, each budget share equation is augmented with the 'Wu–Hausman residuals' as in Banks et al. (1997), Blundell and Robin (1999), Bargain and Donni (2012a) and Bargain et al. (2014). According to Bargain et al. (2014), these residuals can be calculated from reduced-form estimations of *x* on all exogenous variables used in the model plus some excluded instruments, precisely, a polynomial of a convenient degree in household disposable income. Given the budget shares sum up to one, equation for good *K* is unnecessary. The household budget share equations for the *K*-1 goods and for the three demographic groups are estimated simultaneously. Once corrected for endogeneity of log total expenditure, the error terms are supposed to be uncorrelated across households and with the demographic structure of the household, but correlated across goods within households (BARGAIN; DONNI, 2012a; BARGAIN et al., 2014). The perturbation terms are also assumed to be homoskedastic for each type of household (and covariance matrices are supposed to be different for single males and females).

### 3.1.3 Dealing with endogeneity and non-linearity of total expenditures

One source of endogeneity in our setting is that total expenditures may suffer from measurement error. This source of bias can arouse either because of recall errors, since total consumption is measured by asking households to recall their past expenditures, or because of the infrequency of purchases create a wedge between total expenditures and actual consumption (DUNBAR et al., 2013). Another important issue is that identification of sharing and scaling functions necessitates that budget share equations are non-linear in log total expenditure (BARGAIN;DONNI, 2012a). To check both endogeneity of total expenditure and non-linearity of budget share equations in log expenditure, we perform a Durbin–Wu–Hausman test on subsamples of each household type. In a preliminary step, we perform reduced-form estimations and directly testing exogeneity of log total expenditure through the significance of the Wu–Hausman residuals in the regressions. The budget shares for male and

female clothing are then regressed on age, education, the dummies for white, woman's participation, house ownership and urban residency, as well as the log total expenditure and its squared value. The Wu–Hausman residuals are then sequentially added to the explanatory variables of the regression. The results of these regressions are presented in the next section.

### 3.1.4 Measures of intra-household inequality and individual poverty

We compute inequality within the household using the resource shares $\eta_{i,n}(\mathbf{z})$ estimated for each adult member and for the children as a whole. Specifically, we calculate the amount of household expenditure accruing to each adult as:

$$x_{a,n} = \exp\left(x + \log \eta_{a,n}(\mathbf{z})\right), \qquad \text{for } a = w, m \text{ and } n = 1, 2\ 3 \qquad (3.5)$$

with $\log \eta_{i,n}(\mathbf{z}) = 0$ for single individuals. In the children case, the individual expenditure per child, i. e., child resources divided by the number of children in the household:

$$x_{c,n} = \frac{\exp\left(x + \log \eta_{c,n}(z)\right)}{number\ \ of\ children}, \qquad \text{for } n = 3 \qquad (3.6)$$

To measure poverty at individual level in Brazil, we aggregate the individual resources calculated for each person in the sample and compare it to a poverty line that may depend on the size and the composition of the household. Following Dunbar et al. (2013) and Bargain et al (2014), we use the World Bank's poverty threshold of US$2 per adult and day and US$1.20 per child and day applied to the entire household. These poverty levels arising here are "unadjusted" poverty measures of adults. To test the hypothesis that parents are highly compensated by joint consumption, the measure of adult poverty is adjusted for economies of scale:

$$\tilde{x}_{a,n} = \exp\left(x + \log I_{a,n}(z)\right), \qquad \text{for } a = w, m \text{ and } n = 1, 2\ 3 \qquad (3.7)$$

Based on these measures of individual poverty, poor persons are redefined as poor because the resources they receive in the household are below the aforementioned poverty lines (BARGAIN et al, 2014).

### 3.2 Data and sample selection

The dataset to be used are from secondary source. The information comes from the microdata of *Pesquisa de Orçamentos Familiares* (POF) conducted by *Instituto Brasileiro de Geografia e Estatística* (IBGE). This is a high-quality household survey that is also used in poverty and inequality research (DE SOUZA, 2012). The POF is a cross sectional national survey which gathers information on household expenditures, incomes and socio-demographics for 55,970 representative households. In our empirical analysis, we make use of the most recent available survey for Brazil, namely POF of 2008-2009 (IBGE, 2010a).

Our selection criterion is as follows. To begin with, we restricted the sample to monogamous, nuclear household (i.e., either adults living alone or married couples with or without children). Specifically, the family types that we included are single men, single women, childless couples and couples with one to four children. This selection drops 25% of the initial sample. These households satisfy the following additional sample restrictions: (1) we select households where adults are aged between 20 and 65 years; (2) households with more than one family or unit consumption are excluded; (3) we drop households where children are aged 15 or more in order to differentiate children's clothing expenditures from adults ones in the data (since clothing is the central good used in the identification of our model)[27]; (4) single parents living with children are excluded in our baseline estimations; (5) Since leisure is not modeled here, but is likely endogenous to consumption (and hence savings) decisions, we restrict our sample to households where men are economically active; (6) observations with any missing data on the age or education of members are excluded; (7) we finally exclude households with zero food expenditure together with obvious outlying

[27] In POF of 2008-2009, children's clothing expenditures are defined as the acquisition and rental of children's clothing up to 14 years (IBGE, 2010a).

observations. The final sample is composed of 9,771 households (about to 18% of the initial sample)[28] and it is described in Table 1.

Our private assignable goods are based on clothing expenditures (i.e., one adult male-specific good and one adult female-specific good). These goods, as well as a residual good, are just what we need to identify the main components of the model. However, we also consider other non-durable goods to improve the efficiency of the estimations and to generate tests, namely, food, transport, personal goods and services, household operation and communications or 'housing', leisure goods and services, footwear and paraphernalia, and a children-specific good (i.e., child clothing). Table 1 presents a description of the variables and goods that we use in the estimations. Specifically, in the estimation of the more general model, we use observations for K=9 non-durable commodities: food, transport, leisure goods and services, male, female and child clothing, footwear and paraphernalia, personal goods and services, and household operation and communications (being this latter commodity the omitted good in the Engel curve system). The system estimation comprises a total of 20 individual Engel curves, that is, 3 private assignable goods (men, women, and children clothing) and 6 non-assignable goods, with three individual budget shares. We include 15 demographic variables in our models: region of residence (North, Northeast, Southeast and South with Central-West as the left-out category); the ages and education levels of the household head and spouse; the average age of children less 15; the proportion of children who are boys; binary indicators for women's work participation, house ownership, residence in an urban location and ethnicity (reference category: non-white). All demographic factors are allowed to affect both the preferences of each household member and the allocation of resource across individuals in the households.

[28] This selection can potentially distort our measures of poverty. However, we have some reasons to believe that our results will not be significantly affected. Indeed, the aggregate poverty rate at the level of our study sample using a traditional poverty line (the exact definition of which is given below) amounts to 5.7%, which is of the same order of magnitude as the poverty rate in the extended sample including all family types (8.7%). Of course, our results could still be misleading if the distribution of resources among selected households is very different compared to the rest of the population.

Table 1 — Description of Variables

| Variable | Description |
|---|---|
| **Location of Household** | |
| Urban dummy | Household located in urban area = 1; otherwise = 0 |
| North dummy | Household located in the North region = 1; otherwise = 0 |
| Northeast dummy | Household located in the Northeast region = 1; otherwise = 0 |
| Southeast dummy | Household located in the Southeast region = 1; otherwise = 0 |
| Central-West dummy | Household located in the Central-West region = 1; otherwise = 0 |
| **Household composition** | |
| Men's age | Age of adult male in the household |
| Women's age | Age of adult female in the household |
| Men's education level | Years of schooling of the adult male in the household |
| Women's education level | Years of schooling of the adult female in the household |
| Women's participation | Dummy variable, 1=If adult female works, 0= Otherwise |
| White | Dummy variable, 1=If person is white, 0= Otherwise |
| House ownership | Dummy variable, 1=If adult is house owner, 0= Otherwise |
| Male children | Proportion of male children in the household |
| Children's age | Average age of children in the household |
| Household expenditure | Household total expenditure per week |
| **Goods** | |
| Food | Aggregated household expenditures (in and out of household) on food products and beverages |
| Transport | Aggregated household expenditures on transportation (public transport, gasoline, etc., but no purchase of transportation means) |
| Personal goods and services | Aggregated household expenditures on personal goods and services ((hair care, body care, manicure, hair dressers, medical expenditures not covered by insurance, etc.) |
| Household operations and communications | Expenditures on housing (composed of maintenance costs, rental costs and imputed housing costs for house owners) and telecommunication |
| Leisure goods and services | Aggregated household expenditures on goods and services related to leisure, entertainment and recreation (film, theater, hobbies, sports, photography, books, CD's, DVD's, etc.) |
| Footwear and paraphernalia | Aggregated household expenditures on footwear, bags and belts, and jewelry. |
| Total clothing | Aggregated household expenditures on clothing |
| Women's clothing | Household expenditures on adult female's clothing |
| Men's clothing | Household expenditures on adult male's clothing |
| Children's clothing | Household expenditures on children's clothing |

Source: Own elaboration based on Bargain et al. (2014) and information from POF (2008-2009).

# 4. EMPIRICAL RESULTS

## 4.1 A first look at the data

Table 2 provides summary statistics of our sample by household type and number of children. We observe that the average education level across family types ranging from 7.1 to 8.4 (8.5) years between men (women), where 8 years is the modal education level for both. The representative households are composed of adults aged over 30. Single women are older than single men, but married women are younger than married men according to the average ages of men and women in the subsamples. In general, household structures analyzed here are constituted by urban residents, with a lower frequency of couples with four children in urban areas. Budget shares, in turn, show that household operations and communications are the main items, representing more than 40% of household expenditures. Another important item is food, which comprises of more than 20% of expenditures in households. These descriptive statistics are consistent with previous analysis using POF (2008) data (see, e.g., IBGE, 2010b).

We will now consider a Rothbarth perspective on the variation in consumption when household composition changes. Data reveals that the household budget shares devoted to adult-specific goods tend to decrease with the presence of one additional child. For instance, while childless couples allocate 2.8% (2.4%) of their budget to female (male) clothing, it drops to 2.2% (1.9%) and 2% (1.8%) in couples with one child and two children respectively.

The shifts in consumption patterns are in line with notion that children impose economic costs on their parents. The traditional Rothbarth way of thinking then suggests that, on average, when the family size becomes larger the parents' welfare is likely to be declined due to an income effect which re-allocate limited resources of the parents to accommodate children's needs (BARGAIN; DONNI, 2012a; BARGAIN et al., 2014). On the other hand, the budget share of all the public goods (such as household operations and transport) decreases with family size while the budget share of private goods (total clothing and food) increases. These patterns are consistent with the simplest interpretation that the economies of scale are significant and different across goods. In fact, it can be interpreted that, to some extent, economies of scale generate a wealth effect that shifts consumption from public goods to private goods.

Our strategy follows Bargain and Donni (2012a) in assuming that the presence of private assignable goods can aid in the identification of individual welfare. In other words, by observing how expenditures on clothing vary with total expenditures in the sample of single-person households, it is possible to recover how total household expenditures on all goods are divided up among household members. Table 3 presents monthly expenditures on men's, women's and children's clothing. Single women's monthly expenditures on clothing are on average larger than monthly expenditures on clothing of single men. This may reflects that women likely have a more evident taste for clothing than men. Married women (men) spend around 50 (43) BRL *reais* on clothing per month while mothers (fathers) spend 37.4, 35.5, 27.5 and 17 (32.5, 32.7, 26 and 17.7) BRL *reais* in households with 1, 2, 3 and 4 children respectively. This may implies that, on average, women control a larger proportion of household resources than men, except in couples with 4 children where husband spend more than wife on clothing. However, we cannot rule out the alternative interpretation that wives drop their expenditure on clothing as a consequence of economies of scales. It is imperative to clarify these controversial explanations. More generally, it can be confirmed that children represent a cost for their parents due to the fact that the absolute value of expenditures, as well as the budget clothing shares declines with the number of children (see Table 3).

