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Department of Foundations of Economic Analysis II
University of the Basque Country
Avda. Lehendakari Aguirre 83
48015 Bilbao (SPAIN)
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Rebeca Echávarri

Education and the dynamics of family decisions

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Rebeca Echávarri†

Euskal Herriko Unibertsitatea-Universidad del Pais Vasco

Abstract:

This paper investigates the extent to which a biased transmission of educational endowments affects fertility. To this end, we devise a version of Becker's family decision model that takes preference change into account. Specifically, we model education as an instrument that increases the autonomy (to prefer), and autonomy as an instrument of preference-change for household-structures. The empirical validity of the proposed model is examined for the European setting using the European Community Household Panel. In the context of the model, empirical findings imply the following. On the one hand, both preference for quantity and preference for bequest for each offspring (quality) increases with education, while preference for current consumption decreases. On the other hand, education is found to be negatively correlated with fertility, at a decreasing rate. Therefore, the paper provides a useful additional toolkit for public policy evaluation. It explains how public policies oriented toward the guarantee of personal freedoms, such as the expansion of education and autonomy, are likely to guarantee the same freedoms for subsequent generations.

JEL classification: D1, J1.

Keywords: Intergenerational Transmission; Household Behavior; Education; Autonomy.

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†Avenida Lehendakari Aguirre 83, 48015 Bilbao (Spain). Tel.: +34 946017132. Fax: +34 946017123. *Email: rebeca.echavarri@ehu.es*

1 Introduction

Since a person's preferences and beliefs guide her actions, they may therefore, to some extent also explain her achievements. Inattention to the important role played by preferences may render an egalitarian public policy ineffective. People's lives are unaffected if they lack the necessary skills that will enable them to develop preferences that will guide them to choose the new opportunities that become available, say, after the application of a public policy. The latter may also have the undesired effect of increasing social inequality over time. There is no doubt that parents' decisions exert a powerful influence on their children's future opportunities (see Moav 2005, for an insightful discussion). Parental behavior do, moreover, play a crucial role in determining the type of preferences and beliefs their children acquire, and thereby direct what they do with their available opportunities (Bisin and Verdier 2001; Bowles 1998; Bowles and Gintis 2002).

In order to better predict the social impact of any proposal dealing with family decisions, some attention needs to be paid to the question of how preferences evolve (Bowles 1998; Gintis 1974; Pollak 1978; Robson 2001). By researching into the literature on family decisions, it is found, however, that exogenous preferences are generally assumed. As a consequence, features that are likely to affect preferences - such as education and autonomy - are modeled as instruments of price change (Docquier 2004; Moav 2005). It is thought that preference change and price change modelling strategies are so closely related that the analytical outcome is the same whichever of the two procedures is applied. The differences arise in the interpretation of the results and in the fact that they bring to light different aspects of behavioral patterns (see Pollak 1978). Nevertheless, the socio-cultural studies of human behavior from different disciplines, and now from economics, point out crucial aspects of behavioral patterns, which emerge when the assumption of exogenous preferences is dropped out (Azam 2005; Bowles 1998; Gintis 1974; Phelps 1995, 2001; Pollak 1978; Robson 2001). Specifically in our context, an extensive empirical literature points in the direction of accounting for differences in preferences for household-structures

(Alba, Alvarez and Carrasco 2009; De la Rica and Ferrero 2003; Martín-García and Baizan 2006, for the case of Spain). More work remains to be done, however, to explain how differences might arise and be transmitted.

In an effort to fill this gap, the goal in this paper is to design and test a model to explain the dynamics of family decisions, which takes education as an instrument of *preference change* by increasing individuals' autonomy (Jejeebhoy 1995). To do so, we consider that 'autonomy (to prefer)' may play a key role in shaping preferences. At the risk of oversimplifying, autonomy is described as a mental skill that captures the extent to which individuals are responsible for their own preferences and beliefs (see Bavetta and Guala 2003; Bavetta and Peragine 2006, for a very close literature, and also the body of this paper for a formal definition of autonomy). An alternative way of thinking about autonomy is to interpret this skill as a feature that enlarges the person's capability to question and reassess the prevailing values (using Sen's 1985, 1992, framework), or as a personality feature that captures the person's initiative (Nyhus and Pons 2005).

A person's educational achievements are thought as part of her instrumental freedoms, which enlarge the person's substantive freedoms (Sen 1999). In this spirit, we argue that education increases autonomy to prefer (Jejeebhoy 1995; Agee and Crocker 2000; Dee 2004, for a close discussion). Moreover, the fundamental hypothesis of our study is as follows. The importance that parents attribute to their children's education and autonomy increases with their educational achievements. Throughout the paper, we test this hypothesis under the following two assumptions: (i) preferences are invariant within educational levels, and (ii) parents' actions to influence their children's autonomy do success.

The idea of satisfying property (i) is very appealing, since it relaxes the very common assumption of preferences being invariant across individuals while also allowing for cultural similarities within individuals who coincide in characterizing features (see Henrich and Boyd 1998 for the importance of studying both between-groups differences and within groups similarities, and Bowles et al. 2001; Nyhus and Pons 2005;

Phelps 1995, 2001, for the importance of personality). On the other hand, property (*ii*) is well documented in the literature. Parents appear to have a great influence on the abilities that their children eventually develop. Apart from the biological basis for the transmission of abilities, a person is more likely to develop the abilities to which she is exposed during her developing years. For someone to enjoy art, she must first cultivate her capacity to appreciate art. Certainly, even though the children of musicians may not be themselves brilliant musicians, they do more often than not develop the capacity for enjoying music, as a result of the environment in which they have grown up. In the same way, a person is more likely to achieve a higher level of mental-skill development in and environment that encourages the exercise of mental-skills (see Mill 1859, and Agee and Crocker 2000, 2002; Bisin and Verdier 2001, for recent work).

Henceforth, by generating a favorable scenario, we understand that parents influence the development of their children's abilities including the autonomy to prefer. We model parental effort to generate a favorable scenario as the transmission of bequests. Moreover, for modeling purposes, the following empirical findings are worth noting. A large body of empirical literature documents an inextricable relationship between the couples' choice of bequest to each child and their household fertility (Hanushek 1992; Rosenzweig and Wolpin 1980). This is the well-known trade-off between "quantity" (number of children) and "quality" of children (the bequests endowed to each child), formulated by Becker (1960, 1981) and Becker and Lewis (1973). The framework is therefore in the household-structure decision models, where individuals simultaneously choose the features of their households (leisure, consumption, household fertility and bequests to each child). Moreover, when no confusion arises, we avoid child quality terminology (Browning 1992).

To anticipate the findings, we obtain that education correlates negatively with fertility decisions. The result is in keeping with the findings of the leading studies in the field (Drèze and Murthi 2001; Wang and Famoye 1997; and Docquier 2004; Moav 2005, for a theoretical discussion). Nevertheless, the reasons suggested for the relationship between education and fertility differ according to whether they are based on the assumption of preference change or price change. When based on price change, the authors understand that higher levels of education are associated with reduced relative prices of investing in child bequests (see the aforementioned studies, and Ferrero and Iza 2004, for a theoretical analysis). When the focus is on preference change, the interpretation is less straightforward. Certainly, the negative relationship between education and fertility results from two separate effect: the effect of education on preference for quantity and its effect on preference for bequest for each offspring (see Phelps 1995, for a close discussion).

The data support the hypothesis that preference for quantity and preference for offspring's bequests both respond positively to increases in education. This means having to account for two effects of opposite signs, as higher preference for quantity (bequests) implies larger (smaller) household fertility. Fertility is therefore thought to decrease because the negative impact caused by a higher preference for bequests for offspring is stronger than the positive impact caused by a higher preference for quantity. In this regard, our findings sustain the idea that fertility decreases, even with an increase in preference for quantity. Moreover, our findings imply that preference for current consumption decreases with education. The idea that education leads to sacrifice current consumption for the sake of future generations surfaces in a wide range of theoretical and empirical studies (Agee and Crocker 2000; Azam 2005; Azam and Thelen 2008).

