DEMAND, CHILDBIRTH AND THE COSTS OF BABIES: EVIDENCE FROM SPANISH PANEL DATA*

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ÍNDEX

ABSTRACT

The aim of this paper is to address the question of how children affect household life-cycle expenditure patterns in the surrounding of childbirth date. During this period some potentially important changes are taking place in the household: changing needs (nutrition effects, children clothing), changes in relation to labour supply (specially for the mother) and other possible changes due to the anticipation of the family to the event (saving and/or borrowing). An interesting issue in this context is the concept of intertemporal demographic separability and its relation to Rothbarth demographic separability and the measurement of child costs. To investigate this we estimate a *Frisch* demand system taking special care about the definition of a set of dummies capturing the arrival of a new child in the household. We use a panel of households drawn from the Spanish Family Expenditure Survey for the period 1985-1995. Among the main results, we must emphasise that while we observe important jumps in the consumption of some children related goods (clothing, entertainment and food), we observe no changes in the so called *adult* goods.

JEL Classification: C33, D12, J13.

Key Words: Childbirth, intertemporal demographic separability, Frisch demographic separability, Rothbarth demographic separability, panel data.

The theoretical approach we use to model intertemporal consumption decisions is the conventional model of life-cycle consumption under uncertainty proposed by Hall (1978) and developed in Browning, Deaton and Irish (1985). As stressed by Deaton (1992), one of the distinguishing features of recent research on consumption has been the way in which uncertainty has been introduced into the analysis. We concentrate on the demand for commodities as the decision variables. We will incorporate labour supply variables as conditioning the demand decision. Therefore, this is an intertemporal model that follows the conditional approach put forward by Browning and Meghir (1991) and Meghir and Weber (1996). The advantage of this approach is that one can derive constant marginal utility demand functions, or Frisch demands. This kind of demand functions separate between anticipated and unanticipated effects of both prices and demographic structure of the household. The important development of this kind of modelling due to McCurdy (see Heckman, 1978, Heckman and McCurdy, 1980 or McCurdy, 1981) is the realisation that the constant unobservable marginal utility (over the lifetime of the consumer), can be treated as a fixed effect in the econometric analysis.

We assume that household's preferences over goods can be characterised as satisfying intertemporal additive separability with within period utility function $u_t(q_t, z_t)$ where q_t is a vector of goods in period t and z_t is a vector of demographic variables, labour participation dummies and other socio-economic characteristics[9]. Define a corresponding within period cost function

$$c_t(u_t, p_t, z_t) = \min_{q_t} \{ p_t q_t / u_t(q_t, z_t) \geq u_t \} \tag{1}$$

giving the lowest within period cost of achieving a given utility within the period.

Households maximise utility with continuous replanning (under uncertainty), choosing their most preferred allocation of expenditures subject to the constraint that the discounted value of the lifetime expenditures equals the present value of lifetime wealth. Conditional on labour supply and other socio-demographic variables, commodity demands in period t are chosen to solve the Bellman equation[10].

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[9] The additive separability assumption over time allows separating the optimisation problem into two stages, i.e. two stage budgeting. Total consumption is first allocated between time periods, and then, subject to this upper stage allocation, each period consumption is distributed among commodity groups, Gorman (1959). We also assume that the additive form of the utility function characterises both intertemporal separability and the additivity over states that is implied by the conditional preference axiom of choice under uncertainty, see Browning, Deaton and Irish (1985).

[10] We implicitly assume that the household has made its fertility and human capital plans. Thus, we will not discuss whether children are the result of a choice.

(2) $$V_t(A_t) = \underset{A_{t+1},q_t}{Max}\left\{u_t(q_t,z_t) + E_t V_{t+1}(A_{t+1})\right\}$$

where A_t is non-human wealth at the end of period t[11]. The evolution of assets is given by the standard difference equation.

(3) $$\begin{aligned} A_{t+1} &= (1+i_t)(A_t - p_t q_t) + y_t \\ A_T &= 0 \end{aligned}$$

where i_t is the real interest rate between periods t and $t+1$, p_t is a vector of prices of goods in period t, y_t is household income in period t and T is length of life for the household. The expectations operator E_t is taken with respect to future prices, interest rates, and income flows which are assumed uncertain.

The first order conditions for the solution of (2) subject to (3) are

(4) $$\frac{\partial u_t}{\partial q_t}(q_t, z_t) = \lambda_t p_t$$

(5) $$\lambda_t = E_t\left[(1+i_t)\lambda_{t+1}\right]$$

where l_t is the marginal (lifetime) utility of period t resources (or the reciprocal of the undiscounted price of utility). The equation describing the anticipated evolution of l_t is the standard Euler equation. Using the first order conditions one can derive the Frisch demand functions under uncertainty as

(6) $$q_t = f_t(\lambda_t, p_t, z_t)$$

All variables from outside the period influence demands only through l_t as a consequence of the additivity assumption made for intertemporal utility. Under perfect certainty l_t would be fixed and could be treated in panel data as a fixed effect in econometric analysis. In the case of uncertainty there is a stochastic equation describing the evolution of l_t but a suitable approximation to the Euler equation can allow elimination of the unobservable element.

If we define the within-period profit function by

(7) $$\pi_t(\lambda_t, p_t, z_t) = \underset{u_t}{max}[u_t / \lambda_t - c_t(u_t, p_t, z_t)$$

then Hotelling's lemma establishes that the Frisch demands can be derived from the derivatives of the profit function with respect to the prices (see Browning, Deaton and Irish 1985),

(8) $$f_t(\lambda_t, p_t, z_t) = -\frac{\partial \pi_t}{\partial p_t}(\lambda_t, p_t, z_t)$$

[11] The period sub-utility functions are indexed on age t trying to reflect both intertemporal discounting of utility and the modifying role played by the presence and/or the arrival of children and their changing demands over the family life-cycle, as in Browning, Deaton and Irish (1985).

Satisfaction of the within-period first order conditions (4) alone identifies the utility function only up to increasing monotonic transformation $\psi_t(u_t, z_t)$. However adding the equation (5) linking l_t across periods leaves satisfaction invariant only up to affine transformations of within period utility of the form $au_t + \phi_t(z_t)$.

2.2. Child costs and intertemporal demographic separability

We can define within-period child costs as the difference between the cost of reaching a given standard of living with and without children

$$c_t(u_t, p_t, z_t) - c_t(u_t, p_t, z_t^0) \qquad (9)$$

where z_t^0 differs from z_t in the absence of children. This notion can obviously be made more specific to capture the cost of children of specific ages and sexes, with and without siblings and so on. The within-period cost is one of several possible notions which suggest themselves in a life cycle context. Banks, Blundell and Preston (1994, 1995) relate this to other notions of the cost, including the full life cycle cost allowing for intertemporal substitution responses. However it is the cost defined in (9) that has typically been the focus of empirical study.

The fundamental identification problem involved in estimating (9) from demand behaviour has been pointed out by Pollak and Wales (1979) and Blundell and Lewbel (1991), among others. Within-period demand behaviour identifies only the shape of indifference curves in q_t-space conditional on z_t and nothing about preferences over children. It is therefore informative only about the way in which costs vary with the price p_t of those goods and not about the variation of costs with z_t. If child costs can be identified in any one price regime then within-period demand behaviour allows us to draw inferences about child costs in other price regimes but identification of child costs in that base regime requires information from elsewhere.

As Banks, Blundell and Preston (1994, 1995) point out, setting demands within an intertemporal framework alleviates the problem somewhat since individuals can now be observed choosing how to allocate goods between periods in which children are and are not present. As noted above, the addition of the Euler equation to the within period first order conditions under the assumption of intertemporal additivity narrows the class of utility transformations under which behaviour will be invariant. Specifically, utility is identified up to transformations of the form $au_t + \phi_t(z_t)$, which is to say translation by functions of z_t and rescaling common to all demographic types.

Deaton, Ruiz-Castillo and Thomas (1989) introduce the important concept of demographic separability. A subset of goods q_t^0 is said to be demographically separable (within a period) if Marshallian demands for that group take the form

$$(10) \qquad q_t^0 = g_t^0(x_t, p_t, z_t) = \gamma_t^0(\theta_t(x_t, p_t, z_t), p_t)$$

where x_t is expenditure within the period and $\theta_t(x_t, p_t, z_t)$ is a scalar function. For such goods the effect of demographics are proportional to income effects.

