Are Children Decision-Makers Within the Household?

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Within the Household?

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ABSTRACT

Are Children Decision-Makers Within the Household?[*]

Children are seldom accounted for in household behavioural models. They are usually assumed to have neither the capacity nor the power to influence the household decision process. The literature on collective models has so far incorporated children through the "caring preferences" of their parents or has treated them as household public goods [Bourguignon (1999); Blundell et al. (2005)]. This paper seeks to determine whether children of a certain age are decision-makers. We focus on the decision-making process within households composed of two adults and one child of at least 16 years of age. We first summarize the main restrictions that have been proposed to test the collective model in the context of multiple decision-makers [Chiappori and Ekeland (2006)]. We also show how a minimal number of decision-makers can be inferred from parametric constraints. Second, we apply these tests on data drawn from a series of U.K. Family Expenditure Surveys. Our results show clear evidence that it may be incorrect to assume that daughters and children aged between 16 and 21 are not full members influencing the household decision-making process.

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1 Introduction

Children are seldom accounted for in household behavioural models. At best, they are considered bystanders assumed not to have the capacity nor the power to influence the household decision process. This is not really surprising since until recently households were assumed to act as if their members maximized a unique utility function under the household budget constraint. This so-called unitary model has been forcefully challenged in the last two decades both on theoretical and empirical grounds. At the theoretical level, the unitary model has been challenged for its failure to acknowledge methodological individualism, which is a fundamental tenet of microeconomic theory. Because "it is necessary to base all accounts of economic interaction on individual behaviour" [Arrow (1994)], each member's preferences should indeed be explicitly taken into account. At the empirical level, the restrictions of the unitary model have been widely tested and generally rejected [*e.g.*, Fortin and Lacroix (1997);Hoddinott et al. (1997)].

The collective household model has been proposed partly in response to the dissatisfaction with the unitary model. The former simply assumes that the family decision process, whatever its exact nature, leads to Pareto efficient outcomes. One interesting feature of the collective model is that it does not require the specification of the bargaining process. Evidently, the generality of the efficiency assumption comes at a price: the model is not very informative about which variables, other than those in the budget constraint, may influence the decision process. In particular, the model is totally silent as to the role children may play in the process. The literature on the collective model has so far incorporated children through the "caring preferences" of their parents or has treated them as household public goods [Bourguignon (1999); Blundell et al. (2005)].[1] Yet every parent knows that children, even at a very early age, have their own preferences over consumption and their parents' labour supply. In an experiment, Harbaugh et al. (2001) found that "at age 7 children's choices about consumption goods show clear evidence of rationality, though also many inconsistencies. By age 11, choices by children [...] are as rational as choices by adults". Harbaugh et al. (2003) further showed in another experiment that children display good bargaining skills as early as 7 years of age.

Naturally, one may object to the inclusion of young children as decision-makers on several grounds. Within a bargaining framework, the child's threat point could correspond to his level of well-being in a non-cooperating equilibrium with his parents. Parents could then resort to punishment to reduce their child's bargaining power or to make it non existent.[2] One could also argue that the bargaining power of young children is so low and their preferences "defined" over such a limited subset of goods that it is pointless to treat them as economic agents. Yet the relevance of modelling the decision power of older children cannot be discarded so easily. As children grow up, they gradually become more autonomous. Their autonomy eventually leads to the possibility of earning income and, later on, of becoming fully independent at the legal age of majority. Therefore the well-being that

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[1]A number of papers in the bargaining literature have explicitly accounted for children's preferences, although the proposed models were not meant to analyse household consumption or labour supply decisions. For instance, Burton et al. (2002) propose a principal-agent model between the parents and the child to study the interaction between parenting style and child conduct. Lundberg et al. (2007) develop a noncooperative model of parenting control over child behaviour. The model incorporates child resistance and seeks to examine the determinants of decision-making power by children and adolescents. Finally, Hao et al. (2008) present a two-stage repeated game in which the children decide whether to drop out of school or teenage daughters decide whether to give birth. Parents must then decide whether or not to provide support to their children beyond the age of 18.

[2]Conditional positive transfers made by a parent to his child may also induce the latter to behave as if there were only one decision-maker within the household. However, this Beckerian *rotten kid theorem* [Becker (1974)] requires many restrictive assumptions to hold [*e.g.*, Bergstrom (1989)].

a child can attain in a non-cooperative equilibrium might improve as he grows up and so should his bargaining position. Whether and at which age children should be considered as economic agents in household consumption and labour decisions is thus an empirical issue.

Conceiving family decisions as the result of a process involving parents only, when they truly stem from a process involving all family members, is undesirable for at least three reasons. First, it might offer deficient explanations of some very important economic issues such as investment in post-secondary education, child labour and food allocation within poor households.[3] Second, it might lead to incorrect intra-household welfare analysis. Consider for example an increase in the minimum wage. If adolescents are not treated as decision-makers, one would predict the change to have no intra-household welfare effect if both parents are earning a higher wage and the adolescent is not working. Conversely, if adolescents do take part in the decision process, the same policy change might increase their bargaining power and thus have intra-household welfare effects. Any social policy that is conditional upon the household living arrangements is likely to have welfare effects. Taking into account the number of decision-makers in a household and anticipating the response of recipients and non-recipients alike is very important for any policy that targets specific individuals. Third, it may lead to inefficient estimates of the parameters of the household demand system. As we will see, the nature of the restrictions imposed on this system depends on the number of decision-makers.

The objective of this paper is not to provide a general answer to the question of the age at which children become decision-makers. Rather, we more modestly focus on determining whether children of a certain age are decision-makers. We focus on the decision-making process within households composed of two adults and one child who is at least 16 years of age. This threshold corresponds to the age at which a child can start working a significant number of hours and thus earn a sizeable income. Obviously, if children of that age are found not to have significant decision power, then younger children are even more likely to be bystanders in the household. Our analysis is limited to household consumption decisions; we do not address household labour supply decisions. The collective model is particularly well suited to our needs for two reasons. First, most studies have found the collective model to be supported by data in many circumstances [see Vermeulen (2002) and Chiappori and Donni (2006) for recent surveys]. Second, under reasonable assumptions the model provides information on the number of decision-makers within the household. In particular, it can be shown that if a household demand system is found to satisfy certain rank conditions, it is consistent with there being *at least* a given number of decision-makers. Therefore the model provides testable sufficient conditions under which all members (including the child) are decision-makers in a three-member household.

The paper is structured as follows. First, we summarize the main restrictions that have been proposed to test the collective model in the context of multiple decision-makers [Chiappori and Ekeland (2006)]. We also show how a minimal number of decision-makers can be inferred from parametric constraints. Second, we apply these tests on a sample drawn from a series of cross-sectional data from the U.K. Family Expenditure Survey (FES). The sample is composed of couples living with a single child with positive earnings. We estimate a Quadratic Almost Ideal Demand System [see Banks et al. (1997)] similar to that of Browning and Chiappori (1998) but extend their test procedure to apply to households comprising three members, each one considered as a potential

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[3]For example, Moehling (2005) studied child labour in the United States at the beginning of the last century and concluded that children had an incentive to work because it gave them a greater say in household decision-making.

decision-maker.[4] Since living with his parents may be a choice for a child aged over 15, the family composition is likely endogenous [*e.g.*, Rosenzweig and Wolpin (1993); Card and Lemieux (2000)]. Therefore the estimates and the inference may suffer from a selectivity bias. We conjecture that this is more likely for households with older children. We therefore provide separate estimates for households with children aged between 16 and 21 and for those with children aged 22 and older. We also investigate whether daughters and sons differ in terms of their bargaining power and thus stratify the sample by the child's gender.

Our results indicate that daughters and children aged between 16 and 21 are definitely decision-makers. The evidence is less convincing for children aged 22 and older and is simply inconclusive for sons. Along with Moehling (2005), these results are amongst the first to provide theoretically consistent evidence that children play an active role in household consumption or labour choices. Our results also contribute to the scant literature that focuses on testing the collective model with multiple decision-makers [see Rangel (2004) and Dauphin et al. (2006)].

2 The Theoretical Framework

Our theoretical approach is based on the collective model developed in Browning and Chiappori (1998) (hereafter BC1998) and generalized by Chiappori and Ekeland (2006).[5] Consider a household comprising $S + 1$ ($S \geq 0$) members, where S is predetermined. Let $\mathbf{x}_i$ represent the vector of goods privately consumed by member i and $\mathbf{X}$ the vector of goods publicly consumed within the household. The household faces an exogenous price vector $\boldsymbol{\pi}$ and its budget constraint is given by:

$$\boldsymbol{\pi}'\Big(\sum_{i=1}^{S+1} \mathbf{x}_i + \mathbf{X}\Big) = m, \tag{1}$$

where m represents total expenditures, assumed exogenous. In its most general form, the collective model then posit the following two axioms.

Axiom 1 *Each member i, $i = 1, \ldots, S+1$, has his own preferences over the goods consumed in the household.*

We impose no restrictions on the nature of the preferences. We allow for egoism, $U_i(\mathbf{x}_i, \mathbf{X})$, "Beckerian caring," $U_i(v_1(\mathbf{x}_1, \mathbf{X}), ..., v_{S+1}(\mathbf{x}_{S+1}, \mathbf{X}))$, altruism and externalities, $U_i(\mathbf{x}_1, ..., \mathbf{x}_{S+1}, \mathbf{X})$, and other type of preference interactions. We assume that the utility functions are strongly concave, twice differentiable, and strictly increasing in $(\mathbf{x}_i, \mathbf{X})$.

