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A Economic Analysis of Fertility Transition in the Context of Development and Family Planning Program

1. Introduction

The aim of this paper is twofold, one is to interpret the economic framework of fertility analysis by a demand and supply scheme for children, The other is to find the general pattern of change in fertility with development and family planning.

There have been some contrasting suggestions about the effectiveness of development and family planning on decreasing fertility. To explain this contrast by an economic framework, this paper is formulated as follows: (1) The demand and the supply curves are derived from the parents' utility function and production function with the constraint of given resources and prices of goods. (2) The pattern of change in fertility with development and family planning is explained within the demand-supply framework. (3) The relationship between fertility and its explanatory variables is empirically analyzed with the data from Korea. (4) Finally the conclusions about the economic analysis of fertility and the pattern of change in fertility are summarized.

2. Economic Framework for Fertility Transition

Since Gary S. Becker employed the economic framework to analyze the factors determining fertility in 1960, many authors have been explaining demo-

graphic transition in terms of supply and demand for children. However, the characteristics of demand and supply curves for children have not been fully discussed as to their shapes. There have been only debates on the behavior of a family consumption on the demand side.[1] Hence, in this section, more specific demand and supply schedules for children are derived, with a few generally accepted assumptions, from the parents' behavior of having children.

Some of the most difficult characteristics in analyzing fertility as a form of economic behavior are as follows:[2] (1) Parents are both demanders and suppliers, and childbearing and childrearing are non-marketable activities. (2) There is some trade off between the number of children and the quality of children. (3) The relationship between parents and children tends to be a long-term one at least as long as 5-10 years. In consideration with these characteristics, the following principles of analysis are set up. (1) The demand for children is separated from the supply of children by assuming that parents have two different functions; the utility function and the production function. (2) The number and the quality of children are combined into a unit of demand and supply of children. (3) The whole analysis is in the type of comparative static analysis.

A. Demand Curve for Children

To derive the demand curve for children, the utility function which includes children as one of its elements should be defined. Several expressions of the utility function have been described by different authors as follows:

R. J. Willis' family utility function; $U = U(N, Q, S)$

where N; number of children
Q; the quality of children
S; parents' other sources of satisfaction.

D. N. De Tray's household utility function; $U = U(C, Z)$

1) Traditional utility maximizing approach and family production model are the two stems of the debates.

2) For more detailed characteristics, see Willis (1973) p. S16

where C; the stock of child services

Z; all other household production-consumption activities.

B. A. Turchi's couple's joint welfare function; U = U(K, N)

where K; the number of children

N; the present value of all resources remaining to the couple after childbearing.

R. A. Easterlin's parents' utility function; U = f(C, Gp)

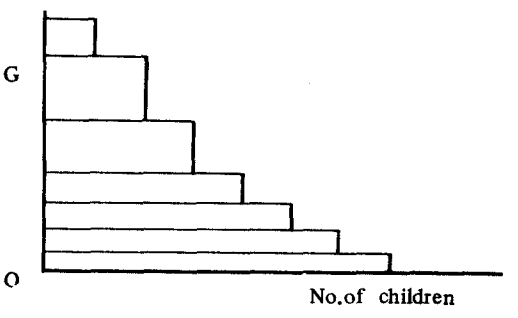
where C; the number of children surviving to adulthood

Gp; quantity of goods consumed by the parents

Referring to each of the components of these utility functions, I will define a utility function which will be used in this analysis. First, the names of the utility function are various; family, household, couple's, and parents' utility function. They seem to be very similar, but the implications of each are different. The first two, family or household utility functions, imply the family production approach to the theory of consumption, the so called new home economics, and the latter two are the traditional utility functions which are maximized subject to budget constraint. Household does not always mean family and all couples are not parents. Therefore I will call the utility function parents' utility function because the people most closely related to children are parents. About the number or the quality of children, as I mentioned earlier, I will take the Willis' composite concept of "the number and quality of children".[3] If children are expressed only by numbers, it is impossible to define a continuous utility function and consequently the indifference curve between children and non-children consumption can not be drawn smoothly.[4] Hereafter, I will use

3) See Willis, *I ibid*

4) If the parents' utility function is defined only by the number of children, then the form of indifference curve will be a step function like the graph in the right figure.



"children" to refer to the number and quality of children.

The parents' utility function can be defined like (1) below. This is the traditional utility function of consumer behavior, and a formal income or budget constraint for maximizing the parents' utility is defined like (2).

(1) $U = U(C, G)$

where C; the number and quality of children

G; quantity of goods consumed by parents other than children.

(2) $Y = Pc \cdot C + Pg \cdot G$

where Pc and Pg are the shadow prices for children and goods

The optimal demand for children can be derived by maximizing the utility function (1) subject to constraint (2). Rather than describing the mathematical process of that derivation, I specify the particular shape of the demand schedule for children graphically with the following three assumptions.

Assumption 1. Threr are upper and lower limits in the demand for children at which the elasticity of demand for children with respect to shadow price of children is almost zero.

Assumption 2. All parents have an optimal or target level of demand for children with respect to the shadow price for children.

Assumption 3. The price elasticity of children is increasing from its lower limit to the target level and, over the target level, the elasticity is decreasing.

With these assumptions, the demand schedule for children can be described like figure 2 from the price-consumption line[5] for children in figure 1.