The most familiar and possibly the most interesting example is the case of *adult* goods discussed by Rothbarth (1944). In this case there is a subset of goods for which the Hicksian demands are independent of z_t

$$(11) \qquad q_t^0 = h_t^0(u_t, p_t, z_t) = \xi_t^0(\lambda_t, p_t)$$

This is demographic separability with $\theta_t(x_t, p_t, z_t) = u_t$ and we refer to it as Rothbarth demographic separability. In this case demand for any of these goods can stand as a welfare indicator independently of demographic type. Households with and without children but which consume similar quantities of these goods enjoy similar utilities and a comparison of their total expenditures furnishes an immediate and simple measure of child costs. The required form for the cost function is well known (see Blackorby and Donaldson 1995). We need

$$(12) \qquad c_t(u_t, p_t, z_t) = a_t(u_t, p_t) + d_t(u_t, p_t^1, z_t)$$

for some functions $a_t(.)$ and $d_t(.)$ where p_t^1 denotes the prices of the non-adult goods.

Another example of within-period demographic separability is readily identified and may be of particular interest in an intertemporal setting. It occurs if a subset of Frisch demands are found to be independent of z_t

$$(13) \qquad q_t^0 = f_t^0(\lambda_t, p_t, z_t) = \psi_t^0(\lambda_t, p_t)$$

This is demographic separability with $\theta_t(x_t, p_t, z_t) = \lambda_t$ and we refer to it as Frisch demographic separability. It is easy to test for Frisch separability given data on intertemporal demands. The interesting question which then arises is whether Frisch and Rothbarth demographic separability are related. The following result establishes the link between the two notions.

Theorem 1. **(***a) A group of goods q_t^0 are Frisch demographically separable if and only if the profit function takes the form*

$$(14) \qquad \pi_t(\lambda_t, p_t, z_t) = \alpha_t(\lambda_t, p_t) + \delta_t(\lambda_t, p_t^1, z_t)$$

(b) A group of goods q_t^0 are both Frisch demographically separable and Rothbarth demographically separable if and only if the profit function takes the form (14) with

(15) $$\delta_t(\lambda_t, p_t^1, z_t) = \Delta_t(p_t^1, z_t)$$

for some function $\Delta_t(.)$ *. Equivalently the cost function takes the form (12) with*

(16) $$d_t(u_t, p_t^1, z_t) = \Delta_t(p_t^1, z_t)$$

Proof. (*a)* By Hotelling's lemma, Frisch demographic separability holds if and only if

$$-\frac{\partial p_t}{\partial p_t^0}(l_t, p_t, z_t) = y_t^0(l_t, p_t)$$

The corresponding form (14) for the profit function follows by integration with respect to p_t^0.

(b) Rothbarth demographic separability holds if and only if the cost function takes the form (12) in which case the profit function has the form

$$\pi_t(\lambda_t, p_t, z_t) = \max_{u_t}[u_t / \lambda_t - a_t(u_t, p_t) + d_t(u_t, p_t^1, z_t)$$

Let the value of u_t solving the problem be $u_t^*(\lambda_t, p_t, z_t)$. Then

$$\pi_t(\lambda_t, p_t, z_t) = u_t^*(\lambda_t, p_t, z_t) / \lambda_t - a_t(u_t^*(\lambda_t, p_t, z_t), p_t)) + d_t(u_t^*(\lambda_t, p_t, z_t), p_t^1, z_t)$$

which takes the form (14) if and only if $u_t^*(\lambda_t, p_t, z_t)$ not depend on z_t and $d_t(u_t, p_t^1, z_t)$ does not depend upon u_t. The latter of these two conditions suffices for the first also to hold, in which case

$$d_t(u_t, p_t^1, z_t) = \Delta_t(\lambda_t, p_t^1, z_t) = \Delta_t(p_t^1, z_t)$$

Intuitively, Frisch and Rothbarth demographic separability can coincide only if l_t and u_t vary together independently of demographic composition z_t. Hence l_t should not vary with z_t given u_t or, in other words, $\partial c_t(u_t, p_t, z_t) / \partial u_t$ should be independent of z_t. Therefore

(17) $$\frac{\partial}{\partial u_t}\left[c_t(u_t, p_t, z_t) - c_t(u_t, p_t, z_t^0)\right] = 0$$

and child costs must be independent of utility level at which they are measured.

The condition (17) is similar to one familiar from the literature on child costs. If the cost function takes the form

(18) $$c_t(u_t, p_t, z_t) = A_t(u_t, p_t) + D_t(p_t, z_t)$$

then costs are said to be independent of base (Lewbel, 1989) or absolute exact (Blackorby and Donaldson, 1995). Households at all levels of utility need to spend the same amount to keep utility unchanged if children are present and child costs as defined in (9) are independent of u_t. The condition (17) is exactly the intersection of absolute exactness with Rothbarth demographic separability.

Absolute exactness is an extremely strong assumption. If it holds then the intertemporal allocation of utility is independent of the intertemporal path of demographics and the lifetime cost of children is simply the sum of the within-period costs - two facts noted by Pendakur (1999). Furthermore, these costs can be measured by comparing the within-period expenditures of households with and without children whose expenditures coincide in periods before children were present. That is to say, the costs are captured by the jump in spending implied by the Frisch demand functions at the birth of a child. This idea, essentially amounting to using out-of-parenthood expenditure as an adult good, is discussed by Banks, Blundell and Preston (1995) who establish the general form of the lifetime cost function justifying such an idea. Adding additivity to their assumptions would imply within-period costs of precisely the absolute exact form under discussion here.

It is more typical to assume that costs of maintaining utility after arrival of a child rise with utility. In this case children increase the *price of utility* and intertemporal substitution would reduce demand for all normal adult goods in periods when children were present, violating Frisch demographic separability.

3. THE EMPIRICAL SPECIFICATION, ECONOMETRIC ISSUES AND THE DATA

3.1. The empirical specification

In selection of the functional form for Frisch demands we seek to introduce the unobserved price of utility additively in order to treat it conveniently as a fixed effect (with or without random elements). Specifically we adopt a household profit function

$$(19) \quad -\pi_t^h(\lambda_t^h, p_t, z_t^h) = \sum_i \mu_i p_{it} \, ln(p_{it}\lambda_t^h) + \sum_i p_{it}\zeta_{it}^h(z_t^h) + \phi(z_t^h) / \lambda_t^h$$

where we have added an *h* supersript to denote the household where the variable in question varies cross-sectionally and an *i* subscript to denote goods. Differentiating with respect to prices and using Hotelling's lemma implies the form for Frisch demands

$$(20) \quad q_{it}^h = \mu_i + \zeta_{it}^h(z_t^h) + \mu_i \, ln \, p_{it} + \mu_i \, ln \, \lambda_t^h$$

Adding a further linear homogeneous function of prices to (19) could generate cross-price effects as in Browning, Deaton and Irish (1985) where the specification is otherwise very similar. However, we omit such terms. The specification is completed by adopting a form for $\zeta_{it}^{h}(z_t^h)$

(21) $$\zeta_{it}^{h}(z_t^h) = \beta_{i0} + \beta_i^{'} z_t^h + \eta_i^h + \varepsilon_{it}^h$$

where η_i^h is a fixed idiosyncratic household effect and ε_{it}^h is a household and period-specific innovation.

Within such a specification a good is Frisch demographically separable if and only if the elements of b_i corresponding to the presence of children are equal to zero so that $\zeta_{it}^{h}(z_t^h)$ is independent of children. This is clearly testable. The costs function corresponding to (19) takes the form

(22) $$c_t^h(u_t^h, p_t, z_t^h) = A_t^h(u_t^h - \phi(z_t^h), p_t) + D_t(p_t, z_t^h)$$

and inferences about Rothbarth demographic separability can be drawn only if child costs are also independent of base which requires $f(z_t^h) = 0$. Since $f(z_t^h)$ does not enter the Frisch demand equation (20) this can not be tested and marks the limits of identifiability for child costs in a framework such as this.

Finally, it is interesting to stress that we have modified the approach of Browning, Deaton and Irish (1985) to account for children, other socio-demographic characteristics and labour supply variables (and some interactions of these variables) by making $z_{it}^h(z_t^h)$ a function of these variables and allowing also for an idiosyncratic error term. This modification is similar to the conditional approach derived in Browning and Meghir (1991) and also applied in Meghir and Weber (1996) in an intertemporal setting. One can notice that these equations are linear in the parameters and in $ln\lambda_t^h$ and can be used for estimation provided that we devise an approximation for the Euler equation.

