Maternal Education and Allocation of Time and Children's Health in South Korea

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Abstract

This paper attempts to identify the mechanisms through which maternal education affects child health through her time allocation. Estimating a LISREL system of production functions for child health with the 1994 Korean household survey data, it is shown that a mother's education promotes her child's health by allocating a greater amount of time for leisure.

I. Introduction

The past theoretical and empirical works on the household production have emphasized two distinctive aspects. On the one hand, the time-allocation behaviour or pattern of household and subjects related to it have been studied by Becker (1965), Gronau (1972, 1977), Wales and Woodland (1977), Kooreman and Kapteyn (1987), Juster and Stafford (1991) and Malathy (1994). On the other hand, the household production of commodities, especially health, using consumer goods and services as inputs and its implications, have been investigated by Grossman (1976, 2003), Inman (1976), Rosenzweig and Schultz (1981, 1982a, 1982b, 1983), and Behrman and Wolfe (1987). These studies, in particular, have paid special attention to the time-allocation patterns or roles of women in the household.

Relatively little, however, is known about how a mother allocates her time for improving child health within the household. The mother's time is assumed to be an essential input for the production of child's health. Therefore, ignoring the time-allocation behaviour of mother can seriously distort her productive role in child health in a household setting. The productivity of the mother's time input is estimated by the mother's educational achievement, which affects how her household production technology influences child health. The efficiency of converting the chosen inputs into output is measured by the resulting child's health status. The productivity of inputs for the produc-

tion of child's health, including the mother's time allocated for the child's health, is determined by the household's own health production technology used by the mother (Leibowitz 1974; Becker 1981). The mother's health behaviour is, in turn, shown to be determined or influenced by the quality of human capital (education) the mother has acquired (Kenkel 1991). The connection between the mother's schooling and her health behaviour may be expressed as an example of a high quality of human capital improving consumption efficiency by adopting an efficient consumption technology (Lancaster 1966).[1] Since the unobserved components of the household may have multiple aspects, empirical studies usually employed latent variable approaches to incorporate these imperfectly observed variables that are related to health such as nutrition, healthcare, home environment, and hereditary traits (Behrman and Wolfe 1987).

This study proposes an integrated study of the allocation of time within the analytical framework of the household production of health using Korea's survey data. To gain much better insights regarding the role of mother's schooling in health, time allocation and health-related inputs, we specify and estimate latent variable models. The objective of this study is to identify the mechanisms through which a mother's education affects a child's health by allocating her time between leisure, work and household chores. In order to see how the allocation of a mother's time affects the inputs and outputs of a household production function for her child's health, we set up the following two structural models. First, the time allocation is assumed to have no impact on child health in the 'basic' model. Second, the mother's allocation of time is added to the basic model in our extended model. The empirical analysis is conducted with the 1994 Korean household data collected through a questionnaire form supplemented by an anthropological mode of intensive follow-up interviews (Scrimshaw 1992; Chambers 1992).

Although the main body of past empirical studies of the household health production had been conducted with the published data of the U.S., recently an increasing number of studies have emerged in developing countries and Japan (Yamada et al. 1998). These include studies based on the data from India (Rosenzweig and Schultz 1982a; Malathy 1994), Botswana (Mueller 1984), Nicaragua (Behrman and Wolfe 1987), Brazil (Psacharopoulos and Arriagada 1989), Philippines (Strauss 1990), Côte d'Ivoire (Senauer and Garcia 1991), Nepal (Pokhrel and Sauerborn 2004), Pakistan (Iram and Butt 2004) and Russia (Fedorov and Sahn 2005). As far as this subject is concerned, no empirical studies are conducted in middle-income countries, including South Korea.

The remainder of this article is organized as follows: Section II outlines an analytical framework that shows how mother's educational attainment affects her time-allocation decisions and heath-related inputs and then how these allocation decisions affect child health. This framework is used to derive an econometric model of child health production in South Korea. Section III presents the survey data and estimation formulation to test the model. The results of the empirical analyses are reported in Section IV. The final section provides the summary and conclusions of the study.

