An Economic Analysis of Fertility in Belgium

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In recent years, considerable progress has been made in developing and testing economic models of fertility. While there is still no complete and satisfactory economic theory of fertility, and while it cannot be argued that all of fertility behaviour falls within the domain of Economics, at the same time recent empirical results confirm that economic variables do play an important role. The economic theories that we have at hand are rich in suggesting explanatory variables, but unfortunately, do not yield unambiguous predictions unless additional constraints are imposed, *a priori*.[1] The supply of empirical evidence in this "infant sub-discipline" must weigh quite highly, therefore, in the search for an economic theory of fertility based on accepted *a priori* tenants.

The present paper, which is written in this spirit, is an application of some of the new economic approaches to fertility to Belgian cross section data. As such, it constitutes one of the few (if not only) attempts to apply these theories to a modern, developed economy in Europe.[2] In the next section, we shall briefly review the "new home economics" of fertility concentrating mainly on the desired child-stock relationships. Then we shall outline a rudimentary theory of child spacing, a relatively neglected area in the economics of fertility. Following that, we shall consider an approach to going from the economic model of the individual to an aggregated econometric model. In the last section, the regression results for Belgium are presented.

The "New Home Economics"

The analysis within a choice theoretic framework of parent's decisions on the number of children to have is made difficult by several aspects of the child bearing process. In the first place, the choice of an appropriate unit of analysis must be settled; there is the question of an optimal completed family size (which is a stock) versus the spacing of that stock though the fertile age period (which is flow); there is, moreover, the question of child quality versus child numbers as it is clear that parential expenditures of time and money vary from family to family. Secondly, child bearing and raising are non-market activities so that many of the associated "prices" are difficult to observe. Thirdly, family units are decision units composed of typically more than one individual. Fourthly, the formation of the family unit in the first place (i.e. marriage) may be intertwined with the child decisions. Fifthly, children are multi-dimensional and the stream of utility derived from them is thus derived from several aspects of the children. In rural areas, for example, children may provide income as child labourers and in any case may contribute a source of old-age security for parents. This is related to yet another complicating feature of the process which is that the child bearing and rearing decision is associated with some long-term, if not, life-time, commitment. Furthermore, at least for the majority of cases, the decision to have another child, once taken and executed, is an irreversable one, short of handing over a child to the State (or a family relative) or disowning them at some older age. The presence of a child in the family unit furthermore alters that unit and hence the decision-taking unit, i.e. the decision process is sequential and hence dynamic. There is much uncertainty, particularly on the supply side, vis à vis conception and the delivery period. Hence, there are also considerable lags in the process, some of these stochastic and some of these planned. Also related to problems on the supply side is the presence of a selection of contraceptive techniques each with its own "clinical effectiveness" and user-specific effectiveness.

The above list of problems facing the economist interested in modeling fertility behaviour is by no means complete and is meant merely to be suggestive.[3] Nonetheless, a rudimentary, if still crude, framework of analysis is emerging which is amenable to empirical testing. The so-called "New Home Economics" which has emerged, perhaps most notably in the Journal of Political Economy supplements of March/April 1973, 1974, is primarily the result of a synthesis of several developments in economic theory. We shall briefly list these here and refer the reader to a more thorough discussion by Schultz elsewhere.[4] First, the concept of investment in human capital is relevant since parental education affects not only income and wages (and hence the opportunity cost of parental time) but also may affect their consumption efficiency. Also, children may be viewed as a form of human capital yielding a stream of utility over (a life-) time. As Schultz notes, children in many ways may be the "poor man's capital".[5]

Secondly, Becker's advance in the theory of the allocation of human time[6] is important since child rearing is a time-consuming activity and there are complex trade-offs facing parents, and particularly mothers, between household work and none-household (i.e. market) work. Indeed, any sort of consumption activity requires some amount of time and hence there is an additional cost of a good over and above its purchase price.

Related to this is the concept of the household production function which also comes out of the Becker-type analysis. Households are seen as having multi-activity production functions which have as inputs, time and the associated goods. These locally produced services are then what enter the decision calculus in the household utility function which is the final main development of relevance here. Samuelson[7] argues that one can consider the family as a small collection of individuals whose common utility is a function of the utility of each of its members and that one may write down a Bergsen-Samuelson "family welfare-function". However, as Samuelson noted, and Willis[8] forcibly argues, the altruistic and cooperative nature of the family cannot be ignored. A trade-off of utility amongst family members would be alien to the concept of the family, so that we can assume the family has a unified family utility function thus by-passing many problems which face public expenditure analysis.

With this background, we now briefly sketch out the most common elements of the "New Home Economics of Fertility". We shall not solve the "model" here but merely write down the implied demand function, giving intuitive arguments with respect to the signs of the partial derivatives.

Any theoretical model must abstract, through its assumptions, from some aspects of the problem at hand in order to focus on a manageable range of the problem. Some "realism" (vis à vis assumptions) and "completeness" must be sacrificed normally to produce a model with testable predictions. The basic household model of family decision making which provides the framework of analysis here is no exception and many of its assumptions can be questioned. Nevertheless there is evidence to suggest that the models "work" in the sense that their predictions are upheld by empirical evidence.[9] The framework used here is basically a one-period, comparative-static framework in which the family decision taking unit (husband and wife) formulate a life-time plan for an optimal number of children and are able to realize this through perfect and costless control and the possession of perfect foresight.