3.2. Some econometric issues

We estimate the unrestricted demand equations using the model under uncertainty and accounting for unobserved individual heterogeneity. To estimate the demand equations (20) we have to account both for the fact that we have a fixed effect capturing individual unobserved heterogeneity and we also have other unobserved elements in the equation that come from the presence of $ln\lambda_t^h$. Taking first differences eliminates the fixed effects. A first order Taylor approximation to the Euler equation (5) gives

(23) $$\Delta\, ln(\lambda_{t+1}^h) \cong -ln(1+i_t) + \omega_{t+1}^h + e_{t+1}^h$$

where $E_t e_{t+1}^h = 0$ and ω_{t+1}^h is proportional to the conditional variance of the shock e_{t+1}^h (see, for example, Attanasio, 1999). By substitution into (20) and (21)

(24) $$\Delta q_{it}^{h} = \beta_i' \Delta z_t^{h} + \mu_i \, ln \, p_{it} - \mu_i \, ln(1 + i_{t-1}) + \mu_i \omega_t^{h} + \mu_i e_t^{h} + \Delta \varepsilon_{it}^{h}$$

The arrival of a new child in the household can induce some *dynamic* behaviour on household demand. Intuitively and looking at the classification of goods we use in this paper there is a group of goods which may be affected by these *new-born children* effects. For example, some expenditures can be done some time in advance as an anticipation of the event (clothing, push chair, cradle, baby bath,...) to spread the expenditures over time. Some of these expenditures are due to an increase in needs (the mother would increase her consumption of food, i.e., nutritional effects). Other expenditures have to be done inevitably once the baby is born (medical expenses, baby food, some clothing), whereas some other expenditures might be reduced due to the financial and time limitations that children impose on the rest of the household (going out, entertainment).

One of the main aims of this paper is to check and estimate how the arrival of a new child affects household demand patterns in the surrounding of child birth. To capture these effects we construct a set of six time dummies (d_6, d_3, d0, d3, d6, d9) that account for the periods (quarters) in the surrounding of birth and birth itself. This set of dummies can be considered as a semiparametric approach for capturing the effects of a new-born child in a family. We incorporate this set of dummies in z_t^h and the way these dummy variables work is as follows. If a child is born in a household in period *t* the dummy variable d0 takes value 1 in period *t* and in subsequent periods. Accordingly, d_3 and d_6 start being equal to 1 in *t*-1 and in *t*-2, respectively. In the same way d3, d6 and d9 start taking value 1 in periods $t+1$, $t+2$ and $t+3$, respectively. Note that since we use quarterly data d_6 tries to reflect that we account children effects 6 months before the baby is born. Moreover, we also account in some goods for differences in the wife's labour supply behaviour as a consequence of the arrival of a child in the household (as we include interactions of labour supply variables and time to birth dummies).

The fact that we are implicitly assuming that households have made their fertility plans (in an upper stage) does not prevent us to account for the effects of children in the demand function. However, we should discuss to what extent we could still have a problem of endogeneity in these variables. We have deliberately chosen the children variables in a way that allows considering them as predetermined. First, we have a group of variables that account for the number, sex and age of children older than one year. Second, to account for children aged less or equal to one year we introduce the set of dummy variables mentioned above. By doing this we avoid, somehow, the endogeneity of the fertility decision given that the first of these dummies takes value one six months before birth[12]. Fertility decisions may be endogenous when they are introduced in the model together with labour supply decisions (as in Arellano and Carrasco, 1996) or when they are modelled with consumption decisions (as in Browning and Meghir, 1991). In our case knowing that a child is born in period *t* makes the set of dummy variables predetermined (to the econometrician), although the fertility decision in itself may still be endogenous.

Browning (1992) highlights that it looks like fertility is "causing" income over the life-cycle, or that some common set of variables are jointly driving income and fertility. He then suggests that it would be worth while to investigate further income, consumption and fertility decisions in a joint framework. We take this view in the sense that, on the one hand, we do not take labour supply as exogenous, and on the other hand, the way we account for children and child birth allows us to consider these variables as predetermined. In our empirical estimation we also account for labour supply variables as we condition demand on labour supply (both for the head of the household and his wife). Due to the potential endogeneity of these variables, we estimate the demand functions instrumenting these variables using education for the head of the household, and job status variables for both workers in the family[13].

Other estimation problems may arise from having zero expenditure records for some goods. The reasons behind these records are diverse and so has to be the estimation technique. After analysing the importance of this problem in our sample[14] we estimate the *entertainment* equation, where the main reasons for the zero records seems to be non-participation and infrequency of purchase, by using a reduced form p-tobit model in each period. We then predict the entertainment expenditure for each household in each period and use a Generalised Method of Moments (GMM) two-step procedure to estimate the structural demand equation, accounting for unobserved heterogeneity[15]. For *tobacco*, where the main reasons for the zeros are non-participation and corner solutions, we estimate a reduced form independent double-hurdle model for each

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12 As mentioned in Browning (1992), some approaches, specially in the female labour supply literature, account for the endogeneity of one or two of the children variables, like planned completed fertility or number of new born babies. Contrary to this approach, we consider that the problem of endogeneity is so only 9 months before birth. In this line Arellano and Carrasco (1996) treat children variables (2 dummies that account for the presence of children between 1-2 years old and between 3-5 years old) as predetermined variables by conditioning on lagged children and wife participation.

13 Education information is only available for the head of the household. Moreover we only use participation dummies for labour supply, as this is the only information we have in our data set.

14 In table A.1. in Appendix A we report the proportion of zeros in each of the demand categories we model.

15 See Bover and Arellano (1997) for details.

period[16]. Combining, again, the reduced form predictions for tobacco expenditure, we obtain the structural form parameters of the demand equation using a two-step GMM estimator (see appendix A for details). The rest of the equations have been estimated using a standard linear GMM procedure (see Arellano and Bond, 1991) under the identifying assumptions previously mentioned.

Finally, an interesting aspect when estimating intertemporal demand functions is the importance of dynamics. The durability of some goods (like *adult*, *baby* and *children clothing*) and habits in consumption of some other goods like tobacco and alcohol suggest the possibility of including some dynamics. For some other goods (like *health* or *house energy*) it seems that dynamics do not play any role in the demand function. Potential cross relationships among goods capturing substitution and complementary effects among goods across time could also be analysed[17].

3.3. The data

We use eleven years (1985-1995) of the Spanish ECPF. This is a rotating panel based on a comprehensive survey run by the Spanish National Institute of Statistics (INE), which involves interviewing 3,200 households every quarter (12.5% of the households being replaced every quarter by a new randomly drawn group).

To estimate our model we select out all those households who are, for whatever reason, not observed for eight quarters in order to get a (balanced) panel of households (with or without children)[18]. Moreover, to follow the arrival of children and to construct the set of dummies to birth we need to have the maximum number of periods. We further select out all those households whose head is very young (less than 18) or retired (more that 65), those households in which both partners are pensioners, and those who reported a zero expenditure on food, total expenditure and total income below a

[16] It would be possible to use the sample of potential smokers and forget the non-participation issue (see Jones and Labeaga, 2001). However, in the context of a complete demand system, we loose an important number of observations by using this strategy and this could affect the parameters of the rest of equations.

[17] Following Meghir and Weber (1996), we have checked using OLS estimates of a simple VAR of order 4 for all the goods we model (together with a joint significance test) to what extent we have some dynamics in our demand equations Our results show that the correlation between levels of consumption is important. Also, it turns out that some of the cross relationships are quite significant. Due to its interest, this issue is going to be analysed in another piece of research and therefore is out of the scope of this paper.

[18] We are aware of the possibility of attrition bias when using the balanced rather than the unbalanced panel. In any case, it is not likely for consumption to be correlated with the decision to leave the survey, given fertility decisions or other conditioning sets.

threshold (25,000 and 45,000 pesetas, respectively). After all these selections, our sample is composed by 45,632 observations (5,704 households during 8 quarters). In the data appendix there is a more detailed description of these data.

The distinctive and extraordinary aspect of these data is that one can follow the same household for eight consecutive periods (2 years), and this enables to detect how many births have occurred during the sampling period. Therefore, we can analyse the effects of new born children on household demand and/or labour supply of the wife in the surrounding of child birth. In our sample we account for 396 children born during the sampling period[19]. This means that a new born child arrives in 6.9% of households participating in the sample (this figure raises to 9.54% if we account for children born within the 3 months before the interview). The distribution of the new born children, by number and sex, is presented in table 1. To check the representativeness of this child birth rate we have calculated the sample fertility rate for this period dividing 9.54% by 8 (number of quarters), obtaining a figure similar to the figure reported by the OCDE for Spain (1.2%)[20].