Table 1 — Summary statistics of the sample, by family type

| Family type | Single men | Single women | Childless couples | Couples with | | | |
|---|---|---|---|---|---|---|---|
| | | | | 1 child | 2 children | 3 children | 4 children |
| Budget shares | | | | | | | |
| Food | 0.278 | 0.217 | 0.239 | 0.257 | 0.272 | 0.312 | 0.351 |
| Transport | 0.152 | 0.099 | 0.187 | 0.178 | 0.170 | 0.142 | 0.106 |
| Personal goods and services | 0.036 | 0.058 | 0.047 | 0.046 | 0.045 | 0.043 | 0.041 |
| Household operations and communications | 0.433 | 0.528 | 0.439 | 0.418 | 0.410 | 0.402 | 0.402 |
| Leisure goods and services | 0.024 | 0.017 | 0.015 | 0.020 | 0.020 | 0.016 | 0.013 |
| Footwear and paraphernalia | 0.019 | 0.019 | 0.018 | 0.020 | 0.021 | 0.020 | 0.021 |
| Budget share(assignable goods) | | | | | | | |
| Women's clothing | — | 0.062 | 0.028 | 0.022 | 0.020 | 0.020 | 0.017 |
| Men's clothing | 0.058 | — | 0.024 | 0.019 | 0.018 | 0.019 | 0.017 |
| Children's clothing | — | — | — | 0.018 | 0.024 | 0.026 | 0.032 |
| Total clothing | 0.058 | 0.062 | 0.052 | 0.060 | 0.062 | 0.065 | 0.066 |
| Demographic variables | | | | | | | |
| Men's schooling (years of education) | 7.8 | — | 7.8 | 8.4 | 8.1 | 7.5 | 7.1 |
| Women's schooling (years of education) | — | 7.9 | 7.8 | 8.5 | 8.2 | 7.6 | 7.1 |
| Men's age (in years) | 37.9 | — | 40.8 | 34.4 | 35.5 | 35.2 | 34.9 |
| Women's age (in years) | — | 42.8 | 38.3 | 30.8 | 31.5 | 30.8 | 30.8 |
| Women's participation dummy | — | 0.762 | 0.557 | 0.531 | 0.503 | 0.461 | 0.462 |
| Urban dummy | 0.770 | 0.917 | 0.770 | 0.795 | 0.779 | 0.703 | 0.665 |
| North | 0.172 | 0.125 | 0.115 | 0.120 | 0.140 | 0.212 | 0.275 |
| Northeast | 0.247 | 0.297 | 0.246 | 0.305 | 0.325 | 0.346 | 0.386 |
| Southeast | 0.310 | 0.273 | 0.296 | 0.263 | 0.249 | 0.192 | 0.131 |
| South | 0.100 | 0.130 | 0.149 | 0.154 | 0.117 | 0.090 | 0.056 |
| Central-West | 0.172 | 0.175 | 0.195 | 0.158 | 0.169 | 0.159 | 0.151 |
| House owner dummy | 0.414 | 0.558 | 0.580 | 0.561 | 0.597 | 0.622 | 0.590 |
| White dummy | 0.393 | 0.457 | 0.492 | 0.479 | 0.463 | 0.335 | 0.295 |
| Proportion of male children | — | — | — | 0.511 | 0.516 | 0.487 | 0.518 |
| Average age of children | — | — | — | 5.529 | 6.815 | 7.163 | 7.131 |
| Proportion of positive values | | | | | | | |
| Women's clothing | — | 0.928 | 0.858 | 0.726 | 0.691 | 0.638 | 0.665 |
| Men's clothing | 0.946 | — | 0.800 | 0.675 | 0.668 | 0.669 | 0.637 |
| Children's clothing | — | — | — | 0.779 | 0.805 | 0.800 | 0.793 |
| Total expenditure per month (in BRL- Brazilian real) | 1,274 | 1,210 | 1,778 | 1,675 | 1,784 | 1,359 | 1,011 |
| Total expenditure per month (in USD- US dollar) | 550.3 | 522.8 | 767.9 | 723.6 | 770.7 | 586.9 | 436.8 |
| Sample size | 1,137 | 787 | 2,406 | 3,510 | 2,701 | 979 | 251 |

Source: Research results.
Notes: (1) Household expenditures for goods selected in the 8 good demand system; (2) The exchange rate is $1 = 2.31 BRL Brazilian real; (3) Men in Brazil typically marry younger women (median difference is 3 years according to: United Nations (2001), World Marriage Patterns; New York, Population Division, Department Of Economic And Social Affairs.

Table 3 — Monthly expenditure on clothing, by family type (in Brazilian *reais*)

| Family type | Single men | Single women | Childless couples | Couples with | | | |
|---|---|---|---|---|---|---|---|
| | | | | 1 child | 2 children | 3 children | 4 children |
| Women's clothing | — | 74.5 | 49.8 | 37.4 | 35.5 | 27.5 | 17.0 |
| Men's clothing | 73.8 | — | 43.4 | 32.5 | 32.7 | 26.0 | 17.7 |
| Children's clothing | — | — | — | 30.8 | 42.2 | 34.7 | 32.1 |

Source: Research results.

### 4.1.1 Results for endogeneity and non-linearity of total expenditures test equations

In order to check for endogeneity of total expenditure and for the non-linearity of budget share equations in log expenditure, we have performed reduced-form estimations on the subsample of each household type *n*. The coefficient corresponding to the main variables (i.e., the log total expenditure, its square and the Wu–Hausman residuals) are presented in Table 4. For all the subsamples, the results suggest that the budget share equations show a quadratic pattern. The same conclusion is obtained by Banks et al. (1997), Bargain and Donni (2012a) and Bargain et al. (2014). In particular, all the coefficients on log expenditure are significant (except for couples with 4 children) and negative, i.e., the budget share for male and female clothing falls as total expenditure rises (thereby implying that, on average, clothing is a necessity good). The coefficients of the quadratic model are also significant and show that the effect of log total expenditure is increasing. In the Appendix A, nonparametric kernel-weighted local polynomial regressions for the Engel curves of our 9 commodity groups are performed in order to illustrate the non-linearity of Engel curves. Figures A1-A9 show nonlinear patterns for most goods so that a double humped specification for the Engel curves is taken for granted. In particular, figures A1-A3 show a distinct nonlinear behavior for clothing, at least in the raw data. In fact, women's clothing seems to be a luxury good for the smallest levels of total expenditure and a necessary good for the highest levels. By contrast, it seems that men's clothing is a luxury good at the highest levels of household expenditure and a necessary good at the smallest levels. Regarding the coefficients of the Wu–Hausman residual, the estimates are not markedly affected by its introduction and it is negative and significant in almost all subsamples. These results suggest that expenditure is not exogenous. Therefore, the Wu-Hausman residuals must also be included in the structural Engel curve estimations[29].

[29] The residuals for the square of log expenditure are not jointly significant. Thus, for the estimation of the basic model only the Wu–Hausman residuals for log expenditure are introduced.

Table 2 — Estimated coefficients of reduced-form regressions

| Models | Linear | Quadratic | |
|---|---|---|---|
| | | Without WH residuals | With WH residuals |
| *Single-persons* | | | |
| Male clothing | | | |
| Log exp | -0.176*** | -0.833*** | -0.559** |
| | (-9.20) | (-4.12) | (-2.56) |
| Square of log exp | | 0.0351*** | 0.0244** |
| | | (3.35) | (2.22) |
| Wu-Hausman residual | | | -0.132*** |
| | | | (-3.80) |
| *Female clothing* | | | |
| Log exp | -0.120*** | -1.678** | -1.586** |
| | (-3.46) | (-2.25) | (-2.09) |
| Square of log exp | | 0.0830** | 0.0792** |
| | | (2.15) | (2.03) |
| Wu-Hausman residual | | | -0.0439 |
| | | | (-0.99) |
| *Couples without child* | | | |
| Male clothing | | | |
| Log exp | -0.110*** | -0.937*** | -0.875*** |
| | (-10.07) | (-5.15) | (-4.78) |
| Square of log exp | | 0.0421*** | 0.0403*** |
| | | (4.70) | (4.49) |
| Wu-Hausman residual | | | -0.0504*** |
| | | | (-3.36) |
| Female clothing | | | |
| Log exp | -0.107*** | -0.935*** | -0.818*** |
| | (-9.28) | (-5.07) | (-4.45) |
| Square of log exp | | 0.0423*** | 0.0385*** |
| | | (4.64) | (4.27) |
| Wu-Hausman residual | | | -0.0847*** |
| | | | (-5.27) |
| *Couples with 1 child* | | | |
| Male clothing | | | |
| Log exp | -0.120*** | -1.074*** | -0.997*** |
| | (-9.70) | (-4.92) | (-4.66) |
| Square of log exp | | 0.0489*** | 0.0459*** |
| | | (4.54) | (4.34) |
| Wu-Hausman residual | | | -0.0426*** |
| | | | (-2.63) |
| Female clothing | | | |
| Log exp | -0.0802*** | -0.418*** | -0.273** |
| | (-10.01) | (-3.18) | (-2.01) |
| Square of log exp | | 0.0172*** | 0.0114* |
| | | (2.65) | (1.73) |
| Wu-Hausman residual | | | -0.0701*** |
| | | | (-4.66) |

Table 4 — (*continued*)

| Models | Linear | Quadratic | |
|---|---|---|---|
| | | Without WH residuals | With WH residuals |
| *Couples with 2 children* | | | |
| Male clothing | | | |
| Log exp | -0.0956*** | -0.447*** | -0.354*** |
| | (-11.16) | (-3.67) | (-2.85) |
| Square of log exp | | 0.0178*** | 0.0148** |
| | | (2.96) | (2.42) |
| Wu-Hausman residual | | | -0.0713*** |
| | | | (-4.75) |
| Female clothing | | | |
| Log exp | -0.0746*** | -0.436*** | -0.355*** |
| | (-8.43) | (-3.59) | (-2.97) |
| Square of log exp | | 0.0183*** | 0.0155*** |
| | | (3.04) | (2.63) |
| Wu-Hausman residual | | | -0.0522*** |
| | | | (-3.84) |
| *Couples with 3 children* | | | |
| Male clothing | | | |
| Log exp | -0.128*** | -1.196*** | -1.007*** |
| | (-6.57) | (-4.23) | (-3.43) |
| Square of log exp | | 0.0557*** | 0.0481*** |
| | | (3.94) | (3.31) |
| Wu-Hausman residual | | | -0.0865*** |
| | | | (-2.67) |
| Female clothing | | | |
| Log exp | -0.0942*** | -0.928** | -0.747** |
| | (-4.55) | (-2.51) | (-1.99) |
| Square of log exp | | 0.0433** | 0.0360* |
| | | (2.33) | (1.93) |
| Wu-Hausman residual | | | -0.0875** |
| | | | (-2.41) |
| *Couples with 4 children* | | | |
| Male clothing | | | |
| Log exp | -0.127*** | -0.852 | -0.445 |
| | (-4.05) | (-1.42) | (-0.67) |
| Square of log exp | | 0.0392 | 0.0200 |
| | | (1.20) | (0.57) |
| Wu-Hausman residual | | | -0.0930* |
| | | | (-1.78) |
| Female clothing | | | |
| Log exp | -0.114*** | -1.213 | -1.225 |
| | (-2.76) | (-1.28) | (-1.08) |
| Square of log exp | | 0.0595 | 0.06 |
| | | -1.19 | -1.03 |
| Wu-Hausman residual | | | 0.00336 |
| | | | -0.04 |

Source: Research results.
Notes: All calculations use the sample weights. Standard errors are heteroskedastic-consistent and clustered at federal unit level. *t* statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

In a preliminary step, we want to estimate a system of only three budget share equations which exploits information on adult-specific goods (men's and women's clothing) and a residual good. This latter is omitted from the estimations. To increase the efficiency of the estimators, the specifications used in this primary model are slightly simplified: all the parameters $\mu_i$ in equation (3.1) and $\beta_i^{\sigma}$ in (3.4) are set to zero. The estimates obtained with this simple model have the advantage of requiring fewer parametric assumptions (i.e., the model is based on quite restrictive functional forms). However, because of its simplicity and the fact that the model is based on limited amount of information, the estimates of the structural components are less efficient by comparison with a more general model presented in the next subsection.

The estimated coefficients of the budget share equations for men and women are presented in Table 5. Specifically, the coefficients of log scaled expenditure and its square are significantly different from zero. This result implies that the regularity conditions of Proposition 1 discussed in Section 2.1.3 are satisfied. Furthermore, the effect of log scaled expenditure on budget shares is negative and increasing. These results are compatible with reduced-form estimations reported in Table 4 for the sample of single persons. In general, budget shares for male and female are characterized by estimated coefficients of the same sign, except for *white*, and almost the same order of magnitude. In effect, the coefficients of the dummies for house owner, urban resident and women's participation are positive and mostly statistically significant at the 1% level. In addition, as explained below, we will also present the estimates an additional model that exploits information on the other goods only in order to check the robustness of our results.

Table 3 — Estimated coefficients of the three-equation model-budget share equations

| | Budget share for male clothing | Budget share for female clothing |
|---|---|---|
| Constant | 5.304*** | 4.419*** |
| | (7.14) | (6.30) |
| Adult's age | -0.00102** | -0.000195 |
| | (-2.42) | (-0.49) |
| Adult's education | 0.00221** | 0.00135 |
| | (2.58) | (1.10) |
| Women's participation | | 0.0408*** |
| | | (3.73) |
| White | -0.00679 | 0.0130* |
| | (-0.83) | (1.68) |
| House owner | 0.0476*** | 0.0397*** |
| | (6.48) | (5.26) |
| Urban resident | 0.0220** | 0.0295*** |
| | (2.50) | (3.28) |
| Log scaled exp | -0.894*** | -0.744*** |
| | (-6.17) | (-5.40) |
| Log scaled exp squared | 0.0402*** | 0.0337*** |
| | (5.68) | (5.11) |
| *Demographic translations* | | |
| Adult's age | 0.0051* | -0.00183 |
| | (1.91) | (-0.72) |
| Adult's education | 0.0686*** | 0.0551*** |
| | (3.88) | (7.40) |
| White | 0.326** | 0.262*** |
| | (2.70) | (3.14) |
| Women's participation | | 0.0810 |
| | | (0.92) |

Source: Research results.