Current research and analysis provide important contributions for economic governance. Education seems to explain social positions, while it helps people become aware of the returns of children's quality care. Thus, guided by family norms, children of educated parents are likely to make greatest use of available and non-compulsory educational opportunities. The latter provides additional arguments for considering intervention on children's care as a public policy on curbing inequality.

The paper is structured as follows. In section 2, we develop a model of family decisions that captures the preference evolution across overlapping generations. The relationship is tested in an empirical framework, developed for the European setting, using the 2003 European Community Household Panel (ECHP). The empirical framework is displayed in section 3, and conclusions are given in the final section.

2 The Theoretical Framework

In our investigation of the dynamics of family decisions, we first focuses on a single dynasty, and on the decisions of a representative individual. This person's decisions are discussed in a two-period economy (representing youth and adulthood). Moreover, the person's life at each stage is described by her achievements. This brings us to the choice of an appropriate space in which to measure and evaluate the individuals' achievements.

Traditionally, a person's belongings (commodities) are understood as her achievements. However, the commodities approach does not take into account the pervasive human diversity that may prevent two different human beings from deriving the same utility from a given bundle of commodities. Circumstances, as an expression of human diversity, play a relevant role in the relationship between an individual's endowment of commodities, on the one hand, and freedoms actually enjoyed, on the other. Individuals may differ one another not only in personal characteristics, such as gender, abilities and health, but also in non-personal features, such as place of birth, religion, social status. This type of features, both personal and non-personal, often determine what people are able to do or be with a given bundle of commodities (Sen 1985, 1992).

Accordingly, it is easier to predict a person's future decisions based on information concerning her current states of being (such as being well-sheltered and well-educated) than on the basis of information about her commodities. In an attempt to provide an evaluative space the dimensions of which are directly states of being, Amartya Sen (1985, 1992) put forward the 'space of functionings'. Indeed, he refers to states of being as 'functionigs', which is the term used in what follows.

Henceforth, the individual's life-cycle is structured as follows. During her youth, each person obtains a vector of functionings, one which represents her degree of autonomy. This is her capacity to update values (by values, we mean preferences and beliefs) in light of current evidence. Thus, the person's degree of autonomy is to capture preference changes across educational levels with respect to household-structures (this assumption is to be empirically tested in subsection 3). The features of a household-structure correspond to the commodities that lead to one's functioning vector in adulthood.

2.1 Preliminary notation and definitions

We first introduce some general notation and definitions. Within a dynasty, we use the subscript i to denote the family of a decision-maker, including herself; and the subscript $-i$ to denote the family of the preceding generation of the dynasty.

We denote X_i to the set of all commodity bundles, any of which can be chosen by i. For simplicity and without loss of generality in the discussion, each element in X_i will be taken to be a vector of four components: consumption, z_i; leisure time, l_i; total number of offspring (fertility), n_i; characteristics of the bundle of commodities (e.g., time, energy, income) transferred from i to her offspring, e_i. The last of these elements indeed captures the vertical transmission of culture (Bisin and Verdier 2001). Henceforth, we refer to this term as 'bequest-education' or bequests.

The following subsections present the problems solved by i in her youth and adulthood, respectively.

2.2 The problem during the youth period

During the first stage of her life, a person i, born in time-period $t-1$ receives the bequest-education, e_{-i}^{t-1}, from her parents, $-i$. As already mentioned, varying personal and non-personal features imply that various achievements are plausible given the same bequests.

Let F be the set of all functions representing usage patterns of bequests; where $f_i \in F$ is a concave increasing function representing one usage pattern of bequest of i, where $f_i(0) > 0$ for mathematical purposes. Usage patterns can be thought of as cognitive elements. That is, the pattern is interpreted as the person's ability to take advantage of her available opportunities. Therefore, we can define the degree of autonomy as follows:

Definition 1 *In a period of time $t-1$, given the bequests received by i, e_{-i}^{t-1}, and her ability to take advantage of available opportunities, f_i. The degree of autonomy of i, denoted by a_i^{t-1}, is given by the expression*

$$a_i^{t-1} = f_i(e_{-i}^{t-1}). \tag{1}$$

Equation (1) means that a person's degree of autonomy is the result of the combination of her bequests (availability of choice) and her usage pattern (cognitive element). This definition is guided by the definition of functionings in Sen (1985). It also attempts to capture the requirements of the appropriate metric of autonomy, further discussed by Bavetta and Guala (2003) and Bavetta and Peragine (2006). The authors support the use of the cardinality of the set of potential preferences on the choice set as the adequate measure of the person's autonomy (freedom). We endorse this same spirit as mentioned in the introduction.

First one goes on to capture the idea of the set of potential preferences on the choice set. In the aforementioned studies, the potential preference relations are thought to be elicited by through the person's awareness of choice. The awareness element is brought into the model though the cognitive elements, f. Meanwhile bequests, e, represent the choice set. The result of $f(e)$ is, therefore, reminiscent of the set of potential preferences on the choice set. Concave transformations can be thought, indeed, as ways of ranking sets based on their cardinality. Because, by definition, f is an increasing concave transformation, equation (1) deals with the requirements for the appropriate definition of autonomy.

Some further properties of equation (1) are worth noting. By relating the choice set to parental bequest, we thereby capture the idea that parents play a key role in shaping their children's process of generating potential preferences. Certainly, this effort comes into the model via parents' bequests to their offspring, e. With the cognitive level fixed -given a function $f(.)$-, bequests increments lead to the expansion of the individuals' set of potential preferences. Apart from this, and for simplicity, it is convenient to continue the discussion as thought the degree of autonomy were the same along the two stages of the person's life. That is, we consider $a_i^{t-1} = a_i^t$. One might consider that autonomy achievement happens once-in-a-lifetime occurrence.

2.3 The problem at adulthood

The person's adulthood is to be represented by a functioning vector, resulting from the combining two choices: (i) the choice of a commodity bundle, x, and (ii) the choice of a usage pattern, f. Since the fundamental hypothesis of our study refers to the importance that parents attribute to their children's autonomy, we focus on the choice of the commodities relating to household-structure. As already mentioned, the commodities in which we focus the study are: number of offspring, n; bequest-education to children, e; current consumption, z, and leisure time, l. The parents' effort to influence their children's autonomy is indeed captured by their bequests to children, e.

People's preferences for these commodities may depend on their level of autonomy (see Behrman et al. 1999; Phelps 2001, for a close framework). So, let $A \in \mathbb{R}$ be the set of all the possible values of autonomy; and consider the following functions that represent the individual's preferences: $\theta(.)$ the continuous function, defined from A to the interval of the real numbers $[0, 1]$, reflecting the preference for child quality; $\gamma(.)$ the continuous function, defined from A to the interval of the real numbers $[0, 1]$, reflecting the preference for child quantity. Since this is the common procedure in the field, stemming from preference for child quantity, preference for current consumption is given by $(1 - \gamma(.))$.

Following the same procedure, one may derive the preference for leisure time from the person's degree of autonomy. Modeling this (possible) relationship may divert our attention toward the closely-related issue of the person's labor decisions, which is beyond the scope of the paper (see the foundations of "incentive-enhancing preferences" identified by Bowles et al. 2001, and explored by Nyhus and Pons 2005). The issue is given further attention in the empirical framework, where it is dealt with throughly.