Lower limit (C_L) is the minimum level of demand for children, which all parents may have in mind. Although that level is different from person to person, there probably that level in the instinct of a human being. The upper limit can be considered in relation to the biological ability of childbearing. On the graph, the target level point is the inflection point.

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5) Price-consumption line is the set of points at which indifference curve makes contacts with the budget line. As the price for children changes, the slope of the budget line is also changed and new optimal point occurs.

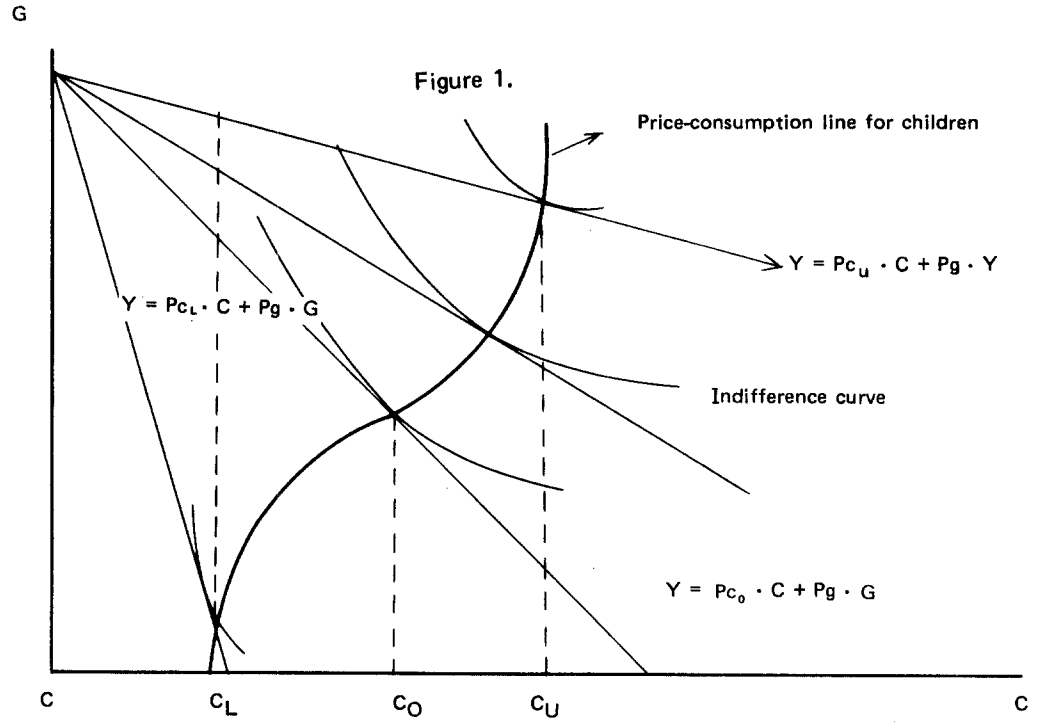


Figure 1.

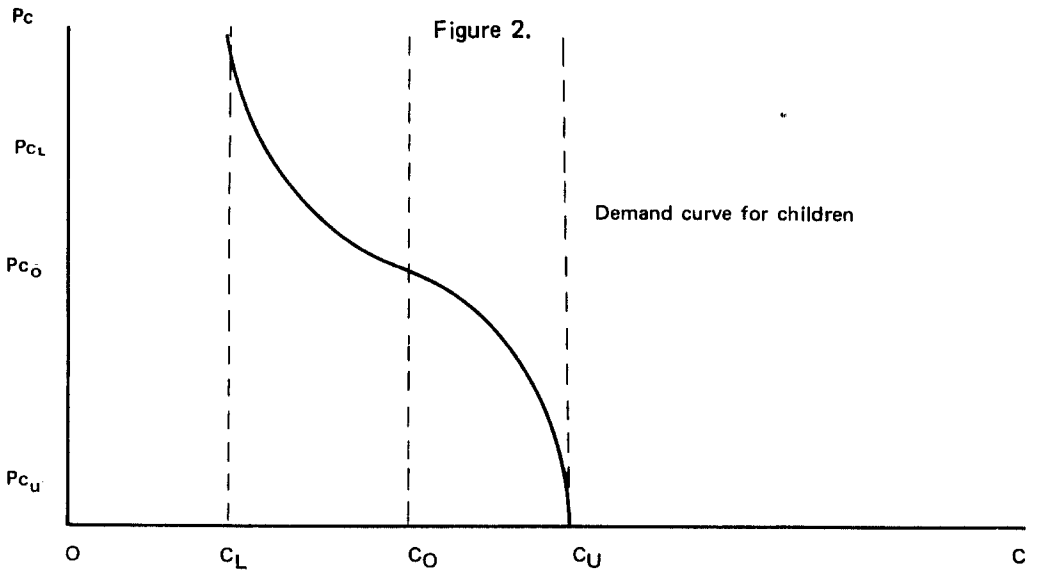


Figure 2.

Parents prefer more children for the same change of the shadow price of having children until they reach the target level. After reaching target level, the rate of change in demand to the same size of price change is decreasing.

The restrictiveness of linear demand models for the study of fertility and the nonlinearity between explanatory variables and fertility was suggested by Paul Schultz (1976). Hence, the above nonlinear demand curve is not an entirely new idea, but it is a clear specification of the nonlinearity which is very useful for the analysis of the effectiveness of development and family planning.

