Externalities, Risk Aversion and the Family Size

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The purpose of this article is, first, to argue that the fertility cannot be reduced rapidly through widespread diffusion of contraceptive practices which has been the main drive of the national policy in population control, because there involves the inescapable externalities in procreation, second, family sizes tend to be larger because of the financial externalities arising from government subsidies to families with children, and finally, the decreasing relative risk aversion of households with wealth may induce the poor to have large family sizes.

Throughout the discussion we make two assumptions: first, parents' individual preferences regarding their family size are to be decisive; second, their completed family size is in accordance with their plan. Of course, these two assumptions are interrelated. A recent survey shows that our assumptions are partially confirmed.[1)]

The postwar Japanese experiences seem to suggest that the effects of diffusion of contraceptives in fertility reduction has been small relative to the economic forces.[2)]

> ……The conclusion that emerges from this study, however, is that the economic forces identified by the new economic theory of household decision making have been operating to produce a considerable part of the

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1) Chi Hoon Choi, et al., *A National Survey of Family Planning Information, Education, and Communication*, PPFK, 1975, pp. 21—2.

2) M. Hashimoto, "Economics of Postwar Fertility in Japan: Differentials and Trends," *Journal of Political Economy*, Vol. 82, No. 2(Mar./Apr., 1974), pp. 170—94.

observed differentials and trends in Japanese fertility. Indeed, increased use of abortion and contraceptive devices appears to have been induced to some extent by economic forces…… Cross-section analyses of 1960 data reveal that the economic theory of fertility, with its emphasis on the effects of female education and earning power on fertility demand, provides a useful framework for analyzing fertility differentials in Japan. In particular, regression of completed fertility and live birth rates in 1960 shows that female education and earnings affect fertility and are the most significant variables in the regression……

The phenomenal growth of the Japanese economy during the postwar years has been widely noted: between 1950 and 1969 real gross national product grew at an average annually compounded rate of close to 10 percent. Coupled with this education and employment opportunities for women grew also; the proportion of women in nonagricultural employment increased from 29 percent in 1950 to 35 percent in 1960 and to 37 percent in 1970. Against this background of rapid economic development, Japanese fertility dropped sharply. The crude birth rate, which had been about 35 in the late 1940s, first dipped below 30 in 1950; 5 years later it fell below 20 and stayed there since. Fetility decline began in Japan about 1920, but the rate of decline accelerated in 1950s. By the early 1960s the persistent decline appears to have ended, and then leveling off began, even if female education and employment opportunities grew rapidly.

The Korean case seems to provide similar experiences. Between 1960 and 1974 real gross national product grew at an average annually compounded rate of 9.1 percent. It is beyond doubt that education and employment opportunities for women must have grown also with the rapid dissemination of information on contraceptives. Consequently, Korean fertility had fallen steadily from 1960 to 1974 with some noticable slow-down since 1973: the crude birth rate was 42 in 1960, dropped to 37 after 5 years, reached 30 in the beginning of 1970s, and then leveled off around 25 since 1972.

Table 1 shows the relevant vital statistics for both Korea and Japan. The leveling off of the crude birth rate in both countries, since 1965 in Japan and since 1972 in Korea seems to suggest that both countries approaches to a kind of lower limit of fertility. Particularly, it is unfortunate for Korea to have the limit at a level much higher than Japan's. This fact must have something to do with the structure of children preference function which we would like to investigate in this paper.

Table 1. Crude Birth Rate, Crude Death Rate, Crude Natural Rate of Increase in Korea and Japan

Year	CBR		CDR		CNRI	
	Korea	Japan	Korea	Japan	Korea	Japan
1950	—	25.4	—	10.0	—	15.4
55	—	19.4	—	7.8	—	1.6
1960	42.0	17.2	13.0	7.6	29.0	9.6
61	42.0	16.9	13.0	7.4	29.0	9.5
62	41.0	17.1	13.0	7.5	28.0	9.6
63	40.0	17.3	12.0	7.0	28.0	10.3
64	39.0	17.7	11.0	6.9	28.0	10.8
65	37.0	18.6	10.0	7.2	27.0	11.4
66	35.0	18.7	10.0	6.8	25.0	11.9
67	33.0	19.4	9.1	6.8	24.0	12.6
68	31.9	18.7	8.9	6.8	23.0	11.9
69	30.6	18.6	8.6	6.8	22.0	11.8
1970	31.3	18.8	9.4	6.9	21.8	11.9
71	29.4	19.3	7.6	6.6	21.8	12.7
72	25.5	19.4	6.8	6.5	18.7	12.9
73	25.3	19.4	7.9	6.6	17.4	12.8
74	24.6	18.6	7.2	6.5	17.4	12.1

Source: Statistical Yearbook, 1975.

