Demand versus Supply Factors in the Fertility Transition

Warren C. Robinson

NUPRI Research Paper Series No.10

March 1982

Warren C. Robinson
Professor
Department of Economics
Pennsylvania State University
and
Director
Population Issues Research Center
Institute for Policy Research and Evaluation
Pennsylvania State University

CONTENTS

TABLES

FIGURES

A B S T R A C T

This paper reviews the recent literature in which the economic, or demand-oriented, model of fertility has been countered by the supply-constrained approach. Easterlin's effort to combine both approaches is also touched on. The Blake-Davis scheme for analyzing the determinants of fertility provides the conceptual framework for looking at supply factors as contrasted to demand factors during the course of the fertility transition. We apply a modification of the Bongaarts "proximate determinants" framework to summary data from 27 World Fertility Survey countries. The approach yields estimates of the independent effect of the four main fertility-reducing factors, namely: lactation, non marriage, contraception-abortion, and environmental effects. Since the 27 countries cover a range of total fertilities and income levels, we are able to group the countries by stage of economic-demographic transition and reach conclusions regarding the relative importance of the several fertility-reducing factors at various stages of the transition. We conclude that pure supply effects are never dominant, rather, lactation and societal controls give way to individual control as the transition progresses. Our empirical results are completely consistent with the traditional view of the dynamics of the transition.

This paper was presented at NUPRI's Occasional Seminar on December 7, 1981.

I. Introduction: Demand vs. Supply Models

The recent literature on fertility has been dominated by what has come to be called the "economic approach" (Belgium, 1978; Sanderson, 1976; Robinson and Harbinson, 1980). This economic approach has taken several quite different forms at the hands of Leibenstein, Becker, Easterlin and others. But all versions basically assume that children create utility (or satisfaction) for the prospective parents; that there are costs involved in obtaining this utility; and that consequently the "demand" for children by a couple can be analyzed in much the same way as the demand for any other utility-creating commodity. Demand for children becomes, following this logic, a function of income, relative prices (of children and other goods) and tastes. Among these demand theorists considerable debate has raged over the relative importance of tastes compared to prices and also over what price of children is most relevant.

More recently still, Frisch and others have argued that physiological and environmental constraints on potential fertility are frequently more important than income, tastes or prices (Frisch, 1975; Butz and Habicht, 1976; Mosley, 1978). These supply factors include age at menarche and menopause, stillbirths, fetal wastage and other conditions caused by uncontrolled obstacles to conception and successful parturition. Taking this approach, some have suggested supply models in which actual fertility is limited solely by these non-volitional factors. A new debate has emerged over the relative importance of supply versus demand factors in explaining actually observed fertility trends (Kelley, 1980; Encarnacion, Jr. 1977; DeTray, 1977; Knodel and Van de Walle, 1979; Boulier and Mankiw, 1980; Bean et al., 1978; Simon, 1978).

II. Two Models Combined: Easterlin's Framework

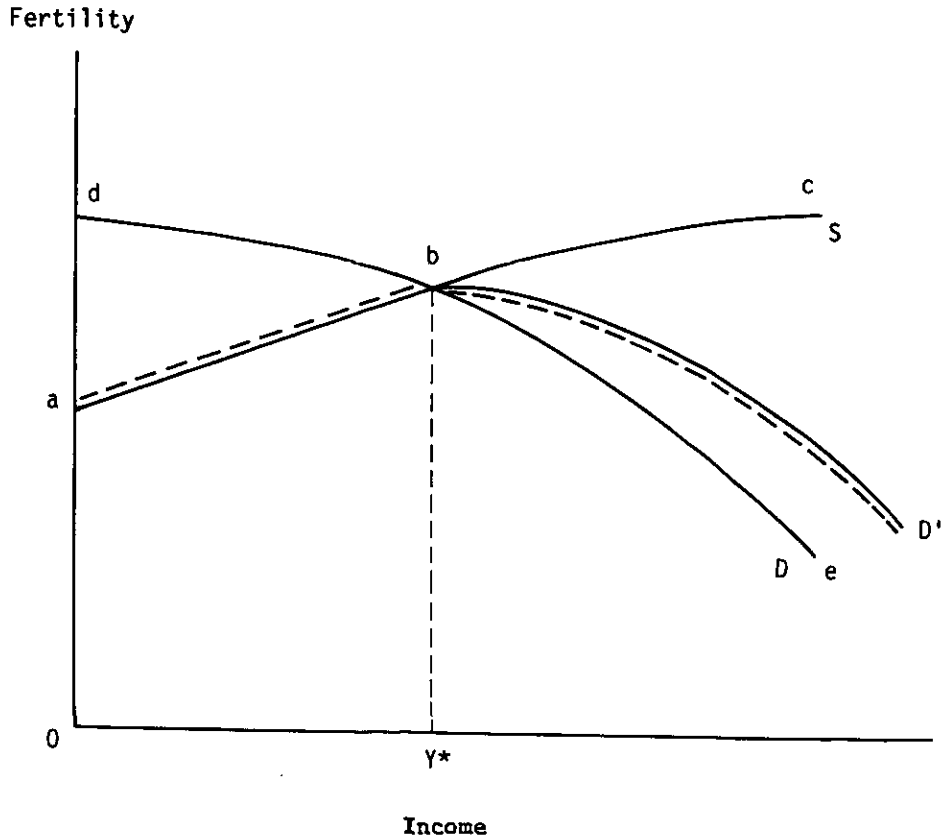
Easterlin (1978, 1980) has proposed a framework combining demand and supply constraints. Figure 1 illustrates this approach. The demand for children, the D curve, falls as income rises, while the supply of children curve, S, rises. The actual fertility levels that correspond to the income levels are shown by the segment ab on the supply curve and the segment be on the demand curve. Income levels 0

to Y* are characterized by "excess" demand and a supply constraint, while levels above OY* are demand-constrained with a controlled supply and an unused potential output. Actual fertility shows a U-shape with respect to the movements along the income axis. A function D' can be added to represent actual fertility since it can be assumed that control is not perfect and actual fertility may exceed desired fertility until the "perfect contraceptive" regime is reached.