Axiom 2 *The decision-making process leads to Pareto-efficient choices. In other words, for any price vector $\boldsymbol{\pi}$ and total expenditures m, the consumption vector $[\mathbf{x}_1, ..., \mathbf{x}_{S+1}, \mathbf{X}]$ chosen by the household members is such that*

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[4]Recently, tests of *individual* rationality have been extended to *nonparametric* demand systems [*e.g.*, Lewbel (1995), Haag et al. (2007)]. These tests focus on the symmetry of the Slutsky matrix that is implied by the single decision-maker model. However, they have yet to be generalized to the case of collective rationality within multi-decision-makers households. See also Cherchye et al. (2007) and Vermeulen et al. (Forthcoming) for a *revealed preference* nonparametric approach applied to the collective framework. While this approach is promising, it still ignores problems such as endogeneity of expenditures and unobserved heterogeneity. Moreover, testing nonparametric conditions for collective rationality may be a computationally difficult problem in particular cases [Deb (2007)]

[5]We ignore domestic production and intertemporal choices. See Chiappori and Ekeland (2006) and Mazzocco (2007) for an analysis of these two issues, respectively.

no other vector $[\overline{\mathbf{x}}_1, ..., \overline{\mathbf{x}}_{S+1}, \overline{\mathbf{X}}]$ *that satisfies the condition* $\boldsymbol{\pi}' \left(\sum_{i=1}^{S+1} \overline{\mathbf{x}}_i + \overline{\mathbf{X}} \right) = m$ *can make all members at least better off and one of them strictly better off.*

These two assumptions are referred to as "collective rationality" in the literature. From axioms 1 and 2, it is clear that the outcomes depend upon preferences, income and prices. The collective model also allows factors that may contribute to the bargaining power of the household members —the "Extra-household Environmental Parameters" (EEPs) in the terminology of McElroy (1990)— to affect the outcomes. Formally:

Axiom 3 *The decision process depends on K distribution factors* $\mathbf{y} \equiv [y_1, \ldots, y_K]'$ *that are independent of individual preferences and that do not modify the overall household's budget constraint.*

There are several examples of distribution factors in the literature: divorce-related legislation, the relative proportion of men and women on the marriage market [Chiappori et al. (2002)], and the relative income shares of the household's members [(BC1998)].

The three axioms imply that there exist $S + 1$ scalar functions $\mu_1(\boldsymbol{\pi}, m, \mathbf{y}) \geq 0, \ldots, \mu_{S+1}(\boldsymbol{\pi}, m, \mathbf{y}) \geq 0$, with $\sum_{i=1}^{S+1} \mu_i = 1$, such that the consumption matrix $[\mathbf{x}_1, ..., \mathbf{x}_{S+1}, \mathbf{X}]$ is the solution to the following program:

$$\text{Max} \sum_{i=1}^{S+1} \mu_i(\boldsymbol{\pi}, m, \mathbf{y}) U_i(\mathbf{x}_1, ..., \mathbf{x}_{S+1}, \mathbf{X}), \tag{P}$$

subject to

$$\boldsymbol{\pi}' \left(\sum_{i=1}^{S+1} \mathbf{x}_i + \mathbf{X} \right) = m.$$

Each function $\mu_i(\boldsymbol{\pi}, m, \mathbf{y})$ is assumed to be twice continuously differentiable and zero-homogeneous in $\boldsymbol{\pi}$ and m (no money illusion). The variable μ_i represents the Pareto weight associated with the preferences of member i and can be interpreted as the importance attached to them in the household decision process. If the Pareto weight of a member is equal to zero, it is as if the household is not taking into account his preferences in the decision process, unless someone with a positive Pareto weight is "caring" for him. Thus, it is as if the member has no decision power. The $S + 1$ Pareto weights can therefore be viewed as the distribution of decision power within the household and the number of positive Pareto weights as the number of members with decision power. We will refer to the members with decision power as decision-makers for short. In our framework, each member is a potential decision-maker. Unlike Bourguignon (1999) and Blundell et al. (2005), we do not assume *a priori* the Pareto weights of children to be zero. The Pareto weights may depend not only on distribution factors, but also on prices[6] and total expenditure since these may influence the distribution of the bargaining power within the household.

The collective model does not provide information on the distribution factors that influence each member's decision power. Bargaining theory, on the other hand, suggests that a member's bargaining power is related to his outside option [*e.g.*, McElroy and Horney (1981)]. In our particular framework, adolescents may threaten to leave the house against their parent's will. Of course the option is more credible if the child has the potential to earn enough income. In most developed countries employers are prohibited from hiring children under the age

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[6] For instance, variations in rental prices or in education fees could clearly affect the bargaining power of children living with their parents.

of 16 during school hours since school attendance is compulsory.[7] In developing countries, child labour is much more pervasive.[8] As suggested by Bergstrom (1996), leaving the family nest may be considered as the ultimate threat. An intermediate threat point could simply be non-cooperation as is often assumed in some bargaining models [*e.g.*, Lundberg and Pollak (1993), Chen and Woolley (2001)]. Irrespective of which strategy grown-ups may turn to when negotiating with their parents, common sense would suggest that earnings potential may be a good proxy for their bargaining power. This will be investigated thoroughly when testing the model empirically.

The solution to program (P) can be derived in two steps.[9] First, the budget constraint and the utility functions determine the household's Pareto frontier. Axiom 2 implies that the outcome of the decision process is located on this Pareto frontier. Second, the vector $\boldsymbol{\mu}\left(\boldsymbol{\pi}, m, \mathbf{y}\right) \equiv \left[\mu_1\left(\boldsymbol{\pi}, m, \mathbf{y}\right), \ldots, \mu_{S+1}\left(\boldsymbol{\pi}, m, \mathbf{y}\right)\right]$ of Pareto weights determines the location along the frontier. Let the vector of Marshallian aggregate household demands obtained by solving (P) for given values of the weights $\boldsymbol{\mu}$ be denoted as $\tilde{\boldsymbol{\xi}}(\boldsymbol{\pi}, m, \boldsymbol{\mu})$. Upon substituting the Pareto weights the demand system can be written as: $\tilde{\boldsymbol{\xi}}\left(\boldsymbol{\pi}, \boldsymbol{\mu}(\boldsymbol{\pi}, \mathbf{y})\right)$, where income, m, has been normalized to 1 and removed from the function to simplify the notation. Unfortunately, these structural demands are unobservable because the Pareto weights are themselves unobservable. Only their reduced form $\boldsymbol{\xi}(\boldsymbol{\pi}, \mathbf{y})$ are observable. A fundamental question raised by the collective model is the following: given the identity $\boldsymbol{\xi}(\boldsymbol{\pi}, \mathbf{y}) \equiv \tilde{\boldsymbol{\xi}}\left(\boldsymbol{\pi}, \boldsymbol{\mu}(\boldsymbol{\pi}, \mathbf{y})\right)$, does collective rationality impose any falsifiable restrictions on the observed behaviour of the household? The recent literature [*e.g.*, BC1998, Chiappori and Ekeland (2006)] has shown that even when no constraints are placed on the nature of the goods that are consumed, the assumption of collective rationality may effectively generate testable restrictions, at least when the number of goods is larger than the number of potential decision-makers in the household. Some tests are based on price variations, others on distribution factor variations, some on both. We briefly review these tests below and we derive their implications for the parametric demand system used in our particular context.

2.1 Tests Based on Price Variations

Collective rationality imposes parametric restrictions on the manner with which prices affect the household demand functions. The first set of restrictions can be formalized as follows:

Proposition 1 *(SR(S) condition): If $\boldsymbol{\xi}(\boldsymbol{\pi}, \mathbf{y})$ solves the program (P), then the Slutsky matrix associated with $\boldsymbol{\xi}(\boldsymbol{\pi}, \mathbf{y})$, and denoted as $\boldsymbol{S}(\boldsymbol{\pi}, \mathbf{y}) \equiv (D_{\boldsymbol{\pi}}\boldsymbol{\xi})(I - \boldsymbol{\pi}\boldsymbol{\xi}')$ when m is normalized at 1, can be decomposed as follows:*

$$S(\boldsymbol{\pi}, \mathbf{y}) = \boldsymbol{\Sigma}(\boldsymbol{\pi}, \mathbf{y}) + \boldsymbol{R}(\boldsymbol{\pi}, \mathbf{y}), \tag{2}$$

where $\boldsymbol{\Sigma}$ is a symmetric and negative matrix and $\boldsymbol{R}$ a matrix of rank at most S.

Proof : See BC1998.[10] ∎

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[7]In the U.K., where our sample is drawn from, the school leaving age was 16 over the sample period.

[8]Interestingly, Basu and Ray (2002) study child labour within the framework of the collective model but do not allow children to have any decision-making power.

[9]For notational simplicity, we have excluded from program (P) the preference variables that may or may not also affect the Pareto weights. However, these variables will be taken into account in the empirical section of the paper.

[10]Chiappori and Ekeland (2006) also prove the converse proposition: If the condition SR(S) is valid (and given a number of reasonable assumptions), then there exist Pareto weights and individual utility functions such that $\boldsymbol{\xi}(\boldsymbol{\pi}, \mathbf{y})$ (locally) solves the program (P).

The intuition for this result is rather straightforward. The matrix $S(\pi, \mathbf{y})$ in Proposition 1 is in fact a *"pseudo" Slutsky matrix.* This is because the elements of $S(\pi, \mathbf{y})$ no longer represents the price effects on the demand functions for a given level of household utility, as in the unitary model. In the collective framework, a price variation generates two effects. When the utility level and Pareto weights are given, a variation in prices changes the household's choices. This change satisfies the symmetry and negativity of the matrix of price effects while shifting the Pareto frontier. This effect corresponds to $\Sigma(\pi, \mathbf{y})$. However, a price variation may also have an impact on the bargaining power of the household members through its effect on the Pareto weights and therefore on the location on the new Pareto frontier. This effect corresponds to $R(\pi, \mathbf{y})$. Since there are no more than S Pareto weights that vary independently given the normalization $\sum_{i=1}^{S+1} \mu_i = 1$, a price variation will change at most all of them, implying that the rank of $R(\pi, \mathbf{y})$ is at most S.

One may wonder whether the *SR(S)* property is binding. Intuitively, we would expect that the greater the number of goods and the fewer the potential decision-makers, the more likely this restriction will be binding. It is well known that for a household with a single individual ($S = 0$), testing the symmetry of the Slutsky matrix requires at least three goods. More generally, the symmetry of Σ when *SR(S)* holds is binding only if $N > 2(S + 1)$. Therefore when there are three potential decision-makers at least seven goods are needed to test this restriction.

The collective model's representation of households comprising several individuals underlines the fact that violation of the traditional Slutsky conditions can be attributed to the omission of the role played by bargaining power in the decision process. Furthermore, if the representation is valid, it also shows how and why this violation occurs. BC1998 have shown that an empirical test of Proposition 1 reduces to testing for the following restriction:

Proposition 2 *Let $M(\pi, \mathbf{y}) \equiv S(\pi, \mathbf{y}) - S(\pi, \mathbf{y})'$. Then the rank of the antisymmetric matrix $M(\pi, \mathbf{y})$ is at most $2S$.*

Proof : See BC1998. ■

The restriction of Proposition 2 leads to a rank test on an observable matrix.[11]

2.2   Tests Based on Distribution Factors

In the unitary model, distribution factors have no impact on the demand functions. In the collective model, on the other hand, distribution factors may impact them, but only in a very specific way. Let $\xi(\pi, \mathbf{y})$ be a system of demand functions satisfying the *SR(S)* condition, and $\Theta \equiv D_{\mathbf{y}}\xi$ a matrix, the (i, k)-th element of which is $\frac{\partial \xi_i}{\partial y_k}$. The following proposition states how the distribution factors may impact the demand functions.

