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Revisiting the Cost of Children: Theory and Evidence from Ireland.*

Olivier Bargain and Olivier Donni

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Abstract

In this paper, we suggest a collective model with parents and (young) children. We identify and estimate scale economies in households and the sharing rule between husband, wife and children. While adult shares and economies of scale are identified thanks to the estimation of individual Engel curves on single individuals, the identification of the resource share accruing to children (the cost of children) requires the observation of adult-specific goods as in the traditional Rothbarth method. The useful aspect of the present approach is that it requires only the estimation of Engel curves on cross-sectional data, i.e. price variation is not required. This is an advantage for many countries where price variations is indeed limited, as in our application on Irish data.

Key Words: Consumer Demand, Collective Model, Sharing Rule, Cost of Children, Equivalence Scales, Indifference Scales.

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1 Introduction

Economists have developed various techniques to measure the cost of children. The major obstacle to empirical research in this field is the lack of direct evidence. Measures of the cost of children are generally based on equivalence scales which suffer from a fundamental identification problem (Pollak and Wales, 1992). Further assumptions are often required to circumvent this difficulty. In particular, the traditional Rothbarth method has been extensively used and relies on the existence of adult-exclusive goods. This approach has already been used by several authors, Gronau (1991) suggesting a formalized version with a household model where the parent is altruistic and the child egoistic (in a Beckerian sense). The income transfer from the parent to the child can be identified from cross-sectional demand data provided that the demand for one adult-specific good (e.g., adult’s clothing) is observed. The main weakness of this model is that the possibility of scale economies is completely ignored.

At the same time, a burgeoning literature on household behavioral models has emerged in the last two decades. The collective model suggested by Chiappori (1988) is recognized as the most general approach as it accounts for individual preferences and relies on the sole assumption of efficiency. This assumption, even if not reaching a consensus, is accepted by many economists as reasonable when it comes to repeated decisions in a stable household. The collective model has been adapted in the recent years to account for more realistic features including public goods and domestic production (see Vermeulen, 2002, for a survey). While most of this research has consisted in testing and identifying the model, only the recent papers by Browning, Chiappori and Lewbel (2006, BCL hereafter) and Lewbel and Pendakur (2008, LP hereafter) suggest a way to fully identify the sharing rule, and not just its responses to changes in prices or distribution factors as in the earlier literature. Equally interesting is the fact that these papers account for

\footnote{See also the survey of Browning (1992) on children and the book of Lazear and Michael (1988) on distribution within households; both contain related approaches and important references.}

\footnote{See also the interesting application on elderly couples by Cherchye, De Rock and Vermeulen}
economies of scale, either through a (price) transformation à la Barten (1964) in BCL or using an independence of base assumption in LP that allows achieving identification without price variation. However, these two papers focus on childless couples. More generally, the literature on structural household models seldom accounts for children. Research on collective models has so far treated children as household public goods (Blundell et al., 2005); the sole exception, to our knowledge, is Bourguignon (1999).

In this paper, we estimate a collective model for childless couples and couples with (young) children which accounts for economies of scale in the household. We recover the share of total income accruing to the mother, the father and the child. We focus on families with young children for whom the assumption that children do not have any decision-making power is reasonable.\(^3\) Therefore, the resource share accruing to children in this setting can be equally interpreted as the cost of children for (benevolent) parents.

Interestingly, this paper is at the intersection of the Rothbarth approach to measure the cost of children, as formalized in Gronau (1991), and the approach of LP to measure scale economies and the sharing rule in a household. In BCL and LP, the identification of resource shares and scale economies in childless couples relies on the assumption that household demands differ from those of single individuals only because of (some) jointness of consumption and sharing within the household. This way, information on individual preferences can be retrieved from observations of single individuals.\(^4\) Accounting for children additionally requires that some

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\(^3\)In fact, these children may have power, but it is impossible to identify their weight from parents’ altruism. Moreover, these children cannot work so that there is no distribution factor that can be used to proceed with such identification. This is not a problem as we are primarily interested by the resource share rule – and not so much by the Pareto weight attached to the utility of these children in a centralized collective model. Note also that Dauphin et al. (2008) provide some tests of the collective model with children above 16, for whom they obtain distribution factors. Indeed, children above 16 can start working a significant number of hours and thus can make credible the threat to leave the house.

\(^4\)The idea of using single data is not new. Older demand systems such as Barten (1964),
goods are exclusively consumed by adults, as recalled above. The advantage of LP’s approach is that it requires only the estimation of household and individual Engel curves on cross-sectional data, i.e. it does not require price variation and the estimation of a full demand system as in BCL. We then present an empirical application with data from Ireland. This country is well adapted for our purpose. Indeed, there is little spatial variation in prices, contrary to large countries like Canada or the US, and only three cross-sections are available over the past twenty years so that time variation in prices may also be limited.

In Section 2, we present the model and discuss identification issues. Section 3 describes the empirical implementation and data selection. Section 4 reports the results and section 5 concludes.

2 The Model

We examine the behavior of a family consisting of one or several persons (e.g., a single or a couple with or without children). The size of the family is equal to \( n \).

The type of family (i.e., its demographic structure) can be completely characterized by its size. For instance, if \( n = 1 \), the family is a "single family"; if \( n = 2 \), the family is a "couple without children"; if \( n = 3 \), the family is a "couple with one child"; and so on.\(^5\) Superscript \( k = 1, \ldots, K \) denotes goods while individuals are indexed by subscript \( j \). By convention, we suppose that \( j = 1 \) is a male and \( j = 2 \) is a female, while \( j \geq 3 \) corresponds to children.

The log total expenditure in a household is denoted by \( x \). We assume that total expenditure \( \exp(x) \) is divided between household members according to some

Gorman (1976), and Lewbel (1985), and more recent specifications such as shape invariance (e.g. Pendakur, 1999) model how demands vary across households of different sizes and exploit data from both single individuals and couples to jointly identify parameters that are common to both, as well as identify parameters that characterize the differences between the two. The use of single data to identify some couple’s parameters can also be found in labor supply models, including Barmby and Smith (2001), Laisney (2002) and Bargain et al. (2004). The first estimation of a collective model using information from singles is to be found in Couprie (2006).