The Individual Equilibrium Family Size

We have been persuaded by Becker to look at children as consumer durables whose flow of services we consume over a long period.[1] This view

1) Gary S. Becker, "An Economic Analysis of Fertility," *Demographic and Economic Change in Developed Countries*, Princeton, 1960.

which rests upon the assumption of independence of utilities between parents and children, however, was challenged by Blandy.[1] He argues that benevolent involvement exists between parents and children and, therefore, the very notion of the cost of a children becomes problematical, because the children represent a social and biological extension of the parents' own personalities in time and space. Blandy thus introduces a complete interdependence of utilities between parents and their children and, consequently, parents face two problems with respect to their family as follows:

> ……First, how to allocate their resources between various parts of this extended personality, i.e., between themselves and that extension of themselves which they recognize in their children (and possibly in other person as well). Second, what degree of biological extension of this personality is optimal (how many family members are wanted) given that additional extensions (family members) reduce the income shares each of the preceding members can enjoy……

Though Blandy's argument can be justifiable there does not seem to exist any basic discrepancy between him and Becker. The whole range of problem he raises in economics of children can be analyzed by the notion of children as consumer durables. Consumer durables are not purchased to be used up themselves but for the flow of services they provide. To obtain this flow of services households have first to invest in durable goods usually with lump-sum funds. Thus consumption of flow of services children provide compete for income with all other uses. Parents in having children actually enter into a long-term debt contract to pay continually for the flow of services they are supposed to provide. There is no basic difference between purchasing durables on consumer credit and having children except one aspect: an interpersonal transfer of title to consumption of flow of services

1) Richard Blandy, "The Welfare Analysis of Fertility Reduction," *The Economic Journal*, Mar., 1974, pp. 109—29.

from children is severely limited. As the quality of consumer durables rises with householods' income, so does the quality of children as argued by Becker:

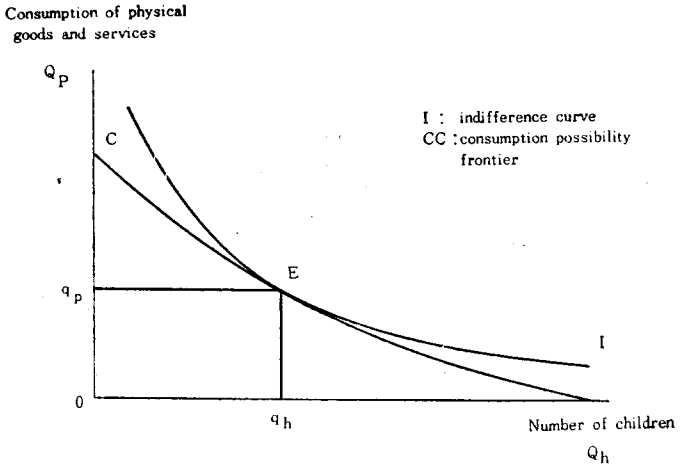
> ……the price of children to rich parents is the same as that to poor parents even though rich parents spend more on children. The rich simply choose higher quality children as well as higher qualities of other goods……

Since there does not seem to exist objective measure of flow of services from children, we measure it by the number of children assuming that flow of services is proportional to the number of children. Thus the unit of measurement becomes a child-unit-of-time such as child-year or child-hour. As was pointed out already two same values of child-hour do not necessarily provide the same value of flow of services because of heterogeneous qualites of children. We assume, however, that homogeneous qualities for children of the same parents.

Suppose that parents estimate their permanent income over their life-cycle and try to allocate it between consumption of physical goods and consumption of flow of services from children, i.e., between physical goods and children so as to maximize their utility over life-cycle. In this allocation decision they, of course, take expected change in their income into consideration. Therfore, expected changes in income will not affect their allocation decision made at the time of parenthood. Fig. 1 shows a consumer equilibrium. The consumption possibility frontier is concave to the origin because the expense and cost of children in a family of given income class are assumed to fall with family size i.e., there are considerable economies of scale in family size whice seems to be uncontestable fertility phenomena. If this conjecture is valid its immediate implication is that fertility is likely to be higher in societies with extended family systems than nuclear families. Hence, the nuclearization of families might have contributed to the fertility reduction by raising the cost of children.