B. Supply Curve of Children

In Economics, supply is defined as the positive function of price and is usually derived from maximizing revenue from a production with given resources. To derive the supply for children, the production in which children are included as one of its outputs should be defined. A family or household has been considered fundamentally as a unit of consumption while a firm is a unit of production. This common logic in Economics makes it very unusual to define a family production function. Fortunately there has been theoretical development of household production by G. Becker and others. They have formulated a framework known as the "household production model" or the "new theory of consumer behavior" to explain the role of factors other than income and price, such as family size, age structure, education, occupation and socioeconomic status in the variation of consumption. In other words, they have formulated the family production function to explain the consumption behavior of a family well. However, I will accept the family production function as just a common production in Economics. It produces nonmarketable household goods or achievements such as children, health, education, prestige and companionship. I separate this family production function from the utility function. To be consistent with the parents' utility function, I call the function parents' production function.

The outputs from the production function can be divided into two parts; the achievements related to children and the non-children achievements. The

former can be considered as the number and quality of children just like in the case of demand. The latter can be everything parents achieve through their lifetime except children.

If parents have high expected value about children, they would have more children than otherwise. If they feel more value on things other than children, they would have fewer children. Parents' production function can be defined in the form of implicit function like (3) and total value function of parents can be written like (4).

(3) $Q(C, NC; r) = 0$

where C; the number and quality of children

NC; non-children achievements of parents

r ; given resources to parents.

(4) $Pc \cdot C + Pnc \cdot NC = R$

where Pc; expected value of children

Pnc; expected value of non-children achievements

R; total expected value for parents' production.

By maximizing the expeted value of products with given resources of parents, the optimal production is given at the tangent point between the production-possibility curve[6] and expected value line as shown in figure 3. One important fact is that there is a biological limit to the production of children which gives an implication of limited supply of children.[7] As the expected value of children goes up, the slope of the value line becomes steeper and the supply of children will increase to the maximum level of biological fertility with given quality of children. Consequently the supply curve for children can be drawn like the one in figure 4.

6) The production-possibility curve is the set of points at which parents maximize their outputs' value. It is sometimes called production-transformation curve.

7) If there is some increase in given resources, the production-possibility curve shifts more upward than rightward in right handside graph because there is limit on the supply of children.

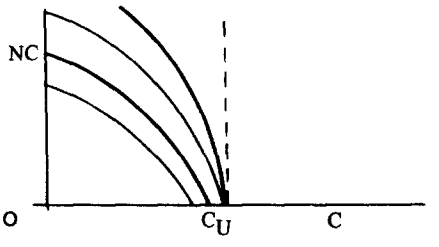


Figure 3.

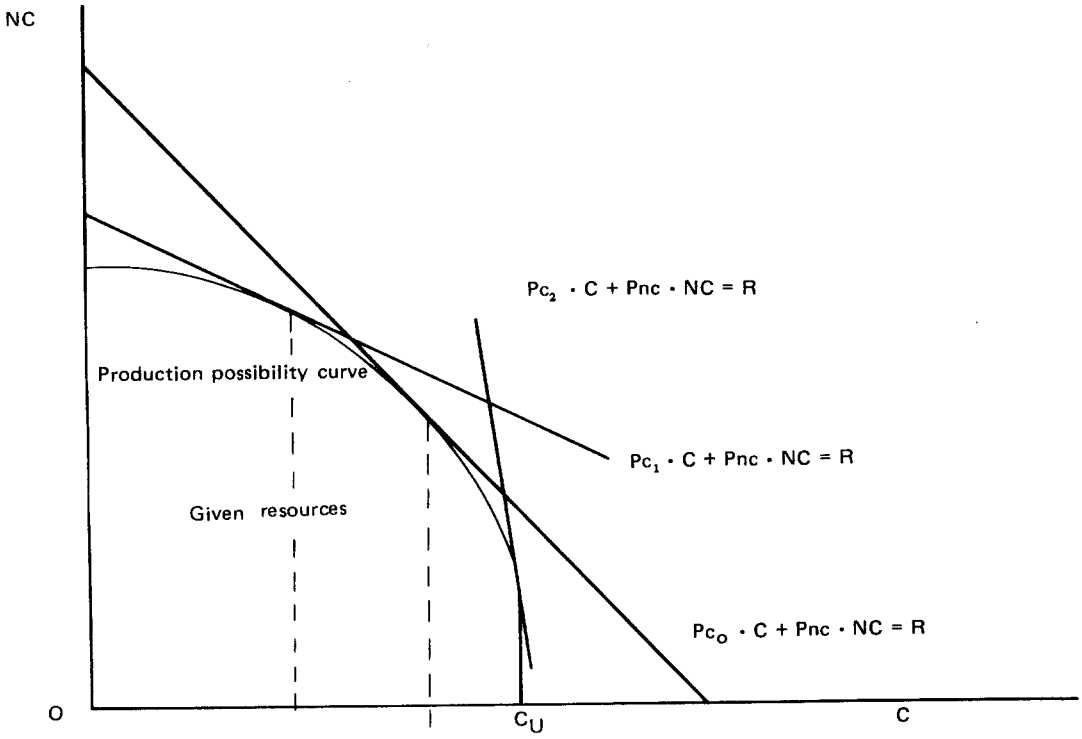
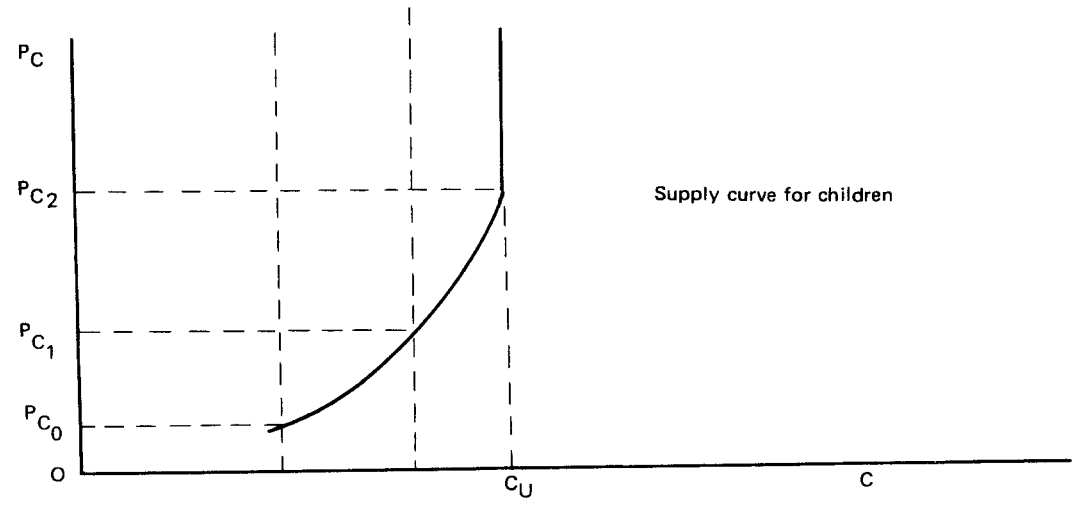