\(^5\)The case of single persons with children is thus excluded from our analysis.
rule. Precisely, individual $j$ living in household $n$ receives a resource share $\eta_{j,n}$ of total expenditure $\exp(x)$. Clearly, the shares of all members sum up to unity, i.e. $\sum_{j=1}^{n} \eta_{j,n} = 1$. We assume that multi-person households ($n > 1$) are characterized by economies of scale (due to the sharing and jointness of consumption in the household) of a Barten (1964) type, as described below.

The "basic" budget share of individual $j$ for good $k$ is denoted $w_{j}^k$; that is, if person $j$ is living alone, he/she spends the fraction $w_{j}^k$ of total expenditure $\exp(x)$ on good $k$. If he/she is living with other persons (parents, children or spouse), his/her "basic" budget share functions change in a way that we describe in detail in what follows. The share spent by household $n$ on good $k$ is denoted by $W_{n}^k$. Similar notations are used hereafter to represent budget share functions, whose determinants are specified as we go along.

Our demonstration proceeds in three steps. We first recall the main ideas of BCL and LP in a first sub-section where we temporarily introduce prices. While we do not require price variation in our model, notations with prices are simply used to interpret the components of the model. Then we present the main model in a setting without price variation, i.e. relying solely on individual and household Engel curves for identification. Finally, we discuss the identification of the model.

2.1 Scale Economies, Indifference Scales and Independence of Base

With price variation, Barten (1964) economies of scale on the consumption of good $k$ correspond to a coefficient $\alpha_k$ that reflects the degree of "publicness" of that good within the household. For instance, suppose that a couple ride together in a car half the time the car is in use, then total consumption of petrol is $3/2$ the purchased quantity. This is perfectly equivalent to saying that each family member faces a log shadow wage $\alpha_k + p_k$ rather than the log market price $p_k$ for that good, with $\exp(\alpha_k) = 2/3$. Barten parameters $\exp(\alpha_k)$ are normally comprised between a half (purely public good) and one (purely private good) for a couple. Hereafter, denote $p$ the vector of log prices and $\alpha$ the vector of log Barten parameters.
Denote $\phi_j$ the log total expenditure of individual $j$. That is, if this person is living alone ($n = 1$), then $\phi_j = x$. If that person lives in a multi-person household of size $n > 1$, then $\phi_j = \log \eta_{j,n} + x$ (i.e. her individual expenditure corresponds to household resources accruing to this person). Let $V_j(p, \phi_j)$ denote an ordinal indirect utility function describing the preferences of individual $j$. BCL define an indifference scale $I_j$ as the solution to:

$$V_j(p, \log I_j + x) = V_j(\alpha + p, \log \eta_{j,n} + x).$$

(1)

That is, if person $j$ is living alone (facing log market prices $p$) but is given total expenditure $\exp(x)$ multiplied by the indifference scale $I_j$, then he/she can achieve the same utility level as if living in a multi-person household, facing log shadow prices $\alpha + p$ and receiving a share $\eta_{j,n}$ of total household expenditure $\exp(x)$. Indifference scales differ from ordinary household equivalence scales (see Lewbel 1997) in that the former attempt to compare the utility of an individual to the utility of a household, and so suffer from the identification problems associated with interpersonal comparisons. In contrast, indifference scales compare the same individual in two different situations, namely living alone, and facing market prices, versus living in a household, consuming his/her share of total resources and benefiting from scale economies. Consequently, they can be identified from revealed preference data as shown in BCL.

We now exploit the Independence of Base (IB) assumption, as suggested by LP to simplify the BCL model. For each person $j$ living in a household of type $n > 1$, we assume that there exists a scalar-valued function $s_{j,n}(\alpha, p)$ such that the indifference curves of individual $j$ and the Barten parameters satisfy the condition:

$$V_j(\alpha + p, \phi_j) = V_j(p, \phi_j - \log s_{j,n}(\alpha, p))$$

(2)

for any level of log individual expenditure $\phi_j$. Equation (2) supposes that price changes, due to Barten scale-economies parameters, can be summarized by a simple income effect, represented by the multiplicative term $s_{j,n}(\alpha, p)$. The latter simply measures the cost savings experienced by person $j$ resulting from scale economies in
the household.\textsuperscript{6} This assumption is similar to the IB restriction in the equivalence scale literature, even if less restrictive,\textsuperscript{7} and refers to the fact that scale economies are assumed to be independent of the base expenditure (and hence utility) level at which they are evaluated.

Applying Roy’s identity to equation (2), it is easy to show that individual \(j\)’s budget share function on good \(k\) can be written:

\[
\omega_{j,n}(\alpha + \mathbf{p}, \phi_j) = d_{j,n}^k(\alpha, \mathbf{p}) + w_{j}^k(\mathbf{p}, \phi_j - \log s_{j,n}(\alpha, \mathbf{p}))
\]

(3)

where

\[
d_j^k(\alpha, \mathbf{p}) = \frac{\partial \log s_{j,n}(\alpha, \mathbf{p})}{\partial p^k}
\]

is the elasticity of \(s_{j,n}\) with respect to the \(k\)-th price. The consequence of the IB assumption is that the budget share functions of person \(j\) when living in a household differ from when alone only in that they are translated over log individual resources \(\phi_j\) by \(\log s_{j,n}\) and over each \(w_{j}^k\) by \(d_{j,n}^k\).\textsuperscript{8}

\[2.2\] Individual and Household Engel Curves

We have all the ingredients to finalize our model presentation. We suppose that we observe data in a unique price regime: both \(\mathbf{p}\) and \(\alpha\) are vectors of constants and can be taken out of equation (3). However, although the scale economies do not

\textsuperscript{6}This is a joint restriction on the behavior of the individual and the household, because it involves the individual’s utility function \(V_j\) and the household’s scale economy parameters \(\alpha\). The scaling factor \(s_j(\alpha, \mathbf{p})\) can be interpreted as the true cost-of-living index for person \(j\) associated with the change from (log) market prices \(\mathbf{p}\) to within-household log shadow prices \(\alpha + \mathbf{p}\).