To proceed, we consider that utility of i from a particular household-structure can be represented by a logarithmic function. Formally, the utility of i in $t+1$ over the four elements of a household-structure is given by the following expression:

$$u_i^t = [1-\gamma^t]\ log\ z_i^t + \gamma^t[log\ n_i^t + \theta^t\ log\ e_i^t] + \ \eta log\ l_i^t. \tag{2}$$

Notice that we write γ^t and θ^t instead of $\gamma(a_i^t(.))$ and $\theta(a_i^t(.))$. Moreover, the specification stems from the literature on fertility decisions (see Rosenzweig and Wolpin's, 1980, pioneering discussion on the necessity of imposing some structure on the household utility function). The common procedure is to consider a utility function which is additively separable in terms of the utility of rearing children and the utility from the consumption of other goods. The logarithmic specification is thought to be more appropriate for the Darwinian paradigm. Hence, we assume the utility function to be represented by a logarithmic specification, as in recent models (Docquier 2004; Moav 2005).

Therefore, the problem of an individual i, born in $t-1$, on reaching adulthood is treated as an optimization problem. That is, this person chooses a bundle of commodities, $x_i^t \in X_i^t$, by maximizing her utility function. Moreover, the choice of x_i^t is to be constrained by the following condition:

$$(n_i, e_i, z_i, l_i) \in x_i \Leftrightarrow y_i = w(T-l_i) \geq z_i + n_i(p+qe_i), \tag{3}$$

where y_i is wealth of i; w represents wage rate; T is total of time; p denotes the price of having another child regardless the price of investing in bequests, and q is the price of investing in bequests regardless the price of bringing up an additional child.

Equation 3 captures the definition of the budget constraint, a definition that in turn captures the inextricable relationship between the choice of the number of offspring and the bequest to each child (Becker 1960, 1981; Becker and Lewis 1973). The following is also worth noting. For modeling purposes, we take prices, p and q to be invariant across individuals sharing the same scenario (the same period and public policies). Nevertheless, we control for plausible price change across scenarios in the empirical framework (see section 3).

Formally, the problem faced by the individual on reaching adulthood is the following:

$$\begin{array}{ll} \text{Max} & u_i^t = [1-\gamma^t]\ log\ z_i^t + \gamma^t[log\ n_i^t + \theta^t\ log\ e_i^t] + \ \eta log\ l_i^t, \\ subject\ \ to & \left\{ \begin{array}{rcl} w(T-l_i^t) & \geq & z_i^t + n_i^t(p^t + q^t e_i^t), \qquad \text{and} \\ a_i^t & = & f_i(e_{-i}^{t-1}). \end{array} \right. \end{array} \tag{4}$$

The utility function is given by equation (2). The restriction of the feasible bundle of commodities is given by equation (3). The second restriction is given by equation (1).

The solution to this optimization problem is not straightforward. It depends on the choices made by i's ancestors in the previous period. In other words, we face the problem of dealing with endogenous preferences. In this paper, preferences are endogenized by the intergenerational transmission of bequest-education, which increase autonomy. Equation (4) therefore represents a dynamic optimization problem. There are different strategies for dealing with this problem. Results of a solution based on the comparative statics are presented in what follows.

2.4 Theoretical findings

We solve the problem faced at adulthood for one early generation in a dynasty, which, since it is taken to be the first generation, receives zero bequest-education. In other words, we solve the system (4) assuming that the degree of autonomy of i is a positive integer as small as necessary. With the solution of the problem, and using Euler's method, we examine the set of solutions when the bequest-education are greater than zero. That is, we calculate the comparative statics for increments in the level of education (see Agee and Crocker 2000 in this same spirit, but they drop out fertility of individuals' decision problem). By definition 1 in equation (1), autonomy increases with increments in bequests, albeit at a negative rate. Furthermore, as we are calculating the choices in equilibrium, we avoid referring to the representative individual by omitting subscripts i, $-i$. To avoid overburdening this paper, details of the solution and comparative statics are provided in the Appendix B, and this subsection is devoted to present fruitful insights into the impact of education on preferences (through increasing autonomy) that we learn from these solutions.

Result 1 *Let $\dot{e}$ the derivative of bequest-education with respect to time. The following statements are held:*

- $\dot{e} = 0 \Leftrightarrow \frac{\partial \theta}{\partial e} = 0$. *Moreover, if $\dot{e} \neq 0$, then*

$$Sign\ (\dot{e}) = Sign\ (\frac{\partial \theta}{\partial e}). \tag{5}$$

- $\frac{\partial z}{\partial e} = 0 \Leftrightarrow \frac{\partial \gamma}{\partial e} = 0$. *Moreover, if $\frac{\partial z}{\partial e} \neq 0$, then*

$$Sign\ (\frac{\partial z}{\partial e}) \neq Sign\ (\frac{\partial \gamma}{\partial e}). \tag{6}$$

Equation (5) states that there is a close relationship between the impact of education on quality of children (the endogenous variation of bequest-education) and on preference for child bequest-education. Both impacts take the same sign. In the same way, equation (6) tells us that there exists a close relationship between the impact of education on current consumption and on preference for child quantity. In this case, the impacts take opposite signs. Moreover, the solution and comparative statics of system (4) also might provide some insight into the relative size of the impact of these preference changes (on fertility decisions).

Result 2 *Assume $\frac{\partial \gamma}{\partial e}$ and $\frac{\partial \theta}{\partial e} \neq 0$. Then, the following statements are held:*

- *If Sign* $(\frac{\partial\gamma}{\partial e})$ = *Sign* $(\frac{\partial\theta}{\partial e})$*, we get that*

$$\frac{\left|\frac{\partial n}{\partial\gamma}\frac{\partial\gamma}{\partial a}\frac{\partial a}{\partial e}\right|}{\left|\frac{\partial n}{\partial\theta}\frac{\partial\theta}{\partial a}\frac{\partial a}{\partial e}\right|}:\begin{cases} >1 & if \quad Sign(\frac{\partial n}{\partial e}) = Sign\ (\frac{\partial\gamma}{\partial e}), \\ <1 & if \quad Sign(\frac{\partial n}{\partial e}) \neq Sign\ (\frac{\partial\gamma}{\partial e}), \\ =1 & if \quad Sign(\frac{\partial n}{\partial e}) = 0. \end{cases} \tag{7}$$

- *If Sign* $(\frac{\partial\gamma}{\partial e}) \neq$ *Sign* $(\frac{\partial\theta}{\partial e})$*, we get that*

$$Sign\ (\frac{\partial n}{\partial e}) = Sign\ (\frac{\partial\gamma}{\partial e}). \tag{8}$$

Result 2 shows that the response of fertility to variations in education provides major insight into the impact of education on preferences. Here note that equation (7) compares the impact size of these preference changes on fertility. Provided that fertility and preferences positively correlate with education, the impact of a change in preference for quantity is greater than the impact of a change in preference for bequest-education. Otherwise, a change in preference for bequest-education has the greater impact. Furthermore, equation (8) implies that if preferences respond differently to increases in education, the response of preference for quantity and of fertility will always coincide. Thus, Results 1 and 2 highlight the importance of studying the dynamics of fertility decisions when the aim is to study the joint evolution of education and preferences. It is therefore convenient to rewrite the household fertility solution here, as it appears in Appendix B. Equilibrium solution for fertility decisions is given by

$$n = \frac{\gamma(1-\theta)y}{p}, \tag{9}$$

where $y = \frac{wT}{1+\eta}$, which results of substituting the leisure equilibrium solution (see equation (35) in the Appendix) into equation (3).

3 Econometric Analysis

In this section, we study the relationship between the evolution of education and the evolution of preferences by estimating the impact of education on fertility decisions. The standard procedure for this is to estimate the variation in the expected household fertility resulting from a unit change in education, $\frac{\partial E[n|e]}{\partial e}$. The equilibrium condition in (9) describes the conditional expected fertility decisions in our framework.

