# Children Costs in a One-Headed Household: Empirical Evidence from the UK.

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February 08, 2024

**Abstract**

The literature on equivalence scales exclusively focuses on children living with couples. This paper explores how tailoring the collective approach to single-headed households can facilitate estimating the cost of children a single parent bears. To that end, I use the United Kingdom Family Expenditure Survey from 1978- 2020. The inferences of children's costs rest on the assignable goods method and the assumption of orthogonality of parents' tastes and demographic change. The results show that the costs of rearing children are significantly similar for a representative parent, whether father or mother. However, the weighted average cost of children for fathers is around six percentage points higher than that of mothers. Also, the findings indicate that the resource per child is invariant from the number of children for the wealthiest parents. In contrast, children from low-income families derive less from their parents' total expenditures with larger family sizes.

JEL Classification: C30, D11, D12, D36, D63, I31, J12, J13

Keywords: Collective Model, Shadow price, Economies of scale, Identification, Resource sharing.

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I am indebted to Olivier Donni for his helpful comments along the writing of this paper. I am grateful to all participants of the THEMA Theoretical ad Applied Economics, the GeFAM, and the KU Leuven. I also wish to thank Olivier Bargain who provided me with the first wave of data that I used in the initial version of this paper. Finally, I express my gratitude to my colleagues, Melanie Marten and Benjamin Brothier, for meticulously reviewing the entire document, ensuring clarity, conciseness, and appropriateness of the English used. Of course, all errors remain mine.

# 1 Introduction

The cost of child-rearing is credited as one of the main determinants of transfer family policies. Thus, treating single and coupled parents equitably through a tax system deduction requires knowing the cost of children in each family type. In recent times, economists have developed complex methods to assess the true cost of children, with a specific focus on those residing in couples (Bradbury, 1994, 2008; Bourguignon, 1999; Apps and Rees, 2001; Blundell et al., 2005; Bargain et al., 2010; Bargain and Donni, 2012a; Dunbar et al., 2013, 2021; Adda et al., 2017; Penglase, 2021; Bargain et al., 2022). The concern is that if government transfer policies rely on the results of such studies, they are likely to treat parents living as couples and single parents uniformly in terms of the cost of children. Furthermore, suppose the pattern of intrahousehold inequality is different across parent-type structures. In that case, the standard resource shares (computed for 2-parent households) are invalid measures of the individual well-being of single parents.

Yet, recent studies have documented that one-headed and bi-headed households are heterogeneous (DeLeire et al., 2005; Nieuwenhuis and Maldonado, 2018).[1] This paper develops a structural approach to assess the children's resource shares in a one-headed household. I also answer that question: Do the child-rearing costs borne by single fathers differ from that of single mothers? For this purpose, I construct and estimate a static model of intra-household allocation to investigate how changes in the parent and children's characteristics translate into changes in individual-level allocation. The model is estimated on a sample of one-adult households with three children from the UK Family Expenditure Survey (henceforth FES) from 1978 to 2020.[2] The estimates are not a direct measure of the well-being of children as they

[1] See Edin and Lein (1997), Grogger (2001), Blank and Schoeni (2003), Meyer and Sullivan (2004, 2008), Winship and Jencks (2004), and DeLeire et al. (2005) on the changes in the material well-being of single families, specifically single mothers; Meyer and Rosenbaum (2000, 2001), Grogger (2001), Schoeni and Blank (2000), Blundell and Hoynes (2004) on the labor supply and labor market participation of single mothers, and Lazear and Michael (1980) on the material well-being of one and two-earner families. Several key themes emerge from studies that have explored the differences between single-parent and couple-parent households: income disparities, labor market participation, child development and well-being, and policy implications, among others. In the early 20th century, the growing economic vulnerability of single mothers led to the development of public assistance programs Folbre (1994).

[2] Family Expenditure Survey (FES) has been replaced by Expenditure and Food Survey (EFS) in 2001, then Living Costs and Food Survey from 2008 onwards. For the sake of convenience, I use FES to qualify all three.

may receive transfers from another parent/agent(government) outside the household.[3] The objective is not to quantify what children receive. Instead, it centers on the costs incurred by parents in raising children.

This research becomes possible due to the relatively large sample data on single household expenditures. However, given that expenditure surveys commonly provide household-level consumption data, addressing such a question becomes challenging. Economists have long been studying this matter. Initial research about the equivalence of scales dated back to Engel (1895) fits into the so-called unitary approach (also known as the conventional approach).[4] However, for over three decades, there has been a consensus among researchers that individuals within the household have conflicting interests. Then, it is unsuitable to treat them as if they were single decision units, as usually done in classical microeconomics textbooks. Therefore, recent studies on children's costs (Blundell et al., 2005; Dunbar et al., 2013; Penglase, 2021; Bargain et al., 2022) adopt the collective approach previously designed by Chiappori (1988, 1992), Apps and Rees (1997), and Browning and Chiappori (1998) to restore the methodological failure in the conventional approach. Nevertheless, these studies differ in how they model household preferences and estimate the structural parameters.

I develop a structural consumption model for single individual and single-parent families to identify the intrahousehold resource allocation into a variant of the collective approach proposed by Bargain and Donni (2012b). It was tempting to align with the wave using the traditional collective model. However, the collective-type approach seems appropriate, assuming that if the parent behaves as a dictator, then children have no bargaining power in the household. In collective models, resource shares are closely tied to Pareto weights, often making them interpretable as indicators of individual bargaining power within a household. Simultaneously, these shares are also influenced by altruistic motivations, particularly those arising from children's

[3] See Folbre (2008) for an in-depth analysis of how conceptualizing the cost of children. Research on child development includes numerous articles addressing external investment in children. Those interested in delving deeper into this issue should refer to the works of Costas Meghir on Early Childhood Interventions. Also, the consideration of cognitive skills investment and its lasting effects on children is explored by Cunha et al. (2010), Del Boca et al. (2014, 2016), and Agostinelli and Wiswall (2016), among others.

[4] The Rothbarth's approach has shaped the work of Lazear and Michael (1988), Deaton and Muellbauer (1986), Deaton et al. (1989), and Gronau (1991).

claims. This latter perspective will be emphasized in this study, thus underscoring the collective-type approach adopted by my model. The suggested household consumption framework with children has three main components: an additive utility function, a consumption technology, and a sharing rule. The latter governs the resource shares, defined as the fraction of a household's total resources devoted to each member.

In Dunbar et al. (2013, 2021, hereafter DLP$^1$, DLP$^2$) and Penglase (2021), children are included in the model as distinct economic agents, possessing their own utility function with associated resource shares. Although Dauphin et al. (2011) and Cherchye et al. (2009) support the consistency of observed household demand functions with the assumption that children have distinct utility functions, I assume that they bring little income and can have bargaining power only once they reach adulthood. In Dauphin et al. (2011), the considered children are 16 years and older and live in biparental families. It is reasonable to infer that children under 16, as is commonly the case in this study, are not decision-makers. Thus, I incorporate the children's utility altruistically into the adult's utility, as previously done by Bargain and Donni (2012b).

Most collective household models assume that goods are purely private or public within the household. Following (Browning, Chiappori, and Lewbel, 2013, hereafter BCL)'s contribution, studies on the equivalence of scales have shifted towards a more general type of economies of scale. See, e.g., Bargain et al. (2010), Bargain and Donni (2012a), Dunbar et al. (2013, 2021), Penglase (2021), and Bargain et al. (2022). In line with (Bargain et al., 2022, hereafter BDH), I use a transformation à la Barten to pinpoint economies of scale.

Gronau (1991) estimates the observed effect of environmental variables on the marginal propensity to consume adult goods to identify the distribution mechanism of resources within the household. I estimate the individual-level consumption through the identification of the sharing rule. The sharing rule is a function that governs the allocation of total expenditures between parents and children in the model. Since Chiappori (1988, 1992)'s seminal papers on the collective model, numerous studies have attempted to estimate resource shares.[5] See, e.g., DLP[1], DLP[2], Penglase (2021), BDH, and Lechene et al. (2022) among others. However, they have primarily concentrated on partnered parents to retrieve the children's resource shares. In contrast, I identify the level of resource shares by observing assignable goods, say clothing, using a sample of unpartnered (individual and parent). An exclusive or assignable good refers to a good consumed by a specific household member, and this information is identifiable to the researcher. The use of clothing as an assignable item on the cost of children is now widely accepted in the literature.[6] This approach has found application in various studies, whether employing a non-structural model like Lundberg et al. (1997) or adopting structural models such as Penglase (2021). Unlike DLP[1] and Penglase (2021), whose level of resource share identification relies on excluding total expenditures from the sharing rule, I argue that the sharing rule is a function of total spending.

I also pick up the assumptions of separability and preference stability traced back to the work of Gronau (1991) to identify the model.[7] On the one hand, Gronau (1988, 1991) has shown that the separability assumption does matter to ensure the inferences of the children's cost.[8] Successive studies of the equivalence of scales took up this assumption.[9] On the other hand, by preference stability assumption, the tastes of adults are assigned to be independent of demographic change. Both assumptions are still widespread in the field. See, e.g., BDH. Exceptions include Cherchye et al. (2011), DLP[1], and Penglase (2021). First, Cherchye et al. (2011) adopt a different path, using revealed preference theory to identify the sharing rule in contrast to the methodology assuming preference stability. Their method entails imposing strong restrictions on household preferences to set identified bounds on the sharing rule. Second, DLP[1]

[5] Resource shares are defined as the fraction of total household spending devoted to each person in a household. They stand out as meaningful metrics for individual consumption expenditures when examining household-level data. Therefore, they are crucial for assessing individual material well-being, inequality, and poverty in multi-person households. Bargain, Lacroix, and Tiberti (2022) provide evidence on the reliability of resource shares to predict individual resources in multi-person households.

[6] Bargain, Lacroix, and Tiberti (2022) found that the collective model exhibits adequate predictive capability for individual resource shares when using clothing as assignable goods.

[7] At the same time, the preference stability assumption is also used by Deaton et al. (1989) and Tsakloglou (1991).

[8] It is worth noting that Gronau is not the first to use the separability assumption in the studies of equivalence of scales. That is also laid down in the research of Lazear and Michael (1988) and Deaton (1989).

[9] See Blundell et al. (2005), Bargain et al. (2010), Dauphin et al. (2011), Bargain and Donni (2012a,b), Lise and Seitz (2011), Cherchye et al. (2012), and BDH.

provide a model that semi-parametrically identifies the levels of resource shares given household-level Engel curve on private assignable goods (through what they called similar preference across types SAT and similar preference across people SAP).[10] An increasing number of studies suggest applications and extensions of the DLP[1]'s method (Tommasi and Wolf, 2018; Calvi, 2020; Brown et al., 2021; Dunbar et al., 2021; Penglase, 2021; Lechene et al., 2022; Bargain et al., 2022; Calvi et al., 2023).

The contribution of this paper is to mark the initial estimation of the cost of children conducted in single-headed households. Also, it presents an identification result tailored to this collective-type approach. Additionally, by accounting for single fathers, this study provides a basis for comparing the relative costs of children between mothers and fathers.[11]

In the empirical application, this study provides new evidence on the measure of the cost of children. First, the costs of children borne by a representative father are not significantly different than that borne by a representative mother; however, fathers allocate a higher average share of resources to children compared to that allocated by mothers.[12] Specifically, the average cost of a child amounts to, respectively, 35% and 27% of the total expenditures of single fathers and mothers. This result might be explained by the fact that the transfer from noncustodial parents - more likely fathers - to custodial ones - generally mothers - acts as a discount on the cost of children mothers bear. Second, the cost of children increases with the number of children but decreases with family size, as found in earlier studies. Third, the resource per child remains consistent irrespective of the number of children for wealthier parents. In contrast, children from low-income families receive a diminishing share of their parents' total expenditures with larger family sizes. Fourth, the household benefits from economies of scale through the number of children and the presence of same-gender siblings. The potential policy implications of this work are noteworthy. For example, it provides a framework for determining payments that guarantee a single-parent household can adequately meet the needs of a child. Furthermore,

[10] DLP[1] and Penglase (2021) do not use distribution factors.