\textsuperscript{7}Indeed, whereas this previous literature restricts how indirect utility responds to changes in demographic characteristics, equation (2) only restricts how an individual’s indirect utility responds to the changes in the price vector resulting from economies of scale. Moreover, the former is untestable while the latter can in principle be tested. See Lewbel (1989), Blundell and Lewbel (1991), Pendakur (1999), Blackorby and Donaldson (1993), Blundell, Duncan and Pendakur (1998).

\textsuperscript{8}Naturally the level of individual resources \(\phi_j\) will also differ because of resource sharing, but this is independent from the restriction that is being made here.
depend on the base expenditure, they may nonetheless vary with the demographic structure of the household. So we should replace \( \alpha \) by household socio-demographic variables in (3). We can also replace \( \phi_j \) by its expression \( x + \log \eta_{j,n} \) for person \( j \) living in household \( n \). We do so by reformulating the IB assumption in the framework with no price variation.

A.1. *The individual preferences and the household technology satisfy the IB assumption, that is,*

\[
\omega_{j,n}^k (x + \log \eta_{j,n}(z), z) = d_{j,n}^k (z_j) + w_j^k (x - \log I_{j,n}(z), z_j),
\]

*where \( \log I_{j,n}(z) = \log s_{j,n}(z_j) - \log \eta_{j,n}(z) \) is the log deflator of total expenditure which combines the scaling effect \( s_{j,n} \) and resource sharing \( \eta_{j,n} \).*

The deflator function \( I_{j,n}(z) \) can be interpreted as an indifference scale as defined above, that is, the fraction of total expenditure that must be given to person \( j \) to keep his/her level of utility unaffected when he/she lives in a household of a different type (by comparison to a type of reference). Yet the household technology depends on the demographic structure of the household.

The left-hand side of equation (4) represents the ‘unconstrained’ budget share of person \( j \) on good \( k \) as a function of his/her individual resources \( x + \log \eta_{j,n} \) and a vector of household characteristics \( z \). The right-hand side puts a bit more structure thanks to the IB restriction. The individual budget share function \( w_j^k \) depends on person \( j \)’s individual resources multiplied by the scaling factor \( s_{j,n} \) and on individual-specific characteristics \( z_j \). This share is also translated by the price elasticity of scale economies. The scaling effect \( s_{j,n} \), and subsequently its price elasticity \( d_{j,n}^k \), depend on individual characteristics \( z_j \). The resource share \( \eta_{j,n} \) depends on the vector of household characteristics \( z \), which nests the individual characteristics \( z_j \) of all members \( j \) and may also incorporate other variables that govern the resource sharing rule in the household (i.e. bargaining factors or distribution factors, cf. Browning et al., 1994).

As can be seen in (4), the IB assumption simplifies the representation of the demographic heterogeneity; it will also allows the identification of the main com-
ponents of the model. Importantly in this respect, we can notice that the central element in (4) is the "basic" budget share function $w^k_j(\cdot, z_j)$, that is, the share of good $k$ chosen by an individual $j$ endowed with characteristics $z_j$. This function is identical for single individuals or adults in multi-person households. For an adult living with other family members, his/her "basic" budget share function is simply affected by resource sharing and scale economies in the household. It is therefore possible to retrieve the "basic" share function using estimates from single individuals; the identification of the other components is discussed in the next sub-section. Importantly here, differences between an individual’s bundle of goods consumed as a single versus within a household are assumed to be due to partially joint consumption, resource sharing, and to changes in total resources, but are not attributed to taste change. Accepting this assumption and identifying the model go hand in hand: if we accept this assumption, the identification is possible, as shown below. As explained in BCL and LP, the assumption is necessary to make possible the comparison of individuals living in different households (see also Gronau, 1988).9

The standard assumption made in the literature on collective models is that household decisions are efficient (cf. Vermeulen, 2000). That is, if there is separability between individual consumption vectors (i.e. no externalities or public goods), the decision-making process can be represented as if each member chose her optimal consumption bundle by maximizing her own utility subject to her budget constraint. The separability assumption is absolutely crucial but relatively standard in the literature.10 The collective model is very general since the negotiation process that determines resource sharing remains unspecified. The budget of each member $j$ corresponds to the resource $\eta_{j,n}(z) \exp(x)$.

9BCL show that taste change and economies of scale affect couple’s demands in exactly the same way; they suggest ways to differentiate them, in particular by using goods which are known to be purely private (for which there cannot be scale economies but only taste change).

10The separability assumption is used by Gronau (1991) in his measure of the cost of children, and also discussed in Gronau (1988). It is also used in most of the papers using collective models, since identification relies on two-stage budgeting (i.e. a sharing rule interpretation).

11Notice the implicit identifying assumption that shares $\eta$ do not depend on (log) total expen-
expenditures on good $k$ being simply the sum of individual expenditures on that good, efficiency results in a simple expression of the household budget share for good $k$:

$$W_n^k(x, z) = \sum_{j=1}^n \eta_{j,n}(z) \omega_{j,n}^k (x + \log \eta_{j,n}(z), z). \quad (5)$$

Using (4), it can be written as:

$$W_n^k(x, z) = \sum_{j=1}^n \eta_{j,n}(z) \left[ d_{j,n}^k(z_j) + w_j^k (x - \log I_{j,n}(z), z_j) \right]. \quad (6)$$

Thus, household budget shares are weighted averages of individual budget shares translated both in budget shares and log-expenditure. As previously described, the translations are meaningful model parameters: translations in log-expenditure are individual indifference scales; translation in budget shares are scales economy price elasticities.

### 2.3 Identification

Our goal is to identify the resources shares $\eta$ and the indifference scales $\log I$ from demand data. Hereafter we add error terms to the household budget shares previously defined. To begin with, it is natural to use single individuals as the demographic structure of reference. In the case of single life, there is neither sharing nor scale economies, that is,

$$\eta_{j,1}(z) = 1, \quad d_{j,1}^k(z_j) = 0, \quad s_{j,1}(z_j) = 1$$

for single men ($j = 1$) or single women ($j = 2$), so that the budget share functions of a single household for all goods $k = 1, \ldots, K$ boil down to:

$$W_1^k(x, z) = w_j^k (x, z_j) + \varepsilon_1^k. \quad (7)$$

These equations can be identified from well-known results in non-parametric econometrics. Note that the additivity of the error term on the right-hand-side makes expenditure $x$. However, it is possible to make it vary with household income in empirical applications.
things simpler because, in that case, identifying the budget share function is analogous to identifying its conditional expectation function.