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[11]Note that the rank of the matrix M is always even (or zero) since it is antisymmetric, that is, $M = -M'$.

Proposition 3 *(Chiappori and Ekeland (2006)) If $\boldsymbol{\xi}(\boldsymbol{\pi}, \mathbf{y})$ solves the program (P) and if the number of distribution factors (K) and the number of goods (N) are at least equal to S, then we have rank $(\boldsymbol{\Theta}) \leq S$.*

Proof : The proof is straightforward. Since $\boldsymbol{\xi}(\boldsymbol{\pi}, \mathbf{y}) \equiv \tilde{\boldsymbol{\xi}}(\boldsymbol{\pi}, \boldsymbol{\mu}(\boldsymbol{\pi}, \mathbf{y}))$, the matrix of the marginal effects of the distribution factors on the demand functions is given by $\boldsymbol{\Theta} \equiv D_{\mathbf{y}}\boldsymbol{\xi}(\boldsymbol{\pi}, \mathbf{y}) \equiv D_{\boldsymbol{\mu}}\tilde{\boldsymbol{\xi}}(\boldsymbol{\pi}, \boldsymbol{\mu})D_{\mathbf{y}}\boldsymbol{\mu}$. Because the dimension of the matrix $D_{\mathbf{y}}\boldsymbol{\mu}$ is $S+1 \times K$ and $\sum_{i=1}^{S+1} \mu_i = 1$, its rank is at most S. Consequently, rank $(\boldsymbol{\Theta}) \leq S$.
∎

Proposition 3 implies that if there are more than S distribution factors, their marginal effects on the demand functions must be linearly dependent. This is a generalization of the result obtained by Bourguignon et al. (Forthcoming) for households composed of only two potential decision-makers $(S = 1)$. In that case, the distribution factors have proportional effects on all the demand functions.

The intuition underlying this result is as follows. The demand system depends on at most S Pareto weights that vary independently and the distribution factors only impact the demand system through the latter. Therefore, if there are fewer weights than there are distribution factors, their effects on the demands must necessarily be linearly dependent.

2.3 Tests Based on Distribution Factors and Price Variations

BC1998 have shown that the (compensated) price effects and the effects of the distribution factors on the demand functions are formally linked as follows when $S = 1$:

Proposition 4 *If $\boldsymbol{\xi}(\boldsymbol{\pi}, \mathbf{y})$ solves the program (P), and as before, letting $\boldsymbol{\Theta} \equiv D_{\mathbf{y}}\boldsymbol{\xi}(\mathbf{y}, \boldsymbol{\pi})$, then $\boldsymbol{\Theta}$ can be written as a linear combination of the columns of $\boldsymbol{S} - \boldsymbol{S}'$.*

This result has recently been extended to collective models for $S > 1$ by Chiappori and Ekeland (2006). The link stems from the fact that both distribution factors and prices affect the demands through the Pareto weights.

Note that the empirical rejection of the restrictions of Propositions 3 and 4 can not necessarily be interpreted as violation of collective rationality. The restrictions could be rejected because the variable used as distribution factors to perform the tests are not true distribution factors. They could instead be preference variables, for example. Browning et al. (2006) have argued recently that the collective model does not give any guidance to distinguish empirically between distribution factors and preference variables. This has lead them to conclude that tests based on distribution factors should not be considered as tests of collective rationality. In some cases, however, simple common sense may clearly establish the distinction. Institutional arrangements (*e.g.*, divorce laws, minimum wage, welfare programs, *etc.*) or the state of the marriage market can hardly feature as preference factors. Yet Chiappori et al. (2002) have found some of these variables to affect household outcomes. Conversely, one could argue that the prices of everyday consumption goods are not likely to vary sufficiently to significantly change the distribution of power within the household. Therefore, tests of collective rationality based on price effects may fail to capture the intricacies of the household bargaining process. Because neither test is flawless, we perform both.

2.4 The number of intra-household decision-makers

Under collective rationality, household consumption provides indirect information on the number of members involved in the decision-making process. Recall that the number of positive Pareto weights can be interpreted as the number of decision-makers in the household. Naturally, the Pareto weights can not be observed. According to Propositions 2 and 3, the number of positive weights can nevertheless be indirectly assessed by focusing on the number of linearly independent (compensated) price and/or distribution factor effects. These, however, will necessarily be fewer than the number of positive Pareto weights for at least four reasons. First, because the Pareto weights are normalized to sum to one, the number of linearly independent price and/or distribution factor effects is always at least inferior by one to the number of positive weights. Second, some Pareto weights might be positive, but (locally) constant. Third, some decision-makers might have identical preferences, in which case the specific effect of their Pareto weights will not be distinguishable. Fourth, the price and/or distribution factor effects on the positive Pareto weights might be (locally) linearly dependent. To acknowledge the last three possibilities, we will refer to the *apparent* number of decision-makers. It represents the minimal number of decision-makers consistent with the collective model. Formally, let $H^* + 1$ stand for the *true* number of decision-makers and let $H + 1$ be the apparent number of decision-makers. We have:

Corollary 1 *Based on price variations, $H =$ rank$(\boldsymbol{M})/2$ and is such that $H \leq H^*$.*

Proof : According to proposition 2, rank$(\boldsymbol{M}) = 2k$ is consistent with collective rationality for households comprising $k + 1$ members and more. If there is exactly $k + 1$ members in the household, then each member is a decision-maker. Since households with more than $k + 1$ members behave no differently, the apparent number of decision-makers for these households is $k + 1$. Therefore, $H =$ rank$(\boldsymbol{M})/2$. Furthermore, since each additional member is a potential decision-maker, households with more than $k + 1$ members must have at least $k + 1$ decision-makers, that is $H \leq H^*$. ∎

Corollary 2 *Based on factor distribution variations, $H=$ rank$(\boldsymbol{\Theta})$ and is such that $H \leq H^*$.*

Proof : *Idem*, using proposition 3. ∎

We will use these results in the empirical section to test whether children are decision-makers. It must be stressed that the identity of the decision-makers is unknown when $H < S$. Note also that the number of apparent decision-makers could vary according to whether it is computed on the basis of the price effects (Corollary 1) or the distribution factor effects (Corollary 2). For instance, if the relative prices have no effect on the Pareto weight of a particular decision-maker, it may follow that rank$(\boldsymbol{M}) < 2$ rank$(\boldsymbol{\Theta})$.

3 Empirical Strategy

To our knowledge, the above propositions have never been tested empirically on households composed of potentially more than two decision-makers. The next section discusses the data that will be used to test the collective model and to determine the number of apparent decision makers when it is not rejected. In Section 3.2 we present the demand system and show how the propositions we intend to test translate into parametric constraints.

3.1 The Data

We use data from the annual Family Expenditure Survey covering the period 1982–1993. The survey contains a broad array of information on household expenditures on durable and nondurable goods, on the income and labour supply of members of the household, and on their socio-economic characteristics. From the annual surveys we selected a sub-sample of 2 745 families comprising three potential decision-makers, *i.e.*, a married couple and a single child aged 16 years and over with a positive wage income. We excluded households in which one of the two spouses was not active on the labour market, was nearing retirement (men over 65 or women over 60), as well as households residing in Northern Ireland.

As with most surveys, only consumption expenditure is observable, not consumption *per se*. This distinction is conceptually important. Indeed, expenditure on a nondurable good at a given time is a good proxy for consumption. However, durable goods provide a flow of services that are consumed over a period of time. Consequently, expenditure on durable goods are an unsatisfactory measure of their consumption. We thus assume that the distinction between a nondurable and a durable good can be made unambiguously. We also assume that the utility function is weakly separable between durable and nondurable goods. Hence consumption of nondurable goods depend solely on the household's total income net of expenditures on durable goods. The assumption of separability, while restrictive, is common in the literature [see Banks et al. (1997)]. In addition, we condition the demand equations on home and car ownership to test a certain form of separability between durable and nondurable goods as shown below.

The demand system we estimate comprises 11 categories of nondurable goods: food, restaurant meals, alcohol, tobacco, services, leisure, heating, transportation, clothing, recreational goods, and personal goods. With respect to the theoretical model, our demand system is thus characterized by $S = 2$ and $N = 11$. Prices are measured monthly at the country level, yielding 144 (12 years $\times$ 12 months) different prices for each good.

Testing Proposition 3 in this context requires observing at least three distribution factors. Given the composition of households, and in light of the fact that the demand system is conditioned on total expenditure on nondurable goods, we can construct three distribution factors from individual incomes. Following BC1998, we use the log of the husband's gross income, $\log(Y_H)$, the difference between the log of the wife and the husband's income, $\Delta \log(Y_{WH})$, and the difference between the log of the child's and the father's income, $\Delta \log(Y_{CH})$.[12] Of course, these variables need to be used cautiously since their validity as distribution factors depends on the assumption of separability. Nonetheless, they may have a significant impact on the decision-making process at the household level for given total expenditures on nondurable goods. Other factors could eventually be included in the analysis (*e.g.* sex ratio, divorce laws, minimum wage, age at which a youngster can drive a car, youth unemployment rate,...). For the time being, and given data constraints, the analysis is limited to the above distribution factors.

Table 1 presents the descriptive statistics of our sample. These statistics are compiled for all the years from 1982 to 1993. Since we omit durable goods, it is not surprising that the largest shares relate to food, recreational goods, and clothing. Moreover, the distribution factors suggest a significant gap between the spouses' income on one hand, and between the father's and the child's income, on the other. Other variables in the table reveal

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[12]BC1998 do not include the third distribution factor because they assume that only the spouses are potential decision-makers in the household.