[11] Prior studies on single parents have predominantly centered on mothers. See, e.g., Edin and Lein (1997), Meyer and Rosenbaum (2000, 2001), Schoeni and Blank (2000), Grogger (2001), Blank and Schoeni (2003), Blundell and Hoynes (2004), Meyer and Sullivan (2004, 2008), Winship and Jencks (2004), and DeLeire et al. (2005).

[12] A representative parent is one with characteristics equal to the average in the population.

by accounting for gender-specific differences between parents, it offers insights into policy considerations regarding which single parent carries a more substantial burden of children's costs. Another illustrative scenario involves the ability to calculate child support payments from a noncustodial parent to a custodial parent in case of divorce. A further application lies in directly measuring child poverty.

The remainder of this paper is organized into four parts. The first presents the theoretical model. The second describes the empirical implementation and data selection. The third reports and discusses the empirical results, and the last section concludes.

# 2 Theoretical Framework

This section presents the consumption household model following Bargain and Donni (2012b). I first describe the consumption behavior of single individuals, which serves as a crucial prerequisite for understanding the consumption behavior of a single-headed household with children.

## 2.1 The Consumption Behavior of Single Individuals

In this section, I model the consumption behavior of a single-adult household without children acting in a one-period. I assume that each household member has a well-behaved utility function $U_i(x_i, X_i)$, that is twice continuously differentiable, strictly increasing and strictly concave utility function over two arguments (an exclusive good $x_i$ and a composite good $X_i$).[13] A composite good can be any other good except the exclusive good. The subscript $i = w, m$ denotes respectively women and men. The individual utility is also subject to preference-driven factors that I introduce subsequently into the budget share function in the empirical section. I also assume that individual preferences over consumption bundles are stable so that some prediction about household behavior could be possible.

[13] Here we could have ignored the exclusive good since there is no confusion about the individual consumption in a one-headed household without children. In such a household, there is no distinction between private and exclusive goods, even private and public goods, provided one person privately consumes all goods. However, I uphold the distinction to enhance clarity and consistency, primarily as the demand function under investigation is associated with exclusive goods.

Each individual $i$ purchases $q_i$ (respectively $Q_i$) quantities of $x_i$ (respectively $X_i$). Thus, each individual faces the budget constraint as follows:

$$q_i p_i + Q_i = y_i \tag{1}$$

where $y_i$ denotes the total household expenditure and $p_i$ the price of the exclusive good. The market price of the composite good is normalized to one.

Household surveys document expenditures rather than consumption per se. Adequate consumption may not reflect expenses at a given time if one accounts for durable goods. In this case, I consider only nondurable goods as these tend toward consumption, as the fraction of purchased goods not consumed is small. Hence, I can assume that:

$$q_i = x_i \quad \text{and} \quad Q_i = X_i \tag{2}$$

At this stage, the optimization program of the household member $i = w, m$ is as follows:

$$\max_{x_i, X_i} \quad u_i(x_i, X_i) \text{ subject to (1) and (2)} \tag{3}$$

The solution of this program allows expressing the demand functions for the exclusive good as:

$$\omega_i = g_i(p_i, y_i) \tag{4}$$

where the subscript $i = w, m$ and $\omega_i = p_i x_i / y_i$. It is worth noting that $U_i(.)$ is strictly increasing, then $\omega_i$ must exhaust the consumer's income.

## 2.2 The Consumption Behavior of One-Headed Households with Children

In this section, I consider a household with several members, an adult, and his children.[14] In the most general case, the parent takes care of his children. Hence, each

[14] In contrast to Penglase (2021), the model treats foster and non-foster children indiscriminately. Penglase's work explicitly separates the two groups of children, focusing on whether there is differential treatment in the allocation of resources for the consumption of foster and non-foster children. At this point, no distinction is made regarding the characteristics of the children. My assumption is limited to the child residing with either the father or the mother and younger than 16 years old.

parent is assumed to be an altruistic agent, in the sense of Becker, while their children are egoistic. Because of the caring nature of the parent, he/she also derives utility from the child's well-being. In this case, each single parent has a well-behaved utility function $W_i[u_i(x_i, X_i), u_c(X_c)]$ that contains two components - the first sub-utility derived from his/her own consumption $u_i$ and the other one from his/her representative child's consumption $u_c$.

The model also supposes that parents may directly benefit from having children. The analysis is conducted under the hypothesis that the utility of children is that perceived by his/her parent. Moreover, there are no externalities. I consider an additive utility function taken the form as follows:

$$W_i = u_i(x_i, X_i) + \delta_i(n)u_c(X_c) \tag{5}$$

represents the single parent total utility function, where $x_i$ stands for the adult exclusive good, $X_i$ and $X_c$ are respectively the composite goods for parent and children. [15] The utility function of children has one argument for simplicity, and it is associated with a parameter $\delta_i$, which measures how the resources devoted to children evolve when the number of children increases. The parameter $\delta_i$ could also be seen as the weight given by the adult to the child (Bargain and Donni, 2012b). Alternatively, one might interpret it as the degree of parents' altruism as shown in Appendix **??**. Note that the previous model is a special case of this one because if $n = 0$, this implies $\delta_i = 0$ and then one goes back to the standard consumption model for a single-adult household.[16] In short, the single parent cares about the children's welfare. I assume that the utility function is endowed with caring preferences. Parents care about their children's allocation only insofar as it gives them some individualistic welfare. In other words, children matter for the household's choices, but only through the utility their parents derive from their well-being (Browning et al., 2014, p.89).

I consider a simple model in which household income is given. Moreover, I assume there are neither time-allocation decisions nor household production.[17] Household in-

[15] Assignable good and exclusive good are used interchangeably as well as single parent and lone parent. See BCL for more details about exclusive and assignable goods.

[16] We see this in more detail along with this subsection.

[17] This broader perspective is addressed by Apps and Rees (2001) and Cherchye et al. (2012).

come is totally spent for purchasing $q_i$ quantities of assignable goods and $Q_i$ quantities of composite goods. Hence, $y_i$ denotes total expenditures instead of total income. The household budget constraint is the following:

$$q_i p_i + Q_i = y_i \tag{6}$$

where $q_i$ and $Q_i$ denote respectively the purchased quantities of parent's exclusive goods and of household composite goods.

Several remarks can usefully be made. First, the purchase of children's consumption is included in $Q_i$. Second, there are two types of goods: an adult private assignable good $x_i$ like adult clothing and all other goods not adult privately assignable $X_i$ and $X_c$. Third, household composite goods consist of private non-assignable, children-exclusive, and public goods. Next, when considering a labor-supply model, $Q_i$ may involve the leisure choices of household members. Finally, overall, household survey data generally do not track the consumption of each individual within the household. At this juncture, information on composite goods provides limited input for assessing the share of resources allocated to children. Conversely, observing adult exclusive goods can unveil relevant insights into household behavior.

An assignable good is purely private. That is, for any demographic structure of the household, the consumption of an assignable good reflects precisely what is expended by the household. Thus,

$$q_i = x_i \tag{7}$$

However, in a household with at least two individuals - an adult and a child - some goods are endowed with public properties. Consequently, the consumption of these goods cannot be accurately captured solely by their purchased quantities. A consumption technology function generally represents the publicness of goods. Currently, two approaches in the literature account for economies of scale. Either researchers assume the independence of base technology of production (Lewbel and Pendakur, 2008; Bargain and Donni, 2012a; Dunbar et al., 2013), or the transformation à la

Barten (Browning et al., 2013; Bargain et al., 2022). In the former approach, the economies of scale are assumed to be independent of the base expenditure. Moreover, the cost of children does not capture variations in prices. This approach is well-suited for projects relying on cross-section data from a single year. Whereas, the second approach relaxes the independence assumption regarding the level of total expenditures and allows the exploitation of price variations to achieve economies of scale. I favor the second approach due to its broader scope and alignment with the data I am using, given that it spans several years during which prices may vary. Hence, their purchased quantities are transformed into a higher level of consumption with a transformation rate that depends on all three exogenous variables. The following assumption is rooted in the studies of BCL.

**Assumption 1** *(Barten prices). For each adult $i$ living in a household of type $n_i > 0$, there exists a scalar-valued, differentiable function $\pi_i(y_i, p_i, n_i)$ such that the household purchases of composite goods satisfy the condition:*

$$Q_i = \pi_i(y_i, p_i, n_i)X_i + X_c \quad with \quad i = w, m \tag{8}$$

The function $\pi_i(y_i, p_i, n_i)$ denotes shadow prices for the parent. For identification purposes, I normalize the shadow price of children to one. The shadow price can be seen as a deflator measuring the cost saving experienced by adult $i$ due to economies of scales within the household Bargain and Donni (2012a). Instead of using the purchased vector of market goods $Q_i$ to produce composite goods contributing to utility, the household essentially yields an increased quantity of market goods $X_i$ through sharing. An outstanding example of a good under this logic is heating. In essence, interpreting the function $\pi_i(y_i, p_i, n_i)$ involves discerning three distinct scenarios. If $\pi_i(y_i, p_i, n_i) = 1$ for $n_i > 0$, then goods are purely private.[18] The parent shadow price depends on the presence of children. If the parent prefers to consume public goods instead of private goods because of children, $\pi_i$ should be greater than one and less than one otherwise.

[18] This explains why it is not necessary to explicitly introduce the function into equation 7.

Put equations (7) and (8) into the household budget constraint (6), and one obtains:

$$x_i p_i + \pi_i(y_i, p_i, n_i)X_i + X_c = y_i \tag{9}$$

Parents maximize their own utility subject to the new budget constraint (9). Note that with one adult household with children, the outcome resulting from the parent's decision is automatically Pareto efficient. This follows from this assumption:

**Assumption 2** *The adult acts as a dictator in the household; assuming the role of decision-maker for his/her child.*

In their research, Dauphin et al. (2011) find evidence that children are decision-makers within the household. However, their study is restricted to a sample of children being 16 years old and over. Yet, in this paper, children are aged 15 years or younger. Children are not supposed to work at this age, they are unlikely to bring income in the household and mostly depend on their parent. Therefore, it is reasonable to infer that children have no bargaining power in the household.

The trade-off that needs to be done will happen in allocating resources for the parent and children consumption. Given the budget and technology constraints, parents cannot make children better off without making themselves worse off. Hence, given Becker's altruistic preferences and the efficiency assumption, the household allocation may be derived from the following optimization program:

$$\begin{aligned} &\max_{x_i, X_i, X_c} u_i(x_i, X_i) + \delta_i(n)u_c(X_c) \\ \text{s.t.} \quad & x_i p_i + \pi_i(y_i, p_i, n_i)X_i + X_c = y_i \end{aligned} \tag{10}$$

where $\delta_i(n)$ represents the weight assigned to the child by the parent and depends on the number of children, for simplicity. The budget constraint exhibits total expenditures on adult and child consumption.