The family is assumed to have a utility function, $U(Z_i)$, where Z_i are consumption activities. The family maximizes U subject to its capacity to produce the Z_i in its household productions:

$$Z_i = f^i(t_{ij}, X_i)$$

The f^i production functions display the usual smooth isoquants and linear homogeneity is sometimes assumed. t_{ij} is the j^{th} family members' time in production and enjoyment of Z_i and the X_i are the necessary goods. Where children are concerned, for example, Z_1 may be viewed as a "family life" or "child services" activity. Usually, to deal with the "quality" versus "numbers" problem, Z_1 is seen as a function of quality (Q) and numbers (N) which are, in turn, internally produced by the family:

$$Z_1 = Z_1 (Q, N)$$

$$Q = Q(t_{Qj}, X_Q)$$

$$N = N(t_{Nj}, X_N)$$

The production functions of Q and N may differ from family to family according to the human capital stock embodied in each member which then influences the production efficiencies of each member (e.g., $\partial Q/\partial t_{Qj}$). For example, education may increase the efficiency of some members in producing Q.

In addition to the production function constraints, the family's life-time decision is also constrained by the total available lifetime resources expressed in a money-income constraint and a time constraint:

$$\sum_i X_i p_i = \sum_j W_j T_{Wj}$$

$$\sum_j T_j = \sum_j T_{Wj} + T_{\ell j}$$

Here p_i are the prices of the X_i goods, W_j is the life-time market wage of the j^{th} member, T_{Wj} is the j^{th} member's time spent in market activities and $T_{\ell j}$ is his time in non-market activities, while T_j is his total available (life) time. The normal procedure is to combine the income and time constraints and, via the principle of duality, argue that at the optimum there is an optimal set of shadow prices which reflects the full marginal opportunity costs of commodities and factors in consumption and production.[10] Thus a "full wealth" constraint, to use Becker's term, emerges

$$I = \sum_i \Pi_i Z_i$$

$$= \sum_j W_j T_{Wj}$$

where the Π_i are the full opportunity costs of the i^{th} activity. Thus the full opportunity cost of rearing a child of given quality is not only the life-time costs of the goods and services spent on the child, but also the opportunity cost, at the optimum, of the parents' time spent in rearing the child.

The full wealth constraint emerges from the family's decision calculus of maximising U subject to the time and production constraints. The choice variables available are essentially the "input" levels of the X_i goods and the husband and wife's two-fold division of labour:

(a) between market and non-market activities, and

(b) between the respective non-market activities.

Given these chosen levels, the optimal activities Z_i^* result. From this basic structure and some exogenous variables, comparative-static analysis can be applied and a demand function for numbers and quality of children derived.

The Child-Stock Demand Function

The exogenous variables which we shall introduce are male and female human capital stock, two exogenous 'taste' for numbers of children variables, and female-market activity. Also, a variable related to child mortality will be introduced here and also later in the birth-spacing function. There are several other variables which could have been introduced and discussed here, but our choice was influenced by the Belgian context in which the model was tested and where these other variables were difficult to observe. We shall briefly discuss the rationale of each of these in the model and the sign of their expected coefficients in the child-numbers demand function. Because it is difficult to specify empirically[(11)] units to measure child-quality, we shall concentrate here on the child numbers relation.

Male and female human capital can enter in two parts of the basic model. Perhaps the most important and usual is through its relation with the wage rate of the husband and wife and thus the opportunity cost of their time. The usual argument,[(12)] is that the stock of human capital at the outset of marriages will positively increase the (life-time) wage rate. Particularly in the context of the wife's time, this leads to a substitution away from time-intensive,non-market activities. The current literature on human fertility generally assumes that children are time-intensive relative to other consumption activities, thus an increase in the opportunity cost of time leads to less children. This is the simplest argument and it should be evident that the full model allows for many more channels of influence, particularly when we consider that male and female capital stock are usually represented in empirical work by education levels. We briefly consider a few of the complicatory other features.

It shall be evident that not only the time-intensity of "children" vis à vis other goods is important but also the time-intensities of the intermediate products Q and N. Thus, for a given level of child services, if Q is more time-intensive than N, numbers may be substituted for quality.

Possibly working against this, is De Tray's argument that education may increase the efficiency in the production of Q relative to N and hence a substitution away from N.

Both of these arguments deal only with the substitution effect of a change in the opportunity cost of time. The size of the resulting income effect will be affected by the market-non-market decisions of the parents, which of course are endogenous in the full model. Willis analyses the case in which the wife does not work in which case there is no income effect. In this case, the effects of education must work through other channels, notably the production function of Z_1. Even considering that there is an income effect and, say, no change in the market/non-market time choice, Michael presents an argument that Q will be substituted for N. His argument is that with more income, the household environment will increase through better housing, more amenities and other household "public goods". If these goods are complementary with the other direct expenditure used in producing Q then the marginal cost of Q decreases relative to N and Q is substituted for N.

Other channels of the influence of education on fertility are on its possible increase in the effectiveness of contraceptive use and hence decrease in unwanted pregnancies (tentative empirical support found by Michael) and its influence on the market/non-market time choice. In this latter argument, more children would increase the depreciation and hence user-cost of human capital since "non use" of a skill or one's education due to child rearing would increase depreciation. Thus capital-intensive (more highly educated) people will choose to work more, *ceteris paribus*, than less capital intensive people and have fewer children.