Notes: All calculations use the sample weights. Standard errors are heteroskedastic-consistent and clustered at federal unit level. *t* statistics in parentheses. State fixed effects are included as dummies for state of residence of individual. *** p<0.01, ** p<0.05, * p<0.1.

### 4.2 Estimation of the resource shares and the economies of scales

It is clear from the previous section that although the simple model provides some robust estimates, they are not sufficiently precise. Thus, in this section we use a more general model, incorporating 7 budget share equations into a completely general specification. The specification allows for free variation of the parameters of the functional form discussed in Section 3.1.1 Additional equations were used to generate overidentifying restrictions, as in Bargain and Donni (2012a)[30] and Bargain et al. (2014). By estimating the complete model, then, it may be possible to estimate the structural components of the model with greater precision and to check for the stability of preferences over consumption (BARGAIN; DONNI, 2012a). Additionally, the Wu–Hausman residuals for log total expenditure and its square are included in each budget share equation. The estimated parameters of the male and female budget share equations are reported in Table 6 while estimates of the child's budget share equations are presented in Table 7. Some comments are in order. Firstly, the estimated parameters of the budget share equations for male and female clothing are of the same order as those obtained with the simple model (reported in Table 5), but standard deviations are generally lower (as is inferred from the t-statistics). Going one step further, it turns out that, for all the budget share equations, the estimated parameters are similar to those obtained from the sample of single-person households (these results are reported in Table B1 in the Appendix). Secondly, the effects of socio-demographic variables for men and women are consistent, i.e., several dummies have the same significant effect on budget share for both men and women. The estimated parameters of the child's budget share equations are unfortunately not precisely estimated. The slopes of the child's budget shares with respect to log total expenditure do not allow us to infer the nature of goods (luxury or necessary) even though this information is identifiable, as explained in the theoretical section.

[30] According to Bargain and Donni (2012), the estimations of the complete model are made for two main reasons. First, we are interested in estimating the structural components of the model with a greater precision. Second, the use a more complete model allows testing the hypothesis that preferences over consumption are stable, i.e. it can be tested the hypothesis according to which the parameters for single persons and for persons living in a couple are the same. For this, we perform a simple Breusch-Pagan test for independent equations. The Breusch-Pagan statistic for independence, which follows a Chi-squared distribution under the null hypothesis, is about to 33,015. The null hypothesis is then rejected at the 1% level. Thus, the assumption that the parameters for singles and couples are the same seems to be a reasonable approximation. The same conclusion is obtained by Bargain and Donni, (2012a, p. 806).

Table 4— Estimated coefficients of the complete model-budget share equations of adults

| | Food | | Transport | | Clothing | | Leisure goods and services | | Footwear and Paraphernalia | | Personal goods and services | | Household | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Man | Woman | Man | Woman | Man | Woman | Man | Woman | Man | Woman | Man | Woman | Man | Woman |
| Constant | 0.941*** | 0.381 | -0.907*** | -0.861*** | 5.592*** | 4.474*** | -0.138** | -0.129** | -0.113** | -0.051 | -0.365*** | -0.314*** | 1.557*** | 1.566*** |
| | (3.25) | (1.32) | (-3.16) | (-2.96) | (17.07) | (11.93) | (-2.49) | (-2.44) | (-2.37) | (-1.05) | (-4.56) | (-3.60) | (5.40) | (5.26) |
| Adult's age | 0.000 | -0.000 | -0.001*** | -0.001*** | -0.001*** | -0.000 | -0.000*** | -0.000*** | -0.000*** | -0.000*** | -0.001*** | -0.000*** | 0.002*** | 0.003*** |
| | (1.59) | (-0.47) | (-3.70) | (-5.11) | (-3.07) | (-1.07) | (-8.09) | (-9.74) | (-7.69) | (-8.35) | (-8.90) | (-7.13) | (10.80) | (14.71) |
| Adult's | -0.001*** | -0.001** | -0.003*** | -0.002*** | 0.003*** | 0.000 | 0.001*** | -0.000 | 0.000 | -0.000 | 0.000** | 0.000*** | 0.003*** | 0.003*** |
| Education | (-3.46) | (-2.00) | (-4.84) | (-4.81) | (2.71) | (0.24) | (4.61) | (-0.41) | (1.60) | (-1.20) | (1.97) | (2.70) | (6.21) | (5.66) |
| White | -0.002 | -0.010*** | -0.006 | 0.004 | -0.007 | 0.013 | 0.000 | -0.000 | -0.001 | 0.000 | -0.001 | 0.002* | 0.013*** | 0.004 |
| | (-0.58) | (-2.80) | (-1.49) | (1.06) | (-0.86) | (1.62) | (0.24) | (-0.05) | (-1.11) | (0.36) | (-1.12) | (1.65) | (3.40) | (1.16) |
| House owner | 0.009*** | 0.008** | 0.005 | 0.002 | 0.048*** | 0.039*** | 0.004*** | 0.003*** | 0.002*** | 0.003*** | 0.003*** | 0.007*** | -0.027*** | -0.029*** |
| | (2.67) | (2.44) | (1.39) | (0.65) | (6.53) | (5.25) | (5.83) | (4.68) | (2.68) | (4.61) | (3.52) | (6.28) | (-7.68) | (-8.22) |
| Urban | -0.019*** | -0.028*** | -0.051*** | -0.057*** | 0.022** | 0.029*** | 0.006*** | 0.005*** | 0.001* | 0.002** | 0.006*** | 0.009*** | 0.059*** | 0.069*** |
| resident | (-4.38) | (-6.77) | (-11.80) | (-13.29) | (2.45) | (3.17) | (6.86) | (6.86) | (1.79) | (2.49) | (4.66) | (7.31) | (13.44) | (16.02) |
| Log scaled | -0.094 | 0.016 | 0.139** | 0.130** | -0.959*** | -0.746*** | 0.026** | 0.024** | 0.029*** | 0.017* | 0.088*** | 0.077*** | -0.214*** | -0.213*** |
| Expenditure | (-1.58) | (0.27) | (2.36) | (2.18) | (-14.45) | (-9.84) | (2.28) | (2.22) | (3.01) | (1.66) | (5.31) | (4.33) | (-3.61) | (-3.50) |
| Square of | 0.002 | -0.002 | -0.002 | -0.002 | 0.044*** | 0.034*** | -0.001* | -0.001 | -0.002*** | -0.001* | -0.004*** | -0.004*** | 0.008*** | 0.008*** |
| Log scale | (0.75) | (-0.98) | (-0.63) | (-0.50) | (12.85) | (8.76) | (-1.71) | (-1.56) | (-3.04) | (-1.70) | (-5.26) | (-4.44) | (2.75) | (2.63) |
| Expenditure | | | | | | | | | | | | | | |
| Women's | | -0.002 | | 0.001 | | 0.033*** | | 0.000 | | 0.002*** | | 0.007*** | | -0.007** |
| participation | | (-0.70) | | (0.33) | | (4.45) | | (0.67) | | (2.84) | | (6.26) | | (-2.03) |
| Demographic translation | | | | | | | | | | | | | | |
| Husband's age in all men's equations | | 0.009*** (12.45) | | Husband's education in all men's equations | | 0.061*** (30.10) | | White men in all men's equations | | 0.272*** (18.05) | | Women's participation in all women's equations | | 0.212*** (14.88) |
| Wife's age in all women's equations | | 0.003*** (3.83) | | Wife's education in all women's equations | | 0.035*** (18.31) | | White women in all women's equations | | 0.285*** (18.66) | | | | |

Source: Research results.

Notes: All calculations use the sample weights. Standard errors are heteroskedastic-consistent and clustered at federal unit level. *t* statistics in parentheses. State fixed effects are included as dummies for state of residence of individual. *** p<0.01, ** p<0.05, * p<0.1.

Table 5 — Estimated coefficients of the complete model-budget share equations of children

| | Food | Transport | Clothing | Leisure goods and services | Footwear and paraphernalia | Personal goods and services | Household operations |
|---|---|---|---|---|---|---|---|
| Constant | 0.474*** | -1.282*** | 0.348*** | -0.154*** | 0.0492*** | -0.711*** | 2.423*** |
| | (57.61) | (-162.05) | (421.78) | (-105.90) | (38.80) | (-337.14) | (308.64) |
| Number of children | 0.0026*** | -0.0050*** | -0.00145*** | 0.00038*** | 0.0006*** | 0.0024*** | 0.0022*** |
| | (24.04) | (-47.77) | (-78.09) | (19.96) | (33.40) | (87.54) | (21.27) |
| Proportion of male children | -0.00390*** | 0.00209*** | 0.000290*** | -0.00119*** | -0.00137*** | -0.000710*** | 0.00459*** |
| | (-40.33) | (22.60) | (17.69) | (-70.10) | (-91.83) | (-28.89) | (50.22) |
| Average age of children | -0.0005*** | -0.0003*** | 0.00001*** | -0.0004*** | 0.00045*** | -0.0007*** | 0.00158*** |
| | (-34.08) | (-19.02) | (4.42) | (-138.68) | (182.09) | (-177.50) | (103.98) |
| White | -0.0158*** | 0.00363*** | -0.00131*** | 0.001*** | 0.00145*** | 0.001*** | 0.0118*** |
| | (-147.92) | (35.43) | (-72.00) | (52.61) | (87.27) | (33.97) | (116.63) |
| Urban resident | -0.0382*** | -0.0350*** | -0.001*** | 0.00434*** | 0.000410*** | 0.00482*** | 0.0670*** |
| | (-265.50) | (-253.88) | (-39.42) | (171.35) | (18.40) | (131.61) | (491.93) |
| House owner | 0.0185*** | -0.0005*** | 0.00138*** | 0.00188*** | 0.00228*** | 0.00291*** | -0.0291*** |
| | (183.63) | (-5.58) | (80.84) | (106.03) | (146.40) | (113.53) | (-305.42) |
| Women's participation | 0.00968*** | -0.00630*** | 0.000185*** | -0.000185*** | 0.000865*** | 0.0000229 | -0.0034*** |
| | (93.08) | (-63.34) | (10.58) | (-10.08) | (53.73) | (0.87) | (-34.93) |
| Log scaled Expenditure | 0.0109*** | 0.217*** | -0.0541*** | 0.0270*** | -0.00503*** | 0.153*** | -0.390*** |
| | (6.51) | (134.85) | (-329.42) | (91.17) | (-19.53) | (357.72) | (-244.67) |
| Square of Log scale Expenditure | -0.00316*** | -0.00689*** | 0.00226*** | -0.000968*** | 0.000167*** | -0.00775*** | 0.0184*** |
| | (-37.52) | (-84.87) | (276.23) | (-64.74) | (12.81) | (-357.95) | (228.12) |
| *Demographic translation* | | | | | | | |
| Number of children | | 0.0336*** | | Average age of children | | 0.0165*** | |
| | | (72.47) | | | | (242.83) | |
| Proportion of male children | | -0.0164*** | | White | | 0.322*** | |
| | | (-39.25) | | | | (711.94) | |

Source: Research results.

Notes: All calculations use the sample weights. Standard errors are heteroskedastic-consistent and clustered at federal unit level. *t* statistics in parentheses. State fixed effects are included as dummies for state of residence of individual *** p<0.01, ** p<0.05, * p<0.1.

The estimates of the coefficients of the sharing and scaling functions are reported in Table 8. In this part, we estimate expenditure shares, scaling factors and indifference scales. We shall essentially consider four variations of the model described above: Model (a) which is the baseline model estimated with the sample described in the previous section; Model (b) in which the *normalized* measures of scale economies $\sigma_{i,n}$ are restricted to be the same for both spouses; Model (c) in which the $\varepsilon_{i,n}$ are restricted to be the same for male and female clothing; and Model (d) in which costs of household operations are incorporated in the system of budget share equations.

We implement a simple test for the IB restriction, following closely Menon et al. (2012, p. 741). In particular, we pool all the household sizes, which would give a test with more statistical power, and estimate coefficients from regressions of each individual resource share on a linear and quadratic models in expenditure which include a categorical variable for each household size and dummies for each federal unit of residence. These regressions are presented in Table C1 and C2 in the Appendix C. The results indicate that households with more children allocate more resources to children, but less for women and men. However, none of the log expenditure is individually statistically significant. This suggests that the hypothesis that resource shares do not vary with expenditure is not violated in these data. In other words, identification of resource shares on the basis of IB restriction may be valid.

In Table 8, we report the main results for scales and total expenditure shares for adults and children. The resource shares $\eta_{i,n}(z)$ are computed at the average point of the sample for each family type. From the Model (a) we see that, for all the family types, the average shares of total expenditure is slightly larger for men than for women, except for couples with more than two children. The average men's share amounts to 0.526 for childless couples while it amounts to 0.411 and 0.372 for couples with one or two children, respectively. These differences between men and women switch in larger families where wife's share of total expenditure is larger than the husband's. In a few words, men seem to have the leading voice in childless couples and households with less than three children while in families with at least three children, women control a larger fraction of household resources than men. Then, a first suggestive point is that the notion created by descriptive data, according to which the fraction of total expenditure received by men is smaller than for women can be rejected here.