Table 1: Descriptive Statistics

Variable	Mean	Std error
Budget shares		
Food	0287	0168
Alcohol	0063	0086
Tobacco	0056	0078
Clothing	0094	0109
Leisure	0036	0072
Transportation	0034	0058
Service (domestic phone)	0047	0047
Restaurant	0052	0054
Personal goods (P.G.) (personal care)	0057	0078
Recreational goods (R.G.)	0120	0095
Distribution Factors		
$\log(Y_H)$	5131	0934
$\Delta \log(Y_{WH})$	-1324	1765
$\Delta \log(Y_{CF})$	-1089	1774
Household characteristics		
Log total expenditure	4241	0613
Quarter1	0298	0457
Quarter2	0263	0440
Quarter3	0214	0410
North	0069	0254
Yorks/Humerside	0102	0302
North West	0115	0319
East Midlands	0079	0270
West Midlands	0104	0305
East Anglia	0039	0194
Greater London	0073	0261
South East	0190	0392
South West	0078	0268
Car	0832	0374
House	0489	0500
Age husband	52071	6551
Age wife	49449	5812
Age child	20952	4131
Sex child 1=male	0577	0494
Education husband	10425	2188
Education wife	10450	2885
Education child	9494	4773
Sample size	2745	

Note : The amounts are expressed in sterling pounds.

that the majority of households have a car (83.2%) and about half own a house (48.9%). Finally, the spouses' education levels are similar, while the children are slightly less educated presumably because of their age.

3.2 The Empirical Model

To implement the empirical tests, we estimate a Quadratic Almost Ideal Demand System (QUAIDS) as proposed by Banks et al. (1997) and used by BC1998. The QUAIDS system has the advantage of being a flexible functional form that accommodates quadratic nonlinearities in the Engel curves. More specifically, it is a rank three demand system in the sense of Lewbel (1991). Also, it has been validated empirically on many occasions [*e.g.*, Banks et al. (1997), Blundell and Robin (1999), Browning et al. (2007)]. In particular, standard tests of Slutsky symmetry in single-person utility maximizing models perform reasonably well when using QUAIDS as compared with alternative nonparametric tests [Haag et al. (2007)].

The budget shares are written as:

$$w = \boldsymbol{\alpha} + \boldsymbol{\Theta}\mathbf{y} + \boldsymbol{\Gamma}\boldsymbol{p} + \boldsymbol{\beta}\left(\ln(m) - a(\boldsymbol{p})\right) + \boldsymbol{\lambda}\frac{\left(\ln(m) - a(\boldsymbol{p})\right)^2}{b(\boldsymbol{p})} + \boldsymbol{v}, \tag{3}$$

where $\boldsymbol{\alpha}$, $\boldsymbol{\beta}$ and $\boldsymbol{\lambda}$ are $(N \times 1)$ vectors of parameters, $\boldsymbol{\Theta}$ and $\boldsymbol{\Gamma}$ are $(N \times K)$ and $(N \times N)$ matrices of parameters, respectively, $\boldsymbol{y}$ is a $(K \times 1)$ vector of distribution factors, $\boldsymbol{p}$ is an $(N \times 1)$ vector of log prices, $\ln(m)$ is the log of the household's total expenditure on nondurable goods, and $\boldsymbol{v}$ is a vector of error terms. The price indexes $a(\boldsymbol{p})$ and $b(\boldsymbol{p})$ are defined as:

$$a(\boldsymbol{p}) = \alpha_0 + \boldsymbol{\alpha}'\boldsymbol{p} + \frac{1}{2}\boldsymbol{p}'\boldsymbol{\Gamma}\boldsymbol{p} \tag{4}$$

$$b(\boldsymbol{p}) = \exp(\boldsymbol{\beta}'\boldsymbol{p}). \tag{5}$$

Additivity implies that $\boldsymbol{\alpha}'\boldsymbol{e} = \mathbf{1}$, $\boldsymbol{\Theta}'\boldsymbol{e} = \mathbf{0}$ and $\boldsymbol{\beta}'\boldsymbol{e} = \boldsymbol{\lambda}'\boldsymbol{e} = \boldsymbol{\Gamma}\boldsymbol{e} = \mathbf{0}$, where $\boldsymbol{e}$ is an N-dimensional unit vector. Homogeneity implies $\boldsymbol{\Gamma}'\boldsymbol{e} = \mathbf{0}$. In practice, additivity necessarily obtains owing to the construction of the data in terms of budget shares. Thus we estimate a system of 10 equations rather than 11 by arbitrarily eliminating one equation from the system (heating). The parameters of the omitted equation are obtained by substitution into the budget constraint. To simplify notation, we let $N = 10$ in what follows. We impose homogeneity by substituting relative prices for absolute prices (we divide them all by the price of heating, the reference price).

In equation (3), the distribution factors are introduced so as to only impact the constants in the share equations. The Pseudo-Slutsky matrix is given by:

$$\begin{aligned}
\boldsymbol{S} = \boldsymbol{\Gamma} \quad &- \quad \frac{1}{2}\left(\boldsymbol{\beta} + 2\boldsymbol{\lambda}\frac{\widetilde{m}}{b(\boldsymbol{p})}\right)\boldsymbol{p}'(\boldsymbol{\Gamma} - \boldsymbol{\Gamma}') \\
&+ \quad \widetilde{m}\left\{\boldsymbol{\beta}\boldsymbol{\beta}' + \frac{\widetilde{m}}{b(\boldsymbol{p})}(\boldsymbol{\lambda}\boldsymbol{\beta}' + \boldsymbol{\beta}\boldsymbol{\lambda}') + \left(\frac{\widetilde{m}}{b(\boldsymbol{p})}\right)^2\boldsymbol{\lambda}\boldsymbol{\lambda}'\right\},
\end{aligned} \tag{6}$$

with $\widetilde{m} = \ln(m) - a(\boldsymbol{p})$. So far we have omitted preference variables that take into account observable individual heterogeneity. In the empirical specification, we incorporate a vector $\boldsymbol{z}$ of socio-demographic characteristics

through the functions $a(\boldsymbol{p})$ and $b(\boldsymbol{p})$. More precisely, we write:

$$
\begin{aligned}
a(\boldsymbol{p}, \boldsymbol{z}) &= \alpha_0 + \boldsymbol{\alpha}(\boldsymbol{z})'\boldsymbol{p} + \frac{1}{2}\boldsymbol{p}'\Gamma\boldsymbol{p}, \text{ and} & (7) \\
b(\boldsymbol{p}, \boldsymbol{z}) &= \exp\left(\boldsymbol{\beta}(\boldsymbol{z})'\boldsymbol{p}\right), & (8)
\end{aligned}
$$

where the functions $\boldsymbol{\alpha}(\boldsymbol{z})$ and $\boldsymbol{\beta}(\boldsymbol{z})$ are linear in $\boldsymbol{z}$, a vector of control variables. The vector $\boldsymbol{z}$ includes a series of dummy variables (nine regional variables, three seasonal dummies, car and home ownership). Preliminary estimations revealed that the variables for education and age were never significant, possibly owing to the homogeneity of the sample.

The linearity of the QUAIDS demand system (3) is conditional on the terms $a(\boldsymbol{p})$ and $b(\boldsymbol{p})$. Consequently, it can be directly estimated using iterated ordinary least squares as proposed by Blundell and Robin (1999). The approach consists in estimating the demand system by OLS, conditional on a given set of initial parameter values Γ^0 and $\boldsymbol{\alpha}^0$ that are substituted into in $a(\boldsymbol{p})$ and $b(\boldsymbol{p})$. The conditional OLS parameters Γ^1 and $\boldsymbol{\alpha}^1$ are next substituted in $a(\boldsymbol{p})$ and $b(\boldsymbol{p})$ and a new set of conditional OLS parameters Γ^2 and $\boldsymbol{\alpha}^2$ are estimated. The process is repeated until the conditional OLS parameters Γ^{i+1} and $\boldsymbol{\alpha}^{i+1}$ are equal to those of the previous round, *i.e.* Γ^i and $\boldsymbol{\alpha}^i$.

To account for the possibility that the log of total expenditure on nondurable goods is endogenous, we include the residuals of an auxiliary regression of the log of total expenditure on a set of instruments into the QUAIDS specification in (3).[13] Conditional on this additional regressor, the so-called control function, the expenditure variable is exogenous. In this approach, the error term $\boldsymbol{v}$ can be written as the orthogonal decomposition

$$
\boldsymbol{v} = \rho u + \epsilon. \tag{9}
$$

Testing $\rho = 0$ is equivalent to a test for the exogeneity of the log of total expenditure on nondurables.[14]

4 Estimation Results

The main purpose of the paper is to investigate the extent to which adolescent and older children exert some influence on household consumption choices. The empirical strategy must necessarily rest on a sample of households in which children interact with their parents. It could be argued that the household composition is precisely determined by the relative bargaining power of its members. In other words, children who live with their parents may do so precisely because their bargaining power is strong. Those who did not enjoy such an enviable situation may have left the family nest. In statistical terminology, our sample may suffer from self-selection problems.[15] In our particular framework the direction of the bias is ambiguous however. Some children may have left the

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[13]After some experimentation, and following Banks et al. (1997), we chose not to include a residual generated by a regression of the square of expenditure on the instruments as an additional variable.

[14]We also tested the exogeneity of the distribution factors using the same approach. The exogeneity of each distribution factor could not be rejected in nearly every demand equation. These results are not reported for the sake of brevity but are available upon request.

[15]Note that this problem applies equally well to unitary and non-unitary models because the analysis is always carried out conditionally on household composition. The same problem arises when studying couples because the decision to marry or to divorce is also endogenous in most models. The same criticism may be addressed at all the tests of the collective model that have been conducted so far in the literature.

family nest because they enjoyed a good outside option. Others may have left because their parents had a very good threat point. Excluding children from the former group will underestimate the decision-making power of children. Excluding children from the latter group will overestimate the bargaining position of children. We investigate this issue by stratifying our sample into two groups.[16] The first includes households in which the child is aged between 16 and 21 years. The second includes children that are at least 22 years of age. Since the probability of leaving the family nest is lower for the younger group, this sample is less likely to suffer from selectivity bias.

The parameter estimates of the demand system for the complete sample are presented in Table 2. The first panel of the table reports the parameter estimates of the distribution factors ($\mathbf{\Theta}$). The second panel focuses on the price variables ($\mathbf{\Gamma}$). The regression also includes a series of control variables, $\mathbf{z}$, which includes dummy variables for home and car ownership, 9 regional dummy variables, and 3 seasonal dummy variables, and that are not reported for the sake of brevity. Each distribution factor has a significant impact on at least two demand equations. For instance, an increase in the husband's income ($\log Y_H$) translates into more being spent on food and less on recreational goods. Likewise, as the wife's income increases relative to that of her husband ($\Delta \log(Y_{WH})$) more is spent on food and less on leisure goods. Finally, as the children's income increase relative to their father's ($\Delta \log(Y_{CH})$), more is spent on tobacco and less is spent on recreational goods.