The bulk of the above arguments is that education (particularly female) and numbers of children will be negatively related. Through all of this, implicit assumptions are made about the sign and size of particular factors. As noted, children are assumed to be time-intensive. While this may not seem unreasonable, we must add the caveat that this time-intensity of the child may vary as it becomes older and also may vary with the social setting. Thus families living in an extended-family and/or agricultural setting may enjoy certain time-economies in the production of children. In particular, the labour services of the children may partly offset any time "spent" in their rearing; grand-parents' and other "external" persons' time may be used instead of the parents', and the line between market/non-market work may be less clear on the farm.

A second implicit assumption has been that it is the wife's time which is important. (Willis assumes the husband's time completely unproductive at home). De Tray, while sympathetic with this view, points out that it may be more valid only at the early ages of children and cautions the extension of the proposition to lifetime considerations. Smith[13] finds empirical support for the female-time intensity assumption. A corollary to this assumption is that the coefficients of "female" variables should be absolutely larger and more significant than the "male" variables. In fact, while most arguments assign a negative coefficient to female education, a positive one for males (mainly through a positive income effect) is not ruled out.

Finally, in considering the effect of education on fertility, let us consider a possible positive relation which may be of relevance in the Belgian context. The argument here is that if education increases wages and income, it may also induce the "importing" of someone elses services to look after the children (e.g. a maid or au-pair girl). Given that the maid's services are good substitutes for the mother's and also that there are limited economies of scale (a maid can probably look after two or three children as well as one), ceteris paribus more children may be chosen by educated people than by less educated.

We turn next to the female market activity variable which shall be included as an exogenous variable. In the full model this is, of course, an endogenous variable determined simultaneously with the amount of time spent in particular non-market activities and the money-income level sufficient to buy the optimal inputs, X_i^*. However, for our purposes we can split up the optimization process into subprograms such that, for the purpose of exposition, the market/non-market/money income decision is made separately from the child numbers/quality/other activities decision. Hence the wife's labour force decision will then be "exogenous" to the child numbers decision. The trade-off at the optimum between children and the wife's work will depend again on the time-intensity of the wife's time in child rearing relative to other goods. If we assume that children are time-intensive, then a negative relation is implied via the production function between desired child services and female labour participation. The actual relation is much more complicated than this, however, and it is well to bear in mind that the decisions are simultaneous - that is, that the number of children one has chosen will also influence the labor force participation decision. However, for the purposes of this paper we will keep the simple relation running from market activity to child services to numbers of children (assuming both numbers and quality more time intensive than other activities in the household).

Child mortality will also enter as an exogenous variable here in the child-numbers function and also in the birth spacing function. The final expected sign and magnitude of the regression coefficient will depend on the strengths of these two offsetting effects, and we shall return to this aspect later. An infant death may be a serious psychological blow to parents and thereby represent a cost of child bearing. If we assume with Schultz[14] that parents on the whole achieve a greater (discounted) sum of satisfactions the longer a child survives, then increases in infant mortality will result in greater relative decreases in the conditional probability of survival from birth to maturity and thus lower the demand for children. Of course, the usual interaction exists, here with quality and it may be that the quality effects dominate.[15] But, we shall argue that as far as the desired child <u>stock</u> is concerned, the overall effect will be a negative association with infant mortality.

Another exogenous variable which we shall consider is religion. This is seen primarily as entering the utility function vis à vis number of desired children. Thus highly Catholic families will desire more children. Another channel of influence here is that even if a given Catholic and non-Catholic (or less religious Catholic) couple desired the same completed family size, the Church ban on the more reliable contraceptive techniques may influence the choice of such techniques leading to more unplanned births by the Catholic couple. Hence, we expect a positive relationship between degree of religion and number of births.

In the same vein, the Belgian context of this study implies that some account be made of the social/political situation vis à vis the Flemish and French speaking communities and the extent to which this will be reflected in (indeed, is caused by) a difference in utility functions between the two groups. A popular conception exists that, for whatever reason, Flemish-speaking families desire larger families than French-speaking ones. We shall, therefore, attempt to take account of this by using a dummy variable (equal to one for Flemish and zero for French communities) with an expected positive coefficient.

We may sum up this section by writing down the child numbers demand function we shall be using and the signs of corresponding derivatives:

$$N^* = f(EF, EM, ARF, REL, DUMMY, IMR)$$

where $\frac{\partial N^*}{\partial EF} < 0$ $\frac{\partial N^*}{\partial EM} \lessgtr 0$, $\frac{\partial N^*}{\partial ARF} < 0$, $\frac{\partial N^*}{\partial REL} > 0$,

$\frac{\partial N^*}{\partial DUMMY} > 0$, $\frac{\partial N^*}{\partial IMR} < 0$,

EF = female education level or capital stock

EM = male education level or capital stock

ARF = female activity rate

REL = degree of religiousness

DUMMY = 1 for Flemish speaking family

= 0 for French speaking family

IMR = infant mortality rate

N^* = desired life time number of children

The Birth-Spacing Decision

Despite the recent additions to the literature of the economics of fertility, relatively little has been said about birth spacing, particularly in a deterministic framework such as that of the present study. Indeed, because much of the present theory deals specifically with long-run stock decisions, the flow variable has been largely ignored. Yet much of the interest of public policy decision makers in population trends is in the flow variables. For example, birth patterns will have affects on the age-distribution with immediate consequences for public educational investment decisions. This is not to say that the long-run child-number decision will not have effects on the birth rate and spacing decision. Indeed, the outline of a theory presented below hypothesises that it does, but it is not sufficient to look at this dimension for policy analysis.