To identify the other components of budget share equations in the case of multiperson households, we proceed sequentially and first consider the case of a childless couple \((n = 2)\). The household share functions can be written as:

\[
W^k_2(x, z) = \sum_{j=1}^{2} \eta_{j,2}(z) \left[ d^k_{j,2}(z) + w^k_j (x - \log I_{j,2}(z), z_j) \right] + \varepsilon^k_2.
\]

The identification of the household technology and the shares of income can be obtained by various techniques. We shall present here one of them. To eliminate the constant \(d^k_{j,2}(z_j)\), we compute the first order derivative of this expression with respect to \(x\) and obtain:

\[
\nabla_x W^k_2(x, z) = \sum_{j=1}^{2} \eta_{j,2}(z) \nabla_x w^k_j (x - \log I_{j,2}(z), z_j),
\]

where the left-hand-side of this expression is identified on the data. This equation generically defines the functions \(\eta_{1,2}(z)\) and \(I_{j,2}(z)\) with \(j = 1, 2\), while \(\eta_{2,2}(z)\) is simply calculated as \(1 - \eta_{1,2}(z)\). To show this, let us consider a set of observations \(\{(x_T, z_T)\}\) such that \(x_T\) varies within its domain and \(z_T\) is maintained constant and equal to some arbitrary value \(z\). There are three unknowns and, for each observation, there is one equation:

\[
\nabla_x W^k_2(x_T, z) = \sum_{j=1}^{2} \eta_{j,2}(z) \nabla_x w^k_j (x_T - \log I_{j,2}(z), z_j).
\]

Then, under weak regularity conditions, the system of equations obtained from three observations defines the values \(\eta_{1,2}(z)\) and \(\log I_{j,2}(z)\) \((j = 1, 2)\) for any arbitrary value \(z\). Once these functions are recovered, the constant can be identified from:

\[
\sum_{j=1}^{2} \eta_{j,2}(z) d^k_{j,2}(z_j) = W^k_2(x, z) - \sum_{j=1}^{2} \eta_{j,2}(z) w^k_j (x - \log I_{j,2}(z), z_j),
\]

which identifies the left-hand-side. This result is similar (even if the proof is slightly different) to the identification result given by LP.\(^{12}\)

\(^{12}\)Note that the functions \(d^k_{j,2}(z_j)\) can be separately identified if distribution factors enter the
In a further step, we consider the case of a couple with one child \( (n = 3) \). The budget share functions can then be written as:

\[
W_{3}^{k}(x, z) = \sum_{j=1}^{3} \eta_{j,3}(z) \left[ d_{j,3}^{k}(z_{j}) + w_{j}^{k} (x - \log I_{j,3}(z_{j})) \right] + \varepsilon_{3}^{k}.
\]

Here, one problem is that the budget share functions of the child cannot be directly identified from observations of single individuals, as it was the case for male and female adults’ budget share functions. Clearly, children below 16 do not live alone. Therefore, the equivalence scale terms, \( d_{3,3}^{k}(z_{j}) \) and \( s_{3,3}(z) \), cannot be distinguished from the budget share functions since they represent the adjustment to the "basic" budget share functions required for a child with two parents by comparison to a child that would live alone.\(^\text{13}\) Thus, without loss of generality, we can normalize the scale functions, that is:

\[
d_{3,3}^{k}(z_{3}) = 0, \quad s_{3,3}(z_{3}) = 1.
\]

To show how the functions \( \log I_{j,3}(z) \) and \( \eta_{j,3}(z) \), with \( j = 1, 2, 3 \), can be identified, we use the following additional assumption.

**A.2.** There exists at least one exclusive good for adults, that is, a good which is consumed by parents but not by children.

The concept of adult-specific goods plays a major role in a well-known method used to measure the cost of children and referred to as the Rothbarth method.\(^\text{11}\) The separate identification of these terms is not really a matter of concern. Interpreted as the price elasticities of scale economies, their role is not crucial in the analysis. The main component of interest, as far as scale economies are concerned, is the deflator \( s_{j,N}(z_{j}) \) (or equivalently the indifference scale \( I_{j,N}(z) \)).

\(^\text{13}\)In a similar way as we can identify adult preferences only because we accept the assumption that basic preferences of adults do not change with marriage, we cannot identify the equivalence scale terms for children because those are meaningless concepts in a world where young children do not live alone. Thus potential scale economies for children are implicitly incorporated in preferences (just as it is for adults in models where scale economies are not explicitly modeled).
(see Lewbel, 1997, for a survey, and Gronau, 1991, for a formal exposition and an empirical application). To illustrate this, let us suppose that good \( j \) is an adult-specific good. The household budget share function for this good is then equal to:

\[
W_j^j(x, z) = \sum_{j=1}^{2} \eta_{j,3}(z) \left[ d_j^j(z_j) + w_j^j(x - \log I_{j,3}(z_j), z_j) \right] + \varepsilon_j^j.
\]

The functions \( I_{j,3}(z) \) and \( \eta_{j,3}(z) \) can be identified according to the previous methodology. The equation above is derived with respect to \( x \) to eliminate \( d_j^j(z_j) \) and the functions \( \eta_{j,3}(z) \) and \( I_{j,3}(z) \) for \( j = 1, 2 \) can be identified from a set of observations. The resource share of the child can be obtained as follows:

\[
\eta_{3,3}(z) = 1 - \sum_{j=1}^{2} \eta_{j,3}(z)
\]

Then, the knowledge of the resource share of the child allows us to identify his/her budget share functions up to an additive function. Indeed, if we differentiate the budget share function of good \( k \) with respect to \( x \), provided that this good is consumed by both parents and children, we obtain:

\[

\nabla_x W_k^3(x, z) = \sum_{j=1}^{3} \eta_{j,3}(z) \left[ \nabla_x w_j^k(x - \log I_{j,3}(z), z_j) \right].
\]

Since \( \eta_{j,3}(z) \) and \( I_{j,3}(z) \) are well defined for \( j = 1, 2, 3 \), this equation identifies the slope of the child’s budget share function, that is, \( \nabla_x w_3^k(x + \log \eta_{3,3}(z), z_3) \). From this, the child’s budget share function can be retrieved up to a function \( d_k^{3,3}(z_3) \), which has been set equal to zero without loss of generality.