The concept of "natural fertility" has been linked to the "supply" function. Some writers refer to supply-constrained situations as "natural fertility" populations (DeTray, 1977).

Regarding the concept of "natural fertility", Menken writes (1980):

Figure 1. Demand and Supply Constraints in Analysis of Fertility



> Over 20 years ago, Louis Henry (1953) introduced the concept of natural fertility into the demographic literature. He defined natural fertility as fertility which exists in the absence of deliberate control where 'control can be said to exist when the behavior of the couple is bound to the number of children already born and is modified when this number reaches the maximum which the couple does not want to exceed. Factors such as intercourse taboos or long periods of breast-feeding, which lower fertility, are not considered to be evidence of control so long as they do not vary with parity.'

Coale, Trussell and others have defined natural fertility empirically as the average fertility pattern prevailing in a group of non-contracepting populations. This is then used as a benchmark against which other empirical fertility functions can be compared. Again, quoting Menken (1974): "Coale . . . expressed the natural fertility pattern in terms of a standard age schedule with a single parameter, the level, and then added a second parameter to describe the extent of deliberate fertility control in the population." The second parameter has come to be called the "index of fertility control."[1/] But, this is "control" only in a limited sense. Any social or traditional controls which affect the overall level of fertility but not the age pattern of fertility are not taken into account.

Easterlin suggests that "natural fertility" be thought of as a biologically based supply of births function along which a family moves as rising income enables it to improve its health and nutrition. But, when "natural fertility" is properly understood, it is clear that the level of the function itself is the result of societal controls, *including cultural norms*, marriage patterns, intercourse taboos and so on. These amount to a set of societal constraints on fertility which exert an independent effect on realized fertility, an effect different, both conceptually and empirically, from the environment-physiological supply constraints to limit fertility employed by the couples. Complex as the Easterlin framework is, it fails to distinguish clearly between the two very different sorts of constraints which are likely to be present-societal and environmental-physiological-in any "natural fertility" situation.

III. Constraints on Supply

In analyzing the factors governing both demand and supply, it is

helpful to return to the familiar Blake-Davis framework to distinguish among the numerous individual, societal and biological factors affecting fertility (Blake and Davis, 1959).

In Table 1 we group the (slightly revised) Blake-Davis variables into four groups: individual, societal, environmental and lactational controls. Looking at the usual supply constraint, we find four variables under category (C). (While male mortality logically belongs in the (C) group, it is implicit in the proportion-currently-married in category (B).) The first and second variables under (C) affect the proportion of the sterile female population but are not connected easily to any particular environmental or physiological factor. Primary sterility for females is usually relatively low (3 to 5 percent) and consequently is often ignored in calculation of factors affecting fertility. Disease-connected sterility (particularly venereal disease) has been important in some populations but is absent in many others. Both of these combine to reduce the proportion of married females ac-

Table 1. Davis-Blake Fertility Control Typology

(A)	Individual Controls
	(1) Contraception (including abstinence)
	(2) Abortion
	(3) Voluntary sterilization
(B)	Societal Controls
	(1) Age at marriage and proportion unmarried
	(2) Intercourse taboos, enforced separation of spouses, etc.
	(3) Sanctions on pregnancy outside marriage
(C)	Environmental Controls
	(1) Primary (nondisease connected) sterility
	(2) Venereal diseases leading to sterility
	(3) Excess premature male mortality shortening average length of marital unions
	(4) Female nutrition and general health status which affects:
	(a) age at menarche
	(b) fetal wastage
	(c) secondary sterility
(D)	Lactation Control

tually contributing to supply, but we have very little data showing how they change as development occurs (Leridon, 1977).

What remains then as important constraints on fertility are nutrition and health status of the female (variable 4 in category C) plus lactational control (category D). The importance of these two supply constraints contrasted to demand factors underlying category (A) controls is what is at issue in much of the recent debate in the literature.

But, both lactation (category D) and the environmental-physiological constraint (category C) interact with the societal controls (category B) in determining the actual supply of children available at any point in time. These several sets of factors must be disentangled if we are to understand the real determinants of supply so as to contrast them with the determinants of demand (category A).

IV. "Proximate Determinants" Approach

Recently Bongaarts has developed a framework for quantifying these Davis-Blake "intermediate" (or as he calls them "proximate") variables affecting fertility (1978). Following Bongaart's logic but modifying his categories, we propose that:

A. The biological maximum potential supply of children be defined as Total Fecundability (TF) which is equal to that average fertility which would be produced in the absence of any constraints if a female were exposed to a constant risk of pregnancy uniformly throughout a fecund period of roughly 30 years (ages 15 to 45).

B. Total natural fecundability is reduced by environmental and physiological constraints imposed by factors outside the control of the couples (or the societies). This covers nutrition and other pure "supply" effects (Menken, 1980; Bongaarts, 1980). We call this resulting fertility level TFL.

C. The total adjusted natural fecundability (TFL) includes the restraining effect of lactational amenorrhea. Lactation is nearly universal in low-income, high-fertility populations and its effect on fertility through lengthening postpartum amenorrhea has been well documented (Knodel, 1977; Huffman et al., 1980). Data from many populations show that lactating females are less

likely to become pregnant than nonlactating ones, controlling all other factors. Removing this effect we reach TNMF or Total Natural Marital Fertility. ("Natural" in this usage means no contraception is being practiced.)

D. Total Marital Fertility (TMF) is that level of fertility actually achieved by married females, allowing for an effort to prevent pregnancy and/or birth through contraception, abortion or sterilization. TMF is therefore lower than TMNF if contraception is practiced.