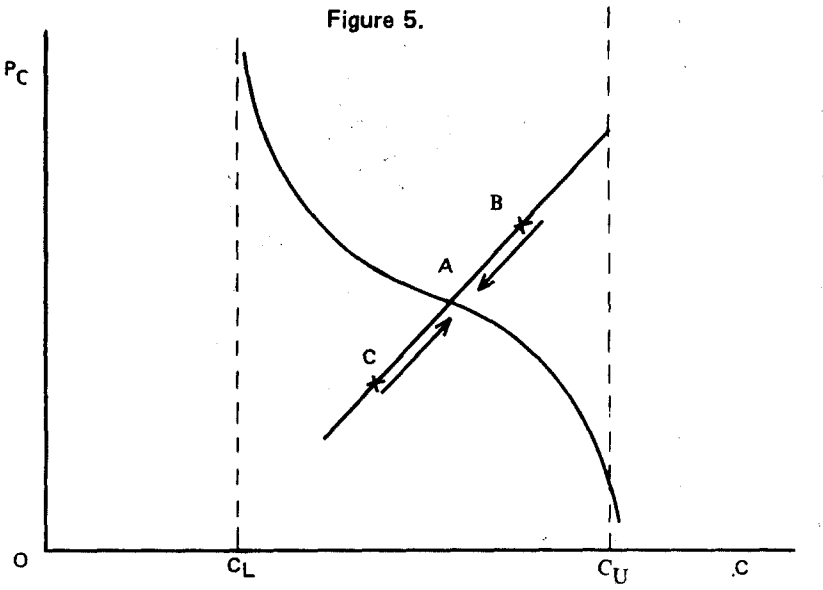
Figure 4.



C. Equilibrium

The actual number and quality of children for parents is determined at the crossing point of the demand and the supply schedules for children. This is illustrated in figure 5. Parents can always reach the equilibrium point E because the horizontal axis implies not only the number but also the quality of children. For example, if parents have more children, in number, than they want to have, they can adjust the quality of their children so that they can reach equilibrium (B to A). Similarly, when the parents have fewer children and they can't have a new child for some reasons, they improve the quality of children (C to A). There can be excess demand or supply in the number of children, but no excess demand or supply in the number and quality of children.

Figure 5.



At the equilibrium, the utility function and the production function work at the same level of children. Children are the common factor in both functions; they are some of the inputs to the utility function and at the same time some of the outputs from the production function of parents.

The demand and the supply schedules can be moved by the change in any

other factors except the price of children. Suppose that there are continuous impacts such as family planning program to force the supply curve to move, and assume the supply curve will shift to the left by the same distance along the vertical axis, then the changes in the equilibrium level of children by the shifts of supply show an accelerating pattern from the higher level of children and deceleration pattern as the equilibrium point goes to the minimum demand. This pattern of fertility change by continuous shifts of the supply curve is illustrated in figure 6 and figure 7.

Figure 6.