II. Analytical Framework

A one-period household production of utility model is constructed on the basis of "revised approach to consumer choices" (Becker 1971). In that model, a household is assumed to choose the amount of health and other commodities as inputs for utility production in such a way to maximize its utility. The household utility function may be presented as follows:

$$U = u(H_c, Z) \tag{1}$$

where H_c is child's health and Z is a vector of other (than health) commodities produced by the household. u represents a strictly convex and twice differentiable utility function. Each household's

1 Since Lancaster's consumption technology may be regarded as the household production technology, it is hypothesized that the mother's schooling improves the child's health by enhancing the household's own health production technology (Haveman and Wolfe 1984). Thus, the advancement of such technology, like any other technological progress, improves the efficiency in the production of child's health.

health and other commodities are produced subject to the household's budget and time constraints, using each household's own technology for the production of health and other commodities. The household's budget and time constraints are determined by the full income available from the household members' disposable income and wealth. The household's budget, therefore, may be seen as determined by the allocation of the total time between market and nonmarket activities given its marginal productivity. In this model, housework is included in the work in the market place. In this way, work and leisure are divided according to the traditional dichotomy of how time is allocated.

In other words, the allocation of time among work, housework and leisure under the assumption of utility maximization behaviour determines the budget and time constraints simultaneously (Kooreman and Kapteyn 1987). The budget for the household production of health is determined by the proportion of total budget allocated for non-health commodities, i.e., Z. The time constraint for the household production of health is, then, determined by the mother's and the father's time allocated for market activities. The maximum time available for the household production of health is the total time for all nonmarket activities. Under a severely restricting assumption, all the inputs for the production of child's health (commodity) are classified into three components: child's nutrition (N), healthcare (C) and home environment (E). The budget and time constraints may be shown as follows:

$$P_N N + P_C C + P_E E + P_Z Z \leq w_M T_{MW} + w_F T_{FW} + I_N \equiv I \tag{2}$$

$$\begin{aligned} T_{MW} + (T_{MH} + T_{ML}) &= 24 \\ T_{FW} + (T_{FH} + T_{FL}) &= 24 \end{aligned} \tag{3}$$

where P's are the respective prices for nutrition, health care and home environment; I_N is non-labour income and I is the total household income. w_M, w_F and T_{MW}, T_{FW} are mother's and father's wage rate and total time spent for work in the market, respectively. T_{MH} and T_{FH} is mother's and father's time allocated for housework activities, and T_{ML} and T_{FL} represent mother's and father's time allocated for leisure, respectively.

Given the above budget and time constraint for the household production of child's health, its function is formulated on the premise that the production of child's health is a commodity of which the inputs include nutrition, healthcare, home environment, allocation of the mother's time for the child's health and pre-determined factors such as hereditary traits, mother's schooling and her age, and household income. Nutrition, healthcare and home environment are widely acknowledged as the vital inputs for the household production of child's health (Rosenzweig and Schultz 1981, 1982a, 1982b, 1983; Behrman and Wolfe 1987). In order to take account of the effects of exogenous variables on the child's health status, the child's hereditary traits or the health heterogeneity of the child at birth (Behrman and Wolfe 1987) are inserted into our child's health (status) estimation model. Mother's schooling and her age are included because it is widely recognized that these variables influence the efficiency in producing child's health. The quadratic in age is also included because, as mother's age advances, the positive influence of her life experience is assumed to face a diminishing return due to physical deterioration. The household production function of child's health can be expressed as follows:

$$H_C = f(N, C, E, T, G, S_M, A_M, A_M^2, I) \tag{4}$$

where T, G, S_M, A_M and I are (allocation of) the mother's time, hereditary traits, mother's schooling, mother's age and household income, respectively. The allocative efficiency is obtained by choosing the optimum combination of health inputs under the condition of maximization of (1) subject to (2), (3) and (4). The production efficiency is obtained by choosing the household's own health production technology f, which maximizes the productivity of health inputs.

III. Empirical Analyses

3.1. Data and Variables

The data are collected using a method that combines a questionnaire survey and anthropological-style intensive interviews during March to August 1994. The sampling method used may be described as a modified random method stratified by the area of residence of interviewees: an urban upper-middle and high-income area, an urban low-income area and a rural (low-middle and low income) area. We include in this study the households of 450 mothers who have children aged five years or less. The data were originally collected with a questionnaire designed for a multi-disciplinary study (Scrimshaw 1992; Chambers 1992). Therefore, they contain qualitative responses to numerous behavioural questions as well as quantitative ones.