Adopting an additive utility function may ease the transition to a decentralized program. The first stage is characterized by the mechanism determining the distribution of resources between parent and children in the household. It results from this maximization program:

$$\max_{\phi_i,\phi_c} \quad \nu_i\left(\frac{p_i}{\pi_i}, y_i\frac{\phi_i}{\pi_i}\right) + \nu_c(y_i\phi_i) \tag{11}$$

where $\nu_i$ and $\nu_c$ denote respectively the indirect sub-utility function of parent and children. The functions $\phi_i$ and $\phi_c$ indicate the share of total expenditures devoted to parents and children respectively. In the cost of children literature, it is a usual practice to assume that parent's preferences can be segregated between their own consumption and consumption related to their children (Gronau, 1991; Bourguignon, 1999; Blundell et al., 2005; Cherchye et al., 2012; Bargain et al., 2022). The second stage leads to the solution of the single-parent decision:

$$\max_{x_i,X_i} \quad u_i(x_i, X_i) \quad \text{s.t.} \quad x_ip_i + \pi_i(y_i, p_i, n_i)X_i = y_i.\phi_i(y_i, p_i, n_i) \tag{12}$$

for some function $\phi_i(y_i, p_i, n_i)$ such that $\phi_i(y_i, p_i, n_i) \leq 1$ and $n_i > 0$. The total expenditure multiplying by $\phi_i$ can be divided into two parts. Thus, $\phi_i$ represents the fraction of resources the parent keeps to satisfy their consumption. The remaining, say $\phi_c = 1 - \phi_i$, is the fraction of total expenditure allocated to children, say, the cost of children. The share of resources accruing to children consumption is positive if and only if the parents' share of resources is less than one. The extreme case where the parent exhausts the total expenditure for themself is excluded. This leads us to an egoistic parent that cares only for themself. Therefore, a parent is expected to care for his/her children. In the absence of children $\phi_i(y_i, p_i, 0)$ is equal to one, that is the adult individual keeps the entire budget as illustrated in the case of the single-household model. There is an intuitive way to understand the individual share function. As previously noted, $\phi_i(.)$ equals one if no children are in the household. With children, $\phi_i(.) = 1 * \phi_i(.)$. That is, from the entire budget without children, say one, parents keep a fraction of $\phi_i$ for themselves, and the other fraction $1-\phi_i$ goes to children. As the budget share equations are homogeneous of degree zero, the solution can be written as:

$$\frac{\omega_i}{\phi_i(y_i, p_i, n_i)} = g_i\left(\frac{p_i}{\pi_i(y_i, p_i, n_i)}, y_i\frac{\phi_i(y_i, p_i, n_i)}{\pi_i(y_i, p_i, n_i)}\right) \tag{13}$$

where $\omega_i = p_i x_i / y_i$. The price of the exclusive goods may affect the share of total expenditure devoted to children, as discussed in Bargain and Donni (2012b). Notice that the stability of adults' preferences upon the exclusive goods means that the presence of children in the family does not alter individual preferences. This process highlights why detailing the child's utility function is not crucial, as it does not dictate the model's outcome. Only the parent's demand function holds significance.

## 2.3 Identification

An important question in the model of consumer behaviour under study is regarding the sharing function and economies of scale and how to recover them. Overall, the answer to this question lies in the homogeneity assumption (typically the state of individual preferences from childless individuals to single parents), the observation of exclusive goods, and the non-linearity of the Engel curve.

As BCL and Bargain and Donni (2012a), I assume that preferences of individuals with identical characteristics over exclusive goods do not change with family status. For this study, this means that preferences of single individuals and single parents upon exclusive goods are similar. Under such a framework, estimating the sharing parameters of single parents and children is possible through the information provided by the demand functions of single individuals since indifference curves are unchanged with the occurrence of children in the household. As such, any shifts in consumption among single parents due to the presence of children should be attributed to household composition changes rather than individual preferences from childless individuals to parents.

Chiappori and Ekeland (2009) mentioned that identification requires estimating at least three goods. However, Bourguignon (1999) and Bourguignon et al. (2009) demonstrated that having an assignable good suffices to recover the sharing rule and reach identification. Assignable goods such as clothing are central in several studies. See, e.g., BCL, Bargain and Donni (2012a), and BDH, among others. I exploit the existence of observable assignable goods (clothing in that case) to identify the model's structural elements.

Finally, Prais and Houthakker (1971) found evidence to prioritize nonlinear Engel curves and add explicitly socio-demographic characteristics as control variables. Identification requires demand equations to exhibit non-linearities in log total expenditures. However, this is not necessarily a significant concern, as budget share equations are generally non-linear as shown by Banks et al. (1997). Additionally, identification relies on two normalization conditions summarized in the following assumption.

**Assumption 3** *For single men* ($i = m$) *or single women* ($i = w$)*, we have:* $\pi_i(y_i, p_i, 0) = 1$ *and* $\phi_i(y_i, p_i, 0) = 1$.

As previously stated, this assumption clearly shows that the childless household model is a special case of the household model with children. Without children, the market price for the composite good is normalized to one for a single household since $\pi_i(y_i, p_i, 0)$ equals unity. Moreover, $\phi_i(y_i, p_i, 0)$ equals to one means that the adult individual keeps the entire budget as illustrated in the case of the single-household model.

The following proposition summarized the main result of identification.

**Proposition 1** *Let the demand functions of the exclusive good respectively for single individuals and single parents be:*

$$
\begin{aligned}
\omega &= g(z_\omega, p, y) \\
\omega &= g(z_\omega, \pi(p, z_\pi, y, n) \cdot p, \phi(p, z_\phi, y, n) \cdot y)
\end{aligned}
$$

*where* $\pi(p, z_\pi, y, n)$ *denotes the (price) transformation à la Barten and* $\phi(p, z_\phi, y, n)$ *the sharing rule. Here,* $p$ *the price of exclusive good,* $y$ *total expenditures,* $n$ *the number of children, and* $z_\omega, z_\pi$ *and* $z_\phi$ *denote the sociodemographic variables associated respectively to* $\omega$*,* $\pi$*, and* $\phi$*.*

*If any of the following conditions are met, the functions* $\pi(p, z_\pi, y, n)$ *et* $\phi(p, z_\phi, y, n)$ *can be generically identified.*

1. *At least one variable in* $z_\omega$ *is excluded from* $z_\pi$ *and* $z_\phi$*.*

2. $\pi$ *and* $\phi$ *are independent of* $y$*.*

3. *$\pi$ and $\phi$ are independent of $p$.*

4. *$\pi(p, z_\pi, y, n)$ and $\phi(p, z_\phi, y, n)$ are known up to some parameters (semi-parametric identification).*

5. *$\pi(p, z_\pi, y, n) = \pi_1(p, z_\pi, y) \cdot \pi_2(n)$ with $\pi_2(1) = 1$ and $\phi(p, z_\phi, y, n) = \phi_1(p, z_\phi, y) \cdot \phi_2(n)$ with $\phi_2(1) = 1$.*[19]

# 3 Empirical Implementation

This section is structured as follows. I start with the sample selection process and an overview of the data. Then I present the empirical methodology in two steps: first I specify the model, then I present the endogeneity issue and the mechanism to resolve it.

## 3.1 Sample Selection

To measure the cost of children in a single-parent household setting, I use data from the UK Family Expenditure Survey (FES) over the period 1978-2020.[20] The FES was closed in 2001 to become Expenditure and Food Survey (EFS) and then Living Costs and Food Survey (LCF) from 2008 onwards.[21] These surveys provide information on the socio-economic profile of households, along with details about their income and expenditure patterns. Additionally, they gather information about the region where the households are located.

Initially and throughout the examined timeframe, the sample contains data on 135,642 households including single individuals, couples, single parents, and bi-headed parents. The adults are between 18 and 60 years old and have, at most, eight children. To perform the empirical analysis, I proceed to some selection. I sample childless adults and single parents aged 55 with at most three children. BDH harbor concerns

[19] See Identification Proof in the Appendix for the proof.

[20] I thank Olivier Bargain who provided me with the first wave of data that I used in the initial versions of this paper.

[21] I refer to FES hereafter to call these surveys for simplicity. These surveys are previously used by Lise and Seitz (2011) and BDH.

about potential confusion between children's clothing and adults' clothing. To such queries, I answer that there is no way that an 18-year-old parent is wearing their child's clothes provided that this child can be 5 years old at most.

Furthermore, I uphold total expenditures in a positive domain while filtering out outlier values of total expenditures for each household category and observations for which crucial data is lacking. Therefore, I arrive at a sample of 40,079 households with 13,921 single males, 10,726 single females, 1,644 single fathers, and 13,788 single mothers. One noteworthy observation is the relatively low proportion of single fathers, constituting a mere 11% of single parents. In addition, among parents, more than half of them have one child respectively 57% of fathers and 51% of mothers.

In the empirical analysis, I set the budget shares on clothing as dependent variables. As emphasized earlier, my focus remains exclusively on non-durable goods, as expenditures related to durable commodities do not accurately reflect their effective consumption. The demand system encapsulates two exclusive goods – adult male and female clothing - alongside a composite good representing omitted goods. The latter is strategically designed to maintain the total budget shares at a cumulative value of one. Prices of all goods are measured yearly at the country level.

Regarding the covariates, I use educational attainment, age, labor force participation, and home ownership as socio-demographic variables of adults. As for children, I analyze the number of children in the household and their average age, in conjunction with the proportion of boys. To leverage the economies of scale, I incorporate a dummy for the presence of siblings of same gender. The level of education is measured in terms of the number of school years completed by the individual. Labor participation and home ownership are indicated using dummies. Additionally, I include year and weekly total expenditures evaluated in pounds. To address regional differences, I draw from the dataset twelve regions of Great Britain: Northern, Northern Ireland, York and Humberside, East Midlands, West Midlands, East Anglia, Greater London, South-East, North Western, South Western, Wales and Scotland.

### 3.2 Econometric Specification

The empirical specification guides the consideration of a demand system quadratic in expenditure, which has been used in earlier studies such as Browning et al. (1994) and BDH. This parameterization overcomes the issue that marginal budget shares are independent of the level of expenditure implied by the linearity hypothesis. Additionally, I introduce an error term $\epsilon_i$ which encompasses optimization errors and accounts for various factors influencing the budget allocation, but remain unaddressed by the model.

$$\omega_{is} = \alpha_i v_{is} + \beta_i \ln p_{is} + \gamma_i \ln y_{is} + \eta_i (\ln y_{is})^2 + \epsilon_{is} \tag{14}$$

for $i = w, m$, where $s$ denoting household and $\alpha_i$, $\beta_i$, $\gamma_i$ and $\eta_i$ represent the parameters to estimate. The vector $v_{is}$ is a linear function of a set of variables such as education level, age, year and its square, labor force participation, home onwership and region of residence. The log price of individual clothing, log total expenditure and its square are additional explanatory variables used. It is of particular interest to note that the equations are gender-specific and consequently estimate separately for males and females.

As we see above, without children equation (13) is reduced to equation (4). Now, let's define a dummy variable $\zeta_{is}$ equal to 1 if the adult is a parent and 0 otherwise. From this, the stochastic structure of the budget share equations for single individuals and single parents can be mathematically captured as follows:

$$\text{If} \quad \zeta_{is} = 0, \quad \text{then} \quad \epsilon_{is} = \omega_{is} - \alpha_i v_{is} - \beta_i \ln p_{is} - \gamma_i \ln y_{is} - \eta_i (\ln y_{is})^2 \tag{15}$$

$$\text{If} \quad \zeta_{is} = 1, \quad \text{then} \quad \epsilon_{is} = \frac{\omega_{is}}{\phi_{is}} - \alpha_i v_{is} - \beta_i \ln\left(\frac{p_{is}}{\pi_{is}}\right) - \gamma_i \ln\left(\frac{\phi_{is} y_{is}}{\pi_{is}}\right) - \eta_i \left[\ln\left(\frac{\phi_{is} y_{is}}{\pi_{is}}\right)\right]^2 \tag{16}$$

Now, let's design a logistic function to depict the influence of parental and offspring attributes on child-related costs through the parent resource shares. Given the bounded nature of $\phi_i$ - the parent's share of total expenditure - ranging from zero to one, its representation as a logistic function aligns well with the approach exemplified in the research by Browning et al. (1994) and Lise and Seitz (2011), and BDH, among others.[22]

$$\phi(z,k) = \frac{e^{\psi_{is}(z,k)}}{1+e^{\psi_{is}(z,k)}} \tag{17}$$

In a reversal of usual trends, I do not call on Taylor expansion to linearize the sharing rule. It might be relevant to incorporate an error term to account for unobserved heterogeneity in the sharing rule, but I follow the conventional approach by expressing $\psi_i$ as a deterministic function of respectively parents and children attributes, say $z$ and $k$:

$$\psi(\boldsymbol{z},\boldsymbol{k}) = \boldsymbol{z}'\Delta_z + \boldsymbol{k}'\Delta_k \tag{18}$$

where $\Delta_z$ and $\Delta_k$ are vectors of parameters. Here, $z$ contains a constant, the adult's level of education, age, labor market status including the log total expenditures. The vector $k$ encompasses the child-related variables, say the number of children and its square, the average age, and the proportion of children. The two latter is multiplied by the number of children. As a result, the level of resources accruing to children is assumed to depend on both sets of factors, the parent's socio-demographic variables $z$ and the children's one $k$. The vector $k$ is independent of total expenditures as previously shown by BDH which the proof is given in Appendix ??. Recall that the decision-making process governing resource allocation is assumed not to be subject to children's wishes. In a one-headed household, it is irrelevant to suppose the presence of bargaining power. Nonetheless, there is at least a sharing rule within the model defining how parent and children variables may drive the distribution in the household. For example, I may conjecture that older children cost more. Also, I shall theoretically suppose that expenditures on children rise with the number of children.