In the general case where there are two children or more living in the family, the identification of the scale parameters and the resource shares can be achieved by the previous argument from the following system of equations:

\[

\nabla_x w_n^k(x_T, z) = \sum_{j=1}^{n} \eta_{j,n}(z) \nabla_x w_j^k(x_T - \log I_{j,n}(z), z_j),
\]

provided that an additional assumption is made.
A.3 Two children with the same characteristics $z_j$, whatever their sibling rank may be, have the same utility functions.

With this assumption, budget share functions $w^k_j(\cdot, z_j)$ are identical for all children $j \geq 3$. It implies that all the budget share functions can be identified from couples with one child and used in the expression above to identify the functions $\eta_{j,n}(z)$ and $\log I_{j,n}(z)$ under weak regularity conditions. In the empirical sections, we focus solely on families with at most one child and keep this extension for future applications.

3 Empirical Implementation

3.1 Functional Form and Estimation Method

We suggest a parameterization that balances flexibility and empirical tractability. Since budget shares sum up to one, equations for good $K$ are unnecessary. As said above, we focus on single individuals, childless couples and couples with one child only ($n = 1, 2, 3$ respectively). The first component, which appears in the specification of the different demographic groups, is the "basic" budget share function. For adults, we consider the following functional form:

$$w^k_j(\phi, z_j) = a_j^{k0} + a_j^k z_j + (\phi - e_j^t z_j)b_j^k + (\phi - e_j^t z_j)^2 c_j^k$$

for $j = 1, 2$ and $k = 1, \ldots, K-1$, for a given level of log individual expenditures $\phi$ (equal to $x$ for a single $n = 1$ and to $x - I_{j,n}(z)$ for adult $j$ in a family $n = 2, 3$), with parameters $a_j^{k0}, b_j^k, c_j^k$ and vectors $a_j^k$ and $e_j$. The vectors of adult characteristics $z_1$ and $z_2$ include age ("above 35" dummy), education ("tertiary education" dummy), and dummies for car ownership and urban. The parameters are gender specific (i.e. are indexed $j = 1$ for men and $j = 2$ for women) but do not depend on the demographic type $n$, e.g. the "basic" budget share functions are the same for single women and for women living in a couple. For children, the vector $z_3$ includes a gender dummy in order to differentiate the cost of boys and girls; it could also reflect differences in
children’s age – but in the current application, we focus on the group of children aged 0-4 so that age variables have not been included.

We now turn to the specification of the household budget share functions. Those of single male and female adults are the easiest since they coincide with the "basic" budget share functions, as formally stated in equation (7). For multi-person households $n \geq 2$, the household budget share functions:

$$W^k_n(x, z) = \sum_{j=1}^{n} \eta_{j,n}(z) \left[ a^k_{j,n}(z_j) + w^k_j(x - \log L_{j,n}(z), z_j) \right] + \varepsilon^k_n,$$

comprise the individual functions $w^k_j$ as already specified (recall that for wives and husbands, the parameters of these functions are the same as for single females and males respectively) and three other components.

For the resource shares to be comprised between zero and one, we adopt the following logistic form, that is,

$$\eta_{j,n}(z) = \frac{\exp(\varphi'_{j,n}z)}{\sum_{j=1}^{n} \exp(\varphi'_{j,n}z)},$$

where $\varphi'_{j,n}$ is a vector of parameters. The parameters of one individual (say individual 1) are set to zero for normalization. Vector $z$ includes the sets of individual characteristics $z_j$ for $j = 1, \ldots, n$ plus distribution factors. For the latter, we simply include the wage ratio, i.e. the ratio of wife’s over husband’s earnings expressed in full-time equivalent (as explained below, we restrict our sample to household where all adults are in work).\(^{14}\)

The log scale function that translates expenditure within the basic budget shares can be written as:

$$\log s_{j,n}(z_j) = \sigma^0_{j,n} + \sigma'_{j,n}z_j,$$

where $\sigma_{j,n}$ is a vector of parameters. In principle, it can vary with all the variables used in preferences (vector $z_j$).

\(^{14}\)We could also include the difference in spouses’ education level (schooling years) or age. Since education and age are already in the $z_j$ vector of adults, then vector $z$ automatically accounts for these differences – even if only through age and education dummies.
The scale function that translates the basic budget shares \( d_{j,n}^k(z_j) \) is a price 
elasticity. Price effects are typically difficult to measure, so it is all the more 
difficult to conceive that demographic effects can be captured in any plausible way. 
Therefore we restrict these terms to be constant, that is,

\[
d_{j,n}^k(z_j) = d_{j,n}^{0k}.
\]

We estimate simultaneously the household budget share functions for \( K - 1 \) 
goods and for the three demographic groups. The complete model is estimated 
by the iterated SURE method. The first variant of the model presented hereafter 
(model A) imposes some exclusion restrictions on the demographic variables while 
model B is the complete model; model C is similar to Gronau (1991), that is, a 
structural Rothbarth approach without scale economies. Finally, the last model 
(variant D) accounts for the likely correlation between the error terms \( \varepsilon_n^k \) in each 
budget share function and the log total expenditure by augmenting the specification 
with the errors \( \hat{\nu}_{n,x} \) and \( \hat{\nu}_{n,x^2} \) from reduced form estimations of \( x \) and \( x^2 \) respectively 
on all exogenous variables used in the model plus some instruments (See Blundell 
and Robin, 1999, 2000, Banks et al, 1997). For the latter, we choose log household 
gross income and its square, but find high sensitivity to the choice of instruments, 
in a similar way as in GMM estimations.