We further investigate whether there is a pattern of births by quarters. By a simple inspection of the data, new born babies look as if they were planned to be born in the first and fourth quarters of the year (i.e. between September and March), since 64% of them are born during these months. This gives some evidence to the view that children are, in general, planned. This specific pattern could be associated with the Spanish weather in the sense that women may prefer to carry their babies and to give birth in the coolest months of the year.

To capture the effects of new-born children around child birth date we consider the following non-durable commodity grouping: *food* (consumed at home), *alcohol*, *tobacco*, *adult clothing*, *children clothing*, *baby clothing*, *house services* (electricity, gas, water and other non-durable goods like cleaning products), *health*, *transport* (defined as the sum of motor fuel and public transport), *entertainment*, *out* (defined as meals out and expenditures in bars, pubs, etc.) and *other* (rest of non-durables)[21]. To account for male and female labour su-

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[19] The real figure increases to 543 births if we also account for those children born in the 3 previous quarters that a household collaborates. We can detect these extra children born because in the data we have both number and age of children.

[20] As the sample used by the ECPF is representative of the Spanish population, one could just take the fertility rate on each quarter and calculate an average for the 8 quarters to get the national figure. Regardless of the method we use, we get a figure around 1.2, on average.

[21] Some other children related goods we tried to analyse are expenditures on nappies and expenditures on nurseries. It was impossible to get the first category (nappies) isolated from the other goods in the same category (i.e., expenses in chemist goods), and therefore the impossibility of checking the effects of the arrival of a child on this expenditure. The prediction one can make in a good like nappies would be similar to the effects on food at home: this is a

pply we introduce participation dummies. We account for the effect of demographic and socio-economic characteristics by introducing indicator variables for the presence of children by sex and age, the presence of other adults in the household, age and education of the head. We also include time dummies and use quarterly prices. For the interest rate we use the deflated interest rate charged on credit for consumption (for credits between 1 and 3 years). This interest rate is monthly published by the Bank of Spain[22].

As regards to the demographic variables it is worth giving some more details about the children related variables. To incorporate household composition variables we account both for age and sex of children older than 1 year and younger than 18. Specifically we introduce 12 children indicator variables: *nm1* (*nm2, nm3, nm4_8, nm9_13, nm14_17*) if there is a male child of age 1 (2, 3, between 4 and 8, between 9 and 13, between 14 and 17) in the household, and the same structure if there is a female child (*nf1, nf2, nf3, nf4_8, nf9_13, nf14_17*). For families having a child younger than one year old we introduce a set of dummy variables that are meant to capture the effects of children in the surroundings of child birth. These account for child birth (*d0*), the number of periods before birth (*d_6, d_3*) and the number of periods after birth (*d3, d6, d9*). We can also account for children born in quarters previous to household participation in the sample. This allows us to create *d3*, *d6* and *d9*, for some of the families. *d0* takes value one when a child is born in the family, *d_6* takes valued one quarter before birth and *d_3* takes value one two quarters before birth. And *d3*, *d6* and *d9* take value one, when one, two and three quarters after birth have passed, respectively. Some final remarks on the construction of these demographic variables are worth to be made. It is important to be able to distinguish between just born babies and babies older than one year to avoid the endogenous fertility issue. It is also interesting to take into account whether the child is a first child in the household or there are other siblings in the same household. In the case of households with several children it would be interesting to account for the sex of the children and also, if a new child arrives, the time elapsed between the last baby and the new one, the season in which they are born, etc., as most of the goods that the household buys for their children

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good for which the expenses are difficult to be postponed or anticipated. For the other category (nurseries) it does not exist a category in the ECPF as itself. Finally, it is important to remark that the majority of nurseries in rural areas in Spain are state owned (and are free or highly subsidised) or are public supported (and run privately). For the nurseries in the cities, prices are not so high, and households can get some deduction of these expenses in the income tax system prevailing during the span of the sample.

[22] We build real quarterly prices using monthly prices published by the Spanish National Institute of Statistics (INE). As we do not calculate household specific prices (i.e., we do not use an individual Stone price index), quarter dummies parameters are not independently identified; therefore we only include year dummies for identification reasons. The deflator for both prices and the interest rate is the Retail Price Index also published by the INE.

can be used by a second or other children. We should bear all these questions in mind as the effects of children in some goods like clothing, pushing-chair, etc., may depend quite importantly in all these kind of aspects.

Finally, we have also investigated female participation rates in the labour market in relation to births. Table 3 presents female participation rates and tables 4 to present transition matrices that look at the changes from full-time, part-time and unemployment to full-time, part-time and unemployment, for women who get a child during the sampling period. However, it is important to notice that during the 80s and the beginning of the 90s the Spanish labour market was not flexible enough to allow for a significant proportion of part-time jobs. We look at transitions from six months before birth to the period in which the woman gives birth (i.e., from t-2 to t), to transitions from t to $t+2$ (where t refers to the period in which the child arrives, and to transitions from t-2 to $t+2$. In order to understand these tables we should note that the maternity leave allowance in Spain is sixteen weeks and normally women stay at work, if possible, until they give birth and enjoy the maternity leave right after giving birth. The results we get in these tables seem to be in line with these, i.e., women start leaving the labour market after giving birth (the participation rate of women who get a child drops). Looking at the transitions, we can say that the highest transition before birth is from employment to unemployment, whereas we get that both the transitions from employment to unemployment and from unemployment to employment are important right after giving birth. Therefore, we can distinguish between two changes: first, women joining the labour market once they have given birth, and second, women still dropping (maybe they have decided to drop for good or for a long period to raise their children) after giving birth.

4. EMPIRICAL RESULTS

4.1. An informal look at the data

Before proceeding with the estimation results, we consider that two graphical analyses could be of interest. First, given that our focus is on the life-cycle patterns of consumption, it is interesting to present some of the principal features of the data that might be important for consumption. We look at the life-cycle behaviour of some demographics (the number of young and old children), income and consumption (total expenditure) and female participation in the labour market. In figure 1 to 6 we plot these variables on the mean of the data by cohort[23]. In all figures, each line represents the evolution over time of the relevant variable for one date of birth cohort defined over a five year band. In figure 1 we present the life-cycle path of real income. Figure 2 shows the evolution of real income. We get the familiar pattern that consumption raises initially and then falls after the late 40s, a result which is also obtained by Browning, Deaton and Irish (1985), Attanasio and Weber (1989) and Blundell, Browning and Meghir (1994) using the British Family Expenditure Survey (FES). Comparing figures 1 and 2 it is possible to notice the correlation between them and the shape. As in Blundell, Browning and Meghir (1994) if we assume that income is exogenous, then it seems like consumption tracks income over the life-cycle.

In figures 3 to 6 we plot the paths of some potentially important determinants of consumption and income (children and labour supply of the wife). For the path of children over the life-cycle we construct three figures. First, *old children* (children between 5 and 17 years old), second, *young children* (children between 0 and 4 years old) and third all children in the household (*children*). The shape we get in all these figures is very similar to the one obtained using the FES. Moreover, as expected, the wife's participation in the labour market drops during the child bearing period (at the beginning of the 30s). The number of children starts to drop after women leave the labour market. It seems that women leave the labour market when they get children but they do not come back to the labour market after the child bearing period, therefore there is a decreasing participation over the life-cycle that is more important in the period when children are young. Another interesting feature of the data is that although female participation falls in the period when children are young household income does not. As noticed in Blundell, Browning and Meghir (1994) one explanation would be that the timing of births in a family is decided taking into account the husband's career profile. Although it seems that these graphs look quite intuitive about the life-cycle features of our data, it is very difficult to infer anything about life-cycle consumption since we do not account for the possible endogeneity of some factors that affect consumption and it is impossible to distinguish between anticipated and unanticipated components in the series, Blundell, Browning and Meghir (1994). Therefore we present below a formal analysis that would take account of these problems by conditioning on demographics and labour market variables.