The second panel of the table shows that most parameters of the prices variables are statistically significant.[17] Except for the *Transportation* equation, all the own-price parameter estimates that are significant are negative as expected.

The last panel of the table reports two specification tests. The first line concerns the exogeneity of total expenditure. As mentioned before the residuals from an auxiliary regression of total expenditure on a series of instrumental variables are included as an explanatory variable.[18] The parameter estimates are statistically different from zero in all but one equation (*Transportation*), thus rejecting the exogeneity assumption. The second line of the panel reports the χ^2 statistics of the joint test of the validity of instruments and of the over-identifying restrictions. According to the table neither hypotheses can be rejected.

Tables 4–7 in appendix report the parameter estimates for the samples of households whose child is female, male, aged between 16–21, and aged 22 and over, respectively. The estimates of the price variables are relatively similar across the tables. The main differences relate to the parameter estimates of the distribution factors. The relative income of daughters (Table 4) increases the consumption of tobacco products but no such effect are found in the sample of sons (Table 5). Interestingly we find that an increase in the wife's relative income increases the consumption of alcohol when the child is female. Conversely, when the child is male the father's relative income decreases the consumption of alcohol. Perhaps surprisingly, the relative income of the sons has a negative and significant impact on the consumption of recreational goods. A similar result holds for the samples of daughters and both age groups, although the parameter estimate is only statistically significant at 15% for daughters and the children aged 2 and over. The parameter estimates of the price effects are simply too numerous to make any worthwhile inference. Systematic differences can only be ascertained through formal statistical tests.

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[16]We could not introduce a correction for this selection bias since we have no information on children who left their parents in our sample.

[17]Preliminary estimates revealed that the assumption of homogeneity cannot be rejected.

[18]In addition to the explanatory variables and the distribution factors, the instrumental variables are: age, age^2 , age^3, education, education^2, education^3 of both spouses, a yearly trend, and the log of the price index.

Table 2: Parameter Estimates of the Demand System – Full Sample

Variable	Food	Alc.	Tobac.	Cloth.	Leisure	Trans.	Serv.	Rest.	P.G.	R.G.
					DISTRIBUTION FACTORS					
$\log(Y_H)$	0,011	-0,002	0,002	-0,002	-0,002	-0,002	0,000	0,002	0,001	-0,005
	(3,614)	(1,131)	(1,173)	(0,919)	(1,236)	(1,201)	(0,285)	(1,179)	(0,668)	(2,483)
$\Delta\log(Y_{WH})$	0,003	0,000	0,000	0,000	-0,002	-0,001	0,000	0,001	0,000	0,001
	(1,842)	(0,408)	(0,303)	(0,356)	(2,057)	(0,890)	(0,298)	(1,092)	(0,065)	(1,497)
$\Delta\log(Y_{CH})$	0,001	0,000	0,002	0,001	0,000	0,000	0,000	0,000	0,001	-0,003
	(0,382)	(0,088)	(2,109)	(0,568)	(0,212)	(0,433)	(0,120)	(0,090)	(0,959)	(3,629)
					PRICE VARIABLES					
Γ-Food	-0,527	-0,079	-0,072	-0,018	0,139	0,102	-0,113	0,004	0,062	0,199
	(5,190)	(1,276)	(1,396)	(0,249)	(2,644)	(2,293)	(3,079)	(0,093)	(0,996)	(3,085)
Γ-Alcohol	-0,069	-0,030	-0,059	0,001	0,010	0,032	-0,005	0,003	0,016	-0,044
	(1,808)	(1,270)	(3,031)	(0,031)	(0,484)	(1,876)	(0,364)	(0,163)	(0,675)	(1,812)
Γ-Tobacco	0,000	0,089	0,027	0,032	-0,013	-0,003	-0,141	0,002	0,060	0,003
	(0,006)	(4,048)	(1,438)	(1,263)	(0,721)	(0,196)	(10,849)	(0,111)	(2,723)	(0,148)
Γ-Clothing	0,101	0,052	0,026	0,006	-0,055	-0,027	0,024	0,025	0,018	-0,044
	(1,723)	(1,460)	(0,852)	(0,152)	(1,824)	(1,048)	(1,139)	(1,014)	(0,492)	(1,183)
Γ-Leisure	0,069	0,009	-0,019	0,034	-0,024	0,020	-0,025	0,010	0,013	-0,020
	(3,052)	(0,639)	(1,610)	(2,143)	(2,088)	(1,968)	(3,006)	(1,123)	(0,947)	(1,372)
Γ-Transportation	-1,120	-0,294	0,027	0,387	0,195	0,123	-0,093	0,101	-0,174	0,167
	(9,103)	(3,941)	(0,437)	(4,522)	(3,070)	(2,277)	(2,095)	(2,001)	(2,322)	(2,134)
Γ-Services	-2,645	0,087	-0,288	0,578	0,555	0,138	0,090	-0,048	0,282	0,186
	(7,403)	(0,402)	(1,578)	(2,323)	(3,006)	(0,882)	(0,698)	(0,325)	(1,295)	(0,818)
Γ-Restaurant	1,390	-0,516	-0,076	-0,615	-0,460	-0,162	0,262	-0,005	0,114	0,026
	(6,311)	(3,869)	(0,674)	(4,012)	(4,042)	(1,673)	(3,305)	(0,051)	(0,847)	(0,189)
Γ-Personal	1,230	0,556	0,269	-0,053	-0,085	-0,144	-0,186	-0,063	-0,068	-0,003
	(3,745)	(2,795)	(1,607)	(0,231)	(0,504)	(0,996)	(1,578)	(0,467)	(0,341)	(0,014)
Γ-Recreational	0,893	-0,146	0,114	-0,098	-0,157	-0,095	0,219	0,015	-0,364	-0,352
	(3,656)	(0,987)	(0,915)	(0,579)	(1,247)	(0,884)	(2,495)	(0,151)	(2,444)	(2,265)
					SPECIFICATION TESTS†					
Total Expend (Residual)	-0,131	0,009	-0,009	0,021	0,038	-0,004	-0,012	-0,005	-0,021	0,015
T-Stat.	(25,924)	(2,964)	(3,622)	(6,016)	(14,367)	(1,692)	(6,670)	(2,277)	(6,677)	(4,527)
Over-Ident. $\chi^2_{(8)}$	10,963	8,736	7,547	1,830	3,792	1,113	12,668	0,762	8,019	16,279

† The first line reports the parameter estimates of the residuals from an auxiliary regression of total expenditures on a series of instrumental variables. The second line reports the χ^2 statistics of the over-identification test of the instrumental variables.

4.1 Testing the collective model and determining the number of decision-makers

Propositions 2 and 3 provide two independent tests of the collective model. The former is based upon the price effects, $\mathbf{\Gamma}$, while the latter distribution factor effects, $\mathbf{\Theta}$. In testing the rank of these matrices, we follow a sequential approach. In the context of Proposition 2, we first start by testing $H_0 : \text{rank}(\mathbf{M}) = 0$. If the null hypothesis is rejected, we test for $H_0 : \text{rank}(\mathbf{M}) = 2$.[19] If this null hypothesis is again rejected we move on and test for $H_0 : \text{rank}(\mathbf{M}) = 4$. If all three ranks are rejected, we reject collective rationality since $S = 2$. Otherwise, we do not reject collective rationality. We proceed in a similar fashion with Proposition 3. In the event that the collective model is not rejected by either sets of tests, Proposition 4 can be verified. As mentioned earlier, nothing precludes inconsistencies between the sets of tests. If collective rationality is not rejected on the basis of one with the propositions, then we can assess the number of apparent decision-makers based on the corollary associated to the proposition. For instance, if $\text{rank}(\mathbf{M}) = 2$ was not rejected, then we could conclude from the Corollary 1 that the data is consistent with two apparent decision-makers, or put differently, with at least two decision-makers. Each step of the sequential procedure could alternatively be interpreted as a joint test of collective rationality *and* the number of apparent decision-makers. Testing for $\text{rank}(\mathbf{M}) = 0$ indeed amounts to testing for the collective model with one apparent decision-maker, that is for the unitary model, while testing for $\text{rank}(\mathbf{M}) = 2$ is equivalent to testing for the collective model with two apparent decision-makers, and so on. If the collective model is rejected for the highest possible number of apparent decision-makers, then the collective model is rejected. We use the second interpretation in the presentation of our results.

4.1.1 Tests based on price variations

Testing the rank of $\mathbf{M} \equiv S - S'$ is a relatively demanding task. Fortunately, in the context of the QUAIDS specification, it can be shown that $S - S'$ reduces to $\mathbf{\Gamma} - \mathbf{\Gamma}'$ under collective rationality [BC1998. Therefore our strategy consists in testing sequentially the following null assumption for $H = 0, 1, 2$:

$$H_0 : \text{rank}(\mathbf{M}) = 2H,$$
$$H_A : \text{rank}(\mathbf{M}) > 2H,$$

where $\mathbf{M} = \mathbf{\Gamma} - \mathbf{\Gamma}'$. Let us study each step in turn.

- $\text{rank}(\mathbf{M}) = 0$ (Unitary model or collective model with one apparent decision-maker).

Testing that the antisymmetric matrix $\mathbf{M}$ has rank 0 is equivalent to testing the symmetry of the matrix $\mathbf{\Gamma}$. Recall that the matrix $\mathbf{\Gamma}$ is (10×10). There are thus $10 \times (10-1)/2 = 45$ linear constraints that must be satisfied.

- $\text{rank}(\mathbf{M}) = 2$ (Collective model with two apparent decision-makers).

Because the matrix $\mathbf{M}$ is antisymmetric, all the elements on its main diagonal are zero. BC1998 exploit this property and have shown (their Lemma 3) that this is equivalent to testing that for all (i, k) such that $k > i > 2$

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[19]Recall that the rank of the matrix $\mathbf{M}$ is even since it is antisymmetric.

the following equalities hold (assuming without loss of generality that $m_{12} \neq 0$):

$$m_{ik} = \frac{m_{1i}m_{2k} - m_{1k}m_{2i}}{m_{12}},$$

where m_{ik} is the ik^{th} element of $\boldsymbol{M}$. Under rank$(\boldsymbol{M}) = 1$, as many as 28 constraints must be satisfied.

- rank$(\boldsymbol{M}) = 4$ (Collective model with three decision-makers).