The birth-spacing analysis that we shall discuss here will be very rudimentary and incomplete. We shall concentrate mainly on the economic aspects of the problem.

Each couple cannot and will not (barring multiple births over which they have no control) have all their desired children at once. There are a number of fixed capital costs associated with the first child (such as clothing, prams, etc.) and more of this would be needed if there were more small children. As the capital market in this area is relatively imperfect, new couples face a "barrier to entry" in this regard.(16) In addition, some of this capital may be passed on to younger siblings thus lowering their cost.

In addition, ignorance (or inexperience) of parents with regard to child-rearing techniques may lead them to choose a cautious, "one-at-a-time" approach. Also, to the extent that the characteristics of children which yield utility to the parents (implicitly here through the Z_1 production function) may be age-specific and to the extent that a variety of child characteristics is desired, a stock of differently aged children will be desired.

Having briefly argued, then, that the desired child stock N^* will be accumulated over a period of time and not, normally, all at once, we must approach the question of how the children will be spaced with respect, say, to the couple's (or mother's) age. We shall argue that in general, for parents in the fertile age groups, <u>younger</u> parents will have more babies than <u>older</u> ones. Some of the reasons for this may be rather straight-forward and obvious. First, for a given number of desired children, if parents also desire a period later in life during which they will have no dependents, then births early in marriage as opposed to being evenly spaced will be necessary. Related to this is the phenomena that expected parental (particularly the father's) earnings may reach a maximum around 40-45 years old and the number of dependents thereafter may wish to be minimized by the parents. Also, there may be certain economies of scale in looking after children whose ages are not too different. For example the children can play with each other or their age-related interests may overlap so that the parental time-intensity of each child may be less. In addition, and working somewhat in the opposite direction to our earlier arguments, long birth intervals may increase the cost of children through the increased loss in the mothers' earnings because she will spend more time in non-market activities.(17)

The capital starting costs may also mean that the first birth does not occur directly after marriage. Thus, a young married couple may wish to accumulate some savings before investing in children. Also, if one of the couple's education is not complete at the time of marriage, births may be postponed. Thus we might expect an inverted U-shaped relation between time since marriage and births.

In addition to these foreseeable variables, short run economic factors may play a role. For example, it is well known(18) that births follow a pattern close to that of the business cycle. Thus couples facing short-term economic difficulties may postpone births to a later date. In the aggregate, though, this will be less important to the relation between births and parents' age, unless cyclical economic variations affect couples of different ages differently. And in any case, since our analysis is cross-sectional we shall not be able to take account of this factor unless cyclical variations affect regions of the country differently.

Similarly child mortality may enter the birth decision via a "replacement" mechanism. If parents have a highly inelastic demand for offspring, we would expect a positive association between births and expected (or experienced) infant deaths.[19] This phenomena would, like the business cycle one, be in the nature of an unplanned, perhaps stochastic one. Hence, when the couple formulate their birth interval plans they will have no prior information on cyclical variations or the actual occurrence of an infant death. What they will have, particularly with regard to infant mortality is the survival probability of each birth and from this they can calculate contingency strategies. As we shall be dealing with actual births, many of these contingency strategies will have been realised, so that we would expect relatively more of these to have been brought into effect in areas with high infant mortality. Furthermore, we would expect, for biological and pyschological reasons (an infant death may be a traumatic experience for the parents), any observable effects on births to be lagged by at least a year; Schultz has suggested three years.[20] Thus, while the effect on the desired stock of children of infant mortality is expected to be negative, the effect on births, ceteris paribus, is expected to be positive. Obviously, the two effects work against each other since the total desired number of children is positively related to births.

Finally, there are, of course, biological factors which will enter into the birth function implying that more births at a younger age of a mother will be observed. Fewer medical complications may occur with younger mothers and the period of amenorrhea increases with age so that birth intervals would necessarily be larger for older mothers.[21]

We shall specify then, an age-specific birth function such as

$$N_K^* = g(N^*, K, IMR)$$

where N_K^* is the desired number of births per couple (or mother) at age K

and where we might expect,

$$\frac{\partial N_K^*}{\partial N^*} > 0, \quad \frac{\partial N_K^*}{\partial K} > 0 \text{ and } < 0, \quad \frac{\partial N_K^*}{\partial IMR} > 0, \quad \frac{\partial^2 N_K^*}{\partial K^2} < 0.$$

<u>From the Economic Model to the Econometric Tests</u>

In this section we shall briefly consider an approach for analytically deriving an aggregated testable model from the demand function for N^* and the spacing function for N_K^*. Ideally, the child numbers model is best tested using children - ever-born to a married couple of between 35 and 45 years old. This is the sort of dependent variable used by many other contemporary studies. On the other hand, as I have argued, an aggregated flow measure of fertility may be of more relevance for policy analysis. While of course it is possible to go from the micro to the macro level <u>after</u> having tested at the micro level, a number of additional assumptions particularly with regard to the spacing of children must be made in the process. The framework proposed here is a very simple aggregation model which incorporates the child-spacing relationship and with which the crude birth rate can be used as the dependent variable.