Using our estimation results, in figure 7 we present some graphical evidence of how the arrival of a new child affects the intertemporal consumption of the household. In these figures we plot the estimates (together with confidence intervals) of the six dummies to birth for the 12 goods we model. We take as

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[23] To create cohort data we use the same methodology used in Browning, Deaton and Irish (1985), Deaton (1985) and Blundell, Browning and Meghir (1994). The average number of observations per cell is reported in table B.4 of Appendix B.

reference child birth (set the value equal to zero) and draw a line for each good category that represents the mean sample of each expenditure in each figure (in order to have a reference in each commodity category). Bearing in mind the predictions of the life-cycle theory of consumption and remembering that we are estimating an intertemporal household demand system, we can stress the following results. For most of the non-durable goods we analyse, we get that the effects of the six dummies to birth are not significant (we do not get any significant jump). For some other goods, i.e. *food at home*, *baby clothing* and *entertainment* we do get significant jumps. For the category in which we have expenditure on nappies (and other hygiene products) we also get a significant jump at d0. These results suggest that in households where a new child arrives there are some expenditures (children related expenditures) that can not be smoothed away from the periods around child birth.

Furthermore, it is interesting to think about these goods as intertemporally non-demographically separable, using the intertemporal interpretation of the concept of demographic separability discussed previously. The effects of the arrival of a new child are none for demographic separable goods, whereas we get significant effects on the expenditures of non-demographic separable goods. The most clear cut example is the evolution of baby and children clothing expenditure and also, to some extent, food at home. We get a significant jump at birth date. For food at home we could expect this kind of behaviour as households can not postpone to feed a baby, and the same kind of argument applies to clothing although this is a more spreadable over time commodity. Weaker evidence is found in other goods like house energy for which one could expect an increase in some of its components (i.e., electricity) when a child arrives. In the same line than food at home and children clothing, there are other goods (as nappies and nurseries expenditures) for which we could expect a jump when the child arrives. Unfortunately with the classification of commodities available in the ECPF it is not possible to isolate any of these two categories.

4.2. Estimation results

We estimate an unrestricted demand system of 12 equations presented in equation (24)[24]. Ten of these equations are estimated using a typical linear GMM method (see Arellano and Bond, 1991) and the other two using the two

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[24] Two of the 12 categories have been analysed further. We separate the category house energy and services into two sub-categories: *house energy* on one hand and *house services* on the other hand. As the results did not change substantially we have left the former category. We also separate health into two sub-categories: *nappies* (in which there are other hygiene products) and the rest of *health* categories. As it seems that the results obtained in health are driven by the nappies category we report both set of results.

step-procedure previously explained (see Appendix A, for more details). In table 6 we report some of the estimation results we obtain. We can separate the group of commodities we model into three sub-groups. First, we have those goods for which the coefficients of the dummy variables are jointly non-significant for the six dummies (specifically, *tobacco, house commodities* and *house energy, transport, out* and *other non-durable goods*). Although there are some variables which are individually significant or at least at the borderline of significance, we can not reject the null of joint significance for all these groups. These results suggest that the arrival of a child in a household does not affect the life-cycle demand pattern for these goods. Intuitively, one could expect that new born children would affect the demand of some of these goods, for example *house energy* or *out*[25]*,* as the arrival of a new child implies some extra *needs* and/or time and money restrictions for the household. As we do not get any significant effect, it seems that the household perfectly anticipates the arrival of the child and all the effects are already incorporated in the life-cycle setting.

We have a second group of goods for which we can not reject the null hypothesis that the six dummies to birth are jointly equal to zero, although we get some coefficients significantly different from zero (*alcohol*, *tobacco*, *adult clothing*, *rest of health* and *nappies*). For *alcohol* and *tobacco* it seems that households drop their consumption when a new child arrives. The reasons for this may be diverse, parents may decide to give up smoking when they have a baby, the mother should not drink or smoke if she is breast feeding her child or taking care of her, etc. However, since we have estimated tobacco consumption without conditioning on positives, the cut in consumption could also be due to the decision to give up smoking.

Finally, we have those goods for which some of the dummy variables are significant: *food, children* and *baby clothing*, and *health* (under the broader definition). A good that seems to be affected by the arrival of a child in the family is *food*. We get positive (and significant) coefficients for the dummy variables *d0* and *d3*. For *baby clothing* we get positive and significant parameters for the dummy variables (*d_6, d_3*). For *children clothing*, although we do not get any significant coefficient for the dummies individually, we reject the null hypothesis that the six dummies related to child birth are jointly equal to zero. Interestingly, for *baby clothing* the parameters of the dummy variables are significant some time before the child is born. We also get a positive (and significant) coefficient for the dummy variable *d0* in *health*, highlighting the fact that households can not spread over time the health costs incurred when a new child arrives. When we isolate the *nappies* category from the rest of *health* we obtain that this category is driving the results we get for the full *health* category.

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[25] The composition of *out* (see Appendix B for a detailed description of the goods) includes both eating out for work reasons and for leisure, so maybe the effects of a new child are a bit mixed up.

Somehow, this is not surprising and confirms the *needs story* about children costs. Finally, for *entertainment* we get 3 negative and significant coefficients for the dummy variables. These results are in line with the fact that the arrival of a new baby in the household should affect the demand of these kind of goods[26].

It is important to highlight the relation between needs and jumps around the child birth date for the expenditure of some commodities. Another issue that is worthy to be raised is the question regarding to the smoothing of expenditures over the life-cycle. If households smooth their expenditures over time it is as if babies were, somehow, anticipated and therefore they adapt their consuming behaviour to accommodate these changes. Anticipation will help us to accept the life-cycle theory. Then children are anticipated and you save (or borrow) to afford them. Even if they are anticipated (meaning that you plan to have a child although may be you do not know when, it can be in 1 or 2 years time) there are some expenditures that should be made once the baby is around, like food or nappies. Therefore, the general conclusion that we can draw from these results is that for some commodities is more difficult to smooth consumption over the life-cycle than for others. This is probably so because the time effects of needs are more important than the anticipation of some expenditures, i.e., some expenditures have to be done at certain periods regardless of the expectations formed by the individual.

4.3. Further results for some children related goods

To further investigate the effects of children around birth date, we select some goods in which presumably these effects may potentially be more important. As pointed out earlier, the non-durable goods can be classified, according to the effects of children birth dummies, into 3 sub-groups. The first group is composed by those commodities in which we get no effects at all for these dummies (i.e., *tobacco, house energy and services, transport* and *other non-durable goods*). In a second group we place those goods for which at least one dummy is significant, but we can not reject the null hypothesis that the 6 dummies are jointly equal to zero (i.e., *tobacco, alcohol, adult clothing, health, out, entertainment, and other non-durable goods*). And in the third group enter those goods for which the effects of the dummies are quite significant and where the six dummies to birth are jointly significant. As highlighted by Blundell,

[26] In Spain, in general, every worker (specially civil servants) get two extra month salary per year (one in June and the other in July). Maybe we should investigate further if the arrival of a new child in the family coincides with the jumps that we observe in some of the demand goods analysed. Some of the jumps in expenditure may be related to the fact that a family anticipates the increase of income due to the extra payment. Browning and Collado (2001) give some evidence, using this data set, of the fact that households fulfil the life-cycle expectations in the sense that consumption does not follow the jumps due to the extra payments.

Pashardes and Weber (1993) demand patterns vary considerably across households with different household characteristics. Following their approach we model this variability by making the intercept in the demand equation to depend on demographics. The microlevel estimates in some equations are sensitive to the specification of interaction terms with household characteristics (in our case the six dummies to birth). In a traditional demand system, one would be interested, as in Blundell, Pashardes and Weber (1993), in income effects, substitution demand effects, etc. in order to assess aspects like separability and/or complementarities between goods. Thus, they interact demographic characteristics with income and prices. Given that our interest is to analyse the effects of new born children on demand, in the estimation of some goods (*food*, *adult clothing*, *children* and *baby clothing*, *entertainment* and *out*) we interact the dummies to birth with labour supply variables (husband and wife's participation dummies and with the multi-earners variable), prices and the interest rate. As some of the variables we interact are potentially endogenous we have also instrumented the interactions we introduce by interacting the instruments with the set of dummies to birth.

Interactions with female participation would be indicative, if significant, of non-separabilities between female labour supply and demand. Significant interactions between prices and the presence (arrival) of children suggest that households respond differently to relative prices when children are present in the family. This could be interpreted as compatible with the idea of children re-scaling prices as in the model of Barten (1964). Having children makes some goods relatively more expensive and make other goods relatively cheaper. These changes in prices might be expected to cause substitution away from the relatively expensive goods, but also to amplify or dampen down household responsiveness to price depending on the nature of the scales. In an intertemporal context we might also expect re-scaling of intertemporal prices and changes in the estimated intertemporal substitution elasticity. If children make some goods in some periods relatively more expensive than in other periods, household might be substituting away some of their expenditures from the more expensive periods. This implies rejection of intertemporal demographic separability.