3.2 Data

Our sample is drawn from the 2005 Irish Household Budget Survey (HBS). This 
data is gathered from the third quarter 2004 to the end of 2005, but only little 
price variation is witnessed over this period so that the HBS sample can be treated 
as cross-sectional data. We estimate the system of budget shares for \( K = 9 \) non-
durable commodities: food, vice goods (alcohol and tobacco), male and female 
clothing, transport, leisure, personal goods and services, household operation and 
a composite child good (child clothing and pocket money); the omitted good is
housing costs (rent, observed for tenant or predicted for owners of their dwelling).\textsuperscript{15}

The initial survey is composed of 6,884 households. We select households where adults are aged 25-64, which restricts the initial sample by 30\%. We only keep those comprising a childless single man or woman, childless married couples and married couples with at most three children aged 0-16; in all cases, we discard observations where other household members (relatives or not) are present. This restricts the initial sample by another 27\%. Since leisure is not modeled here, but is likely endogenous to consumption (and savings) decisions, we restrict our sample to working women and full-time working men. This discards another 19\% of the original sample, essentially because of a rather low female participation rate in Ireland. At this stage, we have a selection of 1,642 observations. We exclude temporarily couples with two and three children, as well as those with children above 5. Their inclusion in the analysis is kept for future research. The final sample is composed of 1,023 observations and is described in Table 1.\textsuperscript{16}

\section*{4 Empirical Results}

Table 2 reports the estimated economies of scale $s_{j,n}(\mathbf{z}_j)$ for $j = 1, 2$ and resource shares $\eta_{j,n}(\mathbf{z})$ for $j = 2, 3$ evaluated at the sample mean, as well as their standard errors.\textsuperscript{17} Barten scale economies for a particular good should lie between 0.5 (com-

\textsuperscript{15}In the original data, a marginal proportion of single women reports nonzero expenditures on male clothing. In order to treat clothing as an assignable good, these expenditures are set to zero. The same is done for expenditures on female clothing by single men and expenditures on children by childless households.

\textsuperscript{16}To increase the sample size, it is tempting to pool data of other years available for the HBS (for instance 1999), as done by LP. However, even if it is possible to express all expenditures in 2005 euro using price adjustment for each specific good, price variation over time may lead to differences in consumption behaviors so that the two groups (2005 and 1999) are not really comparable. It may also be the case that the definitions of some goods change over time – but this is a less acute problem insofar as we pool expenditures at a high level of aggregation.

\textsuperscript{17}Estimates for the hundreds of parameters of the model, comprising the coefficients of the basic budget share functions for each good and each variant of the model, are available upon request to the authors.
Table 1: Descriptive statistics

<table>
<thead>
<tr>
<th></th>
<th>Single women</th>
<th>Single men</th>
<th>Childless couples</th>
<th>Couples &amp; 1 child</th>
<th>Couples &amp; 2 children</th>
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<td>Age (head)</td>
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<td>42.4</td>
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<td>Living in city</td>
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<td>(0.32)</td>
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<td>Have a car</td>
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<td>(0.38)</td>
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<td>(0.18)</td>
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<tr>
<td>Wage ratio (wf/wm)</td>
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<td>n.a.</td>
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<tr>
<td>Total expenditure (EUR/week)</td>
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<td>(327)</td>
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<td>Budget shares</td>
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<td>(0.08)</td>
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<td>Vices</td>
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<tr>
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<td>(0.05)</td>
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<td>(0.04)</td>
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<tr>
<td>Child’s clothing</td>
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<td>0.03</td>
</tr>
<tr>
<td></td>
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<td>(0.00)</td>
<td>(0.00)</td>
<td>(0.02)</td>
<td>(0.03)</td>
</tr>
<tr>
<td>Transport</td>
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<td>(0.10)</td>
<td>(0.08)</td>
<td>(0.08)</td>
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<td>Leisure</td>
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<td>(0.11)</td>
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<tr>
<td>Household operations</td>
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<td>(0.07)</td>
<td>(0.05)</td>
</tr>
<tr>
<td>Pers. goods &amp; services</td>
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<tr>
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<td>(0.03)</td>
<td>(0.05)</td>
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<td>Housing</td>
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<td>(0.06)</td>
<td>(0.03)</td>
<td>(0.03)</td>
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<tr>
<td>Sample size</td>
<td>213</td>
<td>191</td>
<td>369</td>
<td>250</td>
<td>343</td>
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</table>

*Standard deviation are in brackets.*
plete jointness of consumption for that good) and 1 (purely private consumption) in a couple. In the same way, .5 and 1 should be natural lower and upper bounds for the deflators $s_{j,n}$, if the latter are to be interpreted as scale economies in a couple. This is due to our assumption that changes in consumption behavior between single life and married life are attributed solely to (some) jointness of consumption and resource sharing.\footnote{These deflators may naturally reflect other aspects which are not accounted for in the model, such as a change in the nature (quality) of purchased goods when married compared to when single, changes in preferences, the presence of pure public goods or externalities of consumption. See BCL and LP for extensive discussions on this point.} A deflator of .75 would mean that shadow prices faced by an adult in couple are associated with a cost-of-living index that is 75% of the costs for the same individual, should she live alone and face market prices.

We first consider results for childless couples. Reassuringly, point estimates reported in Table 2 are reasonable in magnitude, all located in the $0.5 - 1$ range with only one exception (males in model D). Yet, parameters are very imprecisely estimated and results are fairly sensitive to the specification.\footnote{Note that the standard errors reported in the Table are not so informative since they are nonlinear (exponential) transformation of the original coefficients.} We have experimented more specifications than those reported here, including different instruments in model D;\footnote{Detailed results available upon request to the authors. To vary instruments in the first stage estimation of log expenditure, we have replaced household gross income by disposable income, and tried cubic specifications rather than quadratic ones.} overall, we find that point estimates give scale economies between $0.43$ and $0.76$ for men and between $0.53$ and $0.66$ for women. These results correspond to slightly smaller deflators, and hence slightly larger scale economies, than those reported in LP (between $0.74$ and $0.86$ for men and $0.53$ and $0.79$ for women over the different models in LP). However, LP also report large standard errors for the log deflators, of similar magnitude as what we find here. Considering the size of the standard errors, neither study nor model specification can reject that deflators lie in the $0.5 - 1$ range.