Table 1 shows the means, standard deviations and measurements for the variables that we select for our analyses. The definitions of the variables used are as follows.

Child health is represented by child's health status, the number of episodes of child's illness and child's annual average growth rate. Child health status is measured by the mother or the interviewer's subjective assessment of child health status.[2] To indicate a degree of health status, a seven-point rating scale is used, that is, 1 = very poor, 4 = average and 7 = excellent. The number of episodes of illness during the previous year is also used as an indicator of health status. The annual average growth rate is measured by dividing current weight minus weight at birth by age.

Table 1. Means and Standard Deviations for Variables Used In Analysis

Variables	Means (Standard Deviations)	Measurements/Indices
Child Health		
Child health status	5.29 (1.56)	7-point rating scale
Number of episodes of illness	3.61 (2.18)	number during last year
Annual average weight	3.65 (2.27)	Kg
Allocation of Mother's Time		
Work	5.64 (4.44)	hours per day
Leisure	4.08 (3.31)	hours per day
Nutrition		
Diet pattern	3.60 (1.32)	7-point rating scale
Baby feeding	4.34 (2.42)	7-point rating scale
Lactation period	6.30 (3.21)	months
Health Care (Health belief and behaviour)		
Mother's knowledge about her child health	4.88 (1.26)	7-point rating scale
Efficacy for Western type of medicine	5.15 (1.38)	7-point rating scale
Number of immunization injections	-0.06 (1.25)	per year
Home Environment		
Family happiness level	5.12 (1.49)	7-point rating scale
Noise level	4.37 (1.91)	7-point rating scale
Sanitary condition	4.95 (1.61)	7-point rating scale
Hereditary Traits		
Mother's health status	4.87 (1.64)	7-point rating scale
Father's health status	5.18 (1.68)	7-point rating scale
Grandmother's health status	4.52 (2.00)	7-point rating scale
Grandfather's health status	4.83 (1.95)	7-point rating scale
Grandmother-in-law's health status	4.19 (1.97)	7-point rating scale
Grandfather-in-law's health status	4.70 (2.03)	7-point rating scale
Exogenous Independent Variables		
Mother's schooling	12.08 (3.58)	years of schooling
Mother's age	31.25 (3.59)	years old
Total household income	1020.5 (598.8)	U.S. $ per month

2 If the respondent and interviewer disagree, the difference is solved through reconciliation.

Definitional problems exist for allocation of mother's time.[3] For many mothers, it was difficult to distinguish between leisure and housework activities, particularly for those without a job in marketplace. Playing with a child or children is included in leisure activities.

Nutrition is represented by three indices, including diet pattern and baby feeding measured by the seven-point rating scale, and lactation period measured in the unit of months. The diet pattern refers to main diet measured by 1 = vegetable only, 4 = half vegetable and half meat and 7 = meat only. Baby feeding method is represented by a scale ranging from 1 = baby formula only through 4 = half baby formula and half breast-feeding to 7 = breast-feeding only.

Healthcare is represented by three indicators that reflect the level of mother's knowledge about her child's health, her preference for Western over the Oriental medicine[4] and deviation from the age-standardized number of immunization injections for children. The level of mother's knowledge about her child's health is measured by 1 = nothing, 4 = average and 7 = excellent. The efficacy for Western type of medicine is measured by 1 = very inefficient, 4 = moderate and 7 = very efficient.

Three indicators of home environment are adopted. They are the family's happiness scale, the household noise level and sanitation condition. These indicators are also measured by the seven-point rating scale, that is, 1 = very poor (or generally not happy), 4 = fair and 7 = excellent (or generally very happy).

Six indicators are used to represent hereditary traits. They are the health status of mother, father, grandmother, grandfather, grandmother-in-law and grandfather-in-law as assessed by the respondent and interviewer.[5] All indices on their health status are measured by the seven-point rating scale, that is, 1 = very poor, 4 = average and 7 = very good. To a varying extent, the child's health is acknowledged to have been pre-determined before birth according to many known hereditary traits. Therefore, the measurement problem for the contribution of the mother to her child's health is serious (Inman 1976). In this study, the variables representing the child's hereditary traits are used as control variables for health heterogeneity among child's health status.