As above, let $\boldsymbol{M} = \{m_{ik}\}, i, k = 1, \ldots, 10$. Without loss of generality, assume further that:

$$|\boldsymbol{M}_{4\times 4}| = \mathrm{Det} \begin{vmatrix} 0 & m_{12} & m_{13} & m_{14} \\ -m_{12} & 0 & m_{23} & m_{24} \\ -m_{13} & -m_{23} & 0 & m_{34} \\ -m_{14} & -m_{24} & -m_{34} & 0 \end{vmatrix} \neq 0.$$

It can be shown that $\boldsymbol{M}$ has rank 4 if and only if $\forall\, k > i > 4$ the following holds:

$$\begin{aligned}
m_{ik} = \; & \{m_{12}(m_{3i}m_{4k} - m_{3k}m_{4i}) + m_{13}(m_{2k}m_{4i} - m_{2i}m_{4k}) \\
& m_{14}(m_{2i}m_{3k} - m_{2k}m_{3i}) + m_{1i}(m_{23}m_{4k} - m_{24}m_{3k} + m_{2k}m_{34}) + \\
& m_{1k}(-m_{23}m_{4i} - m_{24}m_{3i} - m_{2i}m_{34})\} / (m_{12}m_{34} - m_{13}m_{24} + m_{14}m_{33}).
\end{aligned}$$

The denominator of the last expression corresponds to the square root of $|\boldsymbol{M}_{4\times 4}|$. Under rank$(\boldsymbol{M}) = 4$, 15 m_{ik} constraints must be satisfied.

Simple Wald tests can be computed to determine whether the above constraints are satisfied or not. The main advantage of this statistic is that it does not require the model to be estimated under the null hypothesis as opposed to the LR test or the Lagrange multiplier test. This is definitely important because the restrictions under rank$(\boldsymbol{M}) = 2$, and especially under rank$(\boldsymbol{M}) = 4$, are highly nonlinear and too complex to implement. Evidently the main weakness of the Wald test is that it is not invariant to algebraically equivalent parameterizations of the null hypothesis.[20] We address this issue below in Section 4.2.

4.1.2   Tests based on distribution factors

Recall that Proposition 3 states that rank$(\boldsymbol{\Theta}) \leq S$. The literature contains several statistical tests to determine the rank of a matrix [*e.g.*, Gill and Lewbel (1992), Cragg and Donald (1997) and Robin and Smith (2000)].[21] We

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[20]There exists an extensive literature on this issue, *e.g.*, Gregory and Veall (1985), Phillips and Park (1988), and Agüero (2008).

[21]The test proposed by Gill and Lewbel (1992) is sensitive to the ordering of the variables in the matrix to be tested. In Cragg and Donald (1997), the test statistic is obtained using a numerical optimisation procedure which is not necessarily precise with relatively large matrices. Finally, the test statistic proposed by Robin and Smith (2000) does not follow a standard distribution, making the test procedure difficult to implement.

follow a procedure that was recently proposed by Kleibergen and Paap (2006) and that is based on the singular value decomposition.

The basic idea of their approach is to test how many singular values are significantly different from 0. Recall that the rank of a matrix is given by the number of its non-zero singular values. Let Θ be a $k \times m$ matrix of distribution factor effects that admits a singular values decomposition: $\Theta = U\Sigma V$, where U is a $k \times k$ orthonormal matrix, V is a $m \times m$ orthonormal matrix, and Σ is a $k \times m$ matrix whose main diagonal contains the singular values of Θ. Under the null hypothesis that rank$(\Theta) = q$, $(q = 0, ..., k-1)$, they construct a statistic based on an orthogonal transformation of the smallest $(k-q)$ singular values and on the inverse of the corresponding covariance matrix. The limiting distribution of the test statistic is $\chi^2_{(k-q)(k-q)}$. This allows to test the null against the alternative rank$(\Theta) > q$.

This test procedure is particularly useful in our framework. It allows to easily test sequentially whether the rank of Θ is less or equal to S, as predicted by Proposition 3. One advantage of this test is that, contrary to the Wald test, it is invariant to arbitrary reparameterizations of the null hypothesis. Its main disadvantage is that it can not be used to test the rank of antisymmetric matrices such as M in Proposition 2.

4.1.3 Tests Based on Price Variations and Distribution Factors

Proposition 4 implies that Θ and the columns of M are collinear. When the restriction is binding, that is when rank$(M)/2$ =rank$(\theta) = H$, the collinearity can be easily ascertained using the test procedure proposed by Kleibergen and Paap (2006). Let Ξ stand for the vertical concatenation of M and Θ, *i.e.*,

$$\Xi = \frac{M}{\Theta}.$$

Their test procedure can be applied to investigate the rank of Ξ since the matrix is not antisymmetric. Under the null assumption of collective rationality with $H+1$ apparent decision-makers, it should equal to $2H$ since rank$(M) = 2H$. Testing the rank of Ξ provides the opportunity to test the validity of the Wald statistics used to test Proposition 2. Indeed, under the null hypothesis of collinearity, the test statistics of Propositions 2 and 4 should be equivalent asymptotically. The validity of the Wald statistics will be in doubt should they differ significantly despite not rejecting collinearity.

4.2 Tests Results

Table 3 reports the test results. The table is divided into three sections, each corresponding to Propositions 2, 3 and 4, respectively. Column (1) reports the test result for rank$(M) = 0$, *i.e.* that the household behaves according to the unitary model. The column indicates that the assumption is strongly rejected for all five samples we have considered.

Columns (2) and (3) report the χ^2 statistics for rank$(M) = 2$ and rank$(M) = 4$, that is, collective rationality with two and three apparent decision-makers, respectively. Column (2) shows very interesting results. First, it appears that the collective model with two apparent decision-makers must be rejected when using the whole sample. The χ^2 statistic is equal to 62.6 and the associated p-value is approximately equal to .0002. The same conclusion prevails with the sample of children aged between 16 and 22. When the model is estimated with the

Table 3: χ^2 Test Statistics

	Rank of M			Rank of Θ			Rank of $\left(\frac{M}{\Theta}\right)$
	(Proposition 2)			(Proposition 3)			(Proposition 4)
(Rank)	0	2	4	0	1	2	4
(DF)	45	28	15	30	18	8	54
SAMPLE:	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Complete	445.549	62.599	3.981	167.759	106.345	19.533	
	(0.000)	(0.000)	(0.998)	(0.000)	(0.000)	(0.012)	
Daughters	277.261	41.350	1.923	103.334	37.285	9.138	1.667
	(0.000)	(0.049)	(1.000)	(0.000)	(0.005)	(0.331)	(1.000)
Sons	221.508	27.261		124.588	97.011	34.794	
	(0.000)	(0.504)		(0.000)	(0.000)	(0.000)	
Children 16–21	298.235	49.132	2.135	130.334	92.474	7.843	2.012
	(0.000)	(0.008)	(1.000)	(0.000)	(0.000)	(0.449)	(1.000)
Children 22+	186.407	23.254		128.780	33.381	9.081	
	(0.000)	(0.720)		(0.000)	(0.015)	(0.336)	

[†] Probability under the null between parentheses.

sample of daughters, the test statistic falls slightly above the critical value. The p-value is equal to 0.049. The model is thus marginally rejected at the 5% level and relatively easily rejected at the 10% level. Interestingly, the collective model with two apparent decision-makers cannot be rejected when it is estimated with the samples of sons or of children aged 22 and older. Note that this does not mean that we reject that they are decision-maker, but instead, that we do not reject that they are not decision-makers. Recall that the number of apparent decision-maker is equal or lower than the number of decision-makers. The possibility that children aged 22 and over are not decision-makers could be explained by the unwillingness of parents to negotiate with their children once they reach a certain age and would prefer that they leave the family nest. As was stressed earlier, this sample is the most likely to suffer from selection bias.

Column (3) reports the test statistics based on the null assumption of collective rationality with three decision-makers. Following our sequential approach, the test statistics are only reported for those household configurations for which the null assumption that there are two apparent decision-makers is rejected. Interestingly, in the three cases where this occurs, the null hypothesis cannot be rejected. We must thus conclude on the basis of the rank of M that the collective model with three decision-makers is supported for the complete sample, and in particular for sub-samples of daughters and children aged between 16 and 21. It is rather puzzling that daughters appear to exert influence on the decision process, while sons appear not to. Based on a bargaining approach, it could be argued that daughters' threat point is likely higher because they marry at a younger age. Furthermore, their spouse is usually older and on average has greater earnings.

The second section of the table focuses on Proposition 3 related to the impacts of distribution factors. Recall that under collective rationality the rank of Θ must be less or equal to the number of potential decision-makers minus one ($= S$). The χ^2 test statistics reported in columns (4)–(6) are all based upon the Kleibergen and Paap

(2006) approach. According to the table, the null hypothesis that the rank of Θ is equal to zero is rejected in all cases at the 5% level of significance. As with Proposition 2, the unitary model is thus strongly rejected. Column (5) similarly rejects the null hypothesis that the rank of Θ is equal to one for all the samples. The data are thus incompatible with two apparent decision-makers under collective rationality. Column (6) indicates that when estimating the model with the whole sample, the null hypothesis that the rank of Θ is equal to two is rejected at the 5% level, implying a rejection of the collective model. This is perhaps due to an aggregation problem: the estimation of the model using the sample of sons also rejects the null hypothesis. For this group it could be that the distribution factors also reflect preference variables as we argued earlier [see Browning et al. (2006)]. For instance, sons' relative income may not only affect their bargaining power but may also reflect their preferences for leisure.

For the remaining specifications, *i.e.* daughters, children 16–21, and children aged 22 and over, we cannot reject the null hypothesis of collective rationality with three decision-makers. For the latter group, the apparent inconsistency between tests results from $SR(S)$ and distribution factors may partly be explained by the fact that changes in relative prices do not affect their bargaining power while changes in their relative income do (see our discussion in 2.4).

The last column of the table reports the test statistics based on the null hypothesis that there are three decision-makers in the household *and* that the distribution factors are collinear with the price effects.[22] The test statistics is reported only for the samples that satisfy collective rationality with three decision-makers, *i.e.* daughters and children 16–21. According to the test result, it must be concluded that the consumption behaviour of these households can be rationalized by a collective model with three decision-makers. Finally, note that the test statistics reported in columns (7) and (3) are nearly identical. As mentioned above, this should arise under collective rationality if the distribution factors and the prices are collinear, *and* the Wald statistics of Proposition 2 is not too severely plagued with parameterization problems.

5 Conclusion

To the best of our knowledge, this paper is the first to test the assumption of Pareto efficiency in households comprising potentially more than two decision-makers and using data from a developed country. It is also the first to treat children as regular decision-makers.