We present two sets of results introducing interactions in 6 out of the 12 goods we model. In table 8 we report the interactions of the six dummies to birth with the female participation dummy and the interactions of d0 with both the own price and the interest rate. In table 9 we report the interaction of the six dummies to birth with: female participation dummies (full or part time dummies), the other earners dummy, the own price and the interest rate. This tries to reflect that the effect of children on consumption is far from linear and it could affect through labour market participation, price changes or even the arrival of a child could affect consumption via the price effect of future consumption. The results can be summarised as follows. For *food* at home, we have that without any interaction the dummies to birth start being significant 3 months before birth, in the quarter in which the baby is born and in the following quarter (see table 6). These three dummies are positive and significant suggesting that the arrival of a new child has implications on the demand for food even some time before the child arrives (necessities and nutritional effect). When interacting labour market variables with the set of dummies we get negative effects around child birth (*dwwifef*d_3* or *dwwifef*d3* or *dwwifep*d6*) and positive effects for the *d9* dummy interactions. These results suggest that female participation variables or labour supply variables for all members of the household interact with the presence and/or arrival or children in affecting demand for *food*. This confirms our descriptive finding about female labour market transitions in tables 3 to 5. Some of the interactions of *d0* with the interest rate and with the own price are significant, indicating, in line with the above discussion, that children re-scale prices faced by households, may affect household's responsiveness to relative prices and can have effects on the elasticity of intertemporal substitution.

The second good we have analysed with interactions is *adult clothing*. The interest comes from the fact that there are some changes in female labour supply around child birth from where we can extract some changes in expenditure of *adult clothing*. We have tried several interactions with *dwwife* and *dearn*, and with own price and interest rate, but we obtain non-significant effects almost everywhere, suggesting, somehow, that this may be a *pure adult* good. The interactions with the interest rate and the own price are not significant either. We have also tested the hypothesis of joint significance of the interactions (by groups) and we can not reject the null hypothesis in any case.

Although the distinction between *children clothing* and *baby clothing* is not very accurate in our data set we decided to model these two goods separately. Baby clothing collects all cloths and footwear for children of 0-3 years old and children clothing are items for children between 3-13 years old. We have not available prices for the two subgroups and then we use the same price index. Looking at the results for children effects we have that none of the six dummies to birth is significantly different from zero (table 6a). Once we introduce the interactions, things start to come out, specially with female participation dummies. Interestingly, we get that the own price interaction with the arrival of children affecting the demand for *children clothing*. Interestingly, we get that the own price interaction with *d0* is positive and significant (table 8), indicating that children may affect household's responsiveness to prices and/or children rescale relative prices as suggested by Barten's (1964) model.

We further analyse the effects of the interactions on *baby clothing*. For this good we get that four of the six dummies to birth are already highly significant (d_6, d_3 are positive and significant and d6 and d9 are negative and significant) indicating the strong and predictable effects of babies on this commodity. It is interesting to note that the highest effect of the six dummies is precisely d_3, maybe indicating that most of the baby clothing expenditure is done during the last quarter before birth (see table 6a). Both the fact that parents know about the sex of the baby (which is usual in Spain) and the imminent birth itself makes them decide to start buying baby clothing. Apart from these *plain* results we have also included interactions of the set of dummies with the female participation dummies, with the number of earners dummy and with the own price and the interest rate. As regards interaction with female participation variables (*dwwifef* and *dwwifep* or *dwwife*) and with the number of earners dummy (*dearn*) we get many significant results, indicating that labour supply variables interact with the presence (or arrival) of children in the demand for *baby clothing*. In the joint test of significance for groups of these variables we can not accept the null in any case. When the wife works, households spend more on (in some quarter or another). Interactions with the interest rate and the own price come out significant (see tables 8 and 9), suggesting, as discussed above, that both household's responsiveness to prices and the elasticity of intertemporal substitution are affected by children. One interpretation of the results as regards the interest rate is that future consumption is expensive when a child arrives, because we cannot postpone part of our current consumption.

Finally, we present the results for the interactions of the six dummies to birth in the equation of the good *out*. In this case the only significant (negative) dummy we get is *d0* (table 7a), suggesting that the arrival of a child means a real constraint for the members of the household (both in terms of time and in terms of budget). When we introduce the interactions with labour supply variables the results indicate that before birth the effects are positive (*dwwife* interacted with *d_6* and *d_3*) and after birth the results are negative (although non significant). The interaction of *d0* with the own price is significant, indicating that children may affect household's responsiveness to prices.

5. CONCLUSIONS

In this paper we have estimate an unrestricted *Frisch* demand system for 12 commodities to address the question of how children affect household life-cycle expenditure patterns in the surroundings of child birth. During this period some potentially important changes are taking place in the household: changes in needs (nutrition effects, children clothing), changes in relation to labour supply (specially for the mother) and other possible changes due to the anticipation of the family to the event (saving and/or borrowing). We have also analysed the issue of intertemporal demographic separability and its relation to the measurement of children costs.

Among the main results, we must emphasise that while we observe important jumps in the consumption of some children related goods (*clothing, entertainment* and *food*), we observe no changes in the so called *adult* goods. We also find some effects when interacting dummies capturing the timing of birth with participation dummies, price and the interest rate. The needs and jumps we find seem to reflect that children are to some extent anticipated in the Spanish households within the life-cycle.

In this paper we have looked at some aspects of the effects of children and, somehow, their relation to the identification and measurement of child costs. These costs are important politically and governments should account for them when designing social and other household related policies. A real life example of this is the Spanish 1999 fiscal reform. One of the aims of this reform is the improvement of child related benefits with a final objective to raise the Spanish fertility rate.

APPENDIX A

ESTIMATING LDV MODELS FOR PANEL DATA

To estimate the equations for *tobacco* and *entertainment* we use a LDV model for panel data. Let us assume we have a random sample of observations on the characteristics of N individuals over T periods (in the typical situation that T is small and N tends to infinity). We begin by considering the following static model:

$$q^*_{iht} = \beta_i' X_{iht} + \eta_{ih} + \varepsilon_{iht} \qquad \text{(A.1)}$$

where X_{iht} may include lagged regressors and non-time variant variables and b_i is the parameter vector, η_{ih} represents the individual heterogeneous effect and ε_{iht} a usual random term. q^*_{iht} is a latent dependent variable not directly observed. We observe q_{iht} which is related to q^*_{iht} by the following observability rule:

$$q^*_{iht} = g_i(q_{iht}) \qquad \text{(A.2)}$$

$g_i(.)$ being of the double-hurdle type in the case of tobacco and a p-tobit in the case of entertainment.

In the fixed effects LDV models it is not possible to devise estimators of the parameters that are not function of the effects and, since T is fixed the inconsistency of η_{ih} contaminates the rest of the parameters. This does not seem to be an important problem in static Tobit type models, see Heckman and MaCurdy (1980). An alternative approach to the problem, which is only valid in this static case, consists in assuming the heterogeneous effects to be random and independent of the explanatory variables. But the model under the assumption of absence of correlation between effects and variables has limited interest in our problem, because if, for instance, unobserved heterogeneity contains fertility decisions, the effects and the household composition variables are correlated. If the regressors and the effects are correlated, we can still solve the problem of obtaining consistent parameter estimates using Chamberlain's suggestion of specifying a distribution for the effects conditional on the explanatory variables. Once observability assumptions for (A.2) are assumed as we do, and the reduced form of the model has been estimated, the structural parameters can be derived by imposing the cross-equation restrictions using a MD method. Instead, Bover and Arellano (1997) propose to implement a within-groups procedure, which provides inefficient estimates compared to the MD ones and a GMM method, which gives assymptotically efficient estimators (See Bover and Arellano, 1997 or Labeaga, 1999, for details).