Starting with a linear specification of the demand for N^* by couple i we have,

$$N_i^* = a_1 + b_1 Y_i$$

where Y_i is, for expositional simplicity the only explanatory variable at this stage. Then the total desired stock of children in region j composed of n_j individuals is

$$N_j^* = \sum_{i=1}^{n_j} N_i^* = n_j a_1 + b_1 \sum_{i=1}^{n_j} Y_i$$

or the per capita desired stock is simply,

$$\frac{N_j^*}{n_j} = a_1 + b_1 \overline{Y}_j$$

where $\overline{Y}_j$ is the per capita level of Y in region j.

For the birth-spacing function we will again assume a linear relation such as,

$$N_{Kj}^* = a_2 + b_2 \left(\frac{N_j^*}{n_j}\right) + c_1 K + d_1 IMR_j$$

and $a_2 > 0$, $b_2 > 0$, $c_1 < 0$, $d_1 > 0$ are the expected signs. We have specified a linear relation despite the earlier discussion which suggested a non-linear one, say, a parabola with respect to age, K. The reason is that we shall be confining our analysis to the married female population between 15 and 45 years old as the decision units. In this event, married female girls between 15 and 20 have extremely high fertility rates, largely, one supposes, to legitimize children conceived out of wedlock. (See table 1). Also, data availability did not allow the study to be done using age-specific births. We shall, therefore, confine ourselves to the linear specification of the spacing function.

Thus, if each person of age K has the same spacing function then if there are M_{Kj} married people (or married women) of age K in region j, the desired total number of births per person in region j is:

$$\frac{B_j^*}{n_j} = \frac{\sum_K N_{Kj}^* M_{Kj}}{n_j}$$

where we shall take the relevant range of K to be 15 to 45 years old. Combining this with the desired stock per person in region j, $\frac{N_j^*}{n_j}$ we obtain an expression for CBR_j^*, the desired crude birth rate in region j:

$$\frac{B_j^*}{n_j} = \frac{\sum_K N_{Kj}^* M_{Kj}}{n_j} + a_2 \frac{\sum_K M_{Kj}}{n_j} + b_2 \frac{\sum_K M_{Kj} (N_j^*/n_j)}{n_j} + c_1 \frac{\sum_K M_{Kj} K}{n_j}$$

$$+ d_1 \frac{\sum_K M_{Kj}}{n_j} IMR_j$$

$$CBR_j^* = (a_2 + b_2 a_1) \frac{\sum_K M_{Kj}}{n_j} + c_1 \frac{\sum_K M_{Kj} K}{n_j} + b_2 b_1 \frac{\sum_K M_{Kj}}{n_j} \bar{Y}_j$$

$$+ \hat{d}_1 \frac{\sum_K M_{Kj}}{n_j} IMR_j$$

where the $\hat{d}_1$ is meant to represent the combined parameters of $d_1 + b_2 b_1$ where the b_1 is the relevant parameter on IMR in the child stock function and $\bar{Y}_j$ no longer contains IMR. If we add the further assumption that desired and actual flows (births) of children will be achieved, we can remove the asterisk from CBR_j^* and are left with a basic estimating equation, when we replace $\bar{Y}_j$ with the various explanatory variables introduced in the child stock demand function (except IMR which we have already removed).

The interpretation of the variables is reasonably straight forward. The variable $\frac{\sum_K M_{Kj}}{n_j}$ is, since we shall take married women as the decision taking unit, simply the proportion of married women, aged 15-45 in the total population. A priori we expect the coefficient $(a_2 + b_2 a_1)$ to be positive since a_2, b_2 and a_1 are all positive. The second variable, $\frac{\sum_K M_{Kj} K}{n_j}$, is the average age of married women weighted by the first variable, $\frac{\sum_K M_{Kj}}{n_j}$. Hence, since $\frac{\sum_K M_{Kj} K}{\sum_K M_{Kj}}$ is the average age of married women between 15 and 45 years old.

$$\frac{\sum_K M_{Kj} K}{n_j} = \frac{\sum_K M_{Kj} K}{\sum_K M_{Ki}} \frac{\sum_K M_{Kj}}{n_j}$$

The sign on this variable is, as discussed, expected to be that of $C_2 < 0$. The variables which we shall use in place of $\frac{\sum_K M_{Kj} \bar{Y}_j}{n_j}$ are easily interpreted as being the explanatory variables in the child stock demand function, weighted by $\frac{\sum_K M_{Kj}}{n_j}$. Since C_2 is taken to be positive, it changes none of the expected signs of the coefficients of the explanatory variables in the child stock demand function. The sign on the coefficients of $\frac{\sum_K M_{Kj}}{n_j} \cdot IMR_j$, $\hat{d}_1 = d_1 + b_2 b_1$ will depend on the relative strength of d_1, which is negative against $b_2 b_1$ which is expected to be positive. However, if past information on other studies is relevant in forming a priori expectations on the sign of $\hat{d}_1$, we would have to say $\hat{d}_1 < 0$.(22)

The Regression Results

The Data

Table 2 summarises the variables used in the regressions. Most of the data used were census data for the end of 1961, the last completed Belgian census. The cross section was taken at the arrondisement level of which there were 44 in Belgium following the passage of a law in 1963 which changed many of the boundaries and created a few more arrondisements. Brussels was included, but Brussels-periphery was not. The data used are those pertaining to the new subdivision.