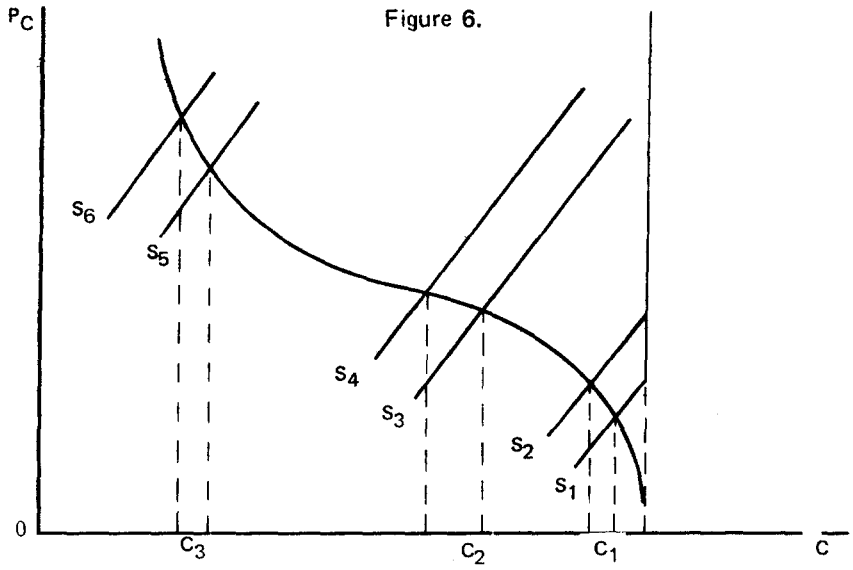
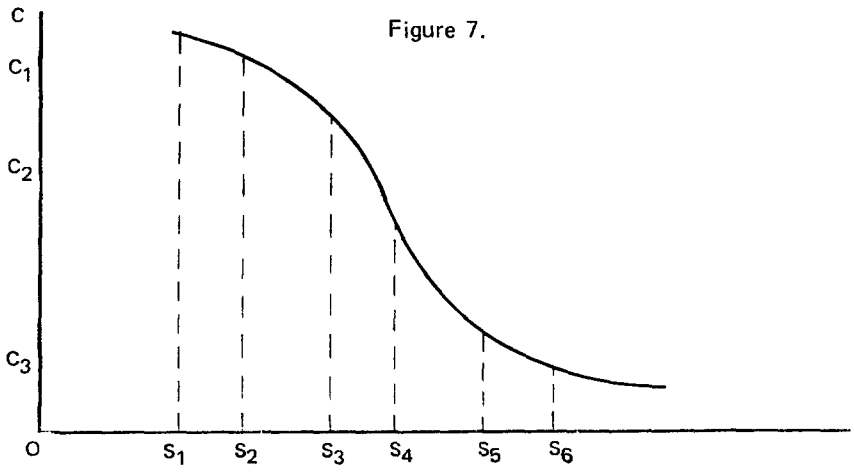


Figure 7.



The pattern of fertility change like figure 7 can be considered, similarly, in the case of the continuous shifts of the demand curve[8].

3. Fertility Transition with Development and Family Planning

One of the practical questions to the policy makers in developing countries today is how much effort should be invested to the family planning (FP). However, it is still unclear historically and little contrasting empirically which of the two is more effective and powerful to reduce fertility. In this section the effectiveness of the two policies will be explained with the previously discussed demand-supply framework.

The effect of development and FP on fertility depends on the shape of the demand-supply curves, the position of initial equilibrium, and the amount of the impacts. I assume the shape is given and will see the effects of development and FP at different positions of the initial equilibrium.

A. Development and Fertility

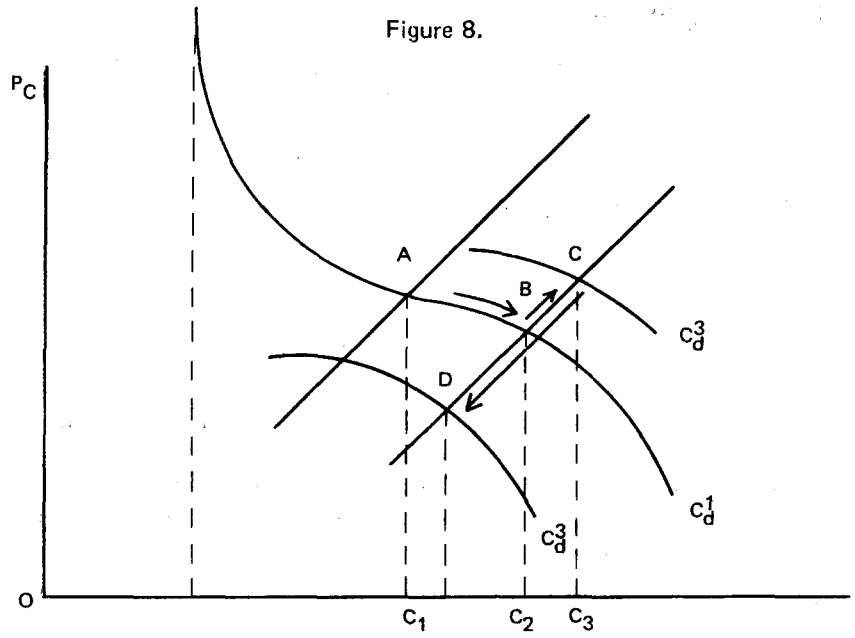
Development increases, in a short period, the supply of children through the increase in consumption, the improvement in health, the decrease of mortality, etc. This is the downward or rightward shift of the supply curves. In the long-run, development makes the demand curve move to the left by providing various sources of satisfaction to parents other than children. I will apply this pattern to the explanation of European transition and the possible transition in less developed countries (LDC).