The estimations of resource shares are comparable to those previously obtained in the literature. In particular, the results for households with at most two children are in line with Dunbar et al. (2013), who found that in Malawi, husband's shares of total expenditure are larger than wife's ones in households with several children. Our estimates for couples with at least three children in which larger shares are found for women are consistent with Browning, Chiappori, Lewbel (2013) on Canadian data, Bargain and Donni (2012a) on French data and Bargain et al. (2014) on Ivorian data. Estimations of the average children's share increase in a plausible way with household size ranging 0.20 to 0.42. Another relevant point to mention when examining Model (a) in Table 8 is that the parameters of the scaling functions are significantly different from 1. This finding may reflect the existence of sizeable economies of scale in the household which invalidates the traditional Rothbarth approach (BARGAIN; DONNI, 2012a).

If $\sigma_{i,n}$ are restricted to be the same for husband and wife as in Model (b), it is interesting to note that the difference between men's and women's shares of total expenditure is relatively less marked. This illustrates that taking economies of scales that are specific to both spouses into account may explains notably the differences in women's and men's expenditure on clothing. Overall it seems that the estimates of scales for childless couples are rather large. For instance, women's scale for a representative childless couple is equal to 0.912; so the cost of living for a married woman is 91.2% of the cost he would experience should she live alone. Nevertheless, economies of scale increase (i.e., deflators $s_{i,n}$ decrease) in larger families (with one or more children) compared to childless couples.

Table 6— Total expenditure shares, scaling factors, and indifference scales

| | Model (a) Baseline model | | Model (b) Model with identical $\sigma_i$ | | Model (c) Model with identical $\varepsilon_i$ | | Model (d) Model with housing | |
|---|---|---|---|---|---|---|---|---|
| | Est | StdErr | Est | StdErr | Est | StdErr | Est | StdErr |
| Childless couples | | | | | | | | |
| Shares of women | 0.474 | 0.0000 | 0.485 | 0.0000 | 0.384 | 0.0425 | 0.474 | 0.0000 |
| Shares of men | 0.526 | 0.0000 | 0.515 | 0.0000 | 0.616 | 0.0425 | 0.526 | 0.0000 |
| Scales of women | 0.534 | 0.0003 | 0.912 | 0.0001 | 0.674 | 0.0309 | 0.534 | 0.0003 |
| Scales of men | 0.587 | 0.0002 | 0.991 | 0.0000 | 0.868 | 0.0407 | 0.587 | 0.0002 |
| Indifference scale for women | 0.888 | 0.0005 | 0.532 | 0.0000 | 0.886 | 0.0005 | 0.888 | 0.0005 |
| Indifference scale for men | 0.897 | 0.0003 | 0.520 | 0.0000 | 0.898 | 0.0003 | 0.897 | 0.0003 |
| Couples with one child | | | | | | | | |
| Shares of women | 0.388 | 0.0001 | 0.388 | 0.0001 | 0.348 | 0.0011 | 0.388 | 0.0001 |
| Shares of men | 0.411 | 0.0000 | 0.411 | 0.0000 | 0.461 | 0.0029 | 0.411 | 0.0000 |
| Shares of children | 0.201 | 0.0001 | 0.207 | 0.0001 | 0.189 | 0.0035 | 0.201 | 0.0001 |
| Scales of women | 0.598 | 0.0003 | 0.401 | 0.0000 | 0.537 | 0.0018 | 0.598 | 0.0003 |
| Scales of men | 0.488 | 0.0001 | 0.419 | 0.0001 | 0.545 | 0.0034 | 0.488 | 0.0001 |
| Indifference scale for women | 0.650 | 0.0005 | 0.962 | 0.0000 | 0.650 | 0.0005 | 0.650 | 0.0005 |
| Indifference scale for men | 0.844 | 0.0003 | 0.974 | 0.0001 | 0.844 | 0.0003 | 0.844 | 0.0003 |
| Couples with two children | | | | | | | | |
| Shares of women | 0.363 | 0.0000 | 0.346 | 0.0000 | 0.332 | 0.0009 | 0.363 | 0.0000 |
| Shares of men | 0.372 | 0.0000 | 0.368 | 0.0000 | 0.411 | 0.0069 | 0.372 | 0.0000 |
| Shares of children | 0.265 | 0.0000 | 0.286 | 0.0000 | 0.257 | 0.0050 | 0.265 | 0.0000 |
| Scales of women | 0.504 | 0.0003 | 0.359 | 0.0000 | 0.462 | 0.0013 | 0.504 | 0.0003 |
| Scales of men | 0.446 | 0.0001 | 0.402 | 0.0002 | 0.492 | 0.0080 | 0.446 | 0.0001 |
| Indifference scale for women | 0.721 | 0.0005 | 0.965 | 0.0000 | 0.721 | 0.0005 | 0.721 | 0.0005 |
| Indifference scale for men | 0.833 | 0.0003 | 0.916 | 0.0001 | 0.833 | 0.0003 | 0.833 | 0.0003 |
| Couples with three children | | | | | | | | |
| Shares of women | 0.364 | 0.0000 | 0.359 | 0.0001 | 0.377 | 0.0077 | 0.364 | 0.0000 |
| Shares of men | 0.333 | 0.0000 | 0.357 | 0.0000 | 0.363 | 0.0011 | 0.333 | 0.0000 |
| Shares of children | 0.304 | 0.0000 | 0.285 | 0.0001 | 0.260 | 0.0045 | 0.304 | 0.0000 |
| Scales of women | 0.412 | 0.0002 | 0.383 | 0.0000 | 0.459 | 0.0081 | 0.412 | 0.0002 |
| Scales of men | 0.414 | 0.0002 | 0.359 | 0.0000 | 0.451 | 0.0014 | 0.414 | 0.0002 |
| Indifference scale for women | 0.883 | 0.0005 | 0.938 | 0.0002 | 0.883 | 0.0005 | 0.883 | 0.0005 |
| Indifference scale for men | 0.804 | 0.0005 | 0.992 | 0.0000 | 0.804 | 0.0005 | 0.804 | 0.0005 |
| Couples with four children | | | | | | | | |
| Shares of women | 0.318 | 0.0000 | 0.336 | 0.0001 | 0.328 | 0.0070 | 0.318 | 0.0000 |
| Shares of men | 0.259 | 0.0000 | 0.271 | 0.0001 | 0.308 | 0.0219 | 0.259 | 0.0000 |
| Shares of children | 0.423 | 0.0000 | 0.393 | 0.0001 | 0.364 | 0.0116 | 0.423 | 0.0000 |
| Scales of women | 0.328 | 0.0002 | 0.337 | 0.0001 | 0.343 | 0.0062 | 0.328 | 0.0002 |
| Scales of men | 0.270 | 0.0002 | 0.277 | 0.0001 | 0.374 | 0.0237 | 0.270 | 0.0002 |
| Indifference scale for women | 0.969 | 0.0008 | 0.996 | 0.0000 | 0.969 | 0.0008 | 0.969 | 0.0008 |
| Indifference scale for men | 0.958 | 0.0007 | 0.977 | 0.0001 | 0.958 | 0.0008 | 0.958 | 0.0007 |

Source: Research results.
Note: Standard errors are heteroskedastic-consistent.

One important contributor to household economies of scale may be expenditure on household operations; hence expenditure on housing can hardly be ignored from the analysis (BARGAIN et al., 2014). The estimations of expenditure shares, scaling factors and indifference scales obtained with Model (d) are not significantly or systematically different from those of the other models. In fact, the estimates of Model (d) are practically identical to those obtained from Model (a). In general, models (a) and (b) provide the most precise estimates, judging by the lower magnitude of standard errors. Because of these low standard errors together with the facts that the Model (c) is based on too restrictive assumptions and the similarity of models (a) and (d), we consider that the results given by models (a) and (b) are more consistent.

Rejecting Model (c), the average women's share goes to 0.474 and 0.485 for childless couples. The proportion of resources devoted to children varies between 0.201 and 0.207 for household with one child, between 0.265 and 0.286 for household with two children, between 0.285 and 0.304 for household with three children, and between 0.393 and 0.423 for household with four children. Note that the level of the total share of household resources devoted to children rise as the number of children increases, but the average share allocated to each child declines. One-child families devote, on average, around 20% of its expenditures to children's consumption. With two children, this share rises to roughly 26%, with three children, to approximately 29%, and to four children, to about 42%. The resource share per child in households with three or four children is around 10%. These results are in line with those obtained by Dunbar et al. (2013) and Bargain et al. (2014). Using the Model (a) in Table 8, we compute that for a household with one child, the average fraction of total expenditure received by child represents about 49% of the resource of the mother. This proportion is smaller than the child's need of resources estimated in the modified OECD scale (i.e., 60% of the need of an adult). Similar results are provided by Bargain et al. (2014) on data from Côte d'Ivoire.

However, note that inequality at the level of individual shares does not necessarily mean large difference in individual welfare, since goods may have a large public component, and persons do not generally benefit from the same level of joint consumption in the household (LEWBEL; PENDAKUR, 2008; BARGAIN; DONNI, 2012a; BARGAIN et al., 2014). Indeed, we find substantial scale economies of living together, according to economies of scale deflators $s_{i,n}(z)$ in Table 8, which are considerably lower than 1 in most of the cases with the exception of childless couples in Model (b). Recall that $s_{i,n}(z)$ should lie between

$\eta_{i,n}(z)$ (purely public consumption) and 1 (purely private consumption). To take an example, a scale of 0.587 (resp. 0.534) for a man (resp. woman) living in a couple without children in Model (a) indicate that his (her) cost of living in a couple is around 59% (resp. 53%) the cost he (she) would experience if living alone. Hence joint consumption among households is remarkably large. As a consequence, it can be shown the existence of sizeable indifference scales, defined as the ratio of shares and scales. In Model (a) estimated indifference scales are greater than 0.80 for husband, at least 0.65 for wife, and close to one for both spouses with four children. Thus, given the estimates from Model (a), the household income must be multiplied by no more than ($1.54 \approx 1/0.65$) for a woman and ($1.19 \approx 1/0.84$) for man to obtain the same level of welfare in a couple with a child than when alone. Such a woman (man), if living alone, would need a fraction 0.888 (0.897) of the couple's income to reach the same indifference curve as when in couples without children. This implies that single persons would not benefit from these important scale economies. The estimated indifference scales in Model (b) for both spouses are close to one, except for childless couples where they are 0.532 and 0.520 for women and men respectively. Following Bargain et al. (2014), we use later these estimated indifference scales, specifically those of the model (a) as explained below, for compute poverty measures at the individual level.

## 4.3 Factors associated with the resource shares and the scale economies

We estimate the effect of demographic variables on the resource shares for the four models. Tables 9, 10 and 11 give estimated parameters of the women's, men's and children's sharing function, respectively. The estimates are consistent across all models[31]. We note that several variables are explanatory of the intra-household allocation process. We find that spouses' age seems to be related to a larger fraction of the total expenditure they receive. The education level of the woman does not much affect the resource shares, but the education level of the man is positively related to the husband's share. That is, spouses have larger resource shares to the extent that they have more years of education. It seems also that the

[31] To check the robustness of our results we also estimate two additional models. In particular, Model (e) exploits information on men's, women's and children's clothing only. On the other hand, Model (f) exploits information on the other goods only. The results using these alternate models are qualitatively the same (See Tables B2-B5 in the Appendix B). In other words, the estimates of the parameters for these two additional models are in line with those for models (a)-(d). Therefore, the estimation of our main results seems generally robust across different specifications.

white race, urban residency and house ownership are positively related to the share of total expenditure devoted to each household member. The effect of urban residency on the share of total expenditure devoted to the child, however, is not statistically significant.

On the other hand, woman's participation in the labor market seems to influence the distribution of resources among spouses in the household: an increase in the wife's work participation entails a shift of the distribution of total expenditure from the husband to the wife. If we interpret this as due to a distribution factor, then it can be interpreted that if women have more bargaining power, then their ability to extract within-household resources would be larger. We also included a measure of the household income in the regressors of the sharing functions. This last regressor was dropped due to collinearity with the explanatory variables of the men's and children's indices. We thus observe that, for women, it seems that the level of income of the household has a positive effect on wife's share, but this effect is not very significant across the models. However, other variables in the models (e.g., education, urban residency and home ownership) can be considered as proxies for household income.

Table 7 — Parameters of the women's sharing functions

| | Model (a) Baseline model | Model (b) Model with identical $\sigma_i$ | Model (c) Model with identical $\varepsilon_i$ | Model (d) Model with housing |
|---|---|---|---|---|
| Constant | — | — | — | — |
| | — | — | — | — |
| Woman's age | 0.0467*** | 0.0436*** | 0.0388*** | 0.0488*** |
| | (19.66) | (18.65) | (13.68) | (21.80) |
| Woman's schooling | 0.00205 | 0.00968 | 0.0117 | 0.00916 |
| | (0.19) | (1.04) | (1.20) | (0.98) |
| White | 0.372*** | 0.321*** | 0.274*** | 0.407*** |
| | (5.47) | (4.97) | (3.70) | (6.61) |
| Woman's participation | 0.574*** | 0.583*** | 0.497*** | 0.604*** |
| | (6.95) | (8.48) | (7.22) | (7.40) |
| Urban | 0.311*** | 0.351*** | 0.389*** | 0.348*** |
| | (4.69) | (4.43) | (4.93) | (4.63) |
| Income | 0.387** | 0.212 | 0.426 | |
| | (2.34) | (0.90) | (0.03) | |
| House owner | 0.206*** | 0.190*** | 0.191*** | 0.201*** |
| | (3.56) | (2.87) | (3.23) | (3.41) |

Source: Research results.