E. Total Fertility (TFR) differs from Total Marital Fertility (TMF) by the proportion of females not currently married or otherwise in-union. As is well known, non-marriage exerts a strong fertility-reducing effect (Coale, 1967).

Table 2 shows a hypothetical set of interrelationships among these variables. The TF (or biological potential supply) is assumed to be 15 per female.[2/] The TFR (or actual completed fertility per female) is 6. Thus, 9 potential births per female are prevented through the four types of constraints. The elements leading to this result are:

A. In our hypothetical illustration we assume that some 75 percent of all females in the child-bearing ages are currently married and that consequently, the TFR is three-fourths of the

Table 2. Illustration of "Proximate Determinants" Approach of Fertility

TF	= 15	
TFL	= 12	
	3	health-nutrition-environment
TFL	= 12	
TNMF	= 9	
	3	lactation
TNMF	= 9	
TMF	= 8	
	1	abortion and contraception
TMF	= 8	
TFR	= 6	
	2	nonmarriage (and other social controls)

TMF (or total marital fertility). This nonuniversality of marriage explains two "potential but unrealized births." TMF is 8.

B. The TMF (or Total Marital Fertility) is lower than it might be to the extent that efforts are made by the couples to prevent pregnancy or birth. Our illustration assumes that this "protection" against pregnancy is something less than 10 percent and prevents about one birth on average. TMF is 9.[3/]

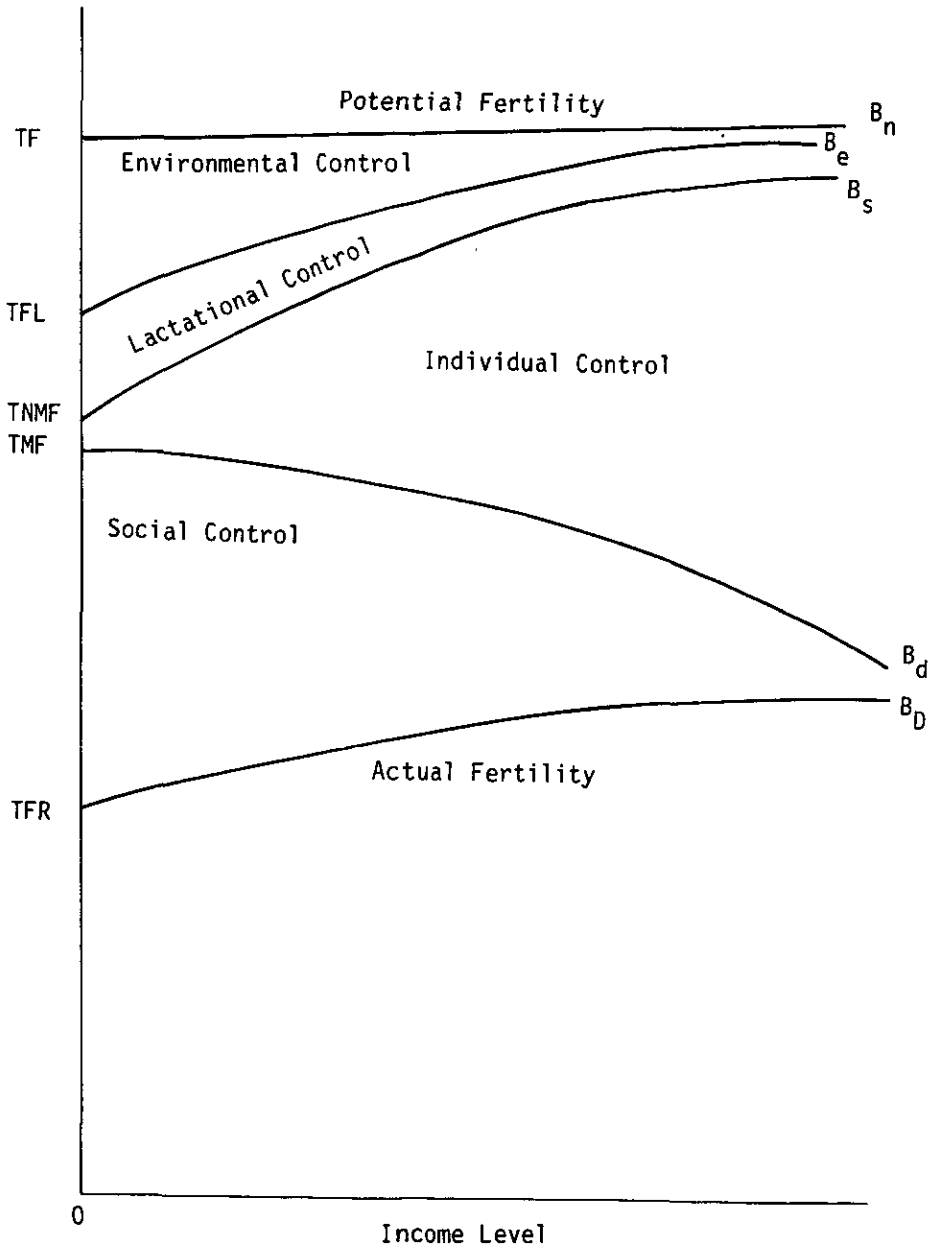
C. The difference between TNMF and TF (biological supply) is 6 births per female. Marriage and fertility controls within marriage have been accounted for, so what is left are environmental factors, including nutrition and health, plus lactation practices.

In our hypothetical example, actual realized fertility per married females (TMF) is 8, and if each of these births generates 10 months of lactational prevention of pregnancy[4/] then some 80 months are removed from the females' fecund age-span. If the total potential of 15 births is related to the total fertile age-span of 30 years, an average birth interval of about 24 months is suggested. Thus, 80 months of total lactation "prevents" about 3 births. Lactation then reduces potential average fertility (TF) by 3. What remains is the TFL-TNMF difference which is the health-nutrition constraint. In our example, it is 3 births per female on the average.