The dependent variable was the crude birth rate in 1964 (CBR 64). Ideally, I would have liked the age-specific birth rate of married women since this would have corresponded closer to the economic model, but the data were not, to my knowledge, available. As it is, the way in which we have set up the aggregation framework takes account of this constraint.

The infant mortality rate (IMR 61) is not exactly the usual one, which is deaths of infants less than a year old per 100 live births.

Instead I have used infant deaths divided by the total population under 5 years old plus the infant deaths in the year 1961. I have chosen a three year lag as suggested by Schultz and again the variable used here was chosen under data availability constraints.

The religion variable used (REL 64) was not lagged and was the ratio of participants at Mass to the total population on the first Sunday in October 1964. The church does a census several times a year, but as attendence is seasonal, I used the October figure on the hypothesis that this is a fairly unexceptional time of the year (there are no highly religious holidays and it is not a vacation period).

I tried two measures of the education variables for men and women. The first measures (EF1 and EH1 for women and men respectively) are a measure of the degree of higher educational attainment. These are the ratio of total men or women aged over 14 years who are no longer studying and who have a superior diploma(23) to the total male or female population who are over 15 years old. These measures roughly give the percentage of people with a university or polytechnic degree. The second measures (EF2 and EH2 for women and men respectively) give a similar ratio of the total men and women aged over 14 years old who are no longer studying and who have a secondary diploma (24) or better to the total male or female population over 15 years old. This, then accounts for people who have obtained a diploma above the compulsory schooling level. I have not considered people below that level on the assumption that the ratio there would be nearly equal to one. Note that the second measure also includes, people with a superior diploma. For this reason, regressions with EF1 and EH1 were run separately from those with EF2 and EH2. Note, also, that the ratios are census data for 1961 and measure people who are no longer students. Thus people who graduated during 1962 and 1963 are not included and could possibly have contributed to the birth rate in 1964.

The female activity rate (TAF 61) was simply the number of working women divided by the total population of women over 15 years old. Ideally, I would have liked the married women's activity rate which was not available. There is some danger that because single women may work more than married women, this variable partly measures the degree to which women are not married. However, since we shall be multiplying this (as well as other) variables by the percentage of married women in the population, the problem is partially overcome. This variable is also for 1961.

The last two variables in Table 2, M/P and MA/P are the variables $\frac{\sum_K M_{Kj}}{n_j}$ and $\frac{\sum_K M_{Kj} K}{n_j}$ respectively. These are again derived from census data and were taken for 1961 accordingly. The relevant range of K was taken to be 15-45 years old and the M_{Kj} was the percentage of married women in arrondisement j with age K. Actually, these figures are subject to a slight amount of error since because the age distribution of married women was not readily available, I had to multiply the number of women in each age group in each arrondisement by the fraction of females of each age who were married for the <u>province</u> to which the arrondisement belonged. Hence, I have made the assumption that age-specific marriage rates are constant within a province. Again these data are for 1961

The Regressions

The main regression results are presented in Table 3. Each regression was run with and without a constant term. This is because, in the first instance, it will be noted that the theoretical structure implies no constant term although the coefficient of $\frac{\sum_K M_{kj}}{n_j}$ (represented by M/P) contains the constant terms in the linear specifications of the N^*_{Kj} and N^*_j functions. However, since it is difficult to interpret the significance tests of regressions without a constant, I ran the same regressions with a constant as well.[25] Also, the arrondisement of Maaseik was dropped because the observation on the birth rate in 1964 put this at .02614 which is .00456 above the next highest arrondisement, Turnhout. Furthermore, the reported birth rate in 1968 was .01944 which, while still the highest reported for Belgium at that time, shows a considerable drop from 1964. I was therefore wary of including Maaseik in the regressions because it appeared to be either an "outlier" which was not typical of the rest of Belgium or one where the accuracy of the observation was suspect. Finally, as the economic theory gave no a priori functional form to the child stock (N_j^*) equation, I tried using squared terms for the economic variables. Only the more interesting of these have been included.

Considering regressions 1 - 6, the differences here are in the specification of the variables for male and female education. In general, the education variables did not work as well as might have been expected, judging by the results of other studies.[26] Only in equations 2 and 6 does female education become significant at the 5% level (with a one tail test) but these regressions contained no constant. Note that the coefficient is, however, negative as expected, and in regression 2 is superior to the male variable which is not significant any way. In general, EF2 and EH2 were always more significant (while remaining not very significant) than EF1 and EH1. (regressions 3 and 4). This could suggest that in Belgium higher education does not affect the opportunity cost of time as much as secondary education. Thus university degrees, particularly for women, may be pursued, not for their "human capital" value but more for their "consumption" value. There is also some weak evidence that EF2 has a non-linear effect on fertility since the t statistics in regressions 1 and 2 are not as strong as in 5 and 6 where the square of EF2 enters. The elasticities of $EF2 \cdot M/P$ and $(EF2)^2 \cdot M/P$ in regressions 2 and 6 are -.21 and -.12 respectively. However, it is difficult to compare these elasticities with other people's work because education has been measured differently in each study.

One possible explanation with respect to the relative weakness of the education variables is the strong collinearity between male and female education. A priori one would expect people to choose mates of roughly the same education level[27] and empirically this seems to be the case. The simple correlation coefficients between variables used in the regressions were .85 and .54 for EF2·M/P and EH2·M/P and for EF1·M/P and EH1·M/P respectively, while the coefficient for EF2 and EH2 (without M/P) was .77 and that for EF1 and EH1 was .72. This collinearity would increase the standard errors of the coefficients making it difficult to obtain high t values.