Two kinds of economies of scale are modelized in the study. To specify the shadow prices that account for economies of scale between parent and children, I follow BDH to allow them to vary with total expenditures.

As stated earlier, I also use siblings variable to capture economies of scale between children in the household.

[22] This function ensures that the share of parent total expenditures transferred to children during estimation can neither be negative nor exceed the parent's total expenditures.

### 3.3 Estimation Strategy and Instruments

The model potentially suffers from two sources of endogeneity issues. The first one is that total expenditures can suffer from measurement error. This is related to the infrequency of purchases that leads to a misrepresentation of actual consumption regarding total expenditures. This is also possibly caused by recall errors from households during surveys. Both would induce a correlation between total expenditures and the error terms in the budget share function.

Following the DLP[1]'s approach, I tackle two types of endogeneity issues attributable to measurement errors in total expenditures. To do so, I use total income as an instrument. The utility function in this setting applies to a single time period $t$. Then, I can readily assume that consumption allocation decisions within a given time period are separable from savings decisions across periods. As a result, total income is uncorrelated with consumption allocation errors within a specific period, although it exhibits correlation with total expenditures. Thus, it qualifies as a valid instrument to measure error, understood as the gap between total expenditures and actual consumption.

Endogeneity stemming from recall errors can also be dealt with using total income. The reason is that, even if total income may also be subject to measurement error due to a misevaluation of some assets or misreporting of some others, as long as these measurement errors are orthogonal to consumption recall errors and the correlation between total income and total expenditures holds, then total income can be claimed as a good instrument.

In the fertility studies Nakamura and Nakamura (1992) and the demand collective models, which generally include the number of children as a nuisance variable, child status variables are often suspected to be correlated with the perturbations. Apps and Rees (2001) suggest that children should be treated as endogenous in the household model. DLP[1] put forward the idea that unobserved preference heterogeneity is connected to fertility decisions and clothing expenditures. In short, if the number of children results from a selection process, then the number of children in the household will be endogenous.

In this model, I assume the number of children is exogenously given. The underlying reasoning for this assumption is straightforward. The marital status of the parent is dissociated from fertility-related choices. When parents decide to have children, they do not prospect (anticipate) their singlehood. Furthermore, a lone parent is assumed to be unable to have children except by artificial insemination or adopting a child which has low probabilities.[23] Thus, a single parent is unlikely to decide how many children to have.

To set the instruments suitably, I write the budget share equations (15) and (16) as a unique budget share equation. To do this, multiply equation (15) by $(1-\zeta_{is})$ if single individual and equation (16) by $\zeta_{is}$ if single parent to get:

$$\epsilon_{is} = (1-\zeta_{is})\left[\omega_{is} - \alpha_i v_{is} - \beta_i \ln p_{is} - \gamma_i \ln y_{is} - \eta_i (\ln y_{is})^2\right] + \zeta_{is}\left[\frac{\omega_{is}}{\phi_{is}} - \alpha_i v_{is} - \beta_i \ln\left(\frac{p_{is}}{\pi_{is}}\right) - \gamma_i \ln\left(\frac{\phi_{is} y_{is}}{\pi_{is}}\right) - \eta_i\left(\ln\left(\frac{\phi_{is} y_{is}}{\pi_{is}}\right)\right)^2\right]$$

Rearranging the right-hand side and obtains:

$$\omega_{is} = \alpha_i v_{is} + \beta_i \ln p_{is} + \gamma_i \ln y_{is} + \eta_i (\ln y_{is})^2 + \zeta_{is}\Theta_{is} + \epsilon_{is} \tag{19}$$

with

$$\Theta_{is} = \beta_i \ln\left(\frac{1}{\pi_{is}}\right) + \ln\left(\frac{\phi_{is}}{\pi_{is}}\right)\left[\gamma_i + \eta_i \ln\left(\frac{y_{is}^2 \phi_{is}}{\pi_{is}}\right)\right] - \omega_{is}\frac{1-\phi_{is}}{\phi_{is}}.$$

To deal with endogeneity issues, I estimate the system of no simultaneous budget share equations by setting the iterated Two Stage Least Square Method.[24] The non-linear estimators are iterated until the estimated parameters and error/orthogonality condition covariance matrices settle.

I use all the exogenous variables as instruments, except total expenditures which are instrumented by total income. For total income to be a valid instrument, it must be uncorrelated with the error term in the budget share equations and partially

[23] Other exceptions, the fact that the single parent can have children with someone outside the household.

[24] Recall that the female budget share equation is estimated separately from the male's one as household decisions are unilateraly taken.

correlated with total expenditures as assumed according to DLP[1]. Furthermore, I set as instruments the product $\zeta_{is}$ and a second-order polynomial of all the exogenous variables that enter $\Theta_{is}$ and total income. This yields 19 instruments for each equation.

# 4 Estimation Results

This section presents the general findings of the model. I sum up the descriptive statistics of the sample. Then, I present and comment the estimation results.

Table 1: Descriptive statistics

| | | Single Women | Single Men | Single Mother | | | Single Father | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Children | | | | | |
| | | | | 1 | 2 | 3 | 1 | 2 | 3 |
| Expenditure data | | | | | | | | | |
| Female clothing | Weekly expenditure (in £) | 9.36 | - | 7.43 | 6.10 | 5.18 | - | - | - |
| | | (17.82) | | (14.74) | (13.10) | (11.35) | | | |
| | Percentage of zeros | 0.43 | - | 0.44 | 0.47 | 0.48 | | | |
| | | (0.50) | | (0.50) | (0.50) | (0.50) | | | |
| Male clothing | Weekly expenditure (in £) | - | 5.25 | - | - | - | 4.30 | 3.76 | 1.35 |
| | | | (15.10) | | | | (11.778) | (10.90) | (4.51) |
| | Percentage of zeros | - | 0.72 | - | - | - | 0.71 | 0.71 | 0.84 |
| | | | (0.45) | | | | (0.46) | (0.46) | (0.37) |
| Total weekly expenditure | | 105.72 | 111.60 | 126.32 | 132.76 | 135.05 | 144.94 | 150.62 | 143.62 |
| | | (73.99) | (82.06) | (86.89) | (86.28) | (86.39) | (90.02) | (96.48) | (75.64) |
| Individual and household characteristics | | | | | | | | | |
| Women's labor participation | | 0.71 | - | 0.50 | 0.43 | 0.29 | - | - | - |
| | | (0.45) | | (0.50) | (0.50) | (0.45) | | | |
| Men's labor participation | | - | 0.65 | - | - | - | 0.55 | 0.52 | 0.39 |
| | | | (0.48) | | | | (0.50) | (0.50) | (0.49) |
| Women's education (in years) | | 12.43 | - | 11.70 | 11.57 | 11.27 | - | - | - |
| | | (3.40) | | (2.39) | (2.25) | (2.04) | | | |
| Mens's education (in years) | | - | 12.28 | - | - | - | 11.32 | 11.46 | 11.31 |
| | | | (3.44) | | | | (2.18) | (2.19) | (2.11) |
| Women's age | | 39.10 | - | 34.84 | 33.90 | 33.33 | - | - | - |
| | | (11.15) | | (9.17) | (7.02) | (5.92) | | | |
| Men's age | | - | 38.32 | - | - | - | 38.39 | 37.10 | 35.95 |
| | | | (10.20 | | | | (9.14) | (7.90) | (7.05) |
| House owner | | 0.52 | 0.50 | 0.28 | 0.28 | 0.19 | 0.46 | 0.46 | 0.27 |
| | | (0.50) | (0.50) | (0.45) | (0.45) | (0.39) | (0.50) | (0.50) | (0.45) |
| Average age of children | | - | - | 7.81 | 7.85 | 7.82 | 8.81 | 8.02 | 8.04 |
| | | | | (4.84) | (3.73) | (3.09) | (5.26) | (4.10) | (3.27) |
| Proportion of boys | | - | - | 0.51 | 0.50 | 0.52 | 0.58 | 0.52 | 0.55 |
| | | | | (0.50) | (0.35) | (0.30) | (0.49) | (0.35) | (0.31) |
| Number of observations | | 10726 | 13921 | 7038 | 4629 | 1577 | 941 | 505 | 150 |

Notes: Expenditures are in 1987 pounds. Standard deviation are in parenthesis.

## 4.1 Sum up the Data

Table 1 reports descriptive statistics of the sample for the main variables, facilitating a preliminary analysis in the Rothbarth sense. Here are the following analyzes of clothing spending by adults. Descriptive statistics provide evidence of a reduction in adult clothing expenses due to the presence of children, regardless of the adults' gender. As illustrated in the first two columns, women and men living alone spend on average respectively £9.4 and £5.3 on clothing per week. These expenditures decrease to £7.4 and £4.3, respectively, for single mothers and single fathers with a child, representing respective declines of 21% and 19%. In addition, note that the more parents have children the less their clothing expenses will be. For instance, the average weekly expenditure on clothing for fathers drops significantly, reaching a minimum of £1.4 (£5.2 for mothers). These findings echo Rothbarth's view since the household size reduces the parents' welfare derived from consumption. Finally, Table 1 also presents the percentage of zeros regarding adults clothing expenses which is quite large. This pattern corresponds with the established understanding that infrequent purchases introduce endogeneity in total expenditure, as discussed by Keen (1986).

## 4.2 Estimations

This section describes and analyzes findings related to the budget share equation detailed above.

### 4.2.1 Budget Share Equations

Table 2 partially presents the results of the budget share equations.[25] I estimate equation (19) for each gender (men and women) with the iterative two-stage least squares method. At first glance, I notice that socio-demographic preference parameters do not always affect individual budget share similarly for both adult members. My findings confirm partly what was previously found in the literature by BDH. The clothing budget share of females decreases with education and age, but increases at a certain age. Regarding age estimates, this report is true and highly significant for both genders. Finally, the results suggest that other factors being equal, house owner men spend less on male clothing than those who are not.

[25]The full results of the budget share equations are reported in Table 8 in Appendix B where the estimated parameters for regions are also given.

Table 2: Results for clothing budget share equations

| | Women's budget equation | | Men's budget equation | |
|---|---|---|---|---|
| Parameters | Est. val. | Std. err. | Est. val. | Std. err. |
| Intercept | 0.195*** | (0.015) | 0.150*** | (0.013) |
| Education | -0.001* | (0.000) | 0.000 | (0.000) |
| Age (in years) | -0.004*** | (0.001) | -0.004*** | (0.001) |
| Age$^2$ (in years) | 0.004*** | (0.001) | 0.004*** | (0.001) |
| Year | 0.819** | (0.343) | 1.049*** | (0.381) |
| Year$^2$ | -0.819** | (0.341) | -1.046*** | (0.380) |
| House owner | -0.000 | (0.002) | -0.003* | (0.002) |
| Labor participation | 0.002 | (0.003) | 0.001 | (0.002) |
| | | | | |
| Log relative price | -0.003 | (0.004) | 0.011 | (0.007) |
| Log total expenditures | 0.004 | (0.0104 | 0.016* | (0.009) |
| (Log total expenditures)$^2$ | -0.022*** | (0.010) | -0.001 | (0.006) |
| Sample size | 24 514 | | 15 565 | |

Notes: * $p < 0.10$, **$p < 0.05$, ***$p < 0.01$.

### 4.2.2 Resource Share Equations

The previous findings focus solely on the impact of individual characteristics on clothing budget share. A second and more important feature of this study centers on the influence of the presence of children on parent resource share. The results for resource share equations are exposed in Table 3. It should be convenient to recall that the resource share equations allow recovering the cost of children borne by the parent. Remember, resources allocated to children depend on two main sets of factors: parent characteristics along with the total expenditures and children characteristics. As I explained above, $\phi_i$ represents the level of resources kept by single parents, inevitably $\phi_c = 1 - \phi_i$ the one diverted to children. As such, a negative coefficient in the sharing function should imply a rise in resources allocated to children, as it works to curtail parental resources.