This "health, nutrition and environmental" factor is obviously still a residual category. Theoretically it should include: "excess" fetal wastage and stillbirths (over and above the rates observable in healthy, well-nourished populations); reduced levels of coital frequency due to poor health of either partner or separation caused by social and economic conditions. Some of these elements are subtle and hard to measure empirically. But, even if no clear nutrition-fecundability link can be established, the totality of the physical and social environment does exert an influence on exposure to the risk of pregnancy and on the probability of pregnancies producing live births.[5/] These environmental factors cannot be readily separated in practice from such random factors as prolonged, regular separation of spouses, or deliberate abstinence to reduce fertility.

We can also look at the relative importance of the several groups of controls over fertility during the development-transition process. Figure 2 (also adapted from Bongaarts) suggests these four categories

Figure 2. Role of Controls over Fertility as Related to Income



as the differences among TF, TFL, TNMF, TMF and TFR. These are plotted as functions B_n, B_l, B_s, B_d and B_D respectively. The potential supply B_n is constant and the difference between B_n and B_d, the actual realized output, is a shifting mixture of lactation, social control, environmental factors and individual controls.

Nothing can be said, *a priori*, about the relationship among these controls at any given level of income. If marriage is nearly universal and no contraception or abortion is practiced, then TFR will equal TNMF and only lactation and environmental controls exist to constrain TFR below TF. At the other extreme, in the absence of lactation, environmental constraints and meaningful societal controls, control becomes totally individual contraception and abortion practice. As Figure 2 is drawn, the environmental and societal controls are important at low levels of income but weaken as income levels rise. This seems the most plausible transition pattern.

In Figure 2, B_D can be seen as a societal demand curve, while B_d as the individual demand curve. If TMF > TFR, this suggests societal controls are constraining potential individual demand. But, if individual controls are present (TNF > TMF), then demand is being individually constrained.

The *potential* supply curve is B_n (TF) but in practice the actual supply curve of a population is presumably B_s (TNM). But so long as any controls on access to marriage (TMF > TFR) and any abortion or contraception exist, (TNMF > TMF) it is questionable to say that supply is constraining demand.

V. Nature of Demand for Children

Our view of demand is more complicated than those proposed by the earlier models. The social demand expressed by B_D (or TMF) may differ from the individual demand (TFR) B_d and we have no *a priori* way of knowing which is greater. In some cases the socially optimum family size may exceed private desires (in which case there will be alarms about underpopulation and national survival); in other cases, society may work hard to restrain a private desire for children judged to be in excess of the societal optimum. Within the demand-oriented approach to a theory of fertility, some writers consider only a household preference function with tastes held constant. But, Leibenstein,

Turchi and others agree that social norms as well can and do affect household preferences.

For traditional societies in which social norms are powerful, proportion married is a meaningful index of social control over fertility. In this case the actual demand by couples is indeed constrained by society as well as environment. Couples attempt to achieve their own desired family size within the limits of the societal norms, which may or may not coincide with their own preferences. The premodern institutional checks on fertility, chiefly control over marriage, reduce potential fertility to some level of marital fertility compatible with resources and optimum numbers (Dixon, 1971, 1978; Hajnal, 1965; Population Information Program, 1979; Nag, 1980). The notion that the socially desired number of children will always be a maximum is contradicted by the fact that societies are not always pro-natalist. The nearly universal existence of social controls has been well documented, and provides evidence that no overall "excess demand" exists (Hines, 1954; Bourgeois-Pichat, 1967; Matras, 1965).

In fact, it is difficult to make any generalization about what societal demand for children will be. The problem of most premodern societies is two-fold: survival and providing a level of fertility to insure this and also maintaining a balance of population with available resources, land area and technological basis. In some cases the situation may be supply-constrained, but in others the demand may be below potential supply, and necessitating social controls. Individual variations within these social norms certainly exist also.

It is well-documented that premodern societies face intermittent calamitous increases in mortality which threaten the population's survival (Charbonneau and Larose, 1980). If we assume that most organized social groups do aim at survival, then such "excess" mortality certainly leads to a "deficit" in population and a later "excess" demand for fertility as well. Past history inevitably structures the present demand. Allowing for these recurrent incidents, the average demand for fertility may be higher than the normal replacement level. But to call this chronic excess demand for fertility is no more accurate than the Malthusian assumption that all such populations are threatened by chronic excess supply. Societal demand and supply may be thought of as simultaneously determined.

VI. Empirical Application of Model

Using the Davis-Blake scheme and Bongaarts "proximate determinants" framework as points of departure, let us attempt to sort our "supply determinants" from "demand determinants" using the 27 countries for which World Fertility Survey data were available as of this writing.

The formal structure of our approach can be defined as follows:

TFR = average birth per female 15-45 as given in WFS. (1)

C_m = proportion of females 15-45 currently married or in-union. (2)

TFM = TFR/C_m, or births per currently married females. (3)

C_{NC} = 1 - (U), or the proportion of currently married women 15-45 who are not contracepting or sterilized. (4)

C_{NA} = 1 - [TFR/TFR + b x TA] in which b is birth averted per abortion [b = 0.4 (1 + U)] and TA is average abortion per female over her career; or the proportion of potential births not prevented by the current level of abortions. (5)

TNM = $TM/(C_{NC} + C_{NA})$, or births per female currently married, non-contracepting and non-aborting. (6)

C_{NL} = 1 - proportion of currently married women who are protected by lactational amenorrhea; or C_L = .5 (average months of lactation x percent of births breastfed) - (2 months); total not to exceed 12 months, as a proportion of minimum mean birth interval possible of 24 months. (7)

TFL = TNM/C_L, or births per female currently married, non-contracepting, non-aborting or non-lactating. (8)