As exogenous independent variables, three variables are used. Mother's schooling is measured by the completed years of schooling, with a mean of 12.08 years.[6] Mother's average age was 31.3 years and average household income was $1,020.5 per month at the 1994 exchange rate.

3.2. LISREL Formulation and Estimation

The household production function of child's health may be tested using Joreskog and Sorbom's linear structural relationship (LISREL) model (see the Appendix).[7] The structural equation model is referred to as the form in which each equation of the model has simultaneous relationship with one another. That is, the structural equation (or covariance structural model) means simultaneous equations model, which is used to detect the causal relationship of latent variables through measurement model.

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3 The mother's time is measured over the sampling period.

4 In Korea, mothers determine their choice of care among the three types of medical services, namely, Western, Oriental and Folk medicine. So, Korean mothers have a greater range of selection in choosing health (care) production technologies than do mothers in the Western world.

5 If either one or both grandparents were deceased, the parent's assessment of grandparent's health status is used. If one grandparent is alive or all grandparents are alive but live in a separate household, again the parent's assessment is used.

6 Although mothers' schooling has a tendency with the potential endogeneity with childbearing decisions, mother's education is considered an exogeneous variable because both the cultural context and a number of previous studies (Rosenzweig and Schultz 1981; Behrman and Wolfe 1987 and Thomas et al. 1991) justify our assumption.

7 For more details, see Joreskog and Sorbom (1983) and Arbuckle and Wothke (1999).

IV. Empirical Results

4.1. Basic model

Table 2 shows LISREL estimates of child health production function. Shown in panel A are the estimates for the measurement model of indicator relations and the goodness-of-fit measures (R^2) for each indicator variable. Panel B represents the estimates for the structural model of child's health production function for health-related inputs such as nutrition, healthcare, home environment and hereditary traits with R-squared values.

First, an examination of the indicator relations to the dependent variables shows that there exist significant associations between our observed indicators and the latent variables. Except for annual average growth, all of the coefficient estimates have a priori predicted signs, marking obviously non-zero at the 1% level. Child health is found to be most highly associated with the number of illnesses for the past one year and the level of mother's knowledge about her child's health. Nutrition is somewhat correlated with all three indicators: the feeding pattern, lactation and diet pattern. Healthcare is associated most strongly with the level of mother's knowledge about her child's health, and to a less extent with the number of immunization injections standardized by age and relative efficacy on Western medicine.[8] Home environment is connected most strongly with sanitation but it has a weaker association with noise and happiness level. Hereditary traits are related highly to all six indicators. Thus, most of our indicators seem to represent the latent variables relatively well.

We next examine the child health production function. Panel B shows that most of the significant coefficient estimates have the expected signs. Home environment and hereditary traits have significantly positive effects on child health, though nutrition is negative and healthcare is positive, albeit never significant. Mother's age and household income have significant and positive impacts on child health. Income shows an added indirect effect on child health through home environment. A noteworthy result is that the quadratic form of age variable has a strong negative effect on child health, indicating that older women have less knowledge of modern type of health-related inputs.[9] Mother's age and the quadratic in age, however, do not have any impacts on the inputs of a household production function for her child's health. Hereditary traits of parents and grandparents as control variables have strong positive effects on future generations, child or grandchild. This result provides adequate evidence that human capital measured by health stock is transferred through generations.

In our basic model, a mother's schooling has less significant impact on child health, though it has significant and positive impact on nutrition and healthcare. While only home environment among health-related inputs has a significant impact on child health, we can see that a mother's education does not have any direct or indirect effects on child health. This result runs counter to findings of many other studies (Rosenzweig and Schultz 1982b; Behrman and Wolfe 1987; Wolfe and Behrman 1982; Thomas et al. 1991).

4.2 Extended Model

Table 3 shows the estimates of the extended LISREL model adding a mother's time allocation for work and leisure time to the basic one. When mother's time allocation is included in the health production function (panel B), time for leisure takes the only significantly positive coefficient for home environment. Time allocation by a mother thus appears to be a relatively more important deter-

8 One unique characteristic of the healthcare system in Korea is that Oriental and Folk medicine, besides Western medicine, are still widely used. Korea's pluralistic healthcare system, distinctive from those of Western developed countries, offers opportunities and challenges for Korean mothers in their children's care and the care of their health. So which type of medicine the mother chooses among the three is an important factor affecting the child's health.