In this sense, the results for individual resource shares indicate that children have an augmenting effect on parent resources. This says that the negative sign of the intercept suggests that the cost of children significantly grows up as the number of children increases. But resources per child fall significantly with family size. Similar findings were previously obtained by Bargain and Donni (2012a), DLP[1], Penglase (2021), and BDH. Moreover, the results suggest that older children cost parents more.

Although only the intercept plays a significant role in explaining the cost of children in the case of single fathers, children estimates for single fathers have the same sign as single mothers. To recall, very few single fathers are present in the sample compared to single mothers.

Table 3: Estimated paramaters of the individual resource shares and individual prices

| | | Without Siblings | | With Siblings | |
|---|---|---|---|---|---|
| | | Women | Men | Women | Men |
| | **Parent characteristics** | | | | |
| $\boldsymbol{z}$ | Intercept | 1.840*** | 0.725 | 1.854*** | 0.775 |
| | | (0.459) | (1.059) | (0.448) | (1.065) |
| | Education | 0.009 | -0.026 | 0.008 | -0.022 |
| | | (0.017) | (0.064) | (0.016) | (0.063) |
| | Age (in years) | 0.005 | 0.036** | 0.004 | 0.037** |
| | | (0.006) | (0.018) | (0.006) | (0.017) |
| | Labor participation | -0.083 | 0.236 | -0.075 | 0.286 |
| | | (0.126) | (0.244) | (0.123) | (0.248) |
| | Log total expenditures | 0.359 | 0.937** | 0.445 | 1.990*** |
| | | (0.547) | (0.410) | (0.549) | (0.580) |
| | **Children characteristics** | | | | |
| $\boldsymbol{k}$ | Intercept | -0.856*** | -0.730** | -0.882*** | -0.876** |
| | | (0.237) | (0.367) | (0.230) | (0.413) |
| | Number of children | 0.101*** | 0.041 | 0.107*** | 0.068 |
| | | (0.032) | (0.069) | (0.031) | (0.077) |
| | Age (in years) | -0.010* | -0.001 | -0.010* | -0.002 |
| | | (0.006) | (0.017) | (0.005) | (0.017) |
| | Proportion of boys | -0.034 | -0.122 | -0.043 | -0.111 |
| | | (0.031) | (0.131) | (0.032) | (0.139) |
| | Same-sex siblings | | | 0.049** | 0.075 |
| | | | | (0.025) | (0.116) |
| | **Shadow prices** | | | | |
| $\boldsymbol{\tau}$ | Log total expenditures | -0.298 | 1.000 | -0.226 | 1.077 |
| | | (0.387) | (0.713) | (0.417) | (0.696) |
| Sample size | | 24 514 | 15 565 | 24 514 | 15 565 |
| Sargan statistics | | 25.51 | 24.24 | 29.79 | 6.62 |
| (Nb of free parameters, Instruments) | | (32, 42) | (32, 42) | (33, 43) | (33, 43) |

Notes: $^*p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

I now turn to parent preference parameters. One observes that the children's share is lower as the parents' total expenditures increase. The results suggest that a 10% increase in fathers' total expenditures leads to an increase in the father's share by around 20%. Nonetheless, it is rational conjecture that affluent parents' children derive, in absolute terms, greater benefit from their parents' income than children of less affluent parent.

In summary, the presence of children in the household hurts parental resources. However, children's effect is nonlinear on parents' budget share. I will present a visual depiction of this later on in this paper.[26] Additionally, the parents' resource share is larger in households with higher total expenditures. Finally, the dependence of the sharing functions on male total expenditure contrasts the core identifying assumption underpinning various models (see, e.g., Bargain and Donni, 2012a; Dunbar et al., 2013; Penglase, 2021).

In the previous lines, I mentioned the fact that the budget share of children decreases with parent total expenditures. Given the heterogeneity of families regarding total expenditures, I report the per-child resource shares at different point of household total expenditures. To that end, I divide total expenditures in the 20th vigintile. Let's concentrate on the second panel of Figure 1. At the bottom of the distribution, the resource shares per child diverge from around 29%, (32% to 50%) respectively for one child, (two, and three children) families. That is, single-child families with limited financial means provide better conditions for their child compared to families with multiple children. Nonetheless, as parent total expenditures rise, the resource allocation per child converges to around 12%. This indicates that, regardless of the number of children, the resources per child are homogeneously distributed in the families at the top of the distribution.

This graph is rich with instructive contents. On the one hand, the underlying idea is that parents have a minimum level of expenditure below which government should consider specific financial support tailored to the characteristics of children. In other words, parents whose income does not exceed this threshold, or comes close to it, should benefit from social policy measures to safeguard the well-being of their children. Typically, there is a baseline consumption level, irrespective of the number of children. Let's illustrate with an example. Suppose a single father earns the minimum wage, say £1100 per month. Assume no family allowances are provided. Additionally, suppose his subsistence total expenditures amount to £1000. For such a parent, if he

[26] See Figure 4.

has one child, that child will receive £100. However, if he has two or more children, they would divide £100 among themselves, as the parent's minimum subsistence total expenditures are £1000. On the other hand, this graph highlights that children living in affluent households experience nearly uniform levels of material well-being in terms of financial ressources they get, irrespective of family size. In essence, the number of children does not matter for the wealthiest parents.

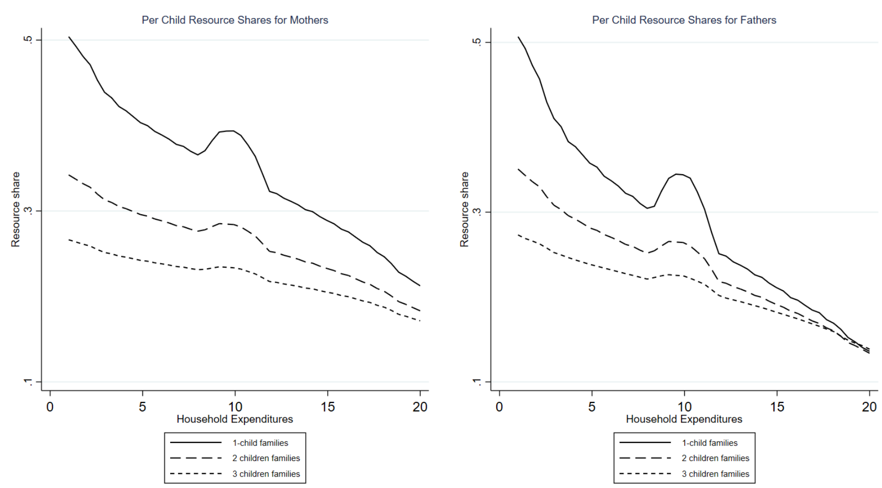


Figure 1: Children resource share by total expenditures

#### 4.2.3 Economies of Scale

I now delve into the scenario involving the control for the presence of siblings in the model. The sign of the coefficient of the number of children provides insights into the potential existence of economies of scale generated by variations in family size. The ensuing estimates shed light on a different kind of economies of scale. In some families, siblings of same gender and close-in-age tend to share clothing. For instance, in specific family contexts, the clothings of older children are passed down to subsequent offspring, indicating a form of economies of scale among siblings. Including the siblings variable in the model facilitates an exploration of these economies of scale. This variable effectively captures both the aspect of family size and the gender-composition-related impact. It is important to remember that the sibling variable is a dummy variable, denoting whether the sibling shares the same gender or not. The coefficient associated with sibling reveals that the share of total expenditures mothers keep is larger when the household comprises siblings of the same gender.

Figure 2 provides us with valuable insights into economies of scale generated by same-gender siblings. Respectively, the straight blue and red lines indicate siblings of mixed and same gender. Figure 2 depicts that, over the years, the average cost of children is lesser in families made up of siblings of same gender. Overall, families comprised of children with distinct genders experience a higher parental cost for child-rearing than families comprised of children sharing the same gender as illustrated by Figure 3.

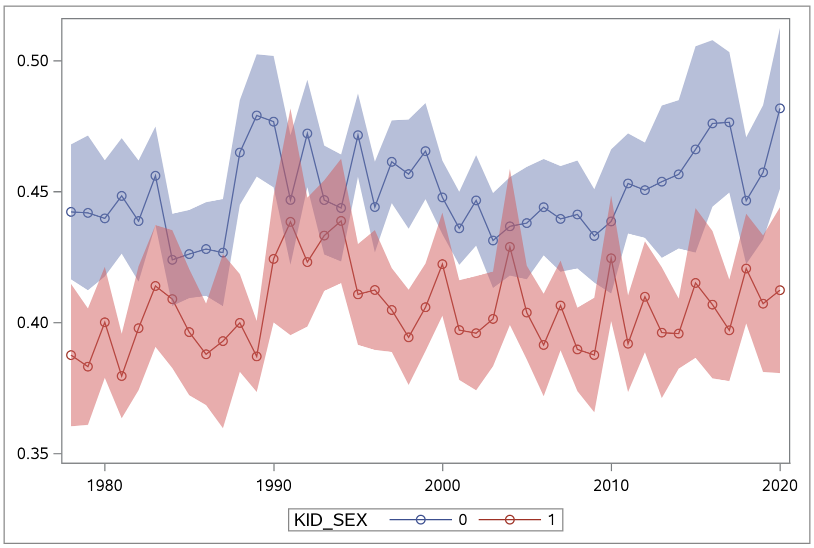


Figure 2: Share of total expenditures allocated to siblings by year

#### 4.2.4 Intra-household Resource Allocation

To determine the cost of children, BDH have computed the cost of children at the average point of the sample. This approach seeks to deduce the cost of children for a representative household. In this paper, I also compute the average cost of children for fathers and mothers. The results will allow us to answer the following questions. How do the cost of children evolve with the number of children? Do children affect

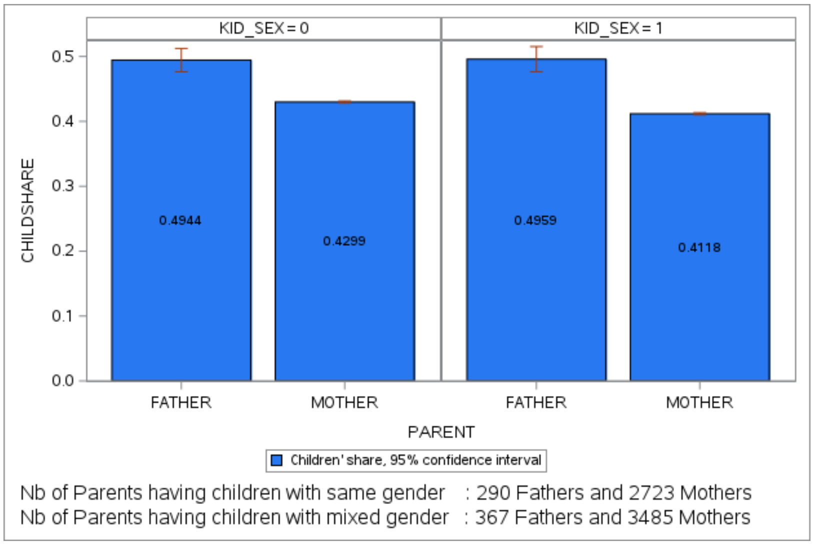


Figure 3: Share of parents resources devoted to children by the gender Composition of Siblings

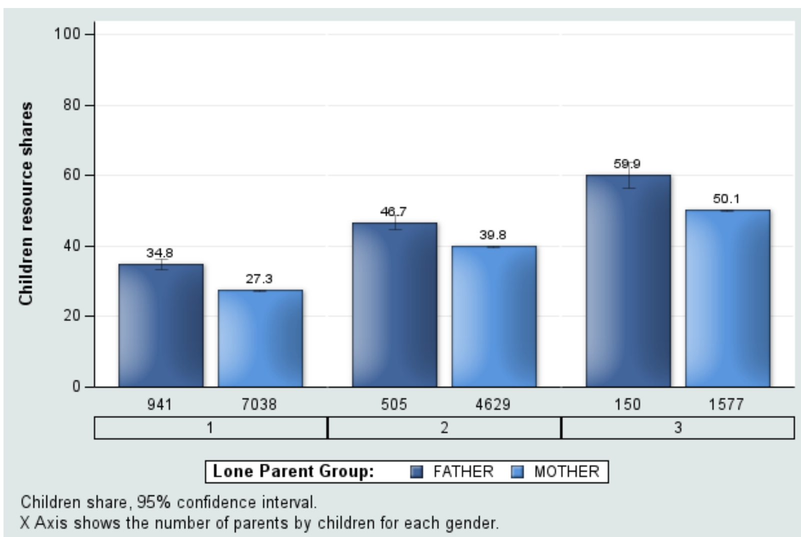


Figure 4: Share of parents total expenditures devoted to children

the resources of both single parents equally? Is the cost of children linear?