C_E = 1 - proportion of total potential births which do not occur due to environmental and/or physiological constraints. This was taken as the residual or TFL/TF. (9)

TF = TFL/C_E, or the maximum potential level of total fertility per female when none of the constraints (C_M, C_C, C_A, C_L or C_E) are present. (10)

TF was calculated directly as follows:

(a) each pregnancy requires 9 months;

(b) a normal postpartum amenorrhea of 2 months;

(c) an average fetal wastage amounting to 2 months per interval;

(d) an average waiting time to conceive of 7 months;

(e) of the females age 15-45, some 18 percent of females are sterile (both primary and secondary) and this adds 18 percent to the average birth interval (it requires 18 percent more time for any group of females to conceive due to the infecund in their midst). Taking the sum of (a) through (d) yields 20 months and 18 percent of 20 is 3.4 added months per interval. Thus, the average minimum birth interval for 15-45 comes to roughly 23.4 months;

(f) ages 15-45 equals 30 years or 360 months of exposure time, or 15.4 births.

Thus, $TF\ (C_E, C_{NL}, C_{NA}, C_{NC}, C_M) = TFR$ (11)

This, clearly, is a slight rearrangement of the Davis-Blake list and a somewhat more significant modification of the Bongaarts approach outlined above.

In our discussion above we hypothetically sketched out a "transition" in the relative importance of the four "control" variables. Let us now test this idea using this framework and data from the 27 WFS reports issued thus far. To simplify our analysis we group the countries by fertility level as follows:

1. High fertility are those countries with a TFR $\geq$ 6.0
2. Medium fertility are those with a TFR $\geq$ 4.0 < 6.0
3. Low fertility are those with a TFR $\geq$ 2.0 < 4.0
4. *Very low fertility are those with a TFR < 2.0*

Table 3 compares the mean value of the TFR and the complement of the calculated control factors (C_M, C_{C+A}, C_L, C_E) for each of the four groups.[7/]

We see that the mean observed TFR falls from 6.6 to 3.5 across the first three groups (High to Low). This is a reduction of 47 percent. The proportion of females 15-45 and married falls from 77 percent to 58 percent, a drop of 19 percent. The proportion of currently contracepting or aborting rises from 9 percent to 53 percent, over a five-fold increase. The proportion of women currently protected from pregnancy by reason of lactational amenorrhea falls from 34 percent to

Table 3. Actual versus Potential Fertility and Four Controls in 27 WFS Countries by Level of Fertility

Fertility	TFR	C_m^*	TMF	C_{NC+NA}^{**}	TNMF	C_{NL}^{***}	TFL	$C_{NE}^{\pm}$	TF
High	6.6	.77	8.6	.92	9.4	.67	14.0	.90	15.4
Medium	4.6	.61	7.5	.66	11.4	.80$^{\mp}$	14.2	.92	15.4
Low	3.5	.58	6.0	.47	12.7	.87	14.6	.92	15.4
Very Low	1.8	.65	2.8	.20	14.0	.92	15.2	.99	15.4

* proportion of females 15-45 currently married.

** proportion of married females 15-45 not currently contracepting or aborting; for High group 85 percent effectiveness assumed; for Medium-90 percent; for Low and Very Low-100 percent.

*** proportion of married females 15-45 not currently protected by lactational amenorrhea.

$\pm$ proportion of potential births not prevented by environmental-physiological controls. As shown here, C_E is a residual after C_M, C_{NC+NA}, C_{NL} have been calculated (as explained above) and applied to the TFR.

$\mp$ C_L as calculated (using previously explained formula) was reduced by 33 percent to allow for overlap with $C_C + C_A$. This is discussed below.

13 percent, a decline of almost two-thirds.

Thus, there definitely does seem to be support for the idea of a "transition" in the control factors which prevent the actual TFR from reaching the potential maximum fecundability rate. Figure 3 sketches out broadly this transition by income levels of the groups of countries. Table 4 presents these results in terms of births prevented by several controls.

Let us return to our original question: the existence of separate demand versus supply effects and their relative importance at different stages of the transition. Our C_E is the most obvious supply constraint and it does indeed decline as income levels rise. Even more powerful as a constraining factor is lactation which declines