If family income rises with the family size fertility is likely to be greater.

Fig. 1. Choice of Optimal Family Size



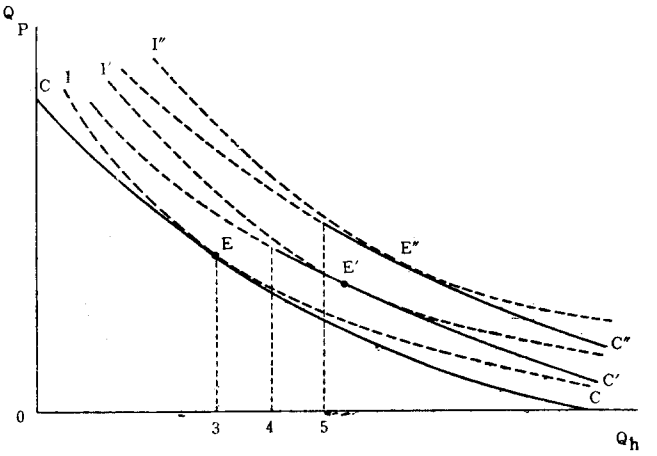
The government's income supplements, tax abatements and free or subsidized government provision of services for families with children warrant special attention not only because they reduce the cost and expense of children, and thus tend to incresase family sizes, but also because they give rise to financial externalities associated with the choice of family sizes. If preceding family members, i.e., elder children are expected to augment family income, this reduces further the cost and expense of children, and thereby increases the family size. Fig. 2 shows a graphical illustration of financial externalities and internal economies.

Suppose that the conumption equilibrium would be at point E without government transfers. If various government transfers supplement the income of families with additional child, parents can anticipate their consumption possibility frontier shifts upward with increasing number of children: the fourth will shift the consumption possibility frontier cc to $c'c'$, the fifth will shift $c'c'$ to $c''c''$ and so on.

As the consumption possibility shifts upward due to government transfers and additional income earned by preceding children, the optimal size of family also increases. If the poor choose low quality children, then schooling of their children tends to terminate earlier than the riches'. Thus, poor

parents may count the early augmentation of family income by their children in making decision on the family size, which is very likely to be greater. The flow of returns from children, therefore, consist not only of the flow of services which is consumed immediately, but also of the future income stream for the poor (as well as for the rich). This aspect of pure investment of having children will be discussed in Section III.

Fig. 2. Effects of Financial Externalities on the Choice of Optimal Family Size



If family income rises with family size, the optimal family size is likely to be greater for all income classes. This fact should not be interpreted that higher income classes tend to have larger family sizes. Like all other consumption decisions the permanent consumption of flow of services from children may be determined by permanent income of parents; hence higher income classes are likely to consume a greater amount of flow of services from children. However, this does not necessarily lead to greater family sizes for the rich; they choose high quality children compatible with their social class which cost them more. Thus there is no a priori ground to assume that the rich take larger family sizes than the poor do. On the contrary, there seem to exist some evidences that the former have smaller completed family sizes than the latter: the ideal number of chldren desired

by mothers with college education was shown to be much smaller than that of mothers with less education.[1] Since women's education level is highly associated with income level and soical interaction is not random, we may interprete mothers' education level as a proxy for the income class.

Consumption Interaction and Externalities

Apart from financial externalities due to various government transfers which tend to increase family size there seem to exist strong consumption interaction of flow of services from children between families. Thus the utility level of one family depends upon the consumption of others, i.e., utilies are interdependent. The immediate implication of this phenomenon is that the desired number of children, and hence the completed size of family, are affected by family sizes of others in the social class which they belong to, and affect others' choices in turn. Though there is no a priori ground to assume that the interaction generates external diseconomies, it is, however, our conjecture that it may beget considerable external diseconomies. The often observed behavior that parents with smaller number of sons or no son are envious of others with greater number of sons may be taken as an example which derives from consumption interaction. If there are external diseconomies in consumption of flow of services from children, it can be easily shown that competitive results in an increase of family sizes of all families.