Given the equation (A.1) and following Chamberlain (1980) we have,

$$\eta_{ih} = \pi_{i0} + \pi'_{i1} X_{ih1} + \ldots + \pi'_{iT} X_{ihT} + \pi'_{ir} R_{ih} + w_{ih} \qquad \text{(A.3)}$$

where R_{ih} is a vector that includes non-time varying variables (Z_{ih}) as well as non-linear terms of X_{iht}, Z_{ih} and interactions. The reduced form of the model for each of the *k* demand equations can then be expressed in matrix notation as:

$$q^{*}_{iht} = \Pi_i' W_{iht} + \xi_{iht} \qquad h = 1, ..., N \tag{A.4}$$

where $W_{ih} = \left[1, X'_{ih1}, ..., X'_{ihT}, R'_{ih}\right]$ is a Px1 vector of exogenous regressors. The key assumptions are: i) the conditional expected value of the individual effect is linear; ii) the variables of this linear combination and the disturbance are independent and iii) the distributional assumptions about ξ_{iht}. However, the reduced form specification will have all the variables in each cross-section, squared and cubed terms of some of them, lags and leads of exogenous time-varying variables and interactions among them. In any case, another useful feature of this approach is that we can check the specification at the level of the reduced form. Functional form and distributional hypotheses about disturbances can be tested when a satisfactory predictor $\hat{q}^{*}_{iht}$ ($i = 1, ..., N; t = 1, ..., T$) is available.

We use the fact that the distribution of q^{*}_{iht} conditional on the explanatory variables, but marginal to the effects, is of the same form as the joint distribution [Chamberlain, 1984], in order to estimate each of the *T* cross-section specification. At a second stage and on the basis of the matrix of the previously calculated estimates for the reduced form, we derive the relevant vector of parameters using a first differences GMM procedure instead of a minimum distance approach. This method provides consistent estimates which asymptotically efficient Once we have P_i, we estimate b_i as follows:

(A.5)

$$\hat{\beta}_{i3SGMM} = \left[\left(\sum_{h=1}^{H} \hat{V}'_{ih} K' W_{ih}\right) A_i \left(\sum_{h=1}^{H} W'_{ih} K \hat{V}_{ih}\right)\right]^{-1} \left(\sum_{h=1}^{H} \hat{V}'_{ih} K' W_{ih}\right) A_i \left(\sum_{h=1}^{H} W'_{ih} K I_0 \hat{\Pi} W_{ih}\right)$$

being A a weighting matrix and K a transformation matrix to first difference operator. We use as weighting matrix:

$$A_i = \hat{V}_{b_i}^{-1} = (K \otimes I_P)\left(\sum_{h=1}^{H} W_{ih} Q W_{ih}\right) \tilde{\Omega}_{1i} \left(\sum_{h=1}^{H} W_{ih} Q W_{ih}\right)(K' \otimes I_P) \tag{A.6}$$

with I_p an identity matrix of order p and $\tilde{\Omega}_{1i}$ the asymptotic covariance matrix of the reduced form estimates of equation *i*.

APPENDIX B

DATA DESCRIPTION OF THE VARIABLES

The data we use in this paper is a balanced panel drawn from the Spanish Panel of Family Expenditure Survey (*Encuesta Continua de Presupuestos Familiares*, ECPF) conducted by the Spanish Statistical Office since the first quarter of 1985 to the fourth quarter of 1995 (the last wave available). We only use information from the first quarter of 1986 onwards since there was no substitution in 1985. This is a quarterly rotating panel carried out over 3,200 households with a 12.5 per cent rotating rate to avoid attrition problems. This implies that the maximum number of collaborating periods for each household is eight. In the empirical application we have selected those households collaborating eight periods. We end up with a sample size of N = 7,718 and T = 8 (the number of observations is 61,744). The structure of the sample used and that for all households collaborating for at least four periods seems to be the same, thus minimising the probability of attrition bias.

This data set provides information of about 280 commodities, 11 sources of household income for different members of the household as well as other household members, labour and socio-demographic characteristics such as age, number of children by age and sex, occupation and labour status of both spouses in the family, education of the head of the household, size of the town of residence, etc. Table B.1 presents a brief description of the commodities included in each category we model and tables B.2 and B.3 present some sample descriptive statistics of the variables used in the empirical analysis. Since we also conduct an exercise based on cohort data, we report the sample size of each cohort in Table B.4.

Table B.1

DESCRIPTION OF THE COMMODITY CATEGORIES AND PROPORTION OF ZEROS

food	All food at home and non-alcoholic beverage categories.	0
alcohol	All alcoholic drink categories bought by the household to be consumed at home.	46
tobacco	Expenditure on all kind of tobacco and smoking accessories.	42
adult clothing	Adult clothing, underwear and footwear categories. Also expenditures on repairing these items.	12
children clothing	Children (between 6 months and 18 years old) clothing, underwear and footwear categories. Also expenditures on repairing these items.	66
baby clothing	Baby (between 0 and 6 months old) clothing and underwear categories.	94
house energy	Electricity, gas and water bill of the household; house services, cleaning products and other non-durables for the house.	0
health services	Medicines and other hygiene related products (i.e., nappies). Medical services and health insurance. Expenditures in hospitals. Nursering services.	39
transport	All types of public transport. Fuel. Other transport related nod-durable goods.	18
entertain.	Expenditures on cinema, theatre, concert, etc. tickets. Sport centres. Rental of videos and other entertainment related items.	45
out	Restaurants and bar expenditures (this includes alcohol out of home).	13
other	Postal services. Non-durable personal care commodities. Taxes (but non-income taxes). Education expenditures (including nurseries expenditures). Other non-durable commodities not reported in the above categories.	2

B.2

DESCRIPTIVE STATISTICS OF VARIABLES

	Whole sample		Sample newb = 1	
Variable	**Mean**	**Std. dev.**	**Mean**	**Std. dev.**
food	1575.717	872.604	1524.615	883.480
alcohol	65.591	147.561	66.402	132.085
tobacco	94.616	135.203	110.047	145.006
adult clothing	558.785	763.778	483.720	734.551
children clothing	95.995	222.939	143.753	249.120
baby clothing	10.815	62.739	59.274	141.728
house energy	341.803	316.041	368.105	377.162
health	153.794	492.828	208.969	416.230
transport	434.062	728.759	466.024	488.374
entertainment	148.498	367.275	119.208	322.936
out	591.090	802.353	596.781	824.329
other non-durabl.	597.436	1104.666	483.571	588.985
husband's age	50.279	13.715	37.051	10.588
wife's age	40.844	19.249	31.683	11.525
male working	0.896	0.305	0.941	0.235
unemployed	0.048	0.214	0.055	0.229
self employ.	0.165	0.371	0.136	0.343
unskilled	0.022	0.147	0.031	0.172
non-active	0.265	0.442	0.071	0.257
blue-collar	0.092	0.289	0.132	0.338
white-collar	0.359	0.480	0.498	0.500
working wife f-t	0.171	0.376	0.226	0.419
working wife p-t	0.039	0.194	0.036	0.186
pensioner husb.	0.257	0.437	0.065	0.246
pensioner wife	0.012	0.108	0.006	0.078
num. of earners	0.576	0.494	0.495	0.500
low educated	0.220	0.414	0.135	0.342
high educated	0.078	0.269	0.127	0.333
rural area	0.187	0.390	0.165	0.371
city	0.385	0.487	0.324	0.468

(Sig.)

(Cont.)

	Whole sample		Sample newb = 1	

d_6	56.090	17.940	0.307	34.192	-24.507	10.691	7.217
	(0.891)	(1.406)	(0.137)	(0.593)	(-1.206)	(1.609)	(0.380)
d_3	88.572	-12.087	0.423	-135.627	23.380	62.151	5.356
	(1.454)	(-0.946)	(0.196)	(-2.136)	(1.510)	(3.961)	(0.287)
d0	128.012	-24.116	-0.112	-11.599	18.564	-4.861	2.173
	(2.187)	(-1.823)	(-0.045)	(-0.231)	(1.134)	(-0.278)	(0.099)
d3	147.935	10.982	0.638	41.319	1.945	-5.839	30.772
	(2.413)	(1.073)	(0.340)	(0.825)	(0.114)	(-0.403)	(1.501)
d6	46.429	-8.647	-3.189	-16.220	-2.670	-16.223	2.061
	(0.739)	(-0.678)	(-1.880)	(-0.286)	(-0.113)	(-1.438)	(0.098)
d9	-24.037	21.412	3.456	-70.189	22.743	-1.524	-2.841
	(-0.286)	(1.282)	(1.385)	(-1.237)	(1.218)	(-0.120)	(-0.084)
$\log p_i$	-112.222	-17.855	4.050	-316.259	-40.540	-3.909	-8.354
	(-1.932)	(-1.435)	(1.987)	(-5.116)	(-2.370)	(-0.773)	(-0.455)
mean value	1575.72	65.59	94.62	558.78	95.99	10.814	341.80
EIS	-0.071	-0.272	0.043	-0.566	-0.422	-0.361	-0.024
(s.e.)	(0.037)	(0.190)	(0.022)	(0.110)	(0.178)	(0.468)	(0.053)

Notes: 1. For d_6-d9 we present t values in parenthesis.