Figure 3. Transition of Control Factors with Respect to Changes in Income

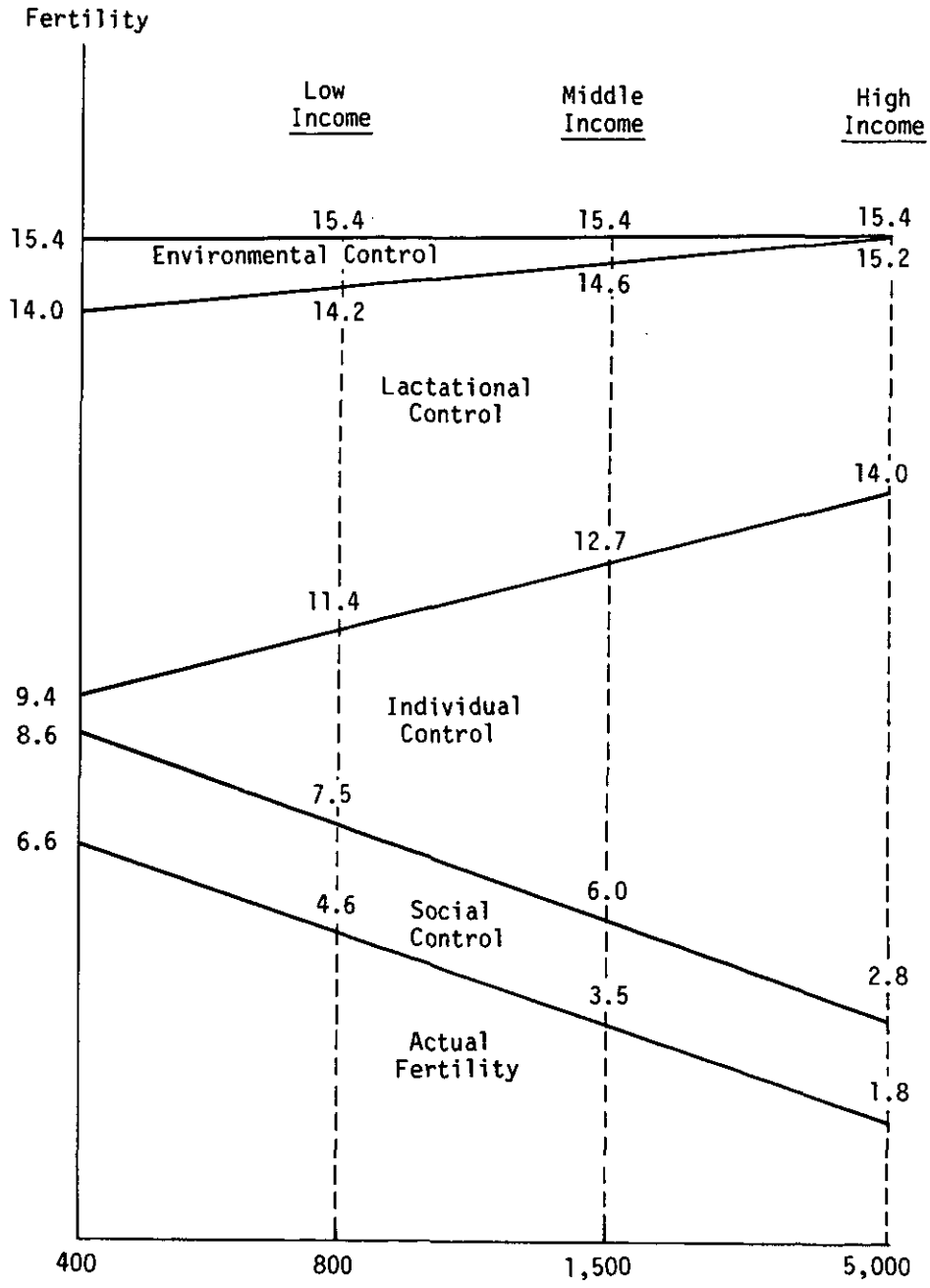


Table 4. Births Prevented by Several Types of Controls

Fertility Level	Total (TF-TFR)	C_M (TMF-TFR)	C_{C+A} (TNM-TMF)	C_L (TFL-TMNF)	C_E (TF-TFL)
High	8.8	2.0	0.8	4.6	1.4
Medium	10.8	2.9	4.6	1.9	1.4
Low	11.9	2.5	6.8	1.9	0.7
Very Low	13.6	1.0	11.2	1.2	0.2

also, but later in the transition. The societal control (via marriage) also exerts substantial influence at first but then falls off in importance. The most powerful factor is clearly the rise of contraception. It prevents less than one birth per female in high fertility countries and almost 12 in very low fertility countries.

These data do offer some confirmation of the existence of a supply constraint. If the low income, high fertility countries had environments as favorable as the high income countries, they could increase their supply by one full child on the average. But the modest existing practice of contraception is already preventing almost this same volume of fertility. This, on balance, is tenuous evidence for "excess demand" or a supply-constrained situation, unless lactation is considered a "supply constraint." Fertility, it seems, is constrained by both supply and demand factors and the former are not dominant even in low-income countries. This "supply constraint" quickly becomes even less important as the transition unfolds.

VII. Cautionary Note on Model

The assumptions of this approach are that: (1) only a negligible amount of nonmarital fertility occurs so that nonmarriage functions as an effective fertility-inhibiting institution; (2) the health-nutrition factors do not affect the maximum fecundability estimate; (3) there is no overlap between women who are contracepting and lactating: (4) the proportion of the married females who are currently contra-

cepting is always on the average removed from the process of child-bearing, and that contraceptive effectiveness increases from the high to low fertility countries.

A. The WFS definition of "in-union" is sufficiently broad to capture most exposed females.

B. Where fetal wastage and secondary sterility are very high, the maximum fecundability will be lower than the limit calculated. However, even if this is not adjusted for, the effect will simply be to increase the fertility-inhibiting effect of the "environmental" control factor since the other three factors (marriage, contraception, lactation) are estimated directly and not affected by the level of fetal wastage and sterility.[8/]

C. Where contraception and lactation proceed simultaneously, the procedure results in overstating their combined fertility inhibiting effect. The result is a TFL rate which is "too" high. This problem emerged very clearly in our medium fertility group of countries. Thus, in Korea contraception and breast-feeding are widespread ($C_{NC} + C_{NA} = .46$; $C_{NL} - .57$), resulting in an estimate of TFL = 25.0 using our methodology. Similar situations emerge in other of these truly "transitional" countries. This forced us to adjust arbitrarily for the overlap as explained in Table 3, by assuming that 33 percent of the lactating females are also contracepting.

D. The assumption that all current contraception is fertility-inhibiting is obviously correct, but this does not mean that this proportion of females is, on the average, totally removed from the child-bearing population. An example will help to clarify this problem. In Belgium, some 86 percent of married women currently contracept. If all of these are seen as not contributing to current fertility, then the total maximum fecundability (TF) of 15.4 is lowered to a total marital fertility rate (TNM) of 2.00. If allowance is made for the proportion of females married (roughly 70.6 percent), then the current total fertility rate implied is 1.40, whereas in fact it is 1.74. This amounts to saying that some women may report they are currently using a method but still have a birth. Thus, efficiency is not 100 percent.

The use effectiveness of contraception varies with income and

education levels. Thus, 10 percent of the women in India contracepting will prevent fewer births than 10 percent of the women in Belgium. This is not simply a question of the method (modern vs. traditional) mix since some very low fertility countries still use mainly traditional methods. Rather, contraceptive efficiency varies with income, education and development.