Turning to estimates for couples with one young child gives similar results, with scale economies between $0.53$ and $0.84$ for men and $0.48$ and $0.73$ for women over all
the models that we have experimented. One would expect that scale economies increase (i.e. that deflators decrease) in families compared to childless couples. This is what we find for most of the specifications reported in Table 2, with the exception of males in models B and D. However, standard errors are even larger than in the case of childless couples – due to the more difficult identification of the model with children – so that it is impossible to conclude in either way.

The estimates of the resource shares $\eta$ are more precisely estimated. For childless couples, the wife’s resource share ranges from .51 to .63 across models with a standard error around .07 (BCL report a female share in excess of .60 while LP report a female share between .36 an .46 with a standard error of .08). The effect of demographic variables on the sharing rule was also investigated but the sign and significance of the coefficients on age and education vary when we introduce the correction for endogeneity in model D. The only stable result is that higher male education plays in favor of a larger resource share for men.

The shares of children – interpreted as the cost of children – is relatively stable across specifications without endogeneity correction. We find in this case an average share around 20%, with no significant difference between boys and girls. Model C is a simpler variant with no scale economies, which results in slightly more precise estimates of the remaining coefficients and in particular of the sharing rule. In the latter model, point estimates of children’s shares are 16.5% for boys and 17.5% for girls. In model D, where endogeneity of total expenditure is controlled for, we find a significantly larger share for boys. Interestingly, the wage ratio, i.e. the ratio of female to male wages, plays positively on the share of children and negatively on the share of husbands. This is a systematic result in all the specifications we have experimented, but the latter effect is rarely significant while the former effect is significant in all the variants of model D (i.e. when using different instruments to control for endogeneity).

As mentioned above, we find more instability in the parameter estimates when endogeneity is accounted for. As reported in Table 2, we can see for instance that the much smaller share for men in model D, compared to models A-C, is
compensated by larger scale economies. This type of substitution is more or less strong depending on the instruments at use. It is possible that the identification of the model is made more complicated when the residuals of a first-stage estimation are included, since they enter linearly in the household budget share functions and are possibly muddled up with the different constants of the model (preferences and scale economies). Further research should determine whether there is a more relevant location in the model for these correction terms.

Finally, note that we can compute indifference scales, that is, the scale to household income that puts a single individual on the same indifference curve that he/she would attain if in a couple. Indifference scales are equal to the scale economy measure divided by the resource share. At the sample means and for model B, the indifference scale of a women with a girl is $\frac{.56}{.44} = 1.24$. This implies that such a women, if she were living alone, would need approximately 80% of the couple’s income to reach the same indifference curve, and hence the same standard of living, that she attains as a family member. The indifference scales for women with a girl (resp. boy) stand between 1.04 and 1.24 (resp. 1.10 and 1.27) depending on the model at use – either A, B or D – while it is between 1.68 and 1.83 (resp. 1.71 and 1.86) for men. Interestingly, if we compare the indifference scale of adults with or without children, for instance for model B, we find that a woman (resp. man) in a childless couple needs 90% (resp. 71%) of total expenditure to be as well off when single, while a woman (resp. man) in a couple with a little boy needs only 79% (resp. 56%). That is, the presence of the boy has increased the resources available to adults by 11 percentage points of total expenditures for women (and 15 points for men) thanks to increased scale economies, i.e. the fact that part of the child consumption is joint. As a result, part of the cost of children (around 20% of total expenditure) is compensated by this gain – children do not cost that much.\footnote{The interpretation of model C is different; the resource shares for adults measure directly their (money-metric) utility. In this model, there is no scale economy and woman (resp. man) alone would need only 45% (38%) of the couple’s income to reach the same indifference curve.} While traditional equivalence scales do not allow separating the potential effect of child costs of fertility from the question of child welfare, the present framework does
indeed identify specifically the resource allocated to children (and child welfare) and how adult net resources vary with the presence of children.

Table 3 gives a few elements of comparison with the previous survey of Garvey (2007) on the cost of children in Ireland, based on older household surveys and using traditional Engel and Rothbarth methods. For comparison purpose, we first look at the results of model C, which corresponds to Gronau (1991)’s structural version of the Rothbarth approach. Garvey (2007) documents a larger cost of children in urban areas and a larger cost for boys compared to girls. We find no evidence of that sort, and in particular no difference between boys and girls except when accounting for endogeneity, as explained above.

To look at possible variations in the cost of children along the distribution of household income, we make use of a variant C+ where the sharing rule varies quadratically with household gross income (results are very similar when it is replaced by household disposable income). With this model, we find slightly larger (smaller) costs for girls (boys) at the median compared to Garvey (2007)’s application of the Rothbarth approach; yet, with standard errors around .04, we cannot reject that results are similar. Yet, the comparison is hindered by the fact that we focus on in-work households. The same type of variant for model B, namely B+, gives similar results. We consistently find that the relative cost of children increases with the income decile and that the share-income pattern is convex, i.e. the cost increases more between the median and the 75th decile than between the 25th decile and the median. If the cost of children coincides with the share of resources accruing to children, i.e. the interpretation retained in this paper, this could mean that the dispersion in ‘child resources’ is larger than that in household income. Suppose that we measure financial child poverty in relative terms, that is, as a proportion of children whose resources are below, say, 50% of the median of child resources. Then, a larger spread in child resource could signify that some poor children (according to the above definition) live in non-poor families (according to the standard definition). This simple example shows that the present framework offers a great potential to study child poverty (and more specifically the financial
condition of certain household members) in a novel way. Interestingly, such child
poverty measures could be compared or validated against alternative concepts or
measures based on specific surveys about child deprivation (see for instance Cant-
tillon and Nolan, 2001).