In traditional European societies, fertility was high but the actual level of children was not so high because mortality was also high. The average woman who survived through her childbearing years had seven or eight children, of whom perhaps one-half survived to adulthood, these facts imply that the

8) In this case, the supply curve is assumed to be fixed and the same size of continuous shifts in the demand curve will result in the accelerating pattern of fertility change at the higher level and decelerating one at the lower level of fertility.

initial equilibrium in the demand-supply framework was on the intermediate level like point A in figure 8. When the mortality decreased and industrializationbegan, the first effect was the shift of the supply curve (C_s^1 to C_s^2) and the actual children increased (C_1 to C_2). During industrialization, the demand curve also moved to the right because there was no hindrance to the participation of children in the labor market so that more children were supplied along C_s^2 (C_2 to C_3). The movement of equilibrium point; A to B to C, could be the explanation about the first transition; from high mortality-high fertility to low mortality-high fertility.

Figure 8.

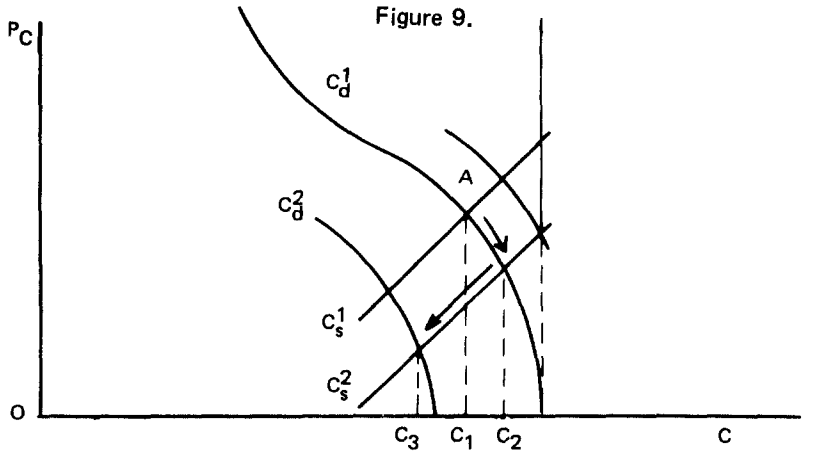


As children labor participation was prohibited by law and the norm of small family was formed by continuous development, the demand curve moved down (C_d^2 to C_d^3), and the actual level of children decreased. This movement, C to D, was the transition from high fertility-low mortality to low fertility-low mortality. This is the very simple explanation of the European transition by supply-demand curves. Of course, there would be many factors to move demand-supply other than mortality and children's labor market participation. Any other change

but the price of children will shift the curves. This may be the reason why the fertility transition in Europe occurred at various stages of development of industrialization.

The pretransitional level of fertility in LDC is much higher than that in Europe, and the mortality is already at a lower level probably by foreign aids. This implies that the initial level of equilibrium is on the high level of children like point A in figure 9. Development would similarly shift the supply to the right on the short period (C_s^1 to C_s^2), but the increase of children-level would not be substantial (C_1 to C_2) because the demand is very steep at that level. There would be no rightward shift of demand by development in LDC because there is no motive to have more children. In the long run, the demand curve will move to the left (C_d^1 to C_d^2) so that the new equilibrium for children will decrease probably over the initial level (C_2 to C_3).[9)]

Figure 9.



One important thing is that development has the effect of increasing the supply of children at any position along the initial equilibrium. In LDC, development restricts its effectiveness on the decrease of fertility because the initial level is high and fundamentally the steep supply curve is located at the high level of children.

9) If the strategy of development is a very labor-intensive one, then there would be no force to move the demand curve to the lower level of fertility.

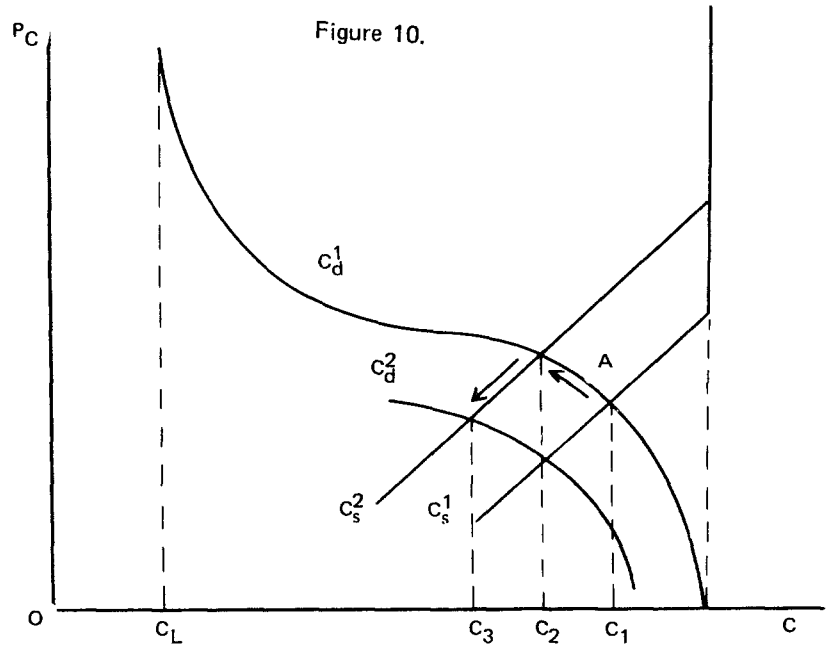
Development can shift the supply curve to the right and the demand curve to the left, but it can't shift the supply to the left unless it is accompanied by the increase of contraception. The suggestion that development is the best police to slow down the rapid population growth can have its validity only if the development brings about a substantial increase of the technical availability of contraception.