The other variables are largely successful, judged by t-statistics. The activity rate of women (TAF·M/P) is always negative and significant at the 1% level. This supports the theoretical expectations and is consistent with results of other studies. The child mortality(IMR 61·M/P) variable has a positive coefficient but its significance is not terribly good. On a one-tailed test, the coefficients in regressions 1 and 5 are significant at the 6% level, while in regression 3 the coefficient is significant at the 5% level. In the equations without a constant, the t values are not high at all. We have argued that infant deaths may have a negative or positive effect on births a priori, while hypothesising that with a lagged child mortality variable, the effect is more likely to be positive (via the replacement behaviour and past observations). One could argue, then, that a two-tailed test may be more appropriate since we do admit the possibility a priori of a negative coefficient. On this score the t values are less encouraging.

I also tried an infant mortality rate variable for 1963 (not reported in full here) which, with t values of never more than .36, could not be viewed as a significant determinant of the birth rate in 1964. This was despite the fact that the variable used was, in the more normal form of deaths/births. The failure of this variable to "work" in the face of the relative success of the 1961 child mortality variable is consistent with the lag hypothesis of the effects of child mortality on births. Finally, one possible explanation for the weakness of the t-values on the (IMR·M/P) coefficient may also be that since the coefficient is the sum of two parameters of opposite sign, they are cancelling each other out. However, we can not separate the parameters so we have no direct test of this hypothesis.

The two social/religious/political variables are successful. The dummy variable (DUMFW) has a positive coefficient which, with t-values of over 4 are always significant at the 1% level. The religion (REL 64·M/P) variable also has a positive coefficient which is significant at the 5% and better level in all the regressions. Yet the significance of the religion coefficients are, in the main, less than those of the dummy. Notice, however that while these variables are highly significant, their effect on CBR is quite small. The elasticities of DUMFW and REL 64·M/P, calculated at the sample means were only between .061 and .092 and between .057 and .091 respectively.

The average age variable, MA/P, also had the expected a priori sign and was significant. Thus the contention in the child-spacing function that older parents will tend to have fewer births was upheld. The significance of the coefficient on this variable was always upheld at the 1% level.

Finally, $\frac{\sum_K M_{Kj}}{n_j}$, (here, M/P) which cannot be viewed as a proper behavioural variable (it enters more or less as a weighting factor), has a positive coefficient which is significant at better than the 2% level. Since the coefficient here is theoretically $a_2 + b_s a_1$, we cannot identify each of these terms. A priori we expected a_2, b_2 and a_1 to be all positive. It seems likely that C_2 is positive since the signs of all the behavioural variables would be reversed if it were negative, and they all have the "right" a priori signs. And the interpretation of a negative a_2 or a_1 (the constants in the N^* and N_K^* function) is difficult to make. Notice, however, that the inclusion and exclusion of the regression constant affects the coefficient on M/P. Without a regression constant the coefficient is larger and more significant.

Conclusions

The crude birth for a cross section of arrondisements at a point in time was analysed to infer the relevance of economic theories of fertility in Belgium. This was done by building, from a child numbers demand function and a birth spacing function a testable econometric model. The regressions results were largely successful with most of the coefficients having the expected signs and being significant. With a corrected R^2 of around .62 and the F test on the coefficients significant at the 1%, the results for a cross-section study of this type cannot be dismissed. Of the variables which were largely economic in nature, female activity rate, male and female education, and infant mortality, the two education variables were the weakest, judged by t values, perhaps because of the high collinearity between these two. Areas with a high percentage of working women have unambiguously lower birth rates and in those with higher child mortality, there is evidence that the longer-run replacement mechanism outweighs the costs aspect of this variable.

The two social/religious characteristics variables were very significant in all regressions. However, the effects of these variables on the dependent variable were not very large, judging from elasticities calculated at sample means.

The average age of married women variable which falls out of the birth spacing relation also has significant coefficients with the anticipated sign.

On balance, the study lends credence to the economic theory of fertility when applied to the Belgian context. Ideally, it must be recognised that both the theory and its testing would be best formulated in a more dynamic context since there are undoubtedly many dimensions of the child-bearing process which take place over time. Many decisions are revised in the light of new information and stochastic shocks and it is difficult to capture this in a cross-section analysis. Also, it may be difficult to accurately measure the effects over time of changes in variables on the basis of cross-section parameters. Nevertheless, the results obtained here provide, at the least, the basis of further research in the Belgian context when more data becomes available.

TABLE 1

Age-Specific Fertility Rates for Belgium, 1961

Age	All Women	Married Women
15-20	.0248	.4276
21-25	.1606	.2860
26-30	.1696	.2012
31-35	.1034	.1175
36-40	.0520	.0595
41-45	.0170	.0197

Source : I.N.S.