3.1 Data set and sample

Our data set is compiled from the 2003 European Community Household Panel (ECHP). The ECHP is a collection of data sets that have been derived from interviews at personal and private household level. The survey is based on a standardized test that involves annual interviewing of a representative sample of households and individuals. Among the various data sets that cover fertility decisions, the ECHP best meets the requirements of our modeling approach[1]. It contains information about family and household types, income, and various other social indicators relating to living conditions (such as health and housing facilities). The 2003 ECHP covers the period 1994 to 2001. We focus on the data set of the 2001 survey, and on a sample of 8 327 households for which detailed information is available. Moreover, these households are in a set of European Countries, namely Belgium, Denmark, Germany, Greece, Spain, Ireland, Italy, Austria, Portugal, Finland and United Kingdom.

In the ECHP data set, one finds detailed information concerning households and individuals' decisions. We take the household rather than the individual as our unit of analysis, while adding information at individual level. The reasons for this choice of unit stem from the common notion that fertility decisions, and also bequests, involve the couple rather than the individual. The weight of the opinions of different family members may, of course, vary. Following common procedure in this literature,

[1] See for instance, the various data sets within the Fertility and Family Surveys project of the United Nations Economic Commission for Europe. Although the questionnaire proposed in this project includes relevant information about fertility decisions -not covered by the ECHP data sets- such as individuals' preferences and beliefs, there is no information about couples' income (see Santos Silva and Covas (2000), page 178), which is nevertheless a key variable in our modeling approach.

we disregard these differences.

Households where the female is aged 45 or more are likely to have completed fertility histories. However, within that target group, it is likely that some children have left the family unit, or are contributing to the family income with their own salaries. Therefore, in order to eliminate most of these cases, our target group consists of households where the female is aged between 25 and 45 (both inclusive). In other words, we account for incomplete fertility data (see Wang and Famoye 1997, for this same approach). As a consequence, unless one controls for the woman's exposure choice, fertility decisions are likely to be deflated.

Moreover, reasons such as stability, health and social norms are often cited as determining factors in causing individual's choices to depart from equilibrium (Melkersson and Rooth 2000; Santos Silva and Covas 2000). Therefore, within the controlling set, we include information about age (and squared age, to control for non linearities in age), health, stability and geographical location (see Table 6 for further details regarding the variables in the controlling set, and the variables of interest).

Our target group involves households with a single couple and we make no difference between biological children and adoptive children. This reduces the probability of choices being guided by either infertility or success in finding a partner. Meanwhile, by focusing on a portion of the population, we might be more likely to incur sample selection bias. This problem only arises when there is endogenous selectivity. In our scenario, it occurs when the explanatory variables in the fertility equation do not account for the full amount of individual heterogeneity and, moreover, this unobserved heterogeneity in the conditional mean is correlated with some attributes that explain the choice 'to live as a couple'. Otherwise, focusing on a portion of the population leads to exogenous selectivity, whereby the results can be extrapolated to the entire population.

For the purpose of testing selectivity, we are guided by Terza (1998) and Greene (2006). The authors base their modeling procedure on Heckman's premises. This consists in modeling as though the attributes that give rise to the selectivity problem are the unobservables in the choice 'to live as a couple'. On this basis, we regress the unobserved heterogeneity in the conditional mean on the unobservables in the choice 'to live as a couple'. Our data suggest that we are not dealing with endogenous selectivity (Table 2 displays the p-value of the parameter that captures selectivity problem).

3.2 Definition of the variables

The dependent variable is the number of children under sixteen that still form part of the household. This is a discrete variable, which in our sample takes a value in the range $0 - 10$, as shown in Table 4 of the Appendix A. Note that we also refer to this variable as household fertility.

The main regressors are the level of education and household wealth. Certainly education, and thus bequest-education, is an unobservable variable (Carter 1999). Following the common procedure in the literature, we use schooling attainment of the representative individual (mother) as a proxy for education. In this regard, schooling is thought as an instrument of social interaction that opens new information about, for example, the cost and benefits of behavioral traits. People with the chance of updating values in light of a grater information set are likely to have a greater cognitive development (Gintis 1974,), and higher degree of autonomy (see Bhattacharya 2006; Jejeebhoy 1995 ; Drèze and Murthi 2001).

Education data are compiled from the variable 'highest level of general or higher education completed' within the ECHP data set. There a person is assumed to have completed the level of education self-declared in the corresponding question in her personal interview (De la Rica and Ferrero 2003). It is worth noting that there is a close correspondence between the levels in the ECHP and the International Standard Classification of Education of 1997 (ISCED97). Recall that the ISCED is a framework put forward by UNESCO in order to facilitate the international comparability of education statistics. For analytical purposes, it is convenient to redefine education as a variable that retains its cardinal nature. Then, using the theoretical ending age at each ISCED level -reported by Eurostat (2003b) at country level-, we calculate the theoretical ending age of the educational level of each member of the sample. This modification of the variable transforms it into the covariate that captures education in our econometric model.

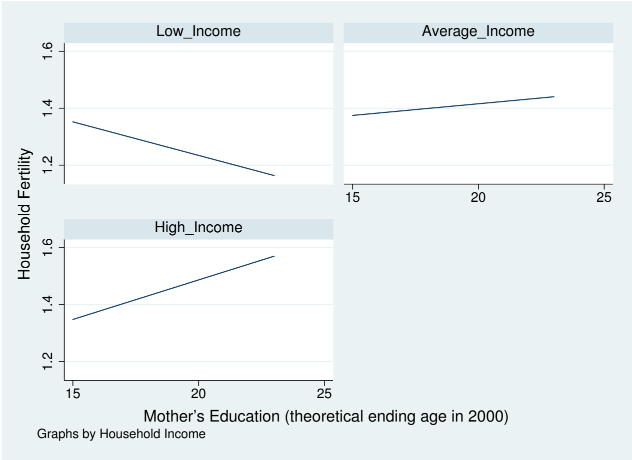
On the other hand, household wealth is calculated from the variable 'total net household income' in the ECHP. In the data set, this information refers to the year prior to the corresponding interview date. Thus, out family's income data, which are given in national currencies, are for the year 2000. For the purposes of our analysis, we calculate household income in terms of the purchasing power standard (pps), which eliminates cross-country price differences. Income in pps is calculated by dividing the national currency by the currency conversion rate. This gives us the purchasing power parity (ppp). The ppp used in this paper corresponds to the Eurostat database NewCronos from the table 'Theme2/price/pp/pppsna95', and it is also given in the ECHP data set.

Moreover, we use the cost of rearing a child independently of the cost of child quality, p^t, as a numeraire. One of the assumptions of the theoretical model is fixed prices across individuals. However, when one brings up the reality, one often finds differences in the regional provision of social services and other facilities that would work against our assumption. Indeed, these facilities play a key role in determining child-rearing costs and, moreover, fertility issues feature on the agenda of many of the countries within our data set. We therefore include information of geographical data (Melkersson and Rooth 2000; Santos-Silva and Covas 2000; Wang and Famoye 1997). This information is compiled from the variable 'country' in the ECHP data set.

3.3 Preliminary data analysis

Among the descriptive features of the sample, it is worth mentioning that 21.22 percent of the households within the sample are not bringing up any child, while 33.09 percent of them are bringing up a single child, and 34.11 percent of the households

Figure 1: Linear regression of household fertility on mother's education



are bringing up two children. Note that less than 12 percent of the households are bringing up more than two children (see Table 4 in the Appendix A).

As far as educational attainment is concerned, 36.90 percent of adult females achieve less than the second stage of secondary education (versus 38.90 percent of males). 35.54 percent of adult females reach the secondary stage of secondary education, and 27.56 percent reach the third level. Meanwhile, 35.75 percent of adult males reach the second stage of secondary education, and 25.35 percent reach the third level (see Table 5 in the Appendix A). Here a careful data cleaning procedure was carried out on the rough data (details of the precise steps followed are available from the author upon request).