B. Family Planning and Fertility

FP can be divided in-to two parts. One is the supply of contraceptive methods at low cost or free, which has an immediate effect on fertility. The other is the formation of a small family norm by providing continuous education and public information about population problem, both of which have long-term effects on fertility.

In my framework, the effect of FP is again the shift of the supply curve to the left in the short period and the shift of demand to the left in the long-run. In figure 10, the shift of C_s^1 to C_s^2 is the result of FP in the short-run and the shift of C_d^1 to C_d^2 is the result of long-term effect by FP. The level of children

Figure 10.



will be decreased from C_1 to C_3.

In comparison with the effect of development, FP has no influence to increase the supply of children because the movement of supply and demand curves for children by FP are always toward the lower level of fertility.

When a country starts development and FP at the same time, the effect can be described as the sum of figure 9 and figure 10. In the short run, the supply curves moves to the left by the supply of contraceptive method, but the size of movement is not so much as that in figure 10 because there would be some counter effect of development on the supply of children. As development and FP go on, the effect of development on demand schedule will occur so that the total effect of development and FP will be accelerated. As the equilibrium approaches to the minimum level of demand for children, the effect would decrease for the same development and FP. The changing pattern of fertility by development and FP would be just like the shape of figure 7.

4. Empirical Findings

Korea is a country which best exhibits the previously explained relationship because development and FP began at the same time and it has been undergoing continuous changes in the level of development and FP such as GNP, urbanization, education, industrialization and CBR.

I chose the following five variables and tried to see the relationship between those variables, which show the degree of development and FP, and CBR during 1964-1979.

Development variables

GNP; per capita gross national product

URB; percentage of non-farm population

ENR; per capita consumption of petroleum

EDM; percentage of students in middle school.

FP variable

RPE; the expenditure to FP by government.

First, I graphed the relationship between CBR and each of the above variables by using Shazam. The results are in figure 11. Graph (1) is just the scatter-diagram of CBR by year. Graph (2)-(5) show the trend between development and fertility. Graph (6) show the relationship between FP and CBR. All of the graphs show a shape very similar to that described in the earlier sections.

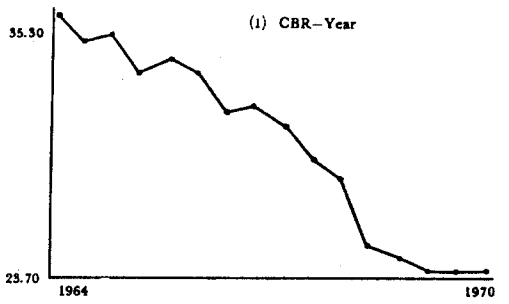
Next, I generated the proxy variables which can denote the composite effect of development and FP. Two kinds of generating methods were used. One is the simple addition of a development variable and a FP variable (for example, GNP + RPE). The other is multiplication of the two kinds of variables (for example, GNP x RPE). Then I again graphed those variables with CBR. The results are shown in figure 12. All of the graphs in it show relationships more like that in figure 7 which gives some evidence to the usefulness of the supply-demand framework for the analysis of fertility transition.

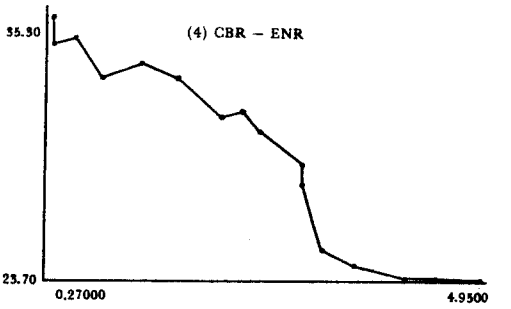
5. Conclusion and Policy Implication

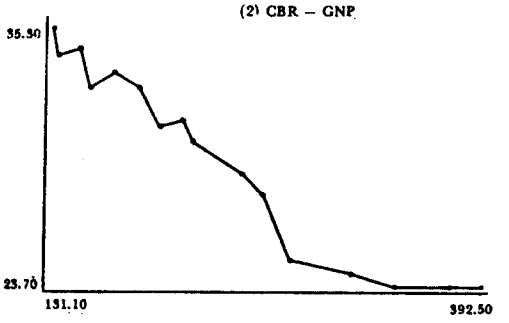
The economic framework of non-linear demand and supply schedules for children shows that the development without FP has its restrictiveness on decreasing fertility for two reasons. One is that development can effect an increase in fertility in the short-run. The other is that, when the inelastic supply curve of children remains in the region of high fertility, the shift of demand curve by development is limited its ability to reduce fertility. On the other hand, FP moves the supply curve, in the short-run, and the demand curve, in the long-run, to a lower level of fertility.

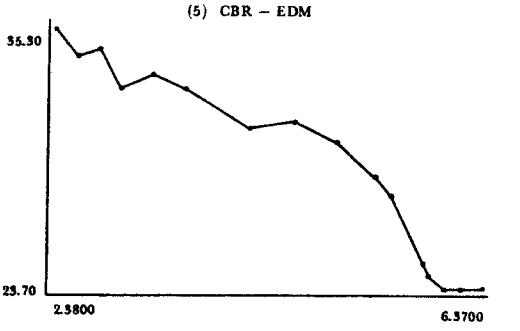
Declining in fertility can be accelerated by both development and FP. However, the effect of both decreases as fertility goes to the minimum level of demand for children. Empirical findings in Korea convince me of this trend of fertility change by development and FP.