Assume that there are only two families with the utility functions in the economy of two goods, physical goods and flow of services from children

$$U^1=U^1(q_{1p}, q_{1h}, q_{2h}) \tag{1}$$

$$U^2=U^2(q_{2p}, q_{2h}, q_{1h}) \tag{2}$$

where

$$q_{1p}+q_{2p}=\bar{q}_p \tag{3}$$

1) Chi Hoon Choi, et al., *op. cit.*, p. 21.

$$p_p(q_{1p}+q_{2p})+p_h(p_{1h}+q_{2h})=\bar{y} \tag{4}$$

U^i: utility of the ith family

q_{ip}: consumption of physical goods of the ith family

q_{ih}: consumption of flow of services from children of the ith family

p_p: price of physical goods

p_h: price of flow of services from children

$\bar{y}$: national income

$\bar{q}_p$: total amount of physical goods produced in one period

In order to obtain Pareto optimality conditions we maximize the utility of family 1 subject to the constraint that the utility of family 2 is at the predetermined level, $U^2=\overline{U^2}$. Thus we form the Lagrangean as follows:

$$L=U^1\left(q_{1p},\ q_{1h},\ \bar{y}-\frac{p_p}{p_h}\bar{q}_p-q_{1h}\right)$$
$$-\lambda\left[\overline{U^2}-U^2\left(\bar{q}_p-q_{1p},\ \bar{y}-\frac{p_p}{p_h}\bar{q}_p-q_{1h},\ q_{1h}\right)\right]$$

From the first order condition for the relative extremum of equation (5), we get the necessary condition for Pareto optimality

$$\frac{\dfrac{\partial U^1}{\partial q_{1h}}-\dfrac{\partial U^1}{\partial q_{2h}}}{\dfrac{\partial U^1}{\partial q_{1p}}}=\frac{\dfrac{\partial U^2}{\partial q_{2h}}-\dfrac{\partial U^2}{\partial q_{1h}}}{\dfrac{\partial U^2}{\partial q_{2p}}} \tag{5}$$

Suppose that there prevail external diseconomies which imply that

$$\frac{\partial U^1}{\partial q_{2h}}<0,\ \frac{\partial U^2}{\partial q_{1h}}<0 \tag{6}$$

If we compare condition (5) with Pareto optimality condition in the absence of externalities

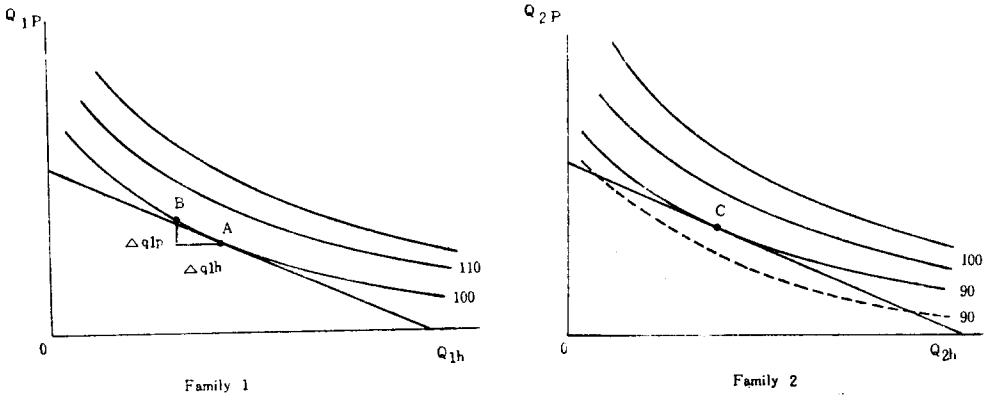
$$\frac{\dfrac{\partial U^1}{\partial q_{1h}}}{\dfrac{\partial U^1}{\partial q_{1p}}}=\frac{\dfrac{\partial U^2}{\partial q_{2h}}}{\dfrac{\partial U^2}{\partial q_{2p}}} \tag{7}$$

it is clear that the competitive market cannot ensure Pareto optimality in the presence of external diseconomies. In a competitive market the marginal rate of substitution of physical goods for flow of services from children or

shortly for children denoted by condition (7) is equated to the relative price p_h/p_p as a result of individual utility maximization. Therefore, the marginal rate of substitution of physical goods for children attained in the competitive market is lower than the marginal rate of substitution which is required to attain Pareto optimality in the presence of external diseconomies. This implies that families consume flow of services from children more than what is socially optimal in the presence of external diseconomies, i.e., family sizes are likely to be greater than what is socially optimal. Graphical illustration of this point is quite simple.