A crude analysis of the role of education on family decisions is also worth noting. Notice, nevertheless, that we control for the incidence of family wealth. To do so, we divide the sample into three income groups. Here the reference for the ends of the grouping intervals is the combination of the sample mean of household wealth and the half of its standard deviation. Thus, for each income group, we calculate the prediction for household fertility based on a linear regression of this variable on education. Resulting predictions are plotted in Figure 1.

It is striking that higher levels of education are associated with reduced household fertility in the low family income group, while the opposite relationship arises in the high family income group. Patterns also suggest that average household fertility regarding families with less than second stage of secondary education (theoretical ending age around 15 years) are invariant across income levels, remained around the sample mean (see table 6 in the Appendix A). In contrast, patterns suggest that highly educated parents raise large families (larger than the sample mean) as and when they belong to the high income group. Recall that this income classification responds to illustration purposes, and is not imposed in the analysis below. Thus, the mentioned findings are taken as insights into the role of education as a key variable that bounds the informational set of individuals, which in turn would support education as instrument for the enlargement of autonomy to prefer (thought of as the chance a person has to update her beliefs and preferences). Moreover, the latter is compatible with the idea that accounting for personality features is crucial to explain family decisions (Phelps, 2001, 1995). Bearing this in mind, we go on to investigate how to identify preference changes over household-structures.

3.4 Identification and econometric methodology

The key identification issue concerns the relationship between education and preferences. Although we know little about the process by which preferences are generated, few plausible assumptions make possible this identification. The assumptions concern the functional form that captures the preference formation process.

In subsection 2.3, we consider that the relationship between preferences and education (through autonomy) can be represented by a continuous function. Among the various non-decreasing and continuous functional forms, we start by assuming that each preference formation process can be represented by a linear function. To avoid overburdening the paper, the results for other functional forms are not reported (it would be moreover redundant since it provides no additional insights into the problem). Henceforth, preferences are defined as follows.

Definition 2 *Preference for child quantity is specified as*

$$\gamma(e) = \alpha_0 + \alpha_1 e. \tag{10}$$

Definition 3 *Preference for child quality is specified as*

$$\theta(e) = \sigma_0 + \sigma_1 e. \tag{11}$$

For analytical purposes it is useful to rescale the metric of the parameters in equations (10) and (11) by the parameter α_0. Then, consider $\bar{\alpha_1} = \frac{\alpha_1}{\alpha_0}$, $\bar{\sigma_0} = \frac{\sigma_0}{\alpha_0}$ and $\bar{\sigma_1} = \frac{\sigma_1}{\alpha_0}$. The model in section 2, moreover, implies that our parameters of interest, $\bar{\alpha_1}$ and $\bar{\sigma_1}$, can be estimated in a single equation. As already mentioned, the parameters are estimated in the fertility equation (shown in equation (9)).

To proceed, consider the following transformations. Substituting equations (10) and (11) into equation (9), gives the following expression:

$$n_i = (1 - \bar{\sigma_0})y_i + [\bar{\alpha_1}(1 - \bar{\sigma_0}) - \bar{\sigma_1}]e_i y_i - \bar{\alpha_1}\bar{\sigma_1}e_i^2 y_i. \tag{12}$$

The equilibrium condition in (12) indicates expected household fertility for each pair of autonomy and income levels, $E[n_i|y_i,\ e_i]$. Moreover, this conditional expected fertility is linear in three parameters, b_1, b_2 and b_3:

$$b_1 \approx (1 - \bar{\sigma_0}), \tag{13}$$

$$b_2 \approx \bar{\alpha_1}(1 - \bar{\sigma_0}) - \bar{\sigma_1}, and \tag{14}$$

$$b_3 \approx -\bar{\alpha_1}\bar{\sigma_1}. \tag{15}$$

The following expression gives the baseline specification of fertility decisions in (12).

$$n_i = b_1 y_i + b_2 e_i y_i + b_3 e_i^2 y_i + \Gamma_i^{'} b_4 + \epsilon_i, \tag{16}$$

where b_1, b_2 *and* b_3 *denote the three parameters in* (13), (14) and (15), *respectively, and* ϵ_i *denotes the random error.*

Noting that (12) reflects an equilibrium condition, the exogenous variables in Γ_i control for the difference between that equilibrium and the current situation. Γ_i includes a constant term, whose associated parameter will be denoted by β_0.

As already mentioned, moreover, we have assumed invariant preferences for leisure across autonomy levels, and thereby preferences are invariant with education. However, no one doubts that schooling - our proxy for education - increases the individual's chances of finding more job opportunities and, thereby, higher incomes. In order to capture the effect of schooling on household wealth, we estimate a reduced form equation (Browning, 1992, for a review). Specifically, the covariates in the household wealth equation capture the effect of female education, age, health and geographical data, as follows:

$$y_i = t_1 e_i + t_2 e_i^2 + \Lambda_i' t_3 + \upsilon_i, \tag{17}$$

where Λ_i *is a vector of exogenous variables, and* υ_i *denotes the random error.*

Therefore, our econometric study lies in a system of two regression equations, (16) and (17). A first step in the analysis involves testing the independence of these two equations. The standard procedure for testing against the simultaneity of decisions involves the Breusch-Pagan test, which checks for evidence of correlation between the residuals of the fertility equation and the family income equation. For this purpose, we initially estimate the system by Generalized Least Squares (GLS) model. The estimates of the parameters in this seemingly unrelated regression model are presented in Table 1 for a range of selected control variables. There we also include the Breusch-Pagan test. The results provide powerful reasons to reject the simultaneity of fertility and wealth decisions, which might rest on the variable definitions (see Connelly et al. 2006, for further discussion). In our scenario, the sequential decisions imply that the couple first determine their own income. They then choose the household fertility (see (9) and (35)). The finding also means that some efficiency is gained by estimating the two equations separately.

The discrete nature of fertility, n_i, implies that, strictly speaking, the parameters, b_1, b_2 and b_3, cannot be estimated consistently by Ordinary Least Squares (OLS). This

Table 1: Generalized Least Squares Estimates of Fertility and Wealth Equations, Europe 2001 (p-value in brackets)

Dependent	Fertility A		Fertility B		Wealth[a] C	
Education (E)					11.452	(.000)
sq. E					−1.725	(.000)
Wealth[a] (W)	−1.694	(.003)	−2.129	(.001)		
W per E	.156	(.011)	.205	(.002)		
W per sq. E	−.004	(.022)	−.005	(.003)		
Age	.528	(.000)			.031	(.036)
sq. Age	−.008	(.000)			−.000	(.490)
Health	.077	(.003)			.061	(.000)
Stability	.689	(.000)			−.021	(.158)
Denmark	.703	(.000)	.587	(.000)	.104	(.013)
Belgium	.478	(.000)	.519	(.000)	.081	(.038)
Ireland	.893	(.000)	.892	(.000)	.069	(.096)
Italy	.062	(.348)	.008	(.903)	−.896	(.000)
Greece	.119	(.074)	.158	(.027)	−.385	(.000)
Spain	.022	(.730)	−.014	(.835)	−.377	(.000)
Portugal	.131	(.046)	.053	(.458)	−.318	(.000)
Austria	.257	(.000)	.266	(.001)	.096	(.016)
Findland	.781	(.000)	.760	(.000)	−.180	(.000)
United kingdom	.415	(.000)	.455	(.000)	.047	(.205)
Constant	−7.945	(.000)	1.234	(.000)	−3.707	(.000)
F		(.000)		(.000)		(.000)
R^2		.205		.068		.460
Breusch-Pagan	.258	(.612)	1.018	(.313)		
Sample size		8 327		8327		8327

Resource: ECHP (see Eurostat (2003a)).