9 The Korean data shows that younger mothers tend to have longer years of schooling than older ones.

minant of home environment than other health-related inputs.[10] Like the result in the basic model, home environment and hereditary traits have significant and positive effects on child health.

Table 2. Estimates of Child Health Production Function – Without Considering Mother's Time Allocation

Panel A. Measurement Model of Indicator Relations		
Indicator Variable	**Estimate (t-value)**	**R^2**
Child health		
- subjective assessment	1[a]	0.415
- no. of illness	-1.475(5.82)	0.461
- annual average growth	0.065(1.71)	0.081
Nutrition		
- diet pattern	1[a]	0.143
- feeding pattern	-2.424(6.05)	0.250
- lactation	-3.022(5.88)	0.222
Health care		
- level of mother's knowledge	1[a]	0.155
- efficacy of Western medicine	0.919(3.47)	0.108
- no. of immunization injections	-0.827(3.42)	0.102
Home environment		
- happiness level	1[a]	0.039
- noisy	2.633(3.49)	0.165
- sanitation	4.882(2.76)	0.804
Hereditary traits		
- mother's health status	0.856(6.88)	0.365
- father's health status	0.722(5.31)	0.245
- grand mother's health status	0.721(4.78)	0.173
- grand father's health status	0.830(4.85)	0.237
- grand mother-in-low's health status	1[a]	0.343
- grand father-in-low's health status	0.836(5.24)	0.225

Panel B. Structural model of production functions				
Explanatory Variable	**Child Health**	**Nutrition**	**Health care**	**Home environment**
Nutrition	-0.804(1.36)			
Health care	0.232(0.74)			
Home environment	0.425(1.65)			
Hereditary Traits	0.342(4.26)			
Mother's schooling	0.011(0.24)	0.072(5.42)	0.037(2.47)	0.004(0.79)
Mother's age	0.562(2.88)	0.021(0.24)	0.188(1.53)	0.076(1.49)
Mother's age^2	-0.009(2.87)	0.001(0.14)	-0.003(1.36)	-0.001(1.27)
Household Income	0.006(1.96)	0.004(4.52)	0.003(2.41)	0.001(1.75)
R^2	0.304	0.711	0.324	0.090

$X^2(183)=528.03$, Adjusted goodness-of-fit index(AGFI)=0.715.

[a] Normalized to be one.

Asymptotic t-ratios are shown in parentheses. The critical asymptotic t-ratios are: 1.28 for a one-tailed test and 1.64 for a two-tailed test at the 10% level; 1.64 for a one-tailed test and 1.96 for a two-tailed test at the 5% level; and 2.33 for a one-tailed test and 2.58 for a two-tailed test at the 1% level.

Though a mother's age and quadratic in age have less significant effects on inputs of a household production function, they have strong effects on child health, that is, output of the function. Therefore, mother's age has a positive effect on child health and home environment, as well as an

10 We allow non-zero covariance between the relations for time for work and leisure because of the possibility of a common unobserved factor affecting both of this pair. The covariance and *t*-value between the disturbances from these time variables are –5.929 and 8.50, respectively, suggesting that there is an omitted common unobserved factor.

indirect effect on child health by means of home environment. Also, income has a significant and positive effect on child health, nutrition and leisure time, and has a negative effect on work time. Moreover, home environment has an indirect effect on child health, especially depending on family's leisure time spending.

Table 3. Estimates of Child Health Production Function – Considering Mother's Time Allocation

Panel A. Measurement Model of Indicator Relations

Indicator Variable	Estimate (t-value)	R^2
Child health		
- subjective assessment	1[a]	0.400
- no. of illness	-1.530(5.85)	0.479
- annual average growth	0.070(1.87)	0.101
Nutrition		
- diet pattern	1[a]	0.142
- feeding pattern	-2.372(6.02)	0.239
- lactation	-3.091(5.97)	0.231
Health care		
- level of mother's knowledge	1[a]	0.129
- efficacy of Western medicine	1.135(3.66)	0.137
- no. of immunization injections	-0.906(3.42)	0.102
Home environment		
- happiness level	1[a]	0.057
- noisy	2.382(3.79)	0.197
- sanitation	3.585(3.48)	0.632
Hereditary Traits		
- mother's health status	0.848(6.87)	0.360
- father's health status	0.717(5.31)	0.243
- grand mother's health status	0.726(4.82)	0.176
- grand father's health status	0.832(4.88)	0.240
- grand mother-in-low's health status	1[a]	0.345
- grand father-in-low's health status	0.833(5.26)	0.225