Table 4 reports the average cost of children and the cost of children for a representative parent as well. I begin with the point estimates, the second part of Table 4. A representative parent is defined as a (mean) individual in the sample. The

Table 4: Children resource share estimates

| | $\bar{\phi_c}$ | | | | | | $\phi_c$(mean of data) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Single Mothers | | | Single Fathers | | | Single Mothers | | | Single Fathers | | |
| Nb. of children | Mean | Lower bound | Upper bound | Mean | Lower bound | Upper bound | Est. | Lower bound | Upper bound | Est. | Lower bound | Upper bound |
| 1 | 0.284 | 0.282 | 0.286 | 0.348 | 0.333 | 0.363 | 0.316 | 0.248 | 0.445 | 0.303 | 0.187 | 0.367 |
| | (0.101) | (0.099) | (0.102) | (0.236) | (0.226) | (0.247) | (0.090) | | | (0.058) | | |
| 2 | 0.397 | 0.394 | 0.401 | 0.467 | 0.446 | 0.488 | 0.524 | 0.309 | 0.726 | 0.454 | 0.380 | 0.538 |
| | (0.118) | (0.115) | (0.120) | (0.241) | (0.227) | (0.256) | (0.125) | | | (0.049) | | |
| 3 | 0.497 | 0.491 | 0.503 | 0.599 | 0.563 | 0.636 | 0.682 | 0.375 | 0.932 | 0.620 | 0.527 | 0.711 |
| | (0.125) | (0.121) | (0.129) | (0.224) | (0.201) | (0.253) | (0.153) | | | (0.046) | | |
| Sample size | | 13 244 | | | 1 596 | | | 13 244 | | | 1 596 | |

Notes: Standard deviation and standard errors are in parenthesis. In the first part of the table, I use the structural parameters associated to $z$ and $k$ to compute $\phi_c$ for each parent, then I take the average to obtain $\bar{\phi_c}$. In the second part, I evaluate $\phi_c$ at the mean of $z$ and $k_{-1}$ for one, two and three children. $k_{-1}$ indicates that I exclude the number of children in $k$.

results suggest that there is significantly no difference between the cost of children incurred by a representative single mother and that of a representative single father. Whereas, regardless of the number of children, the average cost of children is significantly larger for fathers than mothers as illustrated in the first part. At first sight, this result seems unexpected.[27] However, such a result may be attributed to the fact that single mothers receive support from external members of the household, such as fathers' children. In general, child custody, which seems to be an outdated legal term is typically entrusted to the mother following a divorce or civil partnership dissolution. Data itself highlights this fact, with single fathers accounting for only 11% of single parents. Various factors are put forward to explain this. First, domestic and parental work is still predominantly undertaken by women today. Second, mothers in relationship more frequently work part-time than fathers. In that respect, mothers are more apt to be the primary caregivers due to these previous two factors, as they are the ones who typically invest the most time in the upbringing and care of their children. Third, statistics show that fathers are most likely to have a criminal history of domestic violence. Finally, the court is primarily focused on the child's general welfare, thereby the income disparity between parents is of minimal significance. The key consideration is the parent's ability to offer a secure environment and address the child's emotional needs. From this perspective, if parental singleness results from a

[27] Cherchye et al. (2012) found that empowering fathers is more beneficial to children than empowering mothers.

partnership dissolution rather than the death of one of the partners, it is reasonable to assume that the father, typically not the custodial parent, continues to pay child support under the Children Act of 1989. Data on parental singleness status from 1991 to 2020 indicates that widowers account for only 8% and 3%, respectively for mothers and fathers (see Appendix).[28] In this light, child support would act as a discount for the mother, aiming to alleviate the financial burden of raising children. One could argue that mothers would do the same, by paying child support if custody were transferred to fathers. This is not untrue. However, it is reasonable to believe that fathers with custody may have a heightened preference for their children, thus exhibiting greater altruism towards them. In short, the father's contribution through child support and other maintenance payments to the mother, acting as a discount effect, may explain why the average cost of children is larger for fathers than mothers.

Additionally, for both techniques, the resource share allocated to children increases with the size of households. It is noteworthy that the cost of children exhibits non-linear patterns. Figure 4 offers a clearer perspective on this aspect. For instance, the cost attributed to children for a father with three children falls short of doubling that of a father with a unique child. The same pattern is observed for mothers. This might suggest a substantial drain on the income per child. As depicted in Figure 1, this aspect is particularly pronounced for children raised by economically modest households. The distribution of income per child exhibits notable disparities among impoverished households. Similarly, Figure 4 is quite striking as it may indicate significant economies of scales among children within the households. It further allows comparison between the cost borne by each single parents. As discussed earlier, one shows that fathers allocate a substantial share of their budget to children instead of mothers. In that respect, the average cost of children for single fathers that raises one child, (two and three children) is around 35% (47% and 60%) compared to 27% (40% and 50%) for single mothers. This difference is statiscally significant as illustrated by confidence intervals. A lingering question is: do fathers, as a whole, dedicate a larger part of their total expenditure to children than mothers? The answer is affirmative, as indicated in Table 9 in Appendix B. The weighted average cost of children for

[28]Detailed information on marital status is unavailable for years before 1991.

fathers is around 6 percentage points higher than that of mothers.[29] Overall, single mothers spend less on their children than their counterparts regarding the share of total expenditures reserved for children. As fathers demonstrate greater total expenditures than mothers, one might infer that fathers are more generous than mothers. Put it in more explicit terms, fathers, in absolute value, allocate a larger portion of their resources to their children than mothers do. Table 5 test whether or not the variance between each sample is equal. The output indicates that the hypothesis of variances equality is strongly rejected.

Table 5: Test for equality of variances

| Equality of variances | | | | |
|---|---|---|---|---|
| Method | Num DF | Den DF | F Value | Pr>F |
| Folded F | 1 595 | 13 243 | 6.12 | <.0001 |

Notes: DF for Degree of Freedom.

#### 4.2.5 Sensitivity Analysis

I set three procedures to check the robustness of the results. Firstly, I set up seven variants of the model. Secondly, I test overidentifying restrictions. Thirdly and finally, I estimate the model on a restricted sample of households. The core results exhibit qualitative consistency, albeit less pronounced in significance.

One of the main goals of this paper is to determine whether the sharing rule function can generate an accurate estimate of the cost of children over time. I have assumed that the sharing rule is a function of both children and parent characteristics. The first two specifications I estimate are whether the results change to include time successively in $z$ and $k$ parts. Table 6 reports the results of Sargan's test and LR-type statistics. The null hypothesis that the sharing rule is not affected by linear time trend neither in $z$ nor in $k$ is not rejected at usual significance levels. The drivers of $z$ and $k$ remain fairly steady over time. In that respect, year is a relevant variable for identifying the sharing rule (see Proposition 1). As such, potential shifts

[29] I weight by the number of children. Keep in mind that the unweighted test draws the same conclusion. See Table 9 in Appendix B.

Table 6: Robustness tests

| Models | | Female | | | | Male | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Sargan statistics | LR-type statistics | Degrees of freedom | p-value | Sargan statistics | LR-type statistics | Degrees of freedom | p-value |
| Reference model | | 20.79 | | 10 | | 6.63 | | 10 | |
| Models with | linear time trend in $z$ | 17.46 | 3.33 | 1 | 0.07 | 5.62 | 1.00 | 1 | 0.32 |
| | linear time trend in $k$ | 19.06 | 1.73 | 1 | 0.19 | 4.19 | 2.44 | 1 | 0.12 |
| | prices of clothing in $z$ | 18.45 | 2.34 | 1 | 0.13 | 3.50 | 3.13 | 1 | 0.08 |
| | prices of clothing in $k$ | 19.58 | 1.21 | 1 | 0.27 | 3.49 | 3.14 | 1 | 0.08 |
| | cubic term in Engel curves | 20.65 | 0.14 | 1 | 0.93 | 3.12 | 3.51 | 1 | 0.06 |
| Models without | economies of scale | 29.19 | 0.60 | 1 | 0.44 | 9.02 | 2.39 | 1 | 0.12 |
| | log total expenditures in $z$ | 23.51 | 2.72 | 1 | 0.10 | 10.45 | 3.83 | 1 | 0.05 |

Notes: The first column in each panel for both females and males shows up the Sargan statistics, which are the objective function value times the number of observations. The LR-type statistics in the second column in each panel are computed as the absolute value of the difference between the Sargan statistics of the baseline model and those of the respective alternative model. It is worth noting that the objective function calculation for the alternative models is conducted using the identical baseline model weighting matrix.

in child resources are unlikely to be mediated by time through parent or children characteristics.

The second check allows for differences in the sharing rule parameters by introducing the price of clothing into the sharing rule function. The results suggest that the prices play an insignificant role in the variability of individual resource shares. The next specification test examines the results' sensitivity to integrating a third order term in Engel curves. The p-values (0.93 and 0.06 respectively for female and male) lead to a failure in rejecting the null hypothesis in the sharing rule equation at standard significance levels.

The results of the final set of specifications are reported in the second panel of Table 6. First, I test empirically the hypothesis of economies of scale. To this end, I implement the LR-type statistics, which is defined as the difference between the Sargan statistics of the unconstrained and the constrained models. Under the null hypothesis, both models (with or without economies of scales) are significantly equivalent. The findings do not support the theoretical hypothesis of economies of scale within the household setting. The economies of scale function potentially suffers from functional form misspecification. Finally, I find evidence for introducing the log total expenditures in $\boldsymbol{z}$ part of the sharing rule function, even though this approach lacks empirical backing regarding female data.