In Fig. 3 market determined consumer equilibrium points are A for family 1 and C for family 2. Suppose that consumer equilibrium for family 1 is altered by some authority in such a way that its utility remains unchanged. The movement of family 1 from A to B increases the utility of family 2. Thus the family sizes determined individually in the presence of external diseconomies are not Pareto optimal. If some authority intervenes in the competitive market and makes consumption of flow of services from children relatively more expensive than consumption of physical goods, and thereby discourages the former, the welfare of all members of the society increases.

Fig. 3. Consumption Interaction between Families



The immediate policy implication of this result is quite clear: remove all kinds of government transfers which give rise to financial externalities and tax those families with addtional child progressively. Government transfers to families with children are sometimes defended from the view point of redistributional effects. However, as it is now clear, this is not a good way to supplement their income. There are numerous ways to achieve this purpose. One way, for example, is to revoke all subsidy programs for general education and transfer the budget to provision of subsidized housing for the poor. A more drastic and powerful action is certainly enactment of restriction on the number of children per family.

An empirical test of the existence of external diseconomies in consumption of flow of services from children may not be easy. However, we may derive a testable hypothesis: if the community is more compactly interwoven the degree of consumption interaction will be stronger. Since we can assume that farm villages are communities with members more closely interrelated with each other than large cities, we should expect that the average ideal number of childen desired by farm families is larger than that of city dwellers. Table 2 shows living and ideal number of children by residence. From the χ^2 one-sample test we can reject the null hypothesis there is no difference in the expected number of living children from each of the residence. There is, however, one qualification in interpreting the result: the sample data are not standardized with respect to family income. The apparent differences in the observed average number of living children may be partly due to differentials in family income from each residence. Though we have to take this into consideration, the result seems to suggest potential interaction in having children and this may be able to explain the observed large differentials in the number of living children between cities and rural areas. The resulting increase in family sizes due to this external disconomies cannot be removed by economic forces; it can be reduced only through nonmarket intervention by the society as a whole. An outright limitation in

the number of children per family may be the final soultion for this problem.

Table 2. Living and Ideal Number of Childen by Residence

Residence	Number of Living Children	Ideal Number of Children
Large cities	2.5	2.6
Small cities	2.9	2.9
Town	3.5	3.4
Rural areas	3.5	3.0
National average	3.1	3.0

Source: Chi Hoon Choi, et al., *op. cit*

$\chi^2=137.7>\chi^2_{.99}=16.27 \quad d.f.=3$

Risk Aversion, Social Security and Demand for Children

The aspect of pure investment of having children still prevails in developing countries. Parents have children as investment goods which are expected to yield postive monetary returns to augment family income in near future. Furthermore, the income stream is expected to be very stable and certain in comparison with other investment in physical assets, though the private rate of return on investment in human capital is unlikely to be higher than on investment in physical assets except for poor parents whose children are supposed to take jobs after free education.[1] The private rate of return on having children for the poor may be very high because of the free education and other government transfers; therefore, having children is very attractive investment for the poor. The attractiveness of having children for the poor is likely to be enhanced by the imperfect social security systems: there is no better retirement fund than their grown-up children, particularly the sons.

The distinct feature of having children, however, is its safety as earning assets ensuring protection for the old age after retirement rather than its high rate of return. Hence the risk-averting parents might take children

1) Chang Young Jeong, *Rates of Return on Investment in Education: The Case of Korea*, Korea Development Institute Research Paper, Sept., 1974.

rather than other earning assets which are expected to yield higher rate of return. Thus, the decision to have children for families does not differ much from the decision to select optimal portfolios which are expected to maximize their expected utilities, a choice between expected return and risk. If risk aversion decreases with wealth, the rich will select relatively more of risky but high yielding assets, while the poor will select less of them. This point can be better analyzed by some theoretical model.

Suppose that there exist only two assets, risky but high yielding one and safe but low yielding one. Assume that return on the risky asset is subjectively viewed as generated by a continuous Wiener process. Then in paralell with Ross, Friend and Blume[1] we have

$$W_i(t+\Delta t) = W_i(t)[1+\{(1-\alpha_i)r_e+\alpha_i E(r_p)\}\Delta t+\alpha_i\sigma_p z(t)\sqrt{\Delta t}] \quad (8)$$

where $W_i(t+\Delta t)$: wealth of the ith family at time period $t+\Delta t$

α_i: the proportion of wealth of the ith family placed in the risky asset

r_e: the return on risk-free asset

r_p: the return on risky asset

σ_p: the standard deviation of the return on the risky asset

$z(t)$: unit normal random variable

By expanding $U(W_i(t+\Delta t))$ about $W_i(t)$ by Taylor series and taking expected values disregarding terms with high power of Δt we get

$$E[U(W_i(t+\Delta t))] = (W_i(t)) + U'(W_i(t))W_i(t)[(1-\alpha_j)r_e+E(r_p)]\Delta t + 1/2\,U''(W_i(t))W_j^2(t)\alpha_i^2\sigma_p^2\Delta t \quad (9)$$