Notes: [a]The variable Wealth corresponds to the natural logarithm of the family income. We use Germany as control variable.

In column C, education corresponds to the natural logarithm of schooling years.

The joint parameter estimation of A and C is given in column C. Estimations take almost the same values as the result of the joint estimation of B and C. Breusch-Pagan tests of independence in fertility and wealth decisions, chi2(1), and relates each fertility equation with wealth equation in C.

is the case when the variable(s) of interest fails to satisfy the property of continuity. Apart from their discrete nature, it is worth noting that the domain of fertility decisions lies within the set of non-negative integers and, moreover, the values have cardinal nature. The classical linear model fails to capture these features. In order to take them into account, one proceeds by using discrete choice models. In this context, count data models are better able to capture the cardinal nature of the variable of interest.

Furthermore, the Poisson point process becomes the common procedure to represent count data. Here, the main assumption is that household fertility is distributed according to the Poisson distribution. Thus, the probability that the number of children in a household i, n_i, equals $n \in N$, where $N = \{0, 1, 2, \ldots\}$, is formally specified as

$$Pr[n_i = n] = \frac{Exp[-\lambda_i]\lambda_i^n}{n!}, \tag{18}$$

where parameter λ_i *identifies both the conditional expected household fertility of* i *and its sample variance.*

The assumption of Poisson distribution of fertility decisions implies the assumption of equidispersion of the data. Therefore, by equation (16), the specification for the mean (and hence variance) of household i is given by $\lambda_i = \beta_1 y_i + \beta_2 e_i y_i + \beta_3 e_i^2 y_i + \Gamma_i' \beta_4$, where β_1, β_2, β_3 and β_4 denote the parameters (or set of parameters) in (13), (14) and (15), respectively. The Maximum Likelihood (ML) estimation of parameters in an extended version of the model in (18) are displayed in Table 2.

It is well known that, if the household fertility fails to be Poisson distributed, but the conditional expected household fertility is correctly specified, this method provides consistent estimates of the parameters. The method nevertheless fails to provide unbiased estimates of the variance. Note that our unconditional data are slightly underdispersed. The sample mean is 1.393 children per household compared to a value of 1.061 for the sample variance (see Table 6).

The common test of over(under)dispersion relies on the assumption that the true variability is proportional to the Poisson parameter λ. Therefore, in order to perform the test, it is necessary to estimate the true variability. We do this by dividing the sum of squared residuals by the degrees of freedom. Given the true variability as the dependent variable and the parameter λ as the regressor, one goes on to estimate the constant of proportionality by OLS. Values below one indicate underdispersion, while values above one indicate overdispersion in the data. Controlling for the covariates in the extended version of the model, the constant of proportionality indicates underdispersion in the data (.805). The result is in keeping with the findings of earlier studies (see for instance, Melkersson and Rooth 2000; Santos-Silva and Covas 2000; Wang and Famoye 1997). The standard errors in Table 2 (columns A and B) were calculated after correcting for the bias.

It is worth noting that the underdispersion in the data may be due to more intricate problems, such as the mis-specification of the sample mean. In our analysis, the specification of the mean relies on the assumption that people base their decisions on updating in light of current evidence. Recall that the capacity to update values (the degree of autonomy) is thought to be one of the key elements in the preference formation process. The explanation for household fertility in certain couples may differ from the one based on couples' values, however. This is the case of those whose decisions are still constrained by infertility. Deviations toward non-children families are highly documented in the literature on fertility decisions. Moreover, recent studies also document a bias toward two-children families. A portion of the population is thought to believe in a kind of exogenous *compulsory* norm applied to couples, by which couples raise two children irrespective of any other household circumstances (Melkersson and Rooth 2000; Santos Silva and Covas 2000). The existence of these uncontrolled data-generating processes implies that the conditional mean differs from that specified.

In order to test our sample against deviations from the Poisson distribution, and guided by Merlkersson and Rooth (2000), we proceed as follows. We compare the observed distribution of number of offspring below the aged of sixteen with a theoretical Poisson distribution with sample mean of 1.348 children. An initial inspection of the data clearly reveals that there is an excess of two-children families in our sample (see Table 4 in the Appendix A). We therefore modify the density function in equation (18) to account for the 'extra' probability of bringing up zero and two children. Thus, the probability that the household fertility of i, n_i, equals $n \in N$, where $N = \{0, 1, 2, \ldots\}$, is formally specified as

$$Pr[n_i = n] = \begin{cases} \psi_0 + (1 - \psi_0 - \psi_2)(Exp[-\lambda_i]) & if \qquad n_i = 0, \\ \psi_2 + (1 - \psi_0 - \psi_2)(\frac{Exp[-\lambda_i]\lambda_i^2}{2}) & if \qquad n_i = 2, \\ (1 - \psi_0 - \psi_2)(\frac{Exp[-\lambda_i]\lambda_i^n}{n!}) & \qquad \text{Otherwise}, \end{cases} \tag{19}$$

where parameters $\psi_0, \psi_2 \in [0, 1]$, *satisfy the condition:* $\psi_0 + \psi_2 \leq 1$, *and* $\lambda_i = \nu_1 y_i + \nu_2 e_i y_i + \nu_3 e_i^2 y_i + \Gamma_i' \nu_4$.

The ML estimation of parameters of an extended version of the model in equation (19) are displayed by Table 2 (see columns C and D), which also gives the estimates of ψ_0 and ψ_2.

By comparing the estimates of equations (16), (18) and (19), it is evident that there is no difference in the sign and significance of the relevant estimates, revealing their robustness. From there, we go on to study the relationship between education and preferences.

3.5 Empirical results

For further insight into the relationship between education and preferences, we have estimated the parameters in the fertility equation. On the basis of our theoretical framework, these estimates lead us to interpret the impact of education on preferences. This subsection describes how we reach our main empirical outcomes.

Before proceeding, it is worth taking note that there are powerful reasons to support that the three parameters of interest (b_1, b_2 and b_3) are all significantly different from zero (see estimates in Tables 1 and 2). While b_1, b_3 take below zero values, b_2 takes positive values. The sign of the parameters highlights the linkages between the impact of education on preference for quantity and on preference for bequest for

Table 2: Maximum Likelihood Estimates of Fertility Decisions, Europe 2001

(p-value in brackets)

	Poisson model				Zero and Two inflated model			
	A		B		C		D	
Wealth[a] (W)	−2.137	(.000)	−2.143	(.003)	−2.215	(.004)	−2.079	(.010)
W per E	.202	(.001)	.221	(.005)	.211	(.009)	.215	(.012)
W per sq. E	−.005	(.003)	−.006	(.004)	−.005	(.015)	−.006	(.010)
Age	.501	(.000)			.511	(.000)		
sq. Age	−.007	(.000)			−.007	(.000)		
Health	.052	(.032)			.039	(.178)		
Stability	.612	(.000)			.613	(.000)		
Denmark	.655	(.000)	.106	(.143)	.696	(.000)	.129	(.115)
Belgium	.466	(.000)	.186	(.008)	.510	(.000)	.225	(.004)
Ireland	.854	(.000)	..577	(.000)	.933	(.000)	.690	(.000)
Italy	.007	(.900)	−.231	(.000)	.004	(.959)	−.294	(.000)
Greece	.090	(.124)	−.097	(.118)	.088	(.243)	−.158	(.023)
Spain	.005	(.925)	−.286	(.000)	.028	(.686)	−.364	(.000)
Portugal	.122	(.032)	−.219	(.000)	.143	(.052)	−.266	(.000)
Austria	.236	(.000)	−.080	(.244)	.236	(.005)	.384	(.000)
Findland	.747	(.000)	.296	(000.)	.817	(.000)	.362	(.000)
UK	.394	(.000)	.071	(.258)	.431	(.000)	.078	(.266)
Constant	−7.453	(.000)	1.457	(.000)	−7.688	(.000)	1.419	(.000)
ψ_0					−1.747		−.924	
ψ_2					.390		.017	
Selectivity		(.072)		(.731)		(.117)		(.645)
Sample size		8327		9717		8327		9717

Resource: ECHP (see Eurostat (2003a)).