Table 7 presents further results of robustness. Due to the relatively small sample

Table 7: Estimated paramaters of the individual resource shares: further results

| | | I-Simplified | | II-Only Mixed Gender Siblings | | III-Only Working Individuals | |
|---|---|---|---|---|---|---|---|
| | | Women | Men | Women | Men | Women | Men |
| | Parent characteristics | | | | | | |
| $\boldsymbol{z}$ | Intercept | 8.458 | 1.796 | 1.831*** | -0.819 | 1.859*** | 0.051 |
| | | (6.338) | (2.547) | (0.477) | (1.245) | (0.657) | (2.315) |
| | Education | -0.002 | -0.022 | 0.013 | 0.039 | 0.008 | 0.002 |
| | | (0.018) | (0.079) | (0.017) | (0.096) | (0.025) | (0.172) |
| | Age (in years) | 0.002 | 0.037* | 0.002 | 0.068*** | -0.003 | 0.047 |
| | | (0.006) | (0.020) | (0.006) | (0.024) | (0.008) | (0.039) |
| | Labor | 0.046*** | 0.327 | -0.086 | 0.740** | - | - |
| | | (0.111) | (0.340) | (0.133) | (0.290) | - | - |
| | Log total expenditures | 0.900 | 1.904*** | 0.549 | 2.637*** | 0.289 | 2.675*** |
| | | (0.442) | (0.727) | (0.525) | 0.764 | (1.129) | (0.859) |
| | Children characteristics | | | | | | |
| $\boldsymbol{k}$ | Intercept | -8.569*** | -2.086 | -0.804*** | -1.083** | -0.752** | 0.290 |
| | | (7.475) | (3.373) | (0.213) | (0.506) | (0.321) | (1.377) |
| | Number of children | 2.089*** | 0.348 | 0.098*** | 0.126 | 0.074* | -0.197 |
| | | (2.081) | (0.823) | (0.030) | (0.087) | (0.042) | (0.348) |
| | Age (in years) | -0.014** | -0.007 | -0.009* | -0.047* | -0.009 | -0.003 |
| | | (0.006) | (0.023) | (0.005) | (0.025) | (0.009) | (0.040) |
| | Proportion of boys | -0.098 | -0.113 | -0.120** | 0.527 | -0.017 | -0.218 |
| | | (0.067) | (0.168) | (0.056) | (0.374) | (0.059) | (0.455) |
| | Same-sex siblings | 0.469 | 0.189 | - | - | 0.071* | -0.412 |
| | | (0.202) | (0.274) | - | - | (0.043) | (0.396) |
| | Shadow prices | | | | | | |
| $\boldsymbol{\tau}$ | Log total expenditures | 0.147 | -5.787 | -0.142 | 1.407* | -0.154 | 1.246 |
| | | (0.563) | (0.810) | (0.413) | (0.793) | (0.796) | (0.528) |
| Sample size | | 24 514 | 15 565 | 21 713 | 15 268 | 13 685 | 9 823 |
| Sargan statistics | | 4.56 | 5.60 | 16.10 | 9.36 | 14.11 | 11.77 |
| (Nb of free parameters, Instruments) | | (33, 38) | (33, 38) | (32, 42) | (32, 42) | (31, 38) | (31, 38) |

Notes: $*p < 0.10$, $**p < 0.05$, $***p < 0.01$.

size, especially when considering single fathers, the estimates are prone to biases arising from a high degree of overidentification. To check the sensitivity of the estimates to the number of instruments used, I estimate the model with fewer instruments. This entails the removal of the second-order polynomials for the exogenous variables entering in $\Theta_{is}$. As illustrated by the results of Model I, the main conclusions remain consistent, although the estimated coefficient parameters and standard errors are becoming large. In Model II, I use a sample that excludes parents with children of the same gender. The findings closely mirror those obtained from the benchmark model. The fifth and final columns report the model's estimated coefficients where all individuals are in the labor market. While less significant, the conclusions maintain their qualitative similarity.

# 5 Conclusion

Several models attempted to assess the cost of children for parents. However, these are focused only on children living in bi-headed households, while most OECD countries have experienced a demographic reconfiguration towards single parenthood. I refined the collective approach to fit single-parent decisions in this paper. The fundamental aim is to measure the cost of children borne by each single parent. For this purpose, I use a collective-type consumption model to retrieve information behind the sharing rule function within one-headed households using homogeneity assumptions and observing exclusive goods. The model also allows for identifying the presence of economies of scale between children.

To test the validity of the model, I use data from the UK Family Expenditure Survey (FES) over the period 1978-2020. The results confirm partly the previous estimates in the existing literature for couple-parents, namely, the cost of children increases with the number of children but decreases with family size. Interestingly, I found that the average cost of a child amounts to respectively 35% and 27% of the total expenditures of lone fathers and mothers. As such, children cost more to single fathers than single mothers, which is potentially explained by the transfer from single fathers to single mothers. Globally and significantly, the weighted average cost differential of children supported by parents is six percentage points, favoring fathers. Whereas the cost of children incurred by a representative parent, whether father or mother, is not significantly different. Furthermore, the findings reveal that the number of children does not matter for affluent parents, as the resource per child is invariant from the number of children. On the contrary, children from low-income families derive less from their parents' total expenditures with larger family size. The insight from these findings is that parents have a minimum threshold of expenses. To ensure the needs of children are met, the state must intervene through its family allowance policies, especially for parents whose incomes fall below this critical threshold. This support should be tailored to the characteristics of the children.

To conclude, it seems important to stress some aspects that warrant in-depth exploration in future research. Firstly, the issue of economies of scale deserves special attention. The results presented in this article underscore the existence of economies of scale among children, an aspect that could be thoroughly investigated through the DLP[1] model, where the demand function for exclusive goods for children would be estimated. It is relevant to note that children's clothing may be shared in some households, emphasizing the importance of considering these family dynamics. Another facet related to economies of scale among children pertains to the time parents dedicate to them. Notably, a parent does not necessarily need twice the time spent on one child to care for two children. This feature could be incorporated into a model considering parental time allocation beyond their consumption expenses. This brings us to the second aspect, namely the cost of time spent on children. My results undoubtedly underestimate the cost of children for mothers by not accounting for the time they devote to their children. This time incurs a cost (potentially significant) not currently integrated into the model, and the empirical observation that mothers generally spend more time with their children than fathers emphasizes the importance of considering it in future research.

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# 6 Appendix

# A Identification Proof

**Proof.**

1. Let's write $z_\omega = (z_{\omega 0}, z_{\omega 1})$ where $z_{\omega 1} \notin z_\pi$ and $z_{\omega 1} \notin z_\phi$. Then consider two values of $z_{\omega 1}$, say $z^1_{\omega 1}$ and $z^2_{\omega 1}$. This provides a system of two equations with two unknowns:

$$\omega(\bar{p}, z_\omega, \bar{z}_\pi, \bar{z}_\phi, \bar{y}, \bar{n}) = g(\bar{p}, z^1_{\omega 1}, \pi(\bar{p}, \bar{z}_\pi, \bar{y}, \bar{n}) \cdot \bar{p}, \phi(\bar{p}, \bar{z}_\phi, \bar{y}, \bar{n}) \cdot \bar{y})$$

$$\omega(\bar{p}, z_\omega, \bar{z}_\pi, \bar{z}_\phi, \bar{y}, \bar{n}) = g(\bar{p}, z^2_{\omega 1}, \pi(\bar{p}, \bar{z}_\pi, \bar{y}, \bar{n}) \cdot \bar{p}, \phi(\bar{p}, \bar{z}_\phi, \bar{y}, \bar{n}) \cdot \bar{y})$$

Under some regularity conditions, this system of two equations has generally a unique solution for $\pi(\bar{p}, \bar{z}_\pi, \bar{y}, \bar{n})$ and $\phi(\bar{p}, \bar{z}_\phi, \bar{y}, \bar{n})$, and for each choice of $(\bar{p}, \bar{z}_\pi, \bar{z}_\phi, \bar{y}, \bar{n})$.

2-3. Combine (2) and (3), the proof of this statement is similar to the previous one.[30]

4. Let's consider choosing a parametric specification for the sharing function, specifically a linear form that depends on $k$ parameters. There are $k$ degrees of freedom, representing the $k$ identifiable parameters. The idea is that we need $k$ equations to determine the unknown parameters.

5. Let

$$\omega = g(z_\omega, \pi_1(p, z_\pi, y) \cdot \pi_2(n) \cdot p, \phi_1(p, z_\phi, y) \cdot \phi_2(n) \cdot y)$$

By varying the values of $y$ and $n$, we might obtain the following equations:

$$\omega = g(z_\omega, \pi_1(\bar{p}, \bar{z}_\pi, y_1) \cdot \pi_2(n_1) \cdot \bar{p}, \phi_1(\bar{p}, \bar{z}_\phi, y_1) \cdot \phi_2(n_1) \cdot y_1)$$

$$\omega = g(z_\omega, \pi_1(\bar{p}, \bar{z}_\pi, y_1) \cdot \pi_2(n_2) \cdot \bar{p}, \phi_1(\bar{p}, \bar{z}_\phi, y_1) \cdot \phi_2(n_2) \cdot y_1)$$

$$\omega = g(z_\omega, \pi_1(\bar{p}, \bar{z}_\pi, y_2) \cdot \pi_2(n_1) \cdot \bar{p}, \phi_1(\bar{p}, \bar{z}_\phi, y_2) \cdot \phi_2(n_1) \cdot y_2)$$

$$\omega = g(z_\omega, \pi_1(\bar{p}, \bar{z}_\pi, y_2) \cdot \pi_2(n_2) \cdot \bar{p}, \phi_1(\bar{p}, \bar{z}_\phi, y_2) \cdot \phi_2(n_2) \cdot y_2)$$

The above example shows a set of 4 equations with 4 unknowns. Then we can identify the sharing function as well as the economies of scales. This completes the proof.

■

# B Additional Estimation Results

[30] The complete proof for the statement 2 is given by (Dunbar et al., 2013, online appendix) and (Penglase, 2021, online appendix).

Table 8: Results for budget share equations

| | Women's budget equation | | Men's budget equation | |
|---|---|---|---|---|
| Parameters | Est. val. | Std. err. | Est. val. | Std. err. |
| Intercept | 0.190*** | (0.013) | 0.138*** | (0.010) |
| Education | -0.001** | (0.000) | 0.000 | (0.000) |
| Age (in years) | -0.004*** | (0.001) | -0.003*** | (0.001) |
| Age2 (in years) | 0.004*** | (0.001) | 0.003*** | (0.001) |
| Year | 0.721** | (0.322) | 0.952*** | (0.338) |
| year2 | -0.722** | (0.321) | -0.949*** | (0.337) |
| House owner | -0.002 | (0.002) | -0.004** | (0.002) |
| Labor participation | 0.002 | (0.003) | 0.002 | (0.002) |
| Region: | | | | |
| Norhern | 0.002 | (0.004) | -0.008* | (0.004) |
| York & Humberside | 0.000 | (0.004) | -0.015*** | (0.004) |
| East Midlands | 0.004 | (0.004) | -0.021*** | (0.004) |
| East Anglia | -0.002 | (0.004) | -0.018*** | (0.004) |
| Greater London | 0.002 | (0.004) | -0.016*** | (0.004) |
| South-East | 0.000 | (0.004) | -0.019*** | (0.004) |
| South-West | -0.002 | (0.004) | -0.021*** | (0.004) |
| Wales | -0.002 | (0.004) | -0.014*** | (0.004) |
| West-Midlands | 0.002 | (0.004) | -0.016*** | (0.004) |
| North_West | -0.000 | (0.004) | -0.017*** | (0.004) |
| Scotland | -0.003 | (0.004) | -0.014*** | (0.004) |
| Log relative price | -0.005 | (0.004) | 0.011* | (0.006) |
| Log total expenditures | -0.002 | (0.010) | 0.010 | (0.007) |
| (Log total expenditures)2 | -0.026*** | (0.007) | -0.004 | (0.005) |
| Sample size | 24 514 | 15 565 | 24 514 | 15 565 |

Notes: $*p < 0.10$, $**p < 0.05$, $***p < 0.01$.

Table 9: Estimates of the difference of the average cost of children by parent

| Parents | Method | N | 95% LC Mean | Mean | 95% UC Mean | 95% LC SDV | SDV | 95% UC SDV |
|---|---|---|---|---|---|---|---|---|
| **Panel 1: Unweighed mean** | | | | | | | | |
| I-Fathers | | 1596 | 0.397 | 0.409 | 0.421 | 0.242 | 0.250 | 0.259 |
| II-Mothers | | 13244 | 0.342 | 0.344 | 0.346 | 0.095 | 0.096 | 0.097 |
| Diff(I-II) | Pooled | - | 0.059 | 0.065 | 0.071 | 0.121 | 0.122 | 0.123 |
| Diff(I-II) | Satterthwaite | - | 0.053 | 0.065 | 0.077 | - | - | - |
| **Panel 2: Weighed mean** | | | | | | | | |
| I-Fathers | | 1596 | 0.433 | 0.445 | 0.457 | 0.300 | 0.310 | 0.321 |
| II-Mothers | | 13244 | 0.378 | 0.379 | 0.381 | 0.124 | 0.125 | 0.127 |
| Diff(I-II) | Pooled | - | 0.059 | 0.066 | 0.072 | 0.154 | 0.156 | 0.158 |
| Diff(I-II) | Satterthwaite | - | 0.053 | 0.066 | 0.078 | | | |

Notes: N, LC, UC and SDV mean respectively sample size, Lower Confidence, Upper confidence and Standard Deviation. DF for Degree of Freedom.