We first present an overview of the tests that have recently been developed in the literature to test the collective rationality within multi-person households. These are based on the impact of prices and distribution factors on household demands. Intuitively, prices and distribution factors affect the demands indirectly through the so-called individual Pareto weights. The fact that there are only as many Pareto weights as there are potential decision-makers imposes specific constraints on the rank of the compensated price and factor distributions effects.

The framework we use is general enough to analyse the consumption choices of a variety of household types including, but not limited to, couples living with grown-ups, adult children, elderly parents, *etc.* In the paper we focus on the consumption expenditures of households composed of two parents and a single child of at least 16 years of age. The sample is drawn from a series of U.K. Family Expenditure Surveys covering the period

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[22]The χ^2 statistics is computed on the basis of the Kleibergen and Paap (2006) approach.

1982–1993. We acknowledge that household composition may be partly determined by the relative bargaining power of its members. In particular, adult children may choose to live with their parents because they enjoy a enviable position. Plainly stated, our sample may be plagued by self-selection problems. We investigate this issue by stratifying our sample into two groups: (1) households in which the child is aged between 16 and 21; (2) households whose child is at least 22 years of age. We also stratify the sample by gender to investigate whether sons and daughters have similar bargaining power within the household.

The empirical analysis yields a number of interesting results. First, it is found that households whose child is aged between 16 and 21 behave as tough there are three decision-makers. This result underlines the importance of recognizing the input of adolescent children into the family decision-making process. Daughters are similarly found to affect the consumption decisions, irrespective of their age. Other household configurations yield less clear-cut results. Thus the consumption pattern of households whose child is at least 22 years of age, while compatible with collective rationality, is only consistent with there being at least two apparent decision-makers. The evidence for sons is simply not conclusive. The tests based on the prices and distribution factors yield contradictory results. In fact collective rationality is rejected when tested on the distribution factors alone. However, as argued in the literature, distribution factors can only be hypothesized not to act also as preference variables.

All in all, our analysis underlines the fact that it may be incorrect to assume that there are no more than two decision-makers when a household comprises teenage or adult children. This assumption has never been tested rigourously before and is routinely made in virtually every empirical analysis of household consumption. Clearly, the assumed number of decision-makers is very important for intra-household welfare analysis and policy targeting. Acknowledging that children may influence the household decision-making process could prove important to the way we approach these issues.

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Table 4: Parameter Estimates of the Demand System – Sample of Daughters

Variable	Food	Alc.	Tobac.	Cloth.	Leisure	Trans.	Serv.	Rest.	P.G.	R.G.
					DISTRIBUTION FACTORS					
$\log(Y_H)$	0,011	0,003	0,004	-0,004	-0,003	0,001	-0,002	0,001	0,000	-0,005
	(2,180)	(1,002)	(1,642)	(1,281)	(1,045)	(0,575)	(0,902)	(0,644)	(0,134)	(1,552)
$\Delta\log(Y_{WH})$	0,002	0,003	0,001	-0,001	-0,002	0,000	0,000	0,001	0,001	0,000
	(0,618)	(2,217)	(0,878)	(0,303)	(1,436)	(0,370)	(0,440)	(1,428)	(0,923)	(0,115)
$\Delta\log(Y_{CH})$	-0,001	0,002	0,002	0,001	0,001	0,000	-0,001	0,000	0,000	-0,002
	(0,364)	(1,449)	(2,380)	(0,916)	(0,894)	(0,160)	(1,828)	(0,459)	(0,003)	(1,507)
					PRICE VARIABLES					
Γ-Food	-0,309	-0,165	-0,108	0,087	0,017	0,198	-0,061	0,021	0,089	0,203
	(2,000)	(1,777)	(1,414)	(0,833)	(0,215)	(2,790)	(1,097)	(0,339)	(0,945)	(2,030)
Γ-Alcohol	-0,140	-0,046	-0,063	0,028	-0,004	0,044	0,000	0,062	-0,033	-0,037
	(2,344)	(1,293)	(2,125)	(0,688)	(0,143)	(1,610)	(0,004)	(2,588)	(0,896)	(0,953)
Γ-Tobacco	-0,062	0,123	0,012	0,005	0,002	0,027	-0,152	0,025	0,112	-0,021
	(1,086)	(3,584)	(0,417)	(0,132)	(0,067)	(1,012)	(7,420)	(1,080)	(3,221)	(0,560)
Γ-Clothing	0,155	0,066	0,067	-0,057	-0,007	-0,001	0,086	0,036	0,096	-0,073
	(1,707)	(1,210)	(1,514)	(0,942)	(0,159)	(0,033)	(2,640)	(1,004)	(1,744)	(1,254)
Γ-Leisure	0,088	0,020	-0,014	0,016	-0,057	0,002	-0,017	0,029	0,037	-0,047
	(2,438)	(0,914)	(0,809)	(0,669)	(3,136)	(0,104)	(1,334)	(2,026)	(1,678)	(2,032)
Γ-Transportation	-1,247	-0,172	-0,017	0,439	0,171	0,063	-0,217	0,146	-0,202	0,060
	(6,497)	(1,499)	(0,178)	(3,399)	(1,783)	(0,712)	(3,139)	(1,905)	(1,731)	(0,484)
Γ-Services	-3,035	0,176	-0,463	0,955	0,517	0,356	0,114	0,073	0,601	0,128
	(5,529)	(0,537)	(1,713)	(2,584)	(1,886)	(1,410)	(0,575)	(0,331)	(1,801)	(0,362)
Γ-Restaurant	1,432	-0,649	-0,012	-1,057	-0,421	-0,082	0,304	-0,169	0,081	0,245
	(4,165)	(3,150)	(0,073)	(4,566)	(2,450)	(0,519)	(2,460)	(1,228)	(0,387)	(1,107)
Γ-Personal	1,538	0,564	0,377	0,167	0,103	-0,235	-0,110	0,074	-0,112	-0,143
	(2,946)	(1,803)	(1,466)	(0,474)	(0,397)	(0,978)	(0,588)	(0,354)	(0,352)	(0,424)
Γ-Recreational	0,764	-0,079	0,190	-0,280	-0,073	-0,318	-0,019	-0,055	-0,701	-0,332
	(1,982)	(0,343)	(0,999)	(1,078)	(0,378)	(1,796)	(0,137)	(0,356)	(2,995)	(1,334)
					SPECIFICATION TESTS†					
Total Expend (Residual)	-0,133	0,016	-0,006	0,022	0,032	-0,002	-0,016	-0,002	-0,016	0,021
	(16,935)	(3,398)	(1,436)	(4,141)	(8,129)	(0,463)	(5,658)	(0,503)	(3,408)	(4,095)
Over-Ident. $\chi^2_{(3)}$	10,979	6,551	13,576	8,089	1,040	3,869	11,240	2,860	3,821	17,280

† The first line reports the parameter estimates of the residuals from an auxiliary regression of total expenditures on a series of instrumental variables. The second line reports the χ^2 statistics of the validity of instruments and of the over-identification restrictions.

Table 5: Parameter Estimates of the Demand System – Sample of Sons

Variable	Food	Alc.	Tobac.	Cloth.	Leisure	Trans.	Serv.	Rest.	P.G.	R.G.
					DISTRIBUTION FACTORS					
$\log(Y_H)$	0,011	-0,005	0,000	0,000	-0,002	-0,003	0,002	0,002	0,003	-0,005
	(2,680)	(2,054)	(0,132)	(0,016)	(0,775)	(1,905)	(1,305)	(1,319)	(1,173)	(1,969)
$\Delta\log(Y_{WH})$	0,004	-0,001	0,000	0,000	-0,001	-0,001	0,001	0,000	-0,001	0,002
	(1,992)	(1,169)	(0,225)	(0,166)	(1,556)	(1,263)	(0,951)	(0,189)	(0,539)	(1,742)
$\Delta\log(Y_{CH})$	0,001	-0,002	0,001	0,000	-0,001	0,001	0,001	0,000	0,002	-0,004
	(0,721)	(1,672)	(0,748)	(0,109)	(1,122)	(0,850)	(1,484)	(0,288)	(1,479)	(3,506)
					PRICE VARIABLES					
Γ-Food	-0,631	-0,035	-0,042	-0,117	0,227	0,032	-0,144	-0,025	0,037	0,216
	(4,692)	(0,422)	(0,592)	(1,224)	(3,207)	(0,567)	(2,982)	(0,438)	(0,455)	(2,562)
Γ-Alcohol	-0,035	-0,011	-0,051	-0,024	0,018	0,024	-0,004	-0,043	0,059	-0,040
	(0,714)	(0,368)	(1,955)	(0,675)	(0,693)	(1,167)	(0,241)	(2,059)	(1,960)	(1,295)
Γ-Tobacco	0,064	0,060	0,038	0,049	-0,026	-0,027	-0,132	-0,012	0,017	0,013
	(1,351)	(2,103)	(1,547)	(1,455)	(1,041)	(1,362)	(7,787)	(0,636)	(0,578)	(0,455)
Γ-Clothing	0,049	0,048	-0,005	0,050	-0,084	-0,042	-0,013	0,024	-0,038	-0,030
	(0,643)	(1,025)	(0,130)	(0,927)	(2,084)	(1,320)	(0,480)	(0,760)	(0,822)	(0,623)
Γ-Leisure	0,073	-0,004	-0,021	0,048	0,003	0,031	-0,026	0,003	-0,011	-0,008
	(2,458)	(0,220)	(1,369)	(2,277)	(0,168)	(2,473)	(2,468)	(0,205)	(0,586)	(0,436)
Γ-Transportation	-0,994	-0,388	0,068	0,331	0,219	0,154	0,007	0,066	-0,185	0,247
	(6,206)	(3,976)	(0,808)	(2,906)	(2,599)	(2,281)	(0,114)	(0,993)	(1,887)	(2,463)
Γ-Services	-2,173	0,007	-0,149	0,256	0,522	-0,041	0,061	-0,187	0,049	0,215
	(4,676)	(0,024)	(0,612)	(0,773)	(2,131)	(0,208)	(0,366)	(0,967)	(0,172)	(0,737)
Γ-Restaurant	1,351	-0,412	-0,131	-0,280	-0,482	-0,217	0,239	0,187	0,125	-0,115
	(4,684)	(2,349)	(0,867)	(1,365)	(3,176)	(1,788)	(2,309)	(1,561)	(0,711)	(0,636)
Γ-Personal	0,840	0,553	0,183	-0,179	-0,182	-0,052	-0,243	-0,210	0,009	0,071
	(1,982)	(2,147)	(0,823)	(0,593)	(0,815)	(0,289)	(1,599)	(1,193)	(0,035)	(0,266)
Γ-Recreational	0,921	-0,183	0,054	0,084	-0,179	0,060	0,395	0,116	-0,155	-0,371
	(2,939)	(0,959)	(0,331)	(0,378)	(1,084)	(0,454)	(3,514)	(0,891)	(0,810)	(1,890)
					SPECIFICATION TESTS[†]					
Total Expend (Residual)	-0,129	0,004	-0,012	0,020	0,042	-0,005	-0,009	-0,008	-0,024	0,011
	(19,437)	(0,878)	(3,467)	(4,254)	(11,964)	(1,720)	(3,689)	(2,966)	(5,822)	(2,686)
Over-Ident. $\chi^2_{(3)}$	7,272	4,172	10,557	4,442	7,770	2,191	8,387	1,114	8,991	7,991

[†] The first line reports the parameter estimates of the residuals from an auxiliary regression of total expenditures on a series of instrumental variables. The second line reports the χ^2 statistics of the over-identification test of the instrumental variables.