2. EIS = Elasticity of intertemporal substitution. Standard errors in parenthesis.

3. Mean value = sample mean.

Table 6b

DIAGNOSTIC TESTS

	food	alcohol	tobacco	adult clothing	children clothing	baby clothing	house energy
Wald(6)	22.124	8.592	5.205	7.689	11.034	45.183	3.060
Sargan(6)	4.683	4.371	227.453	9.363	14.058	13.567	4.797
Autocorr.	-1.012	-0.088	-0.749	5.610	4.177	0.409	-2.257

Notes: 1. We test for the join significance of the six dummies related to child birth by using a standard Wald test.

2. Sargan test accounts for the validity of the instrumental set. The Sargan test for baby clothing and children clothing has 12 degrees of freedom.

3. Autocorrelation test = test for second order serial correlation.

Table 7a

DEMAND SYSTEM ESTIMATES

	health	trans-port	enter-tain.	out	other non-durables	nappies	rest health

d_6	-23.418	-33.955	-11.118	62.214	-25.366	-4.916	-22.502
	(-0.858)	(-0.951)	(-0.739)	(1.032)	(-0.446)	(-1.762)	(-0.907)
d_3	38.505	-3.887	-28.824	-49.908	14.935	6.333	24.794
	(1.496)	(-0.116)	(-2.111)	(-0.729)	(0.281)	(2.239)	(1.064)
d0	107.243	13.859	-27.580	-80.188	-97.582	44.339	35.315
	(3.281)	(0.338)	(-1.629)	(-1.302)	(-1.639)	(10.817)	(1.217)
d3	-28.116	18.095	10.153	65.004	-32.045	-9.832	-17.056
	(-0.838)	(0.444)	(0.716)	(1.196)	(-0.591)	(-1.660)	(-0.542)
d6	82.216	-28.689	-28.549	-73.239	3.405	4.819	78.699
	(1.467)	(-0.808)	(-2.349)	(-1.299)	(0.064)	(0.743)	(1.402)
d9	-143.477	19.359	-10.058	-5.020	-13.163	-2.758	-122.658
	(-2.335)	(0.499)	(-0.650)	(-0.083)	(-0.224)	(-0.424)	(-2.053)
$\log p_i$	4.498	-230.400	-24.527	128.894	-299.068	-2.637	79.242
	(0.025)	(-1.334)	(-1.745)	(2.326)	(-4.984)	(0.667)	(1.065)
mean value	153.79	434.06	148.50	591.09	597.44	14.52	138.77
EIS	0.029	-0.531	-0.165	0.218	-0.501	-0.182	0.571
(s.e.)	(1.144)	(0.398)	(0.094)	(0.093)	(0.100)	(0.272)	(0.535)

Notes: 1. For d_6-d9 and $\log(p_i)$ we present t values in parenthesis.

2. EIS = Elasticity of intertemporal substitution. Standard errors in parenthesis.

3. Mean value = sample mean.

Table 7b

DIAGNOSTIC TESTS

	health	trans-port	enter-tain.	out	other non-durables	nappies	rest health
Wald(6)	20.573	1.874	14.666	7.633	4.155	193.642	8.642
Sargan(6)	1.566	4.083	131.149	3.603	1.953	21.49	10.774
Autocorr.	-2.523	-1.744	0.189	0.218	0.579		

Notes: 1. We test for the join significance of the six dummies related to child birth by using a standard Wald test.

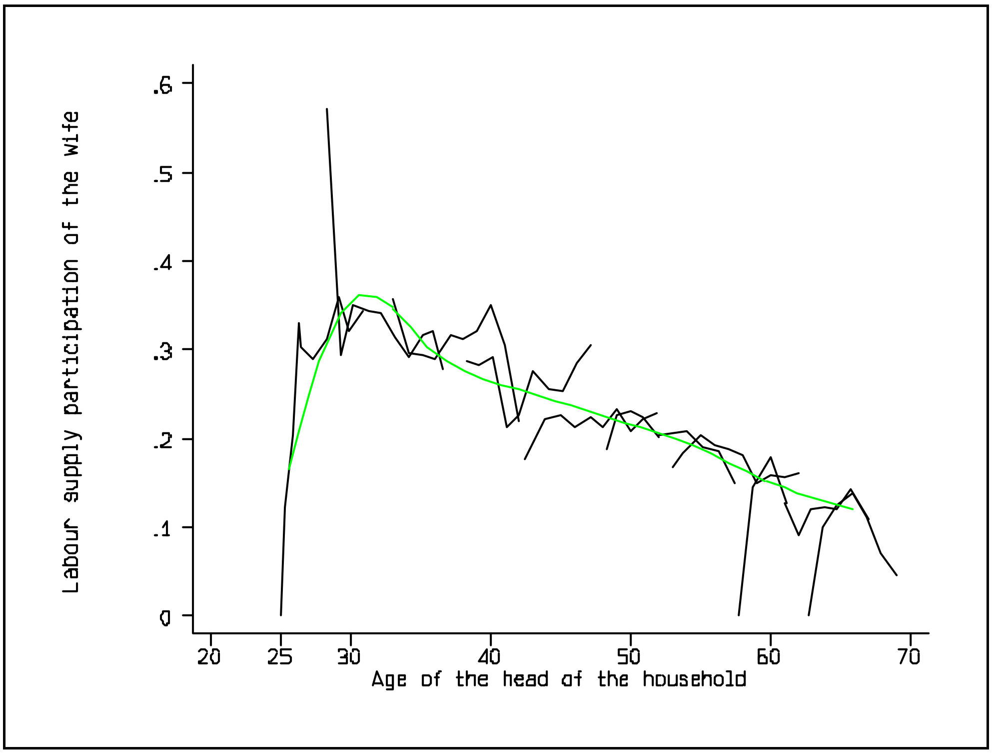
2. Sargan test accounts for the validity of the instrumental set. The Sargan test for baby clothing and children clothing has 12 degrees of freedom, and for nappies and rest health has 11 degrees of freedom.

3. Autocorrelation test = test for second order serial correlation.

Table 8

PARAMETER ESTIMATES FOR INTERACTIONS (I)

	Good				
Interactions	**food**	**adult clothing**	**children clothing**	**baby clothing**	**out**
D_6	35.23 (0.51)	29.75 (0.40)	-15.51 (-0.76)	10.65 (1.69)	-25.55 (-0.42)
D_3	98.44 (1.49)	-184.08 (-2.55)	12.18 (0.63)	66.95 (11.11)	-59.38 (-1.03)
d0	148.52 (2.11)	27.45 (0.32)	-0.58 (-0.03)	-2.76 (-0.44)	-55.44 (-0.95)
d3	140.00 (2.01)	55.78 (0.46)	7.24 (0.35)	-5.28 (-0.83)	103.69 (1.75)
d6	121.73 (1.68)	-55.11 (-0.70)	-22.46 (-1.05)	-10.57 (-1.60)	-38.93 (-0.62)
d9	2.75 (0.04)	-38.54 (-0.45)	25.08 (1.10)	24.17 (3.42)	2.27 (0.03)
d_6*dwwife	83.31 (0.82)	7.72 (0.07)	-26.37 (-0.88)	4.66 (0.50)	307.15 (3.18)
d_3*dwwife	-61.79 -0.58)	219.36 (1.87)	13.62 (0.43)	-6.72 (-0.69)	177.65 (1.75)
d0*dwwife	1.73 (0.02)	-93.01 (-0.72)	79.39 (2.29)	35.59 (3.32)	-151.35 (-1.36)
d3*dwwife	79.82 (0.62)	-82.11 (-0.58)	-84.97 (-2.23)	0.15 (0.01)	-157.69 (-1.28)
d6*dwwife	-294.38 (-2.19)	210.62 (1.43)	82.18 (2.08)	27.79 (2.27)	-194.97 (1.53)
d9*dwwife	72.67 (0.51)	-239.70 (-1.55)	-77.46 (-1.86)	-56.06 (-4.36)	-87.70 (-0.66)
d0*p_i	-343.85 (-0.29)	300.75 (0.17)	1461.7 (2.98)	1228.5 (8.08)	—
d0*r	-113.99 (-0.72)	27.43 (0.16)	39.48 (0.85)	-39.98 (-2.78)	—



Labour supply participation of the wife
.6
.5
.4
.3
.2
.1
0
20
25
30
40
50
60
70
Age of the head of the household

Figure 7