Notes: All calculations use the sample weights. Standard errors are heteroskedastic-consistent and clustered at federal unit level. The women's index is the exponential functions entering the logistic function. The estimated parameters and the standard errors indicated by – are set to zero for identification purpose. *t* statistics in parentheses. State fixed effects are included as dummies for state of residence of woman. *** p<0.01, ** p<0.05, * p<0.1.

Table 8 — Parameters of the men's sharing functions

| | Model (a) | Model (b) | Model (c) | Model (d) |
|---|---|---|---|---|
| | Baseline model | Model with identical $\sigma_i$ | Model with identical $\varepsilon_i$ | Model with housing |
| Constant | -2.133*** | -2.146*** | -2.146*** | -3.283*** |
| | (-16.88) | (-17.76) | (-16.90) | (-27.72) |
| Man's age | 0.0418*** | 0.0422*** | 0.0419*** | 0.0601*** |
| | (23.52) | (22.33) | (23.65) | (24.90) |
| Man's schooling | 0.0229*** | 0.0244*** | 0.0221*** | 0.0237*** |
| | (3.31) | (3.00) | (3.12) | (2.77) |
| White | 0.425*** | 0.430*** | 0.421*** | 0.636*** |
| | (8.07) | (7.66) | (8.35) | (10.74) |
| Urban | 0.328*** | 0.333*** | 0.346*** | 0.325*** |
| | (3.79) | (4.13) | (3.87) | (5.10) |
| House owner | 0.157*** | 0.157*** | 0.164*** | 0.206*** |
| | (3.41) | (3.35) | (3.63) | (4.09) |

Source: Research results.
Notes: All calculations use the sample weights. Standard errors are heteroskedastic-consistent and clustered at federal unit level. The men's index is the exponential functions entering the logistic function. *t* statistics in parentheses. State fixed effects are included as dummies for state of residence of man. *** p<0.01, ** p<0.05, * p<0.1.

Table 9 — Parameters of the children's sharing functions

| | Model (a) | Model (b) | Model (c) | Model (d) |
|---|---|---|---|---|
| | Baseline model | Model with identical $\sigma_i$ | Model with identical $\varepsilon_i$ | Model with housing |
| Constant | -2.889*** | -2.879*** | -2.957*** | -2.906*** |
| | (-16.69) | (-15.62) | (-16.73) | (-19.16) |
| Number of children | 0.156*** | 0.0642* | 0.143** | 0.161*** |
| | (2.64) | (1.85) | (2.38) | (3.31) |
| Proportion of male children | -0.0442 | -0.0397 | -0.0402 | -0.0216 |
| | (-0.38) | (-0.38) | (-0.40) | (-0.19) |
| Average age of children | 0.397*** | 0.400*** | 0.402*** | 0.399*** |
| | (25.78) | (25.49) | (25.41) | (25.94) |
| White | 0.146*** | 0.155** | 0.149** | 0.134** |
| | (2.63) | (2.27) | (2.37) | (2.30) |
| Urban | 0.0474 | 0.0357 | 0.0583 | 0.0303 |
| | (0.37) | (0.28) | (0.44) | (0.24) |
| Woman's participation | 0.129* | 0.116 | 0.109 | 0.145** |
| | (1.78) | (1.58) | (1.51) | (2.01) |
| House owner | 0.315*** | 0.344*** | 0.329*** | 0.313*** |
| | (6.70) | (7.46) | (6.84) | (6.49) |

Source: Research results.
Notes: All calculations use the sample weights. Standard errors (in parentheses) are heteroskedastic-consistent and clustered at federal unit level. *t* statistics in parentheses. State fixed effects are included as dummies for state of residence of children. *** p<0.01, ** p<0.05, * p<0.1.

Regarding the distribution of resources between children, as the number and the average age of children increases, the total share of household resources devoted to them goes up. These results are consistent with Dunbar et al. (2013) and Bargain et al. (2014). The fraction of total expenditure received by boys is relatively smaller than for girls but the effect is not statistically significant. This result does not confirm the hypothesis that there is discrimination in favor of boys. In contrast, Rose (1999) Bargain and Donni (2012a) and Dunbar et al. (2013) show that discrimination in favor of boys is revealed by the structure of consumption. Our results are in line with those obtained by Deaton (1989) and Bargain et al. (2014) who found no evidence of child gender bias in the overall treatment of boys and girls in Côte d'Ivoire. The effect of the white race, mother's work participation and house ownership on the share of total expenditure devoted to children, on the other hand, is positive and statistically significant.

Table 12 shows the estimated parameters of the scaling functions. In model (a) economies of scale seem to be more favorable to men and dependent of the number of children. In particular, joint consumption for husbands (resp. wives) represents roughly 50% (resp. 45%) of the consumption of the other members in the household. Economies of scale are expected to increase in families with children compared to childless couples. Although reasonable in magnitude, these parameters of scale economies are not very precisely estimated because they are not very statistically significant and there is a fair amount of instability in their estimates across models. For these reasons, we believe that the results given by model (a) are more reliable. In particular, the baseline model provides, in our opinion, the most precise scale economy parameter estimates because it is based on less restrictive assumptions and it is more statistically powerful than the other models. Yet, even this model's standard errors are uncomfortably large. Thus, in what follows we only consider model (a) for the analysis of poverty at individual level.

Table 10 — Parameters of the scaling functions

| | Model (a) | Model (b) | Model (c) | Model (d) |
|---|---|---|---|---|
| | Baseline model | Model with identical $\sigma_i$ | Model with identical $\varepsilon_i$ | Model with housing |
| Women's scaling function | | | | |
| Constant | 0.450*** | 0.446*** | 0.548*** | 0.470*** |
| | (60.38) | (59.53) | (464.08) | (1189.51) |
| Number of children | 0.129*** | 0.0127 | 0.00317 | 0.00135** |
| | (22.17) | (1.65) | (1.69) | (2.49) |
| Men's scaling function | | | | |
| Constant | 0.503*** | 0.446*** | 0.548*** | 0.543*** |
| | (92.36) | (59.53) | (464.08) | (57.95) |
| Number of children | 0.217*** | 0.0127 | 0.00317 | 0.00877 |
| | (51.23) | (1.65) | (1.69) | (1.01) |

Source: Research results.

Notes: All calculations use the sample weights. Standard errors are heteroskedastic-consistent and clustered at federal unit level. *t* statistics in parentheses. State fixed effects are included as dummies for state of residence of individual. *** p<0.01, ** p<0.05, * p<0.1.

### 4.4 Individual poverty rates

Considering first the empirical results described so far, we estimated the levels of resource shares and the marginal effects of various demographic factors on them. Although estimated shares tell us how total expenditure is allocated among persons in reference households, they do not automatically reflect needs of each individual or intra-household inequality in terms of welfare. On the other hand, resource allocations could change across household sizes due to the fact that the demographic factors themselves covary with household size (DUNBAR et al., 2013). Thus, to evaluate the implications of our estimations on the distribution of individual consumption for the different family members, it is illustrative to consider the allocation of total expenditure shares in households of different sizes. For the reasons stated in the previous section, we focus on our baseline model.

The upper panel of Table 13 presents a few summary statistics on the sharing of total expenditure for people in households of different composition. It is worth noting that the minima and maxima values of resource shares do not fall outside the range between zero and one for any person in any household in the sample. As Table 13 shows, the dispersion of resource shares is relatively large. To take an example, the total expenditure share of a women living in a childless couple varies between 0.351 and 0.715 depending on the demographic

variables. The distribution of shares of men and children are also largely dispersed. Nevertheless, total expenditure shares do not necessarily include unobserved heterogeneity (BARGAIN et al., 2014). One possible interpretation is then that the effects of the demographic variables are important on resource shares. Hence, these factors are as important as the household sizes themselves. This justifies that it is pertinent not only identify the level of resource shares but their response with respect to demographic variables.

Two different approaches have tried to measure poverty at individual level based on the distribution of resources within households, namely the models of Dunbar et al. (2013) and Bargain et al. (2014). In this respect, these two approaches are similar in using the total expenditure shares and comparing them to the World Bank's poverty threshold of US$2 per day for adults and US$1.20 per day for children (according to the OECD estimate of the relative needs of children, i.e., 60 % that of adults). We thus follow these two studies and use such poverty thresholds applied to our sample of households. Firstly, in the lower panel of Table 13 we report under the label of 'household poverty' and based on the standard headcount ratio, the estimated poverty rates for households of different sizes and composition. These measures assume that each household member gets an equal share of household income. In general, we observe that poverty tends to systematically increase with household size or with the number of children. In particular, poverty ranges from 5.6% of single men and 3% of single women to 9.1% of childless households and 18%, 26%, 44% and 64% of households with one, two, three and four children, respectively. Yet it is unclear why singles are remarkably less affected by poverty than couples.

Table 11 — Poverty rates and the distribution of individual shares

| Family type | Single men | Single women | Childless couples | Couples with | | | |
|---|---|---|---|---|---|---|---|
| | | | | 1 child | 2 children | 3 children | 4 children |
| Women's shares | | | | | | | |
| Minimum | | | 0.351 | 0.278 | 0.265 | 0.268 | 0.236 |
| Median | | | 0.473 | 0.363 | 0.317 | 0.318 | 0.278 |
| Maximum | | | 0.715 | 0.593 | 0.553 | 0.549 | 0.478 |
| Men's shares | | | | | | | |
| Minimum | | | 0.393 | 0.303 | 0.273 | 0.245 | 0.193 |
| Median | | | 0.526 | 0.386 | 0.325 | 0.291 | 0.227 |
| Maximum | | | 0.798 | 0.622 | 0.562 | 0.504 | 0.390 |
| Children's shares | | | | | | | |
| Minimum | | | | 0.142 | 0.192 | 0.224 | 0.317 |
| Median | | | | 0.200 | 0.298 | 0.341 | 0.423 |
| Maximum | | | | 0.337 | 0.424 | 0.471 | 0.640 |
| Household poverty levels | 0.056 | 0.030 | 0.091 | 0.180 | 0.261 | 0.448 | 0.633 |
| Women's poverty | | 0.030 | 0.177 | 0.220 | 0.210 | 0.221 | 0.287 |
| levels (unadjusted) | | | (0.021) | (0.018) | (0.021) | (0.032) | (0.055) |
| Men's poverty | 0.056 | | 0.112 | 0.176 | 0.184 | 0.256 | 0.351 |
| levels (unadjusted) | | | (0.012) | (0.014) | (0.020) | (0.032) | (0.051) |
| Children's poverty | | | | 0.064 | 0.154 | 0.453 | 0.554 |
| levels (unadjusted) | | | | (0.013) | (0.011) | (0.014) | (0.022) |
| Women's poverty | | 0.030 | 0.024 | 0.062 | 0.046 | 0.031 | 0.036 |
| levels (Adjusted) | | | (0.017) | (0.014) | (0.016) | (0.025) | (0.044) |
| Men's poverty | 0.056 | | 0.020 | 0.027 | 0.031 | 0.042 | 0.036 |
| levels (Adjusted) | | | (0.017) | (0.014) | (0.016) | (0.025) | (0.043) |

Source: Research results.

Notes: All calculations use the sample weights or expansion factor provided by the POF 2008-2009. Standard errors (in parentheses) are heteroskedastic-consistent and clustered at federal unit level.

To disentangle these patterns of distribution across households, it may be necessary to account for inequality within the household. For this, we use our estimates of the resource shares $\eta_{i,n}(\boldsymbol{z})$ to construct individual-level expenditures. Specifically, we calculate the amount of household expenditure accruing to each individual (i.e., household expenditure times the resource share) and compare this to the thresholds of US$2 per day for each adult and US$1.20 per day for each child. We first compute the individual resources for each person in the sample and then aggregate into poverty rates at the individual level. The lower panel of Table 13 provides these measures referred to as men's, women's and children's (unadjusted) poverty levels. We can see that the poverty rates are also lower for singles than for adults in

couples with and without children. Table 13 also reports the level of poverty adjusted for scale economies. In all cases, we observe a stunning decrease in poverty levels among adults in couples. For example, for women (resp. men) in childless couples the poverty rate drops from 17.7% (resp. 11.2%) to 2.4% (resp. 2%). The reduction in poverty rates is larger for married women than for men in couples in almost all cases; couples with 3 and 4 children indicate the contrary. In terms of joint consumption, the poverty decline is compatible across all types of households and with the gender differences in scale economies stated in previous section. These results compare well to those of Bargain et al. (2013), in which the poverty rates of adults living alone and in a family are of the same order of magnitude because the fact that adults in families must share resources is compensated by the gains from joint consumption (i.e., economies of scale).