Table 6: Parameter Estimates of the Demand System – Sample of Children 16–21

Variable	Food	Alc.	Tobac.	Cloth.	Leisure	Trans.	Serv.	Rest.	P.G.	R.G.
					DISTRIBUTION FACTORS					
$\log(Y_H)$	0,015	-0,003	0,001	-0,003	-0,002	-0,003	0,001	0,003	-0,001	-0,004
	(3,829)	(1,254)	(0,556)	(0,924)	(1,234)	(1,549)	(0,581)	(1,665)	(0,540)	(1,800)
$\Delta\log(Y_{WH})$	0,003	0,000	-0,001	0,000	-0,001	-0,001	0,000	0,002	0,001	0,000
	(1,431)	(0,231)	(0,545)	(0,330)	(0,913)	(0,630)	(0,035)	(1,904)	(0,443)	(0,111)
$\Delta\log(Y_{CH})$	0,000	0,000	0,002	0,000	0,000	0,000	0,000	0,000	0,001	-0,003
	(0,214)	(0,014)	(2,140)	(0,065)	(0,052)	(0,077)	(0,108)	(0,445)	(0,568)	(3,377)
					PRICE VARIABLES					
Γ-Food	-0,367	-0,205	-0,032	-0,014	0,106	0,098	-0,155	0,032	0,055	0,192
	(2,774)	(2,596)	(0,477)	(0,153)	(1,591)	(1,755)	(3,312)	(0,583)	(0,712)	(2,334)
Γ-Alcohol	-0,061	-0,053	-0,073	0,004	0,026	0,021	0,000	0,011	-0,007	-0,025
	(1,252)	(1,803)	(2,930)	(0,131)	(1,059)	(0,998)	(0,025)	(0,556)	(0,259)	(0,814)
Γ-Tobacco	-0,043	0,122	0,026	0,049	-0,018	0,006	-0,143	0,000	0,066	-0,003
	(0,900)	(4,322)	(1,090)	(1,501)	(0,751)	(0,322)	(8,537)	(0,001)	(2,388)	(0,099)
Γ-Clothing	0,065	0,071	0,045	0,035	-0,038	-0,046	0,059	0,016	-0,002	-0,065
	(0,871)	(1,581)	(1,185)	(0,666)	(1,004)	(1,459)	(2,206)	(0,529)	(0,057)	(1,393)
Γ-Leisure	0,066	0,021	-0,031	0,069	-0,029	0,012	-0,022	0,015	0,006	-0,027
	(2,209)	(1,197)	(2,031)	(3,333)	(1,968)	(0,992)	(2,048)	(1,244)	(0,325)	(1,447)
Γ-Transportation	-1,071	-0,255	-0,016	0,414	0,233	0,138	-0,102	0,107	-0,099	0,128
	(6,714)	(2,677)	(0,193)	(3,735)	(2,894)	(2,054)	(1,804)	(1,639)	(1,071)	(1,291)
Γ-Services	-2,849	0,235	-0,178	0,495	0,391	0,229	0,098	-0,103	0,379	-0,006
	(6,042)	(0,833)	(0,740)	(1,513)	(1,643)	(1,153)	(0,585)	(0,532)	(1,382)	(0,020)
Γ-Restaurant	1,571	-0,704	-0,073	-0,793	-0,428	-0,199	0,212	0,070	0,159	0,049
	(5,504)	(4,123)	(0,503)	(3,999)	(2,972)	(1,656)	(2,092)	(0,602)	(0,960)	(0,276)
Γ-Personal	0,834	0,746	0,238	0,247	-0,003	-0,156	-0,094	-0,158	-0,297	0,139
	(1,995)	(2,982)	(1,120)	(0,850)	(0,014)	(0,887)	(0,631)	(0,920)	(1,223)	(0,536)
Γ-Recreational	0,916	-0,154	-0,047	-0,118	-0,050	-0,069	0,190	0,066	-0,328	-0,243
	(2,798)	(0,788)	(0,282)	(0,520)	(0,300)	(0,501)	(1,640)	(0,494)	(1,724)	(1,196)
					SPECIFICATION TESTS[†]					
Total Expend (Residual)	-0,126	0,007	-0,007	0,023	0,035	-0,004	-0,013	-0,007	-0,018	0,013
	(19,725)	(1,856)	(2,148)	(5,231)	(10,894)	(1,330)	(5,597)	(2,511)	(4,787)	(3,369)
Over-Ident. $\chi^2_{(3)}$	13,423	9,804	4,174	4,643	3,473	3,640	13,064	0,495	7,580	11,039

[†] The first line reports the parameter estimates of the residuals from an auxiliary regression of total expenditures on a series of instrumental variables. The second line reports the χ^2 statistics of the over-identification test of the instrumental variables.

Table 7: Parameter Estimates of the Demand System – Sample of Children 22 and Over

Variable	Food	Alc.	Tobac.	Cloth.	Leisure	Trans.	Serv.	Rest.	P.G.	R.G.
					DISTRIBUTION FACTORS					
$\log(Y_H)$	0,012	-0,003	0,002	-0,001	-0,002	0,000	0,000	-0,001	0,004	-0,007
	(2,044)	(0,937)	(0,726)	(0,272)	(0,760)	(0,035)	(0,161)	(0,468)	(1,164)	(1,840)
$\Delta \log(Y_{WH})$	0,002	0,001	0,001	0,000	-0,002	-0,001	0,000	-0,001	0,000	0,003
	(0,792)	(0,634)	(1,183)	(0,114)	(1,677)	(0,498)	(0,491)	(0,778)	(0,101)	(1,857)
$\Delta \log(Y_{CH})$	0,011	-0,003	0,000	0,002	-0,003	0,001	0,000	-0,001	-0,001	-0,005
	(2,499)	(1,075)	(0,108)	(0,642)	(1,403)	(0,430)	(0,187)	(0,386)	(0,184)	(1,515)
					PRICE VARIABLES					
Γ-Food	-0,871	0,169	-0,146	-0,007	0,191	0,139	-0,044	-0,048	0,076	0,205
	(5,423)	(1,715)	(1,773)	(0,060)	(2,212)	(1,834)	(0,746)	(0,720)	(0,713)	(1,928)
Γ-Alcohol	-0,092	0,014	-0,027	-0,007	-0,019	0,048	-0,006	-0,012	0,061	-0,063
	(1,500)	(0,362)	(0,865)	(0,174)	(0,580)	(1,667)	(0,254)	(0,472)	(1,509)	(1,558)
Γ-Tobacco	0,089	0,016	0,033	0,016	-0,013	-0,017	-0,146	0,010	0,052	0,006
	(1,544)	(0,439)	(1,116)	(0,390)	(0,408)	(0,641)	(6,804)	(0,406)	(1,356)	(0,158)
Γ-Clothing	0,181	0,004	0,008	-0,052	-0,080	-0,007	-0,027	0,046	0,043	-0,009
	(1,940)	(0,076)	(0,175)	(0,805)	(1,596)	(0,162)	(0,785)	(1,175)	(0,698)	(0,144)
Γ-Leisure	0,082	-0,012	0,005	-0,024	-0,016	0,029	-0,032	0,001	0,032	-0,009
	(2,316)	(0,545)	(0,253)	(0,999)	(0,838)	(1,718)	(2,458)	(0,040)	(1,351)	(0,380)
Γ-Transportation	-1,184	-0,333	0,082	0,342	0,144	0,106	-0,084	0,114	-0,299	0,218
	(6,152)	(2,824)	(0,829)	(2,569)	(1,390)	(1,166)	(1,175)	(1,423)	(2,357)	(1,715)
Γ-Services	-2,324	-0,126	-0,482	0,702	0,753	-0,002	0,060	-0,017	0,116	0,419
	(4,322)	(0,383)	(1,751)	(1,888)	(2,602)	(0,009)	(0,304)	(0,075)	(0,326)	(1,180)
Γ-Restaurant	1,026	-0,206	-0,093	-0,279	-0,485	-0,120	0,366	-0,098	-0,028	0,038
	(2,959)	(0,965)	(0,522)	(1,162)	(2,594)	(0,734)	(2,849)	(0,683)	(0,120)	(0,168)
Γ-Personal	1,943	0,193	0,398	-0,568	-0,202	-0,134	-0,351	0,087	0,390	-0,268
	(3,660)	(0,593)	(1,464)	(1,545)	(0,708)	(0,533)	(1,786)	(0,397)	(1,112)	(0,764)
Γ-Recreational	0,905	-0,154	0,370	-0,055	-0,289	-0,140	0,266	-0,026	-0,408	-0,475
	(2,509)	(0,697)	(2,005)	(0,221)	(1,486)	(0,820)	(1,987)	(0,174)	(1,712)	(1,994)
					SPECIFICATION TESTS[†]					
Total Expend (Residual)	-0,139	0,010	-0,014	0,017	0,042	-0,005	-0,011	-0,002	-0,026	0,018
	(16,721)	(1,875)	(3,234)	(2,965)	(9,291)	(1,194)	(3,700)	(0,462)	(4,807)	(3,235)
Over-Ident. $\chi^2_{(3)}$	2,495	1,903	14,964	6,973	5,738	2,010	4,970	2,451	3,045	9,722

[†] The first line reports the parameter estimates of the residuals from an auxiliary regression of total expenditures on a series of instrumental variables. The second line reports the χ^2 statistics of the over-identification test of the instrumental variables.