The value of C_{NC+NA} is the simple proportion of married females 15-45 reported as not contracepting in the WFS data (with an adjustment for abortion). In the case of several countries, the C_{NC+NA} implied by beginning with the total fecundability (TF) then working backwards through TFL and TNM (given the values of C_E and C_{NL}); and then comparing the TNMF and TMF values (since TNM/TMF = C_{NC+NA}) yields a different estimate of C_{NC+NA}.

This would seem to imply: (a) that contraceptive efficiency is, in some sense, greater or less than the simple proportion suggests; or (b) that there is overreporting or nonreporting of contraception and abortion occurring. The differing contraceptive efficiency could be dealt with, in principle, if we had estimates of the method-mix of contraception by country and also estimates of specific method use-efficiency by country. Lacking these, the method outlines assumes 100 percent for low and very low fertility countries; 90 percent for medium; and 85 percent for high.

VIII. Conclusions and Implications

The supply and demand framework *is* a useful way of looking at population's interaction with development. The essence of the demographic transition is from societal and environmental controls on *both* demand *and* supply to almost totally individual determination of demand and individual control over supply. There is an equilibrium in both cases but to understand both as part of the same process requires a relatively complex conceptualization of the demand and supply functions (Wrigley, 1969; Notestein, 1952; Population Studies, 1973; Wrigley, 1978; Abernethy, 1979).

The equilibrium between demand and supply is achieved by a shifting combination of: (1) lactation practices; (2) environment controls working through health, nutrition and other physiological factors; (3) societal controls working through proportions married and other social

behavioral norms; (4) individual controls working through contraception and abortion. At very low income, high fertility levels, lactation is the most powerful single control but even there societal and individual (demand) controls play a role. Very quickly the individual controls come to dominate. At no level do pure supply effects seem very important unless lactation is included.

In any case, societal and natural controls probably overlap, since aside from age at marriage and proportions unmarried, any societal control presumably works through intercourse taboos and other norms governing coital frequency and so do many of the environmental controls. The relative neglect of these factors is due to the almost total lack of any data in developing countries on coital frequency (and its correlates) and on patterns of temporary marital separation. Until more direct evidence on these points is available, these environmental and societal control categories will remain somewhat vague, uncertain categories. This would seem the next step in fertility research.

Notes

1/ $\Sigma r(a) = M \times \Sigma n(a) \times e^{m.v(a)}$, in which a is a given age group (20-24 to 40-49); n(a) is the empirical "natural fertility" rate; r(a) is fertility rate for the given population; M is a scale factor equal to the ratio of r(a) to n(a) at ages 20-24; m is an index of fertility control; v(a) is an empirically derived function expressing typical age pattern of control. Thus, M is the first parameter, the difference in level of fertility between the given population and natural fertility; m is the second and measures the extent to which the age-specific fertility pattern of the subject population is different from that of the natural fertility benchmark.

2/ This figure is explained and defended below. Bongaarts, using two quite different intuitive approaches, ends up with 15 as his estimated TF too.

3/ We should note also that the "controls" discussed above, by society and individuals, is with respect to the formation of sexual unions, conception and successful parturition. Infanticide is thus not included. Perhaps it should be since it has clearly played a real role in many cultures in effectively limiting family size. It would be easy enough to include it on our list of controls at both the societal and individual levels, but it would complicate our definitions and the TF, TNMF, TMF and TFR relationships. In any case, it seems unlikely that infanticide would ever be chosen as *the* principle fertility regulation device by people individually or collectively. It is more likely to function as a back-up system when other regulation fails or when a sudden, urgent need to reduce supply arises.

4/ The lactational period of amenorrhea seems limited to a maximum of about 10 months, regardless of how long the women nurses, since, "nearly all women ovulate within the first year after delivery" and two months of postpartum amenorrhea are normal. Thus, nursing each birth for two years, the lactational constraint would yield at most 10 months of non-risk of pregnancy. George Washington University Medical Center, Department of Medical and Public Affairs. 1975. Population Reports, Series J, No. 4, July, Family Planning Programs, "Breast-Feeding-Aid to Infant Health and Fertility Control." Van Ginneken concludes: ". . . the fertility-reducing effect of lactation is substantial, but this effect lasts a little less than a year." See: "Prolonged Breast-feeding as a Birth Spacing Method," 1974. Studies in Family Planning, Vol. 5, No. 6, p.201.

5/ Bongaarts more or less dismisses the "health-nutrition" constraints as unimportant. He allows two months per birth interval (total interval equal to 20 months) for spontaneous abortions and miscarriages. Yet according to one major study: "At the most conservative estimate, it appears that about 20 percent of all fertilizations end as fetal deaths before the normal period of gestation is concluded." United Nations, Department of Economic and Social Affairs. 1954. Population Studies No. 13, Fetal, Infant and Early Childhood Mortality, New York, Vol. I, p. 51.

6/ In addition to age at marriage and proportions marrying, there is substantial evidence that taboos and enforced separations, leading to involuntary abstinence and reduced coital frequency have functioned as social controls. Prolonged lactation is also mentioned in this connection. Moni Nag. 1980. "Modernization and Fertility," Current Anthropology, October, Vol. 21, No. 5, pp. 571-580.

7/ The countries included are: High - Bangladesh, Nepal, Pakistan, Kenya, and Jordan; Medium - Korea, Indonesia, Malaysia, Turkey, Thailand, Colombia, Guyana, Jamaica, Philippines, Dominican Republic, Peru, Mexico; Low - Panama, Costa Rica, Fiji, Sri Lanka, Spain; Very Low - Hungary, Netherlands, Belgium, Japan, Singapore.