Furthermore, it is worthwhile to note that the per capita measures overstate poverty levels among adults and the incidence of child poverty, mainly for large families[32]. Overall, child poverty level goes up with the number of children and it ranges from 6.4% for one-child household to 55% in households with four children. In particular, for one-child families the incidence of child poverty (6.4%) is of the same order of magnitude as women's poverty with adjustment for scale economies (6.2%). This might either reflect that children's needs are not necessarily those assumed in the OECD scale applied to the poverty line or that there is limited redistribution from parents to their child (BARGAIN et al., 2014). However, poverty rates are dramatically higher for larger families, i.e. more than 10%, 40% and 50% for households with two, three and four children, respectively. Although the high child poverty rates could over-estimate the child needs, we cannot rule out the possibility that the allocation of resources skewed in favor of adults in larger families explains the gap between one-child households and larger households (BARGAIN et al., 2014). This finding underlines that the expenditure per child tends to systematically decrease with the number of children. By comparison, Bargain et al. (2014) find that the per capita children's shares become smaller in families of several children compared to one-child families in Côte d'Ivoire. Dunbar et al. (2013) drew the same conclusion in Malawi. Alternatively, it is possible that larger families may benefit from large economies of scale among children because they can share child specific goods (e.g., food, toys or clothes). For this reason, the increase in child poverty among larger families could be narrowed due to the existence of scale economies induced by joint consumption among children. However, these economies of scale are not modeled here

[32] The exception is the case of couples with three children

and, therefore, results regarding children's poverty levels in Table 13 must be interpreted with caution.

Our results have explicitly incorporated the interactions that occur within Brazilian families in the determination of the intra-household consumption allocation. This is useful to explain the presence of different individual living conditions for different household members. In that vein, previous empirical measures of poverty in Brazil have treated households as if their members enjoy an equal share of all household resources. One way to put into a context our results of poverty rates is to compare them to previous calculations for Brazil. For example, Osorio et al. (2012) found that in 2009 the income poverty level among adults aged between 19 and 64, and children aged 14 or younger was around 7.2% and 26.4%, respectively. Osorio et al. (2012, p. 26) also found that poverty rate is about 3.5% for childless families, while it amounts to 14.6% (62.8%) for persons living in households with 1-3 (4 or more children).

Still, we find that household resources are not equally distributed among household members and, as a consequence, the individuals have different levels of poverty. In addition, our results indicate that there are substantial differences in the demographic structure of households below the poverty line. This is noteworthy if we consider that most policy analysis assumes that effectively individual wellbeing is the adult-equivalent average of the household to which the individual belongs (HADDAD; KANBUR, 1990). Thus analyzing and tackling the differences that occurs within and among households is important for ensuring individuals' welfare. The fact that we do not reject the implications of the collective model for Brazil is imperative because it lays the groundwork for analyzing household behavior in order to establish the consequences of different redistributive policies. With the information given by our results, the design and assessment of government programs aimed to change the condition of individuals within the household (e.g., *Bolsa Família*) could unravel effectively the changes in the control of resources within the households. This basis makes it possible that we can identify if such kind of programs actually changes the allocation of resources within the household.

# 5. FINAL REMARKS

This research attempted to measure the share of total expenditure accruing to children and adults, as well as poverty at individual level in Brazil using a model consistent with scale economies and parental bargaining. Note that this contribution is one of the rare applications of a collective model that reassess these issues in a developing country. The identification strategy requires the observation of expenditure on adult goods, as in the traditional Rothbarth approach. We conducted the joint estimation on pooled sample of single individuals, childless couples and couples with one, two, three and four children, and we applied it for three types of persons (men, women, and young children). Clearly, we have limited the application of our approach to singles and couples with 0-4 children. In order to measure how our estimations change with the household structure and size, it would be easy to extend our framework to more diversified demographic structures. This constitutes an interesting path for future research.

Based on a system of Engel curves for typical aggregated commodities including the assignable good, this paper provided estimates of the returns to scale of living together among spouses and of the shares of consumption among household members. In particular, the presence of an assignable good in the different household types allowed identifying children's shares despite the fact that young children are always observed living with their parents. Evidence from Brazil adds to the growing literature that measures the extent of intra-

household inequalities, presenting a broader picture of people's material wellbeing and its distribution.

A preliminary descriptive analysis has shown the possible existence of large economies of scale in the Brazilian households, which invalidates the traditional Rothbarth approach. In addition, our results indicate that the differences in consumption behavior between singles and couples can be explained by the sizeable scale economies within multi-person households. The empirical findings based on the baseline model also show that the parents' expenditures made for children living in the household amount to about 20% of the resources for one-child households and 26% for families with four children. Regarding the distribution of resources between adults, spouses' education (as well as their age) seems to be related to a larger fraction of the total expenditure they receive. The share of total expenditure devoted to household members is positively related to urban residency, house ownership, white persons and woman's participation in the labor market (in the case of women and children). In particular, the share of total expenditure devoted to children increases with their number and their age. On the other hand, we found no evidence of gender discrimination among children.

Overall, the empirical analysis we report suggests that ignoring intra-household inequalities affects the assessment of levels of poverty. In particular, the neglect of unequal distribution of resources among household members leads to a large overestimation of child poverty. However, child poverty levels are computed based on the differentiation in individual needs across household members, but they do not take joint consumption among children into account. Thus, we cannot rule out the possibility that our results might still overestimate the incidence of child poverty. In particular, the levels of child poverty may be apparently high due to two reasons. As noted above, the empirical model does not include scale economies from joint consumption among children in households. Furthermore, with the method we use, the information on the household production is not incorporated in the collective model framework. This may be a source of bias in our estimations. Indeed, omitting the household production would imply that the rate of child poverty in the sample is higher than in the corresponding population. If this is the case, our estimations may be incapable of capturing adequately children's total expenditure shares and may lead us to wrongly ignore if

children consume relatively more of the goods produced within the household. These last issues deserve more research work.

Our results on the total expenditure share of children are compatible with those obtained by Dunbar et al. (2013) and Bargain et al. (2014) who use data from African countries. All these models rely on the same fundamental principle, i.e., the Rothbarth idea of measuring how the consumption of adult goods varies across different household types. In this setup, evidence from Brazil adds to the growing literature that helps to consolidate such type of models.

Strategies to dealing with poverty and inequality must consider the dynamics of population living in the poorer socioeconomic conditions. In fact, the analysis of poverty and inequality is a well-established research area that constitutes an important input into policy-making. In particular, the estimation of resources allocation process within household and the identification of the pattern of intra-household distribution that we presented here for Brazil should be considered in policy terms. Not only because they may provide a basis for calculating the level of family allowances, but by extension, because they also provide an estimate of both the relative individual welfare and the cost of children. In poverty analysis, family allowances derived from the intra-household resource allocation provide a basis for translating household welfare into individual welfare for families of different sizes and composition, enabling a more accurate identification of the poor in this way. In Brazil, conditional cash transfer programs (such as *Bolsa Família*) and redistributive tax policies, which ignore the distribution of resources within households, may fail to target effectively the population group of concern and reduce material deprivation or vulnerability among people in poverty. From a program effectiveness standpoint, it may be important to understand how resources are allocated among household members in order to target more effectively individuals within households and minimize the incidence of poverty.

However, our concern here is a fairly narrow one, focusing on an economic definition of living standards. We do not consider other important components of welfare, such as freedom, health status or life-expectancy, all of which are related to income and consumption, but which cannot be adequately captured by any simple measure or structural model. In fact, consumption measures are limited in their scope, but are nevertheless a central component of any assessment of living standards.

Given its preliminary nature, the present study allows for many possible extensions. For instance, the incorporation of the scale economies among children in these models is one of the major challenges for future research. On the other hand, we acknowledge that scaling factors, interpreted as economies of scale in households, may capture not only changes in individual preferences but consumption externalities across household types. In order to better understand these different interpretations, it may be important to disentangle exhaustively these scale economies.

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# APPENDIX A

## Deriving the equation (2.3)

Applying Roy's identity to equation (2.2) gives

$$w_{i,n}^{k}(x,\mathbf{p},\mathbf{z}) = -\left.\frac{\partial v_i(\mathbf{p},x_{i,n}-\log s_{i,n}(\mathbf{p},\mathbf{z}),\mathbf{z}_i)/\partial p^k}{\partial v_i(\mathbf{p},x_{i,n}-\log s_{i,n}(\mathbf{p},\mathbf{z}),\mathbf{z}_i)/\partial x}\right|_{x_{i,n}=x+\log\eta_{i,n}(\mathbf{p},\mathbf{z})} \tag{A.1}$$

where

$$\frac{\partial v_i(\cdot)}{\partial p^k} = \frac{\partial v_i(\cdot)}{\partial p^k} + \frac{\partial v_i(\cdot)}{\partial(x_{i,n}-\log s_{i,n})}\left(-\frac{\partial \log s_{i,n}}{\partial p^k}\right) \tag{A.2}$$

and

$$\frac{\partial v_i(\cdot)}{\partial x} = \frac{\partial v_i(\cdot)}{\partial(x_{i,n}-\log s_{i,n})}\left(\frac{\partial x_{i,n}}{\partial x_{i,n}}\right) = \frac{\partial v_i(\cdot)}{\partial(x_{i,n}-\log s_{i,n})} \tag{A.3}$$

Substituting equations (A.2) and (A.3) by the corresponding terms in equation (A.1), yields

$$w_{i,n}^{k}(x,\mathbf{p},\mathbf{z}) = -\frac{\dfrac{\partial v_i(\cdot)}{\partial p^k} + \dfrac{\partial v_i(\cdot)}{\partial(x_{i,n}-\log s_{i,n})}\left(-\dfrac{\partial \log s_{i,n}}{\partial p^k}\right)}{\dfrac{\partial v_i(\cdot)}{\partial(x_{i,n}-\log s_{i,n})}} = \frac{-\dfrac{\partial v_i(\cdot)}{\partial p^k} + \dfrac{\partial v_i(\cdot)}{\partial(x_{i,n}-\log s_{i,n})}\left(\dfrac{\partial \log s_{i,n}}{\partial p^k}\right)}{\dfrac{\partial v_i(\cdot)}{\partial(x_{i,n}-\log s_{i,n})}} \tag{A.3}$$

which in turn can be expressed as

$$w_{i,n}^{k}(x,\mathbf{p},\mathbf{z}) = \frac{-\dfrac{\partial v_i(\cdot)}{\partial p^k}\left\{\dfrac{\partial \log v_i(\cdot)}{\partial p^k}\cdot\dfrac{\partial v_i(\cdot)}{\partial \log v_i(\cdot)}\right.}{\dfrac{\partial v_i(\cdot)}{\partial(x_{i,n}-\log s_{i,n})}\left\{\dfrac{\partial \log v_i(\cdot)}{\partial(x_{i,n}-\log s_{i,n})}\cdot\dfrac{\partial v_i(\cdot)}{\partial \log v_i(\cdot)}\right.} + \frac{\partial \log s_{i,n}}{\partial p^k} = \frac{\dfrac{\partial \log v_i(\cdot)}{\partial p^k}}{\dfrac{\partial \log v_i(\cdot)}{\partial(x_{i,n}-\log s_{i,n})}} + \frac{\partial \log s_{i,n}}{\partial p^k} \tag{A.4}$$

so we can rewrite the equation (A.4) in the form of equation (2.3), that is

$$w_{i,n}^{k}(x_{i,n},\mathbf{p},\mathbf{z}) = \varepsilon_{i,n}^{k}(\mathbf{p},\mathbf{z}) + \omega_i^{k}(\mathbf{p},x_{i,n}-\log s_{i,n}(\mathbf{p},\mathbf{z}),\mathbf{z}_i)$$

where

$$\omega_i^k(\mathbf{p}, x_{i,n} - \log s_{i,n}(\mathbf{p},\mathbf{z}),\mathbf{z}_i) = \frac{\dfrac{\partial \log v_i(\cdot)}{\partial p^k}}{\dfrac{\partial \log v_i(\cdot)}{\partial (x_{i,n} - \log s_{i,n})}}$$

and

$$\varepsilon_{i,n}^k(\mathbf{p},\mathbf{z}) = \frac{\partial \log s_{i,n}}{\partial p^k}$$

To conclude, we recall that households are assumed to be observed in a unique price regime (i.e., **p** is constant), as provided in cross-sectional data, and replacing $x_{i,n}=x+\log \eta_{i,n}$, yields

$$w_{i,n}^k(x,\mathbf{z}) = \varepsilon_{i,n}^k(\mathbf{z}) + \omega_i^k(x + \log \eta_{i,n}(\mathbf{z}) - \log s_{i,n}(\mathbf{z}),\mathbf{z_i}) \,\square$$

## Nonparametric Engel Curves

In all kernel-weighted local polynomial regressions we use the Gaussian kernel function, 0.5 for the bandwidth and a quadratic specification, except for men-clothing and children-clothing where a cubic specification better approximates our data.