By differentiating Equation (9) with respect to α_i we obtain

$$U'(W_i(t))E(r_p-r_e)+U''(W_i(t))W_i^2(t)\alpha_i^2\sigma_p^2=0 \quad \cdots\cdots(10)$$

By rearranging terms we have

$$\alpha_i=\frac{E(r_p-r_e)}{\sigma_p^2}\cdot\frac{1}{R} \quad \cdots\cdots(11)$$

where $R=-W_i(t)U''(W_i(t))/U'(W_i(t))$ is the Arrow-Pratt coefficient of

1) Stephen A. Ross, "Uncertainty and the Heterogeneous Capital Good Model," *Review of Economic Studies*, Mar., Irwin Friend and M.E. Blume, "The Demand for Risky Assets," *The American Economic Review*, Dec., 1975, pp. 900—22.

relative risk aversion.[1] If the relative risk aversion decreases with wealth, we should expect that α_i increases with wealth since $E(r_p-r_c)>0$ and $\sigma_p^2>0$. Since there does not exist cross-sectional wealth statistics published, we estimate households' wealth position from cross-sectional budget studies by capitalizing labor income by 10 percent per year and property income by 15 percent per year. Table 3 shows α_i and marginal α_i for salary and wage earners' households in cities in 1975. Since the monthly income can be thought of measuring permanent income of the income class by averaging out the transitory part, it can be treated as showing the relative wealth position of households. The proportion of nonhuman wealth of total wealth clearly rises with wealth, while there seems to be no clear trend in the marginal ratio between investment in human capital and investment in physical wealth as wealth rises. These observations may support the hypothesis that the relative risk aversion of households decreases with wealth. The immediate implication of this is that the poor are likely to have large family sizes.

Interrelated with the above observation is the old age dependency of parents on their sons. Of all parents living in rural areas 51.2 percent expect that their old age will be provided by their children, while only 22.4 percent of all parents living in large cities expect dependency of their old age upon

Table 3. Ratio between Nonhuman Wealth and Total Wealth of Salary and Wage Earners Households in Cities by Income Class

	Monthly Average Income (thousand Won)									
Income	20—30	30—40	40—50	50—60	60—70	70—80	80—90	90—100	100—110	110& over
α_i	0.200	0.154	0.124	0.128	0.139	0.142	0.214	0.245	0.184	0.430
$\frac{\Delta W_i}{\Delta W}$	0.54	0.56	0.43	0.58	0.53	0.63	0.66	0.67	0.62	0.61

W_h: human wealth
W: total wealth
Source: Bureau of Statistics, Economic Planning Board, 1975

1) John W. Pratt, "Risk Aversion in the Small and in the Large," *Econometrica*, Jan.-Apr., 1964, pp. 122—29.

their sons.[2] On the other, only 0.2 percent consider dependency on daughters! It has been well-known fact that parents are forced to increase their family sizes to get sons. Therefore, to curb population increase in well-designed social security programs should be provided for the retired who are dominated by hedging behavior.

Conclusion

The downward-sticky fertility in Korea in spite of rapid dissemination of contraceptives and increase in real income may arise due to consumption interaction of flow of services from children and the decreasing relative risk aversion with wealth of households as well as the financial externalities generated by various government's support to families with children. The policy implications derived from these conclusions are clear: first, remove various government's support programs to families with children which tends to make having children cheaper, and thereby encourages parents to have larger families; second, the budget thus released from family-supporting programs should be used in providing subsidized housing, health services and social security programs including retirement pension; third, the society must intervene in individual decisions on the choice of family size.

If government transfers to families with children cannot be removed because of income redistributional puprpose these programs must be enhanced by well-designed incentive systems which discourage forming large family sizes by discriminating against those in every subsidy programs. The individual income tax system, for example, may be designed to allow greater personal exemptions for families with one child, less for families with two children, still less for families with three children and so on. The decreasing schedules for personal exemptions and for government subsidies to families with the number of children may be workable scheme.

2) Chi Hoon Choi, et al., *op. cit.*, p. 29.

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