Notes: [a]The variable Wealth corresponds to the natural logarithm of the family income. We use Germany as control variable.

Selectivity is the P-value of the parameter that captures the unobserved heterogenity in the conditional mean on the unobservables in the choice 'to live as a couple' (see Terza (1998) and Greene (2006)).

each offspring. For instance, substituting equations (10) and (11) into equation (15), the negative sign of b_3 implies that the response to changes in education takes the same sign in both types of preferences. Formally,

$$Sign(\frac{\partial \gamma(e)}{\partial e}) = \text{Sign } (\frac{\partial \theta(e)}{\partial e}). \tag{20}$$

Recall that, by definition in equations (10) and (11), $\alpha_1 = \frac{\partial \gamma(e)}{\partial e}$ and $\sigma_1 = \frac{\partial \theta(e)}{\partial e}$. Assuming that, in the absence of any constraint, children are welcomed, it is quite reasonable to discard the case in which both types of preference decrease with education. Regarding preference for bequest-education, the assumption has a great deal to do with the findings reported in the leading literature on household decisions. The authors of these studies find strong evidence to support a positive relationship between education and investment in children's education, while at the same time educational investments are broadly thought as bequest itself (Agee and Crocker 2002; Behrman et al. 1999; and Moav 2005, for a theoretical discussion). By equation (5), this result implies a positive relationship between education and preference for child bequest-education. To the best of our knowledge, however, there is no conclusive evidence regarding the relationship between education and preference for child quantity (Phelps, 1991). Since our empirical findings support that both impacts take the same sign, it is reasonable to consider that both parameters, α_1 and σ_1, take values above zero. The latter in turns implies a negative relationship between education and current consumption, which has been highlighted in previous studies (Agee and Crocker 2000; Azam 2005; Azam and Thelen, 2008).

To proceed, we will now go on to exploit our theoretical findings. According to the analysis (see Result 2), satisfaction of (20) means that our findings for the effect of education on fertility decisions also inform us of the effect of education on preferences. Specifically, we learn whether or not the impact of a change in preference for child quantity on fertility is greater than the impact of a change in preference for bequest-education. In order to calculate the partial effect of education on fertility decisions, it is useful to recall the following expressions.

From the linear econometric model in (16) and for the Poisson model in (18), we get that

$$E[n|\ e,\ y,\ z] = b_1 y + b_2 ey + b_3 e^2 y + \Gamma_i^{'} b_4, \tag{21}$$

where b_j represents the parameter j in each modeling approach.

Meanwhile, for the zero-and-two inflated model in equation (19), we get

$$E[n|\ e,\ y,\ z] = 2\psi_2 + (1 - \psi_0 - \psi_2)(b_1 y + b_2 ey + b_3 e^2 y + \Gamma_i^{'} b_4). \tag{22}$$

By $E[n|e] = E[\ E[n|e, y, z]\ |\ e]$, the variation in the expected household fertility caused by a unit change in education is given by

$$\frac{\partial E[n|\ e]}{\partial e} = (b_2 + 2b_3 e)E[y|e] + (b_1 + b_2 e + b_3 e^2)\frac{\partial E[y_i|e_i]}{\partial e}, \tag{23}$$

if satisfied (21).

$$\frac{\partial E[n|\ e]}{\partial e} = (1 - \psi_0 - \psi_2)[(b_2 + 2b_3 e)E[y|e] + (b_1 + b_2 e + b_3 e^2))\frac{\partial E[y|e]}{\partial e}], \tag{24}$$

if satisfied (22).

We proceed by substituting conditional expected wealth and its variation in (23) and (24). By equation (17), the conditional expected wealth is given by

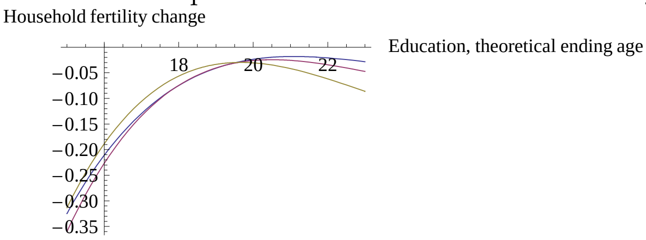
$$E[y|e] = E[\ E[n|\ e,\ y,\ w]\ |\ e] = t_1 e + t_2 e^2 + \Lambda_i^{'} t_3. \tag{25}$$

From (25), the variation is given by

$$\frac{\partial E[y|\ e]}{\partial e} = t_1 + 2t_2 e. \tag{26}$$

The fitted curved lines in Figure 2 represent the non-monotonic relationship between education and the variation in the expected number of children caused by a unit change in education. Specifically, we find education to be negatively correlated with fertility, at a decreasing rate (De la Rica and Ferrero 2003; Martín-García and Baizan 2006). More importantly is that, for all theoretical ending ages in our sample, the variation in the expected number of children caused by a unit change in schooling years take negative values. Regarding the size of the impact of education on the expected household fertility, Table 3 presents the elasticity of fertility decisions with

Figure 2: Education and partial effect of education on fertility decisions



Notes: Calculations are based on estimates from the extended versions of the models. Blue line refers to Generalized Least Squares model, red line to Poisson model and yellow line to Zero and Two Inflated model.

respect to education. It also gives the positive partial effect of education on wealth, which is well documented in the literature. Moreover, our finding is compatible with evidence that shows a decrease in the negative correlation between fertility and income-gaining decisions of the family (Ferrero and Iza 2004). Thus, our model offers a description of this recent phenomena, will capturing how the morality of a society might evolve with education and autonomy to prefer. It can therefore be taken as an additional toolkit to evaluate the effect of public policies.

Table 3: Elasticity of Fertility Decisions with respect to Education, Europe 2001 (at the mean values of the regressors)

Linear		Poisson		Zero-and-two inflated	
A	B	C	D	E	F
−.1755	−.1755	−.0646	−.0369	−.1055	−.1187
Partial effect of education on the natural logarithm of the family income					.4354

Resource: ECHP (see Eurostat (2003a)).

Note: Columns A, C and E are based on extended versions of the models. Columns B, D and F are based on reduced versions of the models.

According to the finding in Result 2 displayed by (27), the negative correlation between education and fertility decisions implies that

$$\frac{\partial n}{\partial \gamma(e)} \frac{\partial \gamma(e)}{\partial e} < \frac{\partial n}{\partial \theta(e)} \frac{\partial \theta(e)}{\partial e}. \tag{27}$$

Equation (27) means that education has a greater impact via quality (bequest-education) than via quantity. This provides an explanation for the negative relationship between fertility and education, while preference for child quantity increases with education. Thus, our findings are compatible with the idea that a biased transmission of educational endowments explains differences in household decisions across individuals grouped in light of their parents' education.

Moreover, from a combination of our theoretical and empirical frameworks, we predict that, by gaining education, population increases their preference for child bequest-education. This result is in keeping with the findings of earlier studies. Indeed, our results are consistent with studies on the dynamics of trade-off phenomena, which document the downtrend in fertility across generations, accompanied by an uptrend in child quality (see Hanushek 1992; Rosenzweig and Wolpin 1980).