8/ The interaction between these "supply" factors and total fecundability is nicely illustrated in a recent paper, which concludes: "Fecundability levels seem to be too heterogeneous for adoption of a single upper ceiling for all populations." R. Lesthaeghe et al. 1981. "Compensating Changes in Intermediate Fertility Variables and the Onset of Marital Fertility Decline," International Union for Scientific Study of Population, International Population Conference, Manila, 1981, Liege, IUSSP, p. 77.

References

Abernethy, Virginia. 1979. Population Pressure and Cultural Adjustment. New York: Human Sciences Press.

Belgium. IUSSP. Population Issues for the 1980's, Proceedings of Helsinki Conference. Liege: Editions Ordina.

Blake, Judith and Kingsley Davis. 1959. "Social Structure and Fertility," Economic Development and Cultural Change, Vol. 4.

Bongaarts, John. 1978. " A Framework for Analyzing the Proximate Determinants of Fertility," Population and Development Review, Vol. 4, No. 1, March.

_____. 1980. "Does Nutrition Affect Fecundity: A Summary of the Evidence," Science, No. 208.

_____. 1982. "The Proximate Determinants of Marital Fertility," in U.S. National Academy of Sciences, Determinants of Fertility in Developing Countries: A Summary of Knowledge.

Boulier, Bryan L. and N. G. Mankiw. 1980. "An Econometric Model of the Demand, Supply and Regulation of Fertility." Unpublished paper.

Butz, William and J. D. Habicht. 1976. "The Effects of Nutrition and Health on Fertility: Hypotheses, Evidence and Intervention," in Ronald Ridker (ed.), Population and Development: The Search for Selective Intervention. Baltimore: John Hopkins Press.

Charbonneau, Hubert and Andre Larose (eds.). 1980. The Great Mortalities: Methodological Studies of Demographic Crisis in the Past. Liege: IUSSP.

Coale, Ansley. 1967. "Factors Associated with the Development of Low Fertility: An Historical Summary," Proceedings of the World Development Conference, 1965, Belgrade. New York: United Nations.

_____, and T. James Trussell. 1974. "Model Fertility Schedules: Variations in the Age Structure of Child-Bearing in Human Population," Population Index, Vol. 40, No. 2, April.

Department of Economic and Social Affairs, United Nations. 1973. Populations Studies, No. 50, The Determinants and Consequences of Population Trends, Vol. I. New York: United Nations.

DeTray, Dennis. 1977. "The Demand for Children in a 'Natural Fertility' Population," Seminar Paper No. 21, Pakistan Institute of Development Economics, August.

Dixon, Ruth. 1971. "Explaining Cross-Cultural Variations in Age at Marraige," Vol. 24, No. 2.

_____. "Late Marraige and Non-Marriage as Demographic Responses: Are They Similar? Population Studies, Vol. 32, No. 3.

Easterlin, Richard. 1978. "The Economics and Sociology of Fertility," in C. Tilly (ed.) Historical Studies of Changing Fertility, Princeton.

Easterlin, Richard et al. 1980. "Towards a More General Economic Model of Fertility Determination: Endogenous Preference and Natural Fertility," in Population and Economic Change in Developing Countries, Richard Easterlin (ed.). National Bureau of Economic Research, Chicago U. Press.

Encarnacian, Jr., Jose. 1977. "Population and Development in Southeast Asia: A Fertility Model," University of the Philippines, School of Economics, Discussion Paper No. 77-6, November.

Fisch, Rose. 1975. "Demographic Implication of the Biological Determinants of Female Fecundity," Social Biology, Vol. 22, Spring.

Hajnal, John. 1965. "European Marriage Patterns in Perspective," in D. V. Glass and D. E. C. Eversley (eds.), Population in History: Essay in Historical Demography. Chicago: Adeline Publishing Co.

Hines, Norman. 1954. A Medical History of Contraception. New York: Williams.

Huffman, Sandra et al. "Lactation and Fertility in Rural Bangladesh," Population Studies, Vol. 34, No. 2, July.

Kelley, Allen. 1980. "Interactions of Economic and Demographic Household Behavior," in Population and Economic Change in Developing Countries, Richard Easterlin (ed.). National Bureau of Economic Research, University of Chicago Press.

Knodel, John. 1977. "Breast-feeding and Population Growth," Science, 198.

_____ and Etienne Van de Walle. 1979. "Lessons From the Past: Policy Implications of Historical Fertility Studies," Population and Development Review, Vol. 5, No. 2, June.

Leridon, Henri. 1977. Human Fertility: The Basic Components. Chicago: U. Press.

Matras, Judah. "The Social Strategy of Family Formation," Demography, Vol. 2.

Menken, Jane. 1980. "Introduction" in J. Menken and H. Leridon (eds.) Natural Fertility. Liege: Editions Ordina.

_____, et al. "The Nutrition-Fertility Link: An Evaluation of the Evidence," Journal of Interdisciplinary History, Vol. 11.

Morris, D. Morris. 1979. Measuring the Condition of the World's Poor: The Physical Quality of Life Index. Oversears Development Council: Pergamon Press.

Mosley, W. Henry (ed.). 1978. Nutrition and Human Reproduction. New York: Plenum Publishing Corp.

Notestein, Frank. 1952. "Economic Problems of Population Change," in Proceedings, 8th International Conference of Agricultural Economics. Michigan State.

Population Information Program Special Topic Monograph, "Age at Marriage and Fertility." Population Reports, Series M, No. 4, November.

Robinson, Warren and Sarah Harbison. 1980. "Towards an Integrated Theory of Fertility," in Thomas Burch (ed.), Demographic Behavior, Westview Press (AAAS).

Sanderson, Warren. 1976. "On the Two Schools of the Economics of Fertility," Population and Development Review, Vol. 2.

Wrigley, E. A. 1969. Population and History. New York: McGraw-Hill Book Co.

_____. 1978. "Fertility Strategy for the Individual and the Group," in Charles Tilley (ed.), Historical Studies of Changing Fertility. Princeton: U. Press.