FIGURE A1.-NONPARAMETRIC ENGEL CURVE FOR MEN CLOTHING

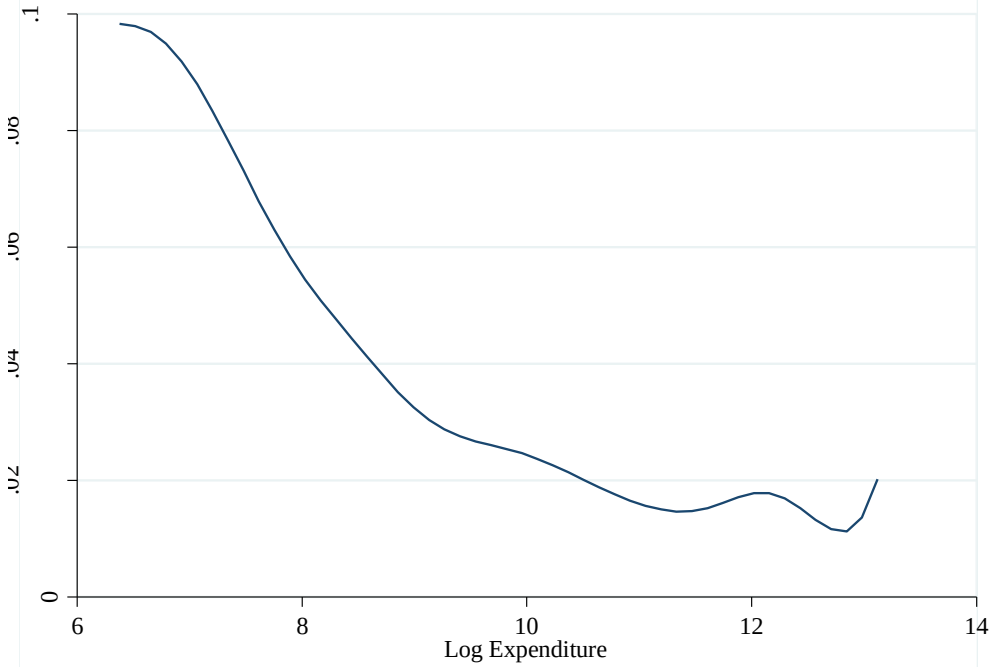



FIGURE A2.-NONPARAMETRIC ENGEL CURVE FOR WOMEN CLOTHING

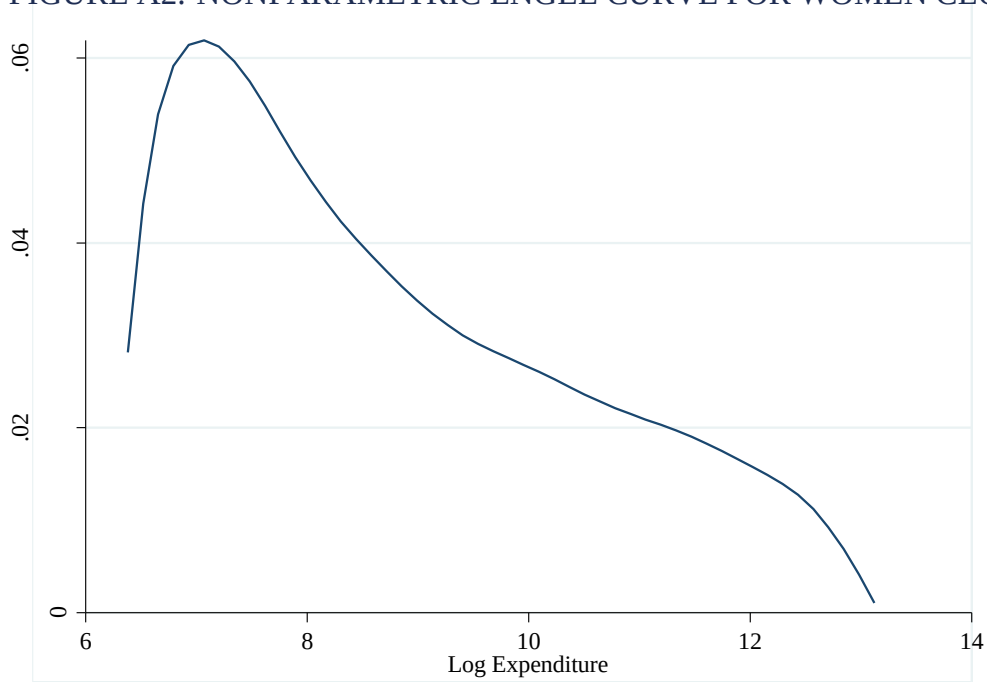


FIGURE A3.-NONPARAMETRIC ENGEL CURVE FOR CHILDREN CLOTHING

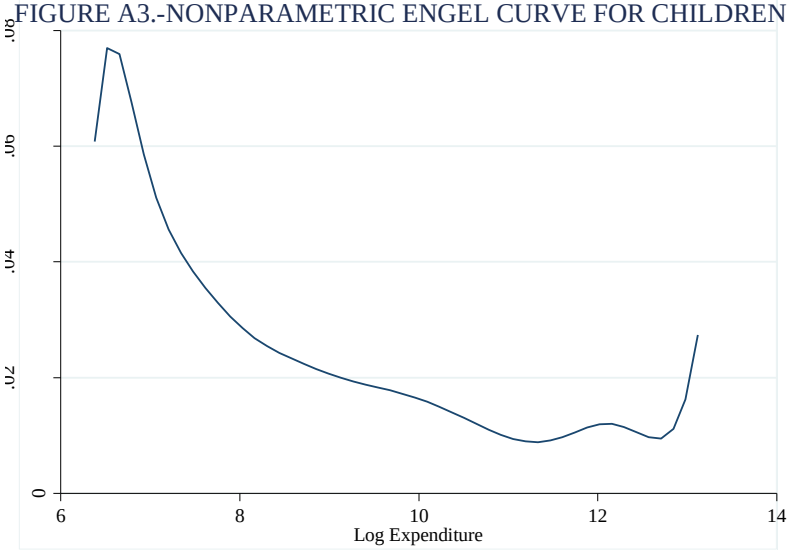



FIGURE A4.-NONPARAMETRIC ENGEL CURVE FOR FOOD

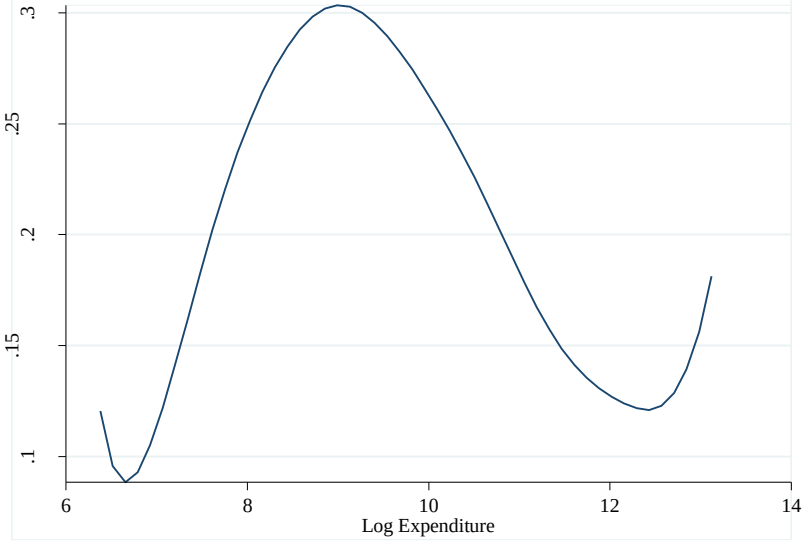



FIGURE A5.-NONPARAMETRIC ENGEL CURVE FOR TRANSPORT

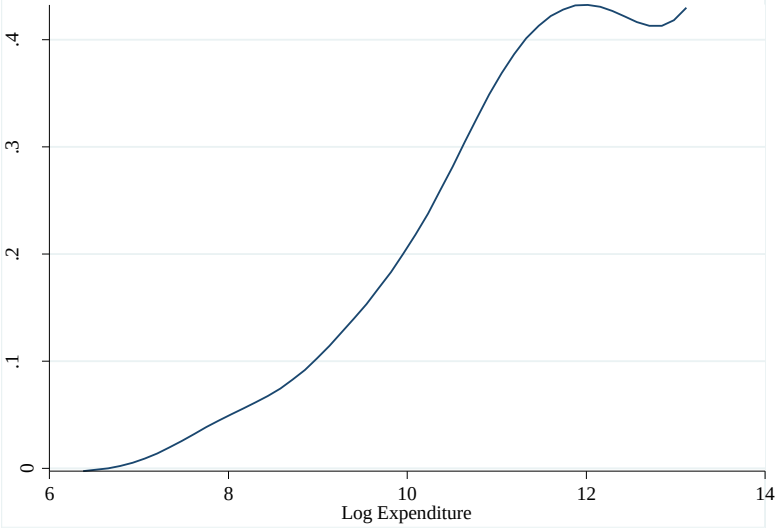


FIGURE A6.-NONPARAMETRIC ENGEL CURVE FOR PERSONAL GOODS AND SERVICES

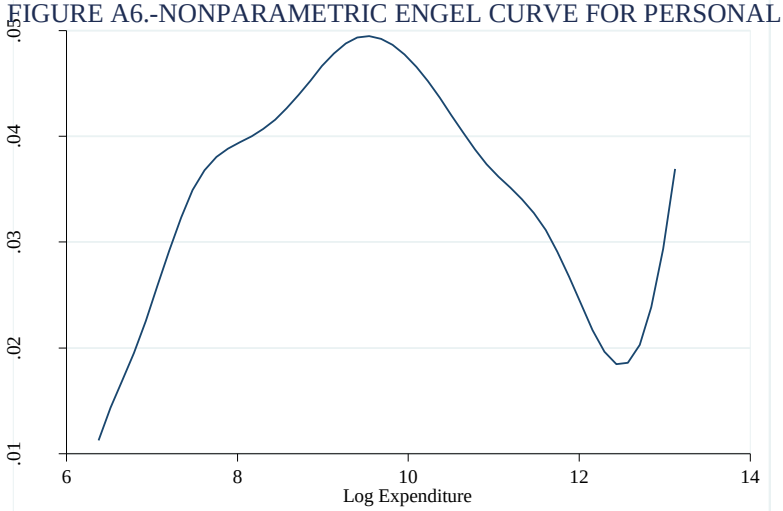



FIGURE A7.-NONPARAMETRIC ENGEL CURVE FOR HOUSEHOLD OPERATIONS

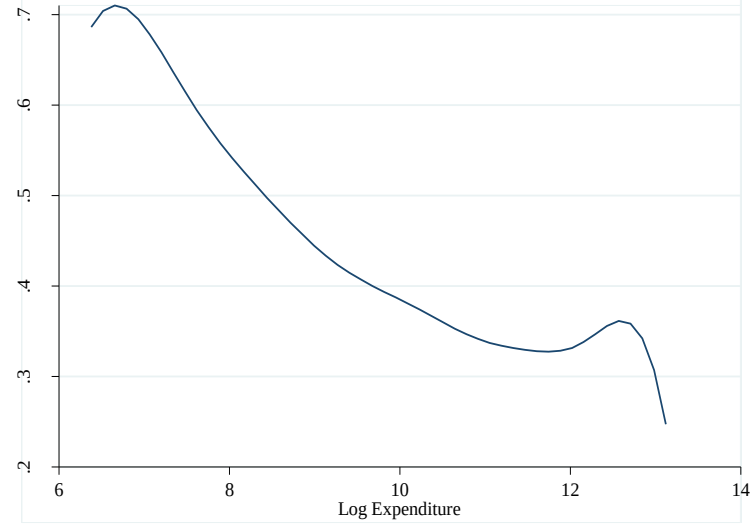



FIGURE A8.-NONPARAMETRIC ENGEL CURVE FOR LEISURE

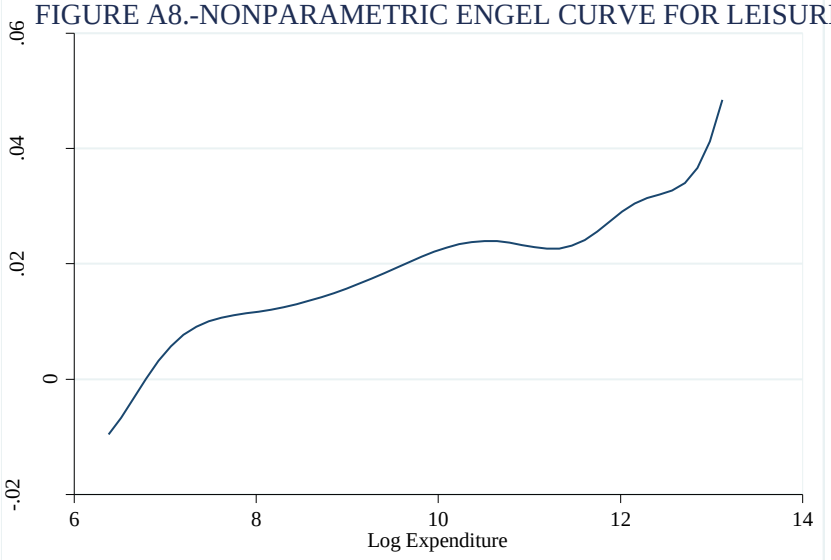
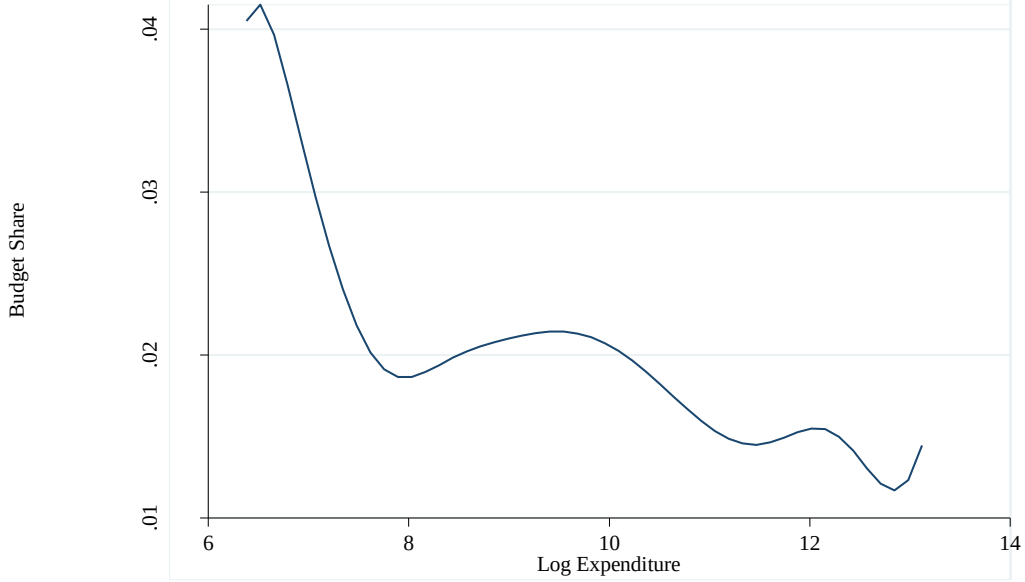