4 Concluding Remarks

The main contributions of the paper are the design and testing of a model that brings two leading bodies of literature together to obtain a reliable explanation for the behavioral dynamics associated with household-structures. While following primarily in the spirit of the vast body of literature on household-structure decisions that has focused on the trade-off between child quantity and child quality (bequest-education for each offspring), it also adopts the spirit of the growing body of literature modeling preference change. As a result, we obtain a model of household-structure decisions that also accounts for preference evolution. In contrast to most of the literature that assumes exogenous-preferences, our model demonstrates the plausibility of education correlating positively with preference for child quantity, though parents with greater education end up raising smaller families.

Through the estimation of our model, we find reasons to support that education has indirectly triggered the trade-off between child quantity and bequests for each offspring. The data support that fertility decisions correlate negatively with education, a result that is in keeping with the earlier literature. Our contribution in this respect is to provide some insight into the reasons for the trade-off. According to our results, there are powerful reasons to support that increments in education lead to a higher preference for both child quantity and child bequest-education. The empirical results are therefore compatible with the idea that fertility might decrease with education, although preference for child quantity increases. Moreover, our findings also compatible with the idea that education leads individuals to sacrifice their own consumption for the sake of future generations.

Nevertheless, the accuracy of our results could be enhanced by using any data sets that carry information on individual autonomy. It would be quite plausible to design a questionnaire to collect information regarding subjects' capacity to question their own preferences and beliefs. To the best of our knowledge, however, there is no data set that brings together all the relevant variables in our framework. This would merit further research.

We believe that the paper here presented provides a useful additional toolkit for public policy evaluation. It explains how public policies oriented toward the guarantee of personal freedoms, such as the expansion of education and autonomy, are likely to guarantee the same freedoms for subsequent generations. According to our model, conditional to other features of the couple, such as wealth, parents with a higher educational attainments aim to leave greater bequest-education to their offspring. In this way, parents are thought to pass on the means to expand freedoms in the next generation.

The model also explains why very crucial public policies on equality of opportunities might fail around the world. Consider the familiar case in which the aim is to provide universal schooling in a place where it was not available to the previous generation. It is little wonder that parents wish their children to achieve at least their own level of educational attainment, and are to encourage their children in this regard. Universal education policies that also enlighten people in the new generation about the enormous returns to education are surely more effective than those that focus exclusively on reducing the monetary costs of schooling. Otherwise, some people might fail to develop the values that lead them to encourage their children to take up the new opportunity.

Appendix

A Tables

Table 4: Distribution of Fertility in the Sample, Europe 2001; and Theoretical Poisson Distribution with the same Sample Mean

Count	Number	Frequencies	Poisson
0	1,767	.2122	.2482
1	2,755	.3309	.3459
2	2,840	.3411	.2410
3	772	.0927	.1119
4	149	.0179	.0390
5	28	.0034	.0109
6	7	.0008	.0025
7	2	.0002	.0005
8	5	.0006	.0001
9	1	.0001	.0000
10	1	.0001	.0000
Total	8,327	1.0000	1.0000

Resource: ECHP, survey year 2001 (see Eurostat (2003a)).

Notes: household fertility is the number of offspring under the age of 16 in households. Sample mean in both distributions is 1.393 children

Table 5: Distribution of Sample Educational Attainments, Europe 2001 (frequencies)

Categories Theoretical ending age (Min, Max)	Females	Males
Less than second stage of secondary education		
(15, 16)	.3690	.3890
Second stage of secondary education		
(18,19)	.3554	.3575
Recognised third level of education		
(22,23)	.2756	.2535
Total	1.0000	1.0000

Resource: ECHP (see Eurostat (2003a)).

.

Table 6: Descriptive Statistics (sample), Europe 2001

Variable	Mean	Std. Deviation	Min	Max
Children in households	1.393	1.030	0	10
Wealth Purchasing Power Standard of 2000	2.726	1.750	0	33.70
Natural logarithm of Wealth	.802	.695	−10.23	3.52
Education, theoretical ending age in 2000	18.381	2.928	15	23
Age	36.408	5.480	25	45
Stability,				
(= 1, same marital status since 1995)	.679	.467	0	1
Health, (=1, very good or good health)	.800	.400	0	1
Denmark(= 1)	.045	.208	0	1
Belgium(= 1)	.064	.245	0	1
Ireland (= 1)	.050	.218	0	1
Italy (= 1)	.187	.390	0	1
Greece(= 1)	.121	.326	0	1
Spain (= 1)	.146	.353	0	1
Portugal (= 1)	.126	.332	0	1
Austria(= 1)	.066	.248	0	1
Findland(= 1)	.063	.243	0	1
Germany(= 1)(reference category)	.031	.174	0	1
United kingdom(= 1)	.084	.277	0	1
Total	8,327			

Resource: ECHP (see Eurostat (2003a)).

B Comparative Statics

To solve the problem shown in system (4), we calculate the first-order conditions with respect to the household features ($n,\ e,\ z\ and\ l$). They are listed below:

$$\frac{\gamma}{n} - \lambda(p+qe) = 0, \tag{28}$$

$$\frac{\gamma\theta}{e} - \lambda nq = 0, \tag{29}$$

$$\frac{[1-\gamma]}{z} - \lambda = 0, \tag{30}$$

$$\frac{\eta}{l} - \lambda w = 0, \tag{31}$$

where the multiplier λ measures the sensitivity of the optimal utility to changes in initial wealth y. In other words, this is the marginal utility of income. Moreover, these equations have an interior solution only if $0 < \gamma < 1$, and $\theta, \eta > 0$.

From equations, (28)-(31), as well as from equation (3), we solve the problem of system (4). Solutions are given by the following equations:

$$n = \frac{\gamma[1-\theta]Tw}{p[1+\eta]}, \tag{32}$$

$$e = \frac{\theta p}{[1-\theta]q}, \tag{33}$$

$$z = \frac{[1-\gamma]Tw}{1+\eta}, \tag{34}$$

$$l = \frac{\eta\, T}{1+\eta}. \tag{35}$$

To develop the comparative statics for increments in education, we proceed as follows. We calculate the derivative of $n,\ e\ and\ z$ with respect to education, keeping prices fixed (the derivative of l is not reported, as it is null), and we obtain the following expressions:

$$\frac{\partial n}{\partial e} = (\frac{\partial n}{\partial \gamma}\frac{\partial \gamma}{\partial a} + \frac{\partial n}{\partial \theta}\frac{\partial \theta}{\partial a})\frac{\partial a}{\partial e}, \tag{36}$$

where $\quad \frac{\partial n}{\partial \gamma} = \frac{Tw[1-\theta]}{[1+\eta]p} > 0, \qquad \frac{\partial n}{\partial \theta} = -\frac{Tw\gamma}{[1+\eta]p} < 0.$

$$\dot{e} = (\frac{\partial e}{\partial \gamma}\frac{\partial \gamma}{\partial a} + \frac{\partial e}{\partial \theta}\frac{\partial \theta}{\partial a})\frac{\partial a}{\partial e}, \tag{37}$$

where $\quad \frac{\partial e}{\partial \gamma} = 0, \qquad \frac{\partial e}{\partial \theta} = \frac{p}{q[1-\theta]} + \frac{p\theta}{q[1-\theta]^2} > 0.$

$$\frac{\partial z}{\partial e} = (\frac{\partial z}{\partial \gamma}\frac{\partial \gamma}{\partial a} + \frac{\partial z}{\partial \theta}\frac{\partial \theta}{\partial a})\frac{\partial a}{\partial e}, \tag{38}$$

where $\quad \frac{\partial z}{\partial \gamma} = -\frac{Tw}{1+\eta} < 0, \qquad \frac{\partial z}{\partial \theta} = 0.$

Equations - (36) to (38) - illustrate the effects of an increment in education on the number of offspring, the bequest-education for each child, and current consumption.

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