Table 10: Estimates of the difference of the average cost of children by gender of children

| Parents | Method | N | 95% LC Mean | Mean | 95% UC Mean | 95% LC SDV | SDV | 95% UC SDV |
|---|---|---|---|---|---|---|---|---|
| **Panel 1: Cost of boys** | | | | | | | | |
| I-Fathers | | 1596 | 0.410 | 0.423 | 0.435 | 0.244 | 0.253 | 0.262 |
| II-Mothers | | 13244 | 0.350 | 0.352 | 0.353 | 0.098 | 0.099 | 0.100 |
| Diff(I-II) | Pooled | - | 0.065 | 0.071 | 0.078 | 0.124 | 0.125 | 0.126 |
| Diff(I-II) | Satterthwaite | - | 0.059 | 0.071 | 0.084 | - | - | - |
| **Panel 2: Cost of girls** | | | | | | | | |
| I-Fathers | | 1596 | 0.380 | 0.392 | 0.404 | 0.237 | 0.246 | 0.254 |
| II-Mothers | | 13244 | 0.335 | 0.336 | 0.338 | 0.091 | 0.092 | 0.093 |
| Diff(I-II) | Pooled | - | 0.050 | 0.056 | 0.062 | 0.117 | 0.118 | 0.120 |
| Diff(I-II) | Satterthwaite | - | 0.044 | 0.056 | 0.068 | | | |

Notes: See the notes to Table 9.

# C Informal Investigation

I present a linear regression model to estimate the share of total resources devoted to children on both parent and children characteristics. The objective is simply to explore and confirm the existing correlation between parental preferences and the average cost of children.

Table 11: Estimates of the average cost of children

| | | Women | | Men | |
|---|---|---|---|---|---|
| | Parameters | Est. value | Std. Err. | Est. value | Std. Err. |
| $\boldsymbol{z}$ | Intercept | 0.055*** | (0.001) | 0.338*** | (0.012) |
| | Education | -0.002*** | (0.000) | 0.004*** | (0.001) |
| | Age (in years) | -0.001*** | (0.000) | -0.007*** | (0.000) |
| | Labor | 0.017*** | (0.000) | -0.062*** | (0.002) |
| | Log total expenditures | -0.096*** | (0.000) | -0.367*** | (0.002) |
| $\boldsymbol{k}$ | Number of children | 0.209*** | (0.001) | 0.182*** | (0.011) |
| | (Number of children)$^2$ | -0.021*** | (0.000) | -0.013*** | (0.003) |
| | Age (in years) | 0.003*** | (0.000) | 0.001** | (0.000) |
| | Proportion of boys | 0.013*** | (0.000) | 0.027*** | (0.003) |
| | Same-sex siblings | -0.026*** | (0.000) | -0.028*** | (0.003) |
| Sample size | | 13 244 | | 1 596 | |

Notes: $^*p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

While caution is needed in interpreting these results as causal effects, asserting that these findings validate a highly pronounced correlation between individual characteristics (parent and children) and the average cost of children remains valid. Furthermore, these estimates corroborate the signs of the different coefficients obtained in the structureal model estimation.

# D Additional Figures

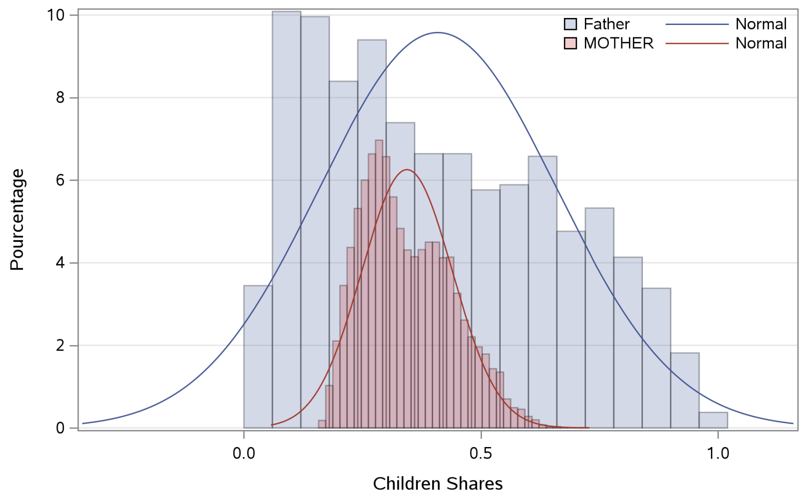


Figure 5: Nonparametric distribution of children's share

Note: Based on the sharing rule estimates, the mean share of children is 0.34 and 0.40 respectively for mothers and fathers.

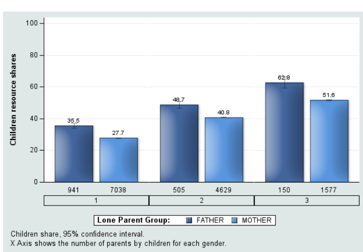


Figure 6: Share of parents' total expenditures devoted to boys

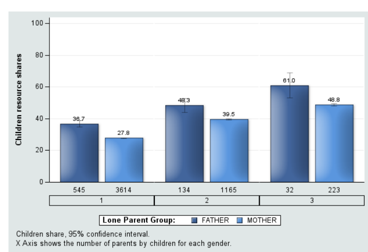


Figure 7: Share of parents' total expenditures devoted to children in families with only boys

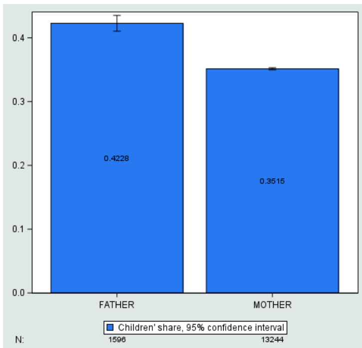


Figure 8: Cost of boys borne by each single parent

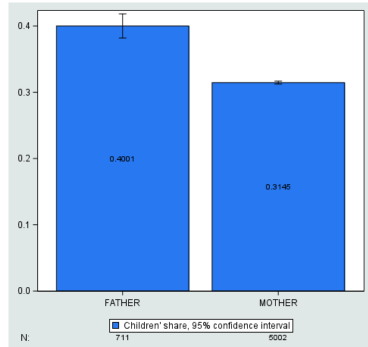


Figure 9: Cost of children borne by each single parent in families with only boys

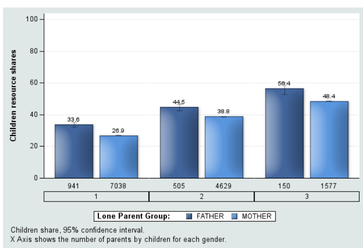


Figure 10: Share of parents' total expenditures devoted to girls

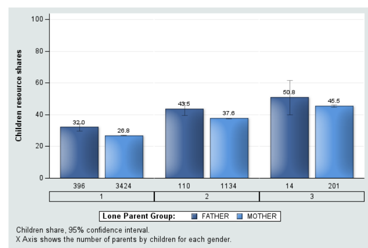


Figure 11: Share of parents' total expenditures devoted to children in families with only girls

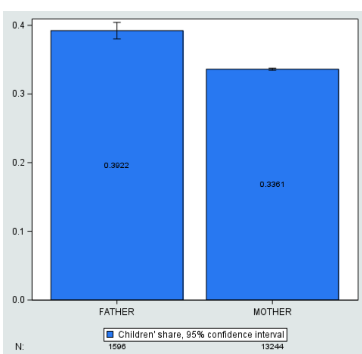


Figure 12: Cost of girls borne by each single parent

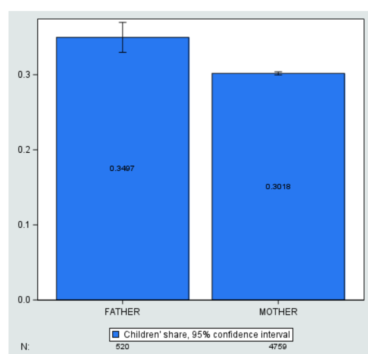


Figure 13: Cost of children borne by each single parent in families with only girls

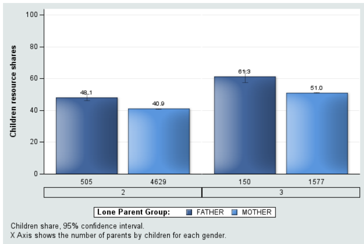


Figure 14: Share of parents' total expenditures devoted to children of mixed-gender

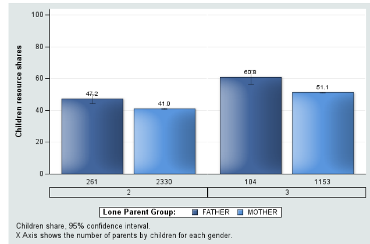


Figure 15: Share of parents' total expenditures devoted to children in families with only mixed-gender siblings

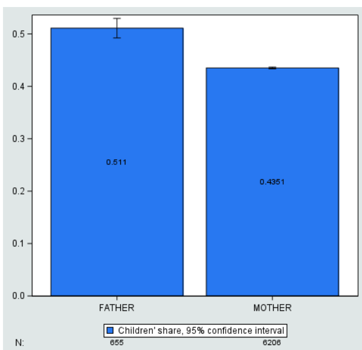


Figure 16: Cost of children of mixed-gender borne by each single parent

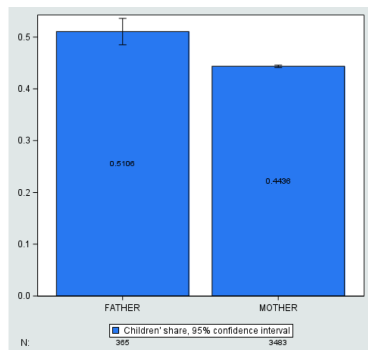


Figure 17: Cost of children borne by each single parent in families with only mixed-gender siblings

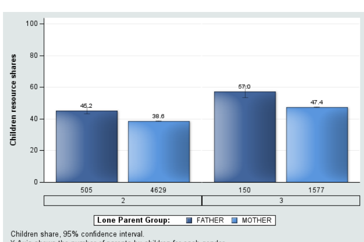


Figure 18: Share of parents' total expenditures devoted to children of same-gender

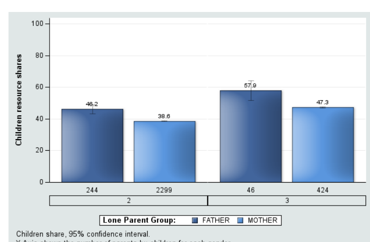


Figure 19: Share of parents' total expenditures devoted to children in families with only same-gender siblings

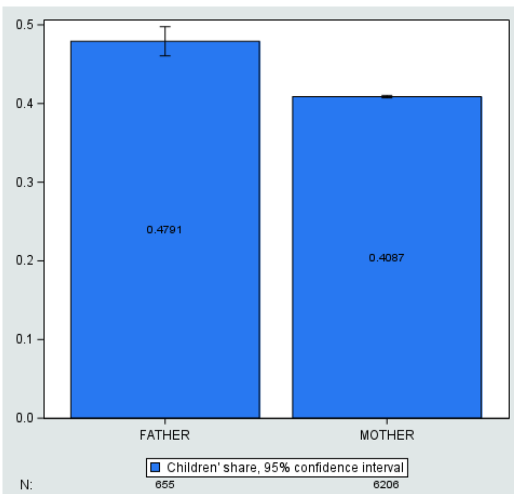


Figure 20: Cost of children of same-gender borne by each single parent

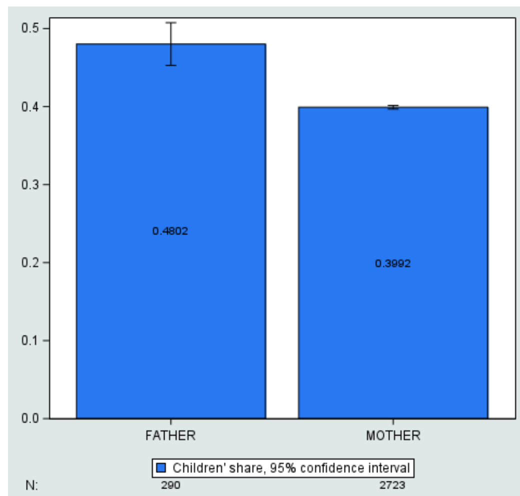


Figure 21: Cost of children borne by each single parent in families with only same-gender siblings