5 Conclusion

This paper suggests a measure of the cost of children based on a collective model of
household consumption augmented with jointness in consumption of some goods.
The identification of adult shares and scale economies for adults relies on an Inde-
pendence of Base assumption and on the observation of Engel curves from single
individuals, as in Lewbel and Pendakur (2008). Contrary to Browning, Chiappori
and Lewbel (2008), who also rely on single estimates, this approach allows pursu-
ing the identification strategy without resorting to price variation. As in Gronau
(1991), the share of household resources accruing to children is obtained thanks to
the Rothbarth method, that is, using adult exclusive goods such as clothing.

We conduct the estimation on a pooled sample of single individuals, childless
couples and couples with one child, using cross-sectional data on the expenditures
of Irish household. The econometric identification of the model relies on adult
goods (clothing, and possibly vice goods) and estimates from single individuals,
but is also strengthen by the use of assignable goods (we distinguish male and
female clothing) and the presence of a child good (child clothing). Even though
the estimates of scale economies are very imprecise, we find relatively stable results
for the cost of children.

Further research should attempt to improve identification by imposing some
meaningful constraints – for instance on the bounds of scale economies deflators –
or by using instruments that affect only certain components of the model (preference,
scale economies, sharing rule). The model is also sufficiently general to test
several restrictions on household and individual preferences; on the types of de-

demographic variables that affect scale economies; on distribution factors that may
Table 2: Estimation Results

<table>
<thead>
<tr>
<th>Model</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>men, no child</td>
<td>0.76</td>
<td>0.63</td>
<td>1.00</td>
<td>0.43</td>
</tr>
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<td></td>
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<td>(0.15)</td>
<td>(0.13)</td>
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<tr>
<td>men, 1 child</td>
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<td>(0.17)</td>
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</tr>
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<td>0.61</td>
<td>1.00</td>
<td>0.61</td>
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<td></td>
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<td>(0.13)</td>
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<tr>
<td>women, 1 child</td>
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<td>1.00</td>
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<td>(0.16)</td>
<td>(0.17)</td>
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<tr>
<td>wife's share (no child)</td>
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<td>0.55</td>
<td>0.54</td>
<td>0.63</td>
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<td>(0.07)</td>
<td>(0.06)</td>
<td>(0.04)</td>
<td>(0.07)</td>
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<td>wife's share (with girl)</td>
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<td>0.45</td>
<td>0.45</td>
<td>0.51</td>
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<td>(0.06)</td>
<td>(0.07)</td>
<td>(0.04)</td>
<td>(0.08)</td>
</tr>
<tr>
<td>wife's share (with boy)</td>
<td>0.39</td>
<td>0.44</td>
<td>0.45</td>
<td>0.48</td>
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<td></td>
<td>(0.06)</td>
<td>(0.06)</td>
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<tr>
<td>girl's share</td>
<td>0.22</td>
<td>0.20</td>
<td>0.18</td>
<td>0.18</td>
</tr>
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<td></td>
<td>(0.07)</td>
<td>(0.07)</td>
<td>(0.04)</td>
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<tr>
<td>boy's share</td>
<td>0.20</td>
<td>0.19</td>
<td>0.17</td>
<td>0.23</td>
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<td>(0.06)</td>
<td>(0.06)</td>
<td>(0.04)</td>
<td>(0.08)</td>
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<tr>
<td>Wage ratio on husband's share</td>
<td>-0.066</td>
<td>-0.070</td>
<td>-0.099</td>
<td>-0.012</td>
</tr>
<tr>
<td></td>
<td>(0.047)</td>
<td>(0.050)</td>
<td>(0.063)</td>
<td>(0.013)</td>
</tr>
<tr>
<td>Wage ratio on child's share</td>
<td>0.026</td>
<td>0.030</td>
<td>0.010</td>
<td>0.084 *</td>
</tr>
<tr>
<td></td>
<td>(0.053)</td>
<td>(0.050)</td>
<td>(0.052)</td>
<td>(0.030)</td>
</tr>
<tr>
<td>Girl dummy on child's share</td>
<td>0.157</td>
<td>0.066</td>
<td>0.068</td>
<td>-0.279 *</td>
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<tr>
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<td>(0.110)</td>
<td>(0.090)</td>
<td>(0.088)</td>
<td>(0.127)</td>
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<td>Objective function</td>
<td>8.8041</td>
<td>8.7870</td>
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Model A: dummies for car holders and urbaners in preference translator only
Model B: these dummies included also in preference deflator, scale economies and sharing rule
Model C: same as B but no scale economies (Rothbarth model)
Model D: same as B but with endogeneity of log expenditure allowed for in a quadratic way

Notes: Goods are food, vices, male and female clothing, transport, leisure, pers. goods & serv., household operation and child good (clothing and pocket money); the omitted good is housing; Demographics affecting preferences (i.e. translate and deflate the log expenditure) and scale economies (deflator) are: male and female age and education, a dummy for car ownership and one for urban/rural. Economies of scale and sharing rules are calculated at sample means. Standard errors in brackets.
Table 3: Cost of Children: Comparisons

<table>
<thead>
<tr>
<th>Table 3: Cost of Children: Comparisons</th>
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<tr>
<td>Results from Garvey (2007)</td>
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<tr>
<td>Engel</td>
</tr>
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<td>Model B</td>
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<tr>
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<td>Model B</td>
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</tbody>
</table>

Note: all tables report the resource share of children aged 0-4. Engel equivalence scales are based on expenditures on food while Rothbarth scales are identified on adult clothing. Model C in the present study is similar to the Rothbarth's approach while model B incorporates scale economies. Garvey (2007) makes use of the the HBS 1994 and 1999 while we use HBS 2004/5.

*a sharing rule varies quadratically with gross income*

affect the sharing rule. An interesting extension of our model would be the introduction of labor supply. This could be done very simply by making demands conditional on female participation to the labor market. In the present application, we have restrained the sample to men and women in work. However, there is still a large proportion of Irish women who are inactive. If one attempts to provide new measures of child poverty based on the resource shares obtained by children, as modeled in this paper, then it is important to cover a larger population and particularly inactive households who are at risk of poverty.

References


[2] Bargain, O., M. Beblo, D. Beninger, R. Blundell, R. Carrasco, M.-C. Chi