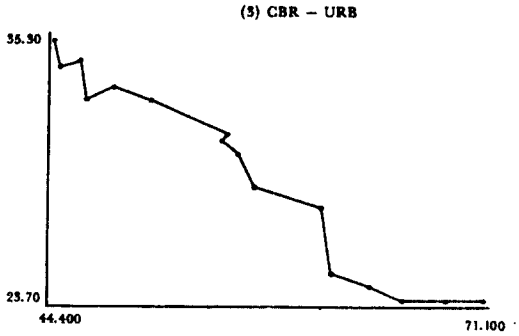
Figure (11)


(1) CBR–Year
35.30
25.70
1964
1970


(4) CBR – ENR
35.30
25.70
0.27000
4.9500


(2) CBR – GNP
35.30
25.70
131.10
392.50


(5) CBR – EDM
35.30
25.70
2.3800
6.3700


(3) CBR – URB
35.30
25.70
44.400
71.100

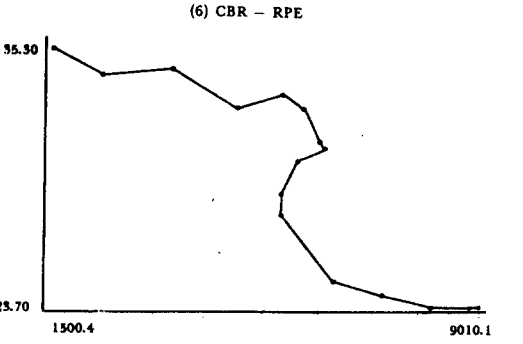
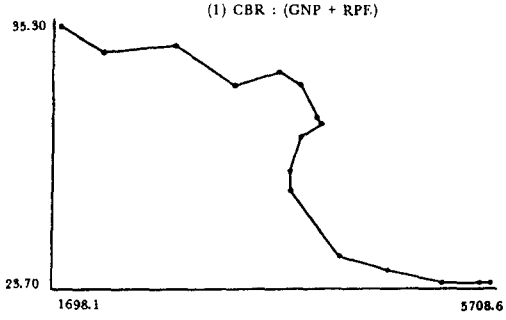
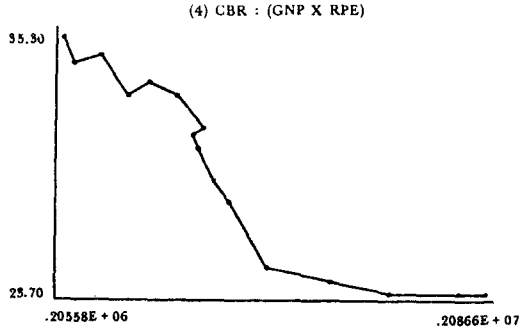

(6) CBR – RPE
35.30
25.70
1500.4
9010.1

Figure (12)

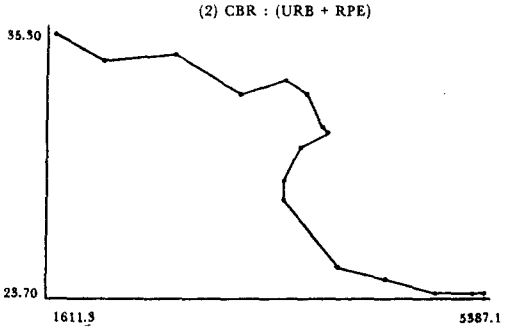
(1) CBR : (GNP + RPE)



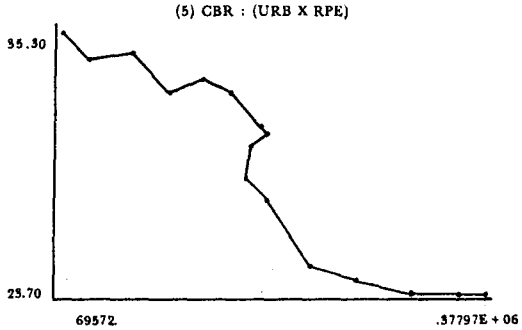
(4) CBR : (GNP X RPE)



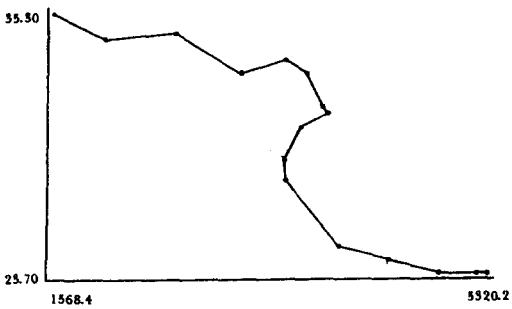
(2) CBR : (URB + RPE)



(5) CBR : (URB X RPE)



(3) CBR : (ENR + RPE)



(6) CBR : (ENR X RPE)

In conclusion, the economic analysis of fertility which is formulated in this paper is very useful to explain the change in fertility with development and FP. The basis of the framework is the non-linearity of demand and supply schedules for children with lower and upper limits. The general pattern of the fertility change by continuous development, of FP, or both of them takes the shape of a negative inverse-tangent-curve like figure 7.

The policy implication from this analysis is that, for a continuous declining the level of fertility, more and more effort should be added to the family planning program as the level of fertility approaches to the minimum or replacement level.

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