TABLE 2

Mean Values and Standard Deviations of Selected Variables

	Mean	Standard Deviation
CBR 64	.01747	.00238
IMR 61	.00592	.00079
REL 64	.4390	.1711
EF1	.03655	.0072
EF2	.04852	.01102
EH1	.04232	.01132
EH2	.08312	.0231
TAF 61	.277	.0519
M/P	.1299	.0057
MA/P	4.23	.2948

TABLE 3

Regressions of Crude Birth Rate (CBR 64)

(t-values in parentheses)

	Constant	M/P	MA/P	REL 64·M/P	DUMFW	TAF·M/P	IMR 61·M/P	EF2·M/P	EH2·M/P	$\bar{R}^2$	F
1	.0154 (2.86)	.1265 (2.25)	-.0032 (-3.59)	.01778 (1.78)	.0024 (4.2)	-.1311 (-3.88)	3.199 (1.59)	-.2089 (-.62)	.0152 (.10)	.62	9.7 (8,33)
2		.2525 (6.58)	-.0026 (-2.79)	.0218 (2.01)	.0029 (4.9)	-.1649 (-4.73)	1.910 (.88)	-.5946 (1.75)	.1017 (.66)		
								EF1·M/P	EH1·M/P		
3	.0177 (3.59)	.1011 (1.91)	-.0032 (-3.68)	.0197 (1.96)	.0020 (4.48)	-.127 (3.6)	3.709 (1.79)	.0266 (.10)	-.0578 (-.33)	.61	9.34 (8,33)
4		.2414 (5.8)	-.0027 (-2.7)	.0284 (2.5)	.0024 (4.32)	-.1725 (4.59)	2.7516 (1.15)	-.1397 (-.47)	-.0868 (-.43)		
								$(EF2)^2$·M/P	EH2·M/P		
5	.0146 (2.70)	.1199 (2.3)	-.0031 (-3.45)	.0186 (1.89)	.0025 (4.44)	-.1255 (-3.76)	3.183 (1.59)	-2.966 (-.89)	.0636 (.40)	.62	9.9 (8,33)
6		.2225 (5.73)	-.0025 (-2.65)	.0238 (2.26)	.0030 (5.18)	-.1483 (-4.21)	2.01 (.95)	-6.836 (-2.09)	.1761 (1.07)		

Data Sources

CBR 64	:	Institute Nationale des Statistiquus (I.N.S.), Annuaire Statistique de la Belgique, 1964.
TAF	:	I.N.S., Recensement de la Population, 1961, Tome 8.
REL 64	:	Population et pratiquents dans les Doyennes et Diocées de la Province Ecelesiastique Belge.
EF1, EF2, EH1, EH2	:	I.N.S., Recensement de la Population, 1961, Tome 10, I, Annexe 2, Tome 5, II, I.
IMR 61, 63	:	Etat Civil.
M/P, MA/P	:	Recensement de la Population, 1961, Tome 5.

FOOTNOTES

(1) See, for example, the papers by Willis, De Tray, Michael, Ben-Porath and Schultz in The Journal of Political Economy, Supplement, March-April, 1974.

(2) The best set of references to date on this subject can be found in The Journal of Political Economy supplement of March-April, 1973,1974.

(3) For a good discussion of these problems, see the articles by Schultz and Willis in the 1973 Journal of Political Economy supplement. Also, the deterministic, static approach is criticised by Crafts and Ireland in "The Role of Simulation Techniques in the Theory and Observation of Family Formation", Warwick Economic Research Paper, No. 39.

(4) Schultz, "The Value of Children : An Economic Perspective", Journal of Political Economy, March/April 1973.

(5) Ibid., p.5.

(6) Becker, G.S., "A Theory of the Allocation of Time", Economic Journal, September, 1965.

(7) Samuelson, P.A., "Social Indifference Curves", Quarterly Journal of Economics, February 1956.

(8) Willis, op.cit., pp 18-19.

(9) See the references of Becker, Pen-Porath, Gardner, Nerlove and Schultz and Ohana in addition to those already referred to.

(10) c.f. Becker, op.cit., 1965, Willis, op.cit., 1973.

(11) De Tray, op.cit., has attempted to approximate this by using expected public school investment per child.

(12) c.f. Willis, op.cit., Michael, op.cit., and Becker, op.cit., 1965.

(13) Smith, James P., "The Life Cycle Allocation of Time in a Family Context", Ph.D. dissertation, University of Chicago, 1972.

(14) Schultz, "Household and Economy : Toward a New Theory of Population and Economic Growth", Journal of Political Economy, March-April, 1974.

(15) c.f. Ibid.

(16) Of course there may be quite an efficient lending or second-hand allocative mechanism at work within the larger context of the relations of the family or neighbours.

(17) I am indebted to N. Crafts for this point.

(18) See, Simon, The Effects of Income on Fertility, University of North Carolina at Chapel Hill, 1971, Chapter 2 for a good review of this evidence.

(19) Schultz, op.cit., 1973, p.246.

(20) Ibid. p.249.

(21) See Salber, et al. "The Duration of Postpartum Amenorrhea", American Journal of Epidemiology, No. 3,1966.

(22) Schultz, op.cit., 1973.

(23) A "superior diploma" was taken to be a diploma obtained in : technique supérieurs; enseignment normal primaire, moyen or technique; enseignment universitaire assimilé.

(24) A "secondary diploma" was taken to be a diploma obtained in : humanités complètes; enseignment technique du niveau secondaire supérieur.

(25) For a discussion of this point see Rao and Miller, Applied Econometrics, Wadsworth : Belmont, California, Chapters 1 - 2. Another rationale for including a constant term is that, although the theoretical specification goes through the origin, if the true functional form is non-linear, the best linear approximation may include a constant term.

(26) For example, see the results of the papers in the 1973 J.P.E. supplement as well as those listed in Schultz paper in that volume.

(27) c.f. Becker's analysis of the theory of marriage

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