FIGURE A9.-NONPARAMETRIC ENGEL CURVE FOR FOOTWEAR AND PARAPHERNALIAE



# APPENDIX B

Table B1 — Estimated coefficients of the complete model-budget share equations of single-households

| | Food | | Transport | | Clothing | | Leisure goods and services | | Footwear and Paraphernalia | | Personal goods and services | | Household | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Man | Woman | Man | Woman | Man | Woman | Man | Woman | Man | Woman | Man | Woman | Man | Woman |
| Adult's age | 0.001** | -0.000 | -0.001*** | -0.001* | -0.004*** | -0.005*** | -0.001*** | -0.001*** | -0.000256*** | -0.000** | -0.001*** | -0.001*** | 0.002*** | 0.003*** |
| | (2.21) | (-0.10) | (-2.83) | (-1.69) | (-3.59) | (-2.90) | (-4.39) | (-4.51) | (-2.90) | (-2.05) | (-3.93) | (-3.75) | (4.00) | (5.08) |
| Adult's Education | -0.001 | -0.001 | 0.000 | -0.000 | -0.001 | -0.002 | 0.001* | 0.000 | 0.000191 | -0.000 | -0.000 | 0.000 | -0.000 | 0.001 |
| | (-0.77) | (-1.07) | (0.37) | (-0.05) | (-0.37) | (-0.48) | (1.68) | (0.12) | (0.77) | (-0.53) | (-0.06) | (0.25) | (-0.07) | (0.95) |
| White | 0.020* | -0.018 | -0.014 | -0.008 | -0.052 | 0.055 | 0.000 | -0.001 | -0.00422** | 0.002 | 0.002 | 0.010** | 0.001 | 0.0126 |
| | (1.69) | (-1.56) | (-1.42) | (-0.92) | (-1.59) | (1.21) | (0.06) | (-0.54) | (-2.02) | (1.03) | (0.53) | (2.13) | (0.12) | (0.92) |
| House owner | 0.020* | 0.039*** | 0.001 | 0.014 | 0.047 | 0.046 | 0.006** | 0.003 | 0.00333* | 0.004* | 0.002 | 0.015*** | -0.038*** | -0.081*** |
| | (1.89) | (3.45) | (0.09) | (1.59) | (1.60) | (1.06) | (2.46) | (1.37) | (1.75) | (1.84) | (0.96) | (3.28) | (-3.47) | (-6.16) |
| Urban resident | 0.033** | -0.045** | -0.054*** | -0.039** | -0.038 | 0.046 | 0.006* | 0.006 | -0.000244 | 0.001 | 0.003 | 0.007 | 0.016 | 0.071*** |
| | (2.35) | (-2.29) | (-4.56) | (-2.49) | (-0.98) | (0.61) | (1.93) | (1.62) | (-0.10) | (0.26) | (0.92) | (0.94) | (1.19) | (3.11) |
| Log scaled Expenditure | 0.106*** | 0.336 | -0.055*** | -0.263 | -0.559** | -1.586*** | -0.004 | -0.044 | 0.00499** | 0.006 | 0.021*** | 0.161* | 0.117*** | 0.052 |
| | (8.12) | (1.51) | (-5.08) | (-1.49) | (-2.34) | (-3.47) | (-1.58) | (-1.03) | (2.23) | (0.14) | (6.50) | (1.70) | (9.05) | (0.21) |
| Square of Log scale Expenditure | -0.009*** | -0.018 | 0.008*** | 0.018** | 0.024** | 0.079*** | 0.001*** | 0.002 | -0.000256 | -0.000 | -0.001*** | -0.008* | -0.008*** | -0.006 |
| | (-8.18) | (-1.61) | (9.53) | (1.98) | (1.96) | (3.31) | (2.82) | (1.19) | (-1.34) | (-0.12) | (-4.94) | (-1.68) | (-7.68) | (-0.47) |
| Women's participation | | -0.031** | | 0.030*** | | 0.061 | | -0.003 | | -0.001 | | 0.008 | | -0.011 |
| | | (-2.35) | | (2.85) | | (1.20) | | (-1.11) | | (-0.34) | | (1.50) | | (-0.74) |

Source: Research results.

Notes: Constant for all men's equations is 0.009*** (12.45). Constant for all women's equations 0.003***(3.83). Standard errors are heteroskedastic-consistent and clustered at federal unit level. *t* statistics in parentheses. State fixed effects are included as dummies for state of residence of individual. *** p<0.01, ** p<0.05, * p<0.1.

Table B2 — Parameters of the women's sharing functions for Models (e) and (f)

| | Model (e) | Model (f) |
|---|---|---|
| | Model with Clothing Only | Model with Other Goods Only |
| Constant | — | — |
| | — | — |
| Woman's age | 0.0363*** | 0.0458*** |
| | (13.05) | (23.24) |
| Woman's schooling | 0.00185 | 0.0131 |
| | (0.25) | (1.49) |
| White | 0.176** | 0.254*** |
| | (2.08) | (3.75) |
| Woman's participation | 0.570*** | 0.454*** |
| | (8.25) | (7.44) |
| Urban | — | — |
| | — | — |
| Income | — | — |
| | — | — |
| House owner | — | — |
| | — | — |
| N(1) | 10,245,969 | 10,017,764 |

Source: Research results.
Note: (1) represents the expanded sample using factor provided by the POF 2008-2009.
Notes: All calculations use the sample weights. Standard errors are heteroskedastic-consistent and clustered at federal unit level. *t* statistics in parentheses. State fixed effects are included as dummies for state of residence of woman. The women's index is the exponential function entering the logistic function. The parameters indicated by – in the women's index are set to zero for identification purpose. *** p<0.01, ** p<0.05, * p<0.1.

Table B3 — Parameters of the men's sharing functions for Models (e) and (f)

| | Model (e) | Model (f) |
|---|---|---|
| | Model with Clothing Only | Model with Other Goods Only |
| Constant | -1.616*** | -2.257*** |
| | (-20.90) | (-21.06) |
| Man's age | 0.0137*** | -0.0309*** |
| | (4.06) | (-12.15) |
| Man's schooling | 0.0178* | 0.0405*** |
| | (1.73) | (8.53) |
| White | 0.306*** | 0.0776 |
| | (3.80) | (1.36) |
| Urban | 0.432*** | 0.205** |
| | (4.23) | (2.31) |
| Income | 0.151*** | 0.766*** |
| | (4.05) | (5.71) |
| House owner | 0.167 | 0.123*** |
| | (1.57) | (2.95) |
| N(1) | 10,254,796 | 10,026,591 |

Source: Research results.
Note: (1) represents the expanded sample using factor provided by the POF 2008-2009.
Notes: All calculations use the sample weights. Standard errors are heteroskedastic-consistent and clustered at federal unit level. *t* statistics in parentheses. State fixed effects are included as dummies for state of residence of man. The men's index is the exponential function entering the logistic function. *** p<0.01, ** p<0.05, * p<0.1.

Table B4 — Parameters of the children's sharing functions for Models (e) and (f)

| | Model (e) | Model (f) |
|---|---|---|
| | Model with Clothing Only | Model with Other Goods Only |
| Constant | -1.814*** | -3.161*** |
| | (-10.43) | (-29.21) |
| Number of children | 0.0770 | 0.0230 |
| | (1.39) | (0.45) |
| Proportion of male children | -0.0124 | -0.115 |
| | (-0.17) | (-1.23) |
| Average age of children | 0.406*** | 0.418*** |
| | (15.90) | (15.95) |
| White | 0.155*** | 0.366*** |
| | (2.62) | (4.14) |
| Urban | 0.111 | 0.384*** |
| | (0.97) | (3.67) |
| Woman's participation | 0.563*** | 0.0825 |
| | (7.51) | (1.25) |
| House owner | 0.262*** | 0.301*** |
| | (3.46) | (6.61) |
| $N^{(1)}$ | 11,764,310 | 10,780,544 |

Source: Research results.
Note: (1) represents the expanded sample using factor provided by the POF 2008-2009.
Notes: All calculations use the sample weights. Standard errors are heteroskedastic-consistent and clustered at federal unit level. *t* statistics in parentheses. State fixed effects are included as dummies for state of residence of children. The children's index is the exponential function entering the logistic function. *** p<0.01, ** p<0.05, * p<0.1.

Table B5 — Parameters of adult's scaling functions for Models (e) and (f)

| | Model (e) | Model (f) |
|---|---|---|
| | Model with Clothing Only | Model with Other Goods Only |
| Women's Scaling Function | | |
| Constant | 0.478*** | 0.387*** |
| | (38.78) | (32.70) |
| Number of children | 0.177*** | 0.335*** |
| | (18.47) | (34.33) |
| Men's Scaling Function | | |
| Constant | 0.478*** | 0.387*** |
| | (38.78) | (32.70) |
| Number of children | 0.177*** | 0.335*** |
| | (18.47) | (34.33) |
| $N^{(1)}$ | 10,245,969 | 10,026,591 |

Source: Research results.
Note: (1) represents the expanded sample using factor provided by the POF 2008-2009.
Notes: All calculations use the sample weights. Standard errors are heteroskedastic-consistent and clustered at federal unit level. *t* statistics in parentheses. State fixed effects are included as dummies for state of residence of individual. The parameters of the scaling functions are imposed to be the same for both spouses. *** p<0.01, ** p<0.05, * p<0.1.

# APPENDIX C

Table C1 — Test for the IB restriction (Linear Model)

| | Women's resource shares | Men's resource shares | Children's resource shares |
|---|---|---|---|
| Constant | 0.442*** | 0.524*** | 0.206*** |
| | (7.81) | (12.67) | (4.10) |
| Household Size | -0.0394*** | -0.0650*** | 0.0634*** |
| | (-40.40) | (-81.87) | (73.82) |
| Log expenditure | -0.00187 | -0.00679 | -0.0108 |
| | (-0.17) | (-0.88) | (-1.10) |
| $N^{(1)}$ | 10,245,969 | 10,254,796 | 12,690,631 |

Source: Research results.
Note: (1) represents the expanded sample using factor provided by the POF 2008-2009.
Notes: All calculations use the sample weights. Standard errors are heteroskedastic-consistent and clustered at federal unit level. *t* statistics in parentheses. State fixed effects are included as dummies for state of residence of individual. *** p<0.01, ** p<0.05, * p<0.1.

Table C2 — Test for the IB restriction (Quadratic Model)

| | Women's resource shares | Men's resource shares | Children's resource shares |
|---|---|---|---|
| Constant | 0.462*** | 0.558*** | 0.209*** |
| | (10.77) | (13.42) | (4.50) |
| Household Size | -0.0403*** | -0.0657*** | 0.0629*** |
| | (-41.03) | (-78.79) | (76.88) |
| Log expenditure | -0.00304 | -0.0108 | -0.0110 |
| | (-0.37) | (-1.36) | (-1.21) |
| Square of log expenditure | 0.000205 | 0.000534 | 0.000358 |
| | (0.52) | (1.40) | (0.79) |
| $N^{(1)}$ | 10,245,969 | 10,254,796 | 12,690,631 |

Source: Research results.
Note: (1) represents the expanded sample using factor provided by the POF 2008-2009.
Notes: All calculations use the sample weights. Standard errors are heteroskedastic-consistent and clustered at federal unit level. *t* statistics in parentheses. State fixed effects are included as dummies for state of residence of individual. *** p<0.01, ** p<0.05, * p<0.1.