Panel B. Structural Model of Production Functions

Explanatory Variable	Child Health	Nutrition	Health care	Home Environment	Time for work	Time for leisure
Nutrition	-0.772(1.26)					
Health care	0.156(0.44)					
Home environment	0.500(1.92)					
Time for work	0.003(0.09)	-0.019(1.24)	0.000(0.01)	-0.007(0.66)		
Time for leisure	-0.019(0.40)	-0.008(0.36)	0.041(1.48)	0.030(1.84)		
Hereditary Traits	0.332(4.22)					
Mother's schooling	0.016(0.34)	0.067(5.02)	0.024(1.72)	-0.003(0.41)	-0.334(4.78)	0.177(3.05)
Mother's age	0.549(2.87)	0.017(0.19)	0.158(1.41)	0.107(1.67)	-0.257(0.43)	0.210(0.42)
Mother's age^2	-0.008(2.86)	0.001(0.11)	-0.002(1.26)	-0.001(1.45)	0.002(0.26)	-0.002(0.30)
Household Income	0.007(2.21)	0.004(3.86)	0.002(1.37)	0.000(0.17)	-0.033(6.00)	0.027(5.90)
R^2	0.306	0.727	0.379	0.182	0.356	0.320

X^2 (211)=577.77, Adjusted goodness-of-fit index(AGFI)=0.771.

[a] Normalized to be one.

Asymptotic t-ratios are shown in parentheses. The critical asymptotic t-ratios are: 1.28 for a one-tailed test and 1.64 for a two-tailed test at the 10% level; 1.64 for a one-tailed test and 1.96 for a two-tailed test at the 5% level; and 2.33 for a one-tailed test and 2.58 for a two-tailed test at the 1% level.

Our primary concern in this paper focuses on the estimated effects of mother's schooling on child health and the allocation of her time. Expanding the basic model to include the time allocation does add to the explanatory power of mother's educational attainment and child health. A Mother's

educational attainment has a significant and positive impact on nutrition, healthcare and time for leisure and negative on time for work and has an added indirect effect on home environment through time for leisure. That is, more educated mothers are likely to allocate a proportionately greater amount of time for leisure and less time for work than the less educated. Also, the mother's education positively influences the child's health by creating a better home environment conducive to the child's health through allocating a greater amount of time for leisure. Therefore, in the Korean case, a mother's schooling has an indirect effect on child health by means of the mother's time allocation and home environment. Thus, the mother's schooling seems to play an important role in this integrated system that considers time allocation effects in the household production of health.

V. Summary and Conclusion

The euphoria about the contribution of the investment in human capital to economic growth in the 1960s and in the early 70s has somewhat subsided recently (Denison 1985). The quality of human capital, however, has found new sources of contribution to economic (human) welfare. The household production theory has shown that the human capital accumulated through education increases the consumption efficiency, thus increasing the utility gained from a given consumption expenditure (Michael 1973). This theory has also shown that health is an indispensable component of human capital and it has a positive correlation with schooling (Grossman 1976).

This study has provided an insight into another aspect of the role of human capital in the household production of health. We believe that this study's contribution lies in showing that there are synergetic effects of a mother's education and the educated mother's allocation of time on her child's health by using a statistical analysis of the data drawn from Korea, a middle-income country. If the time allocation is excluded, the mother's schooling appears to have strong effects on health-related inputs regarding nutrition and healthcare. But when time allocation is included, a mother's educational attainment shows less impact on these variables, but on the other hand, strong effects on time allocations for work and leisure. That is, more educated Korean mothers have a tendency to allocate a proportionately greater amount of time for leisure and to utilize it for making a better home environment than less educated mothers do.

Women in developing countries spend a substantially higher amount of time on housework compared to their counterparts in developed countries. This is perhaps attributable to two major factors. First, in the Western countries, the household with two sources of income is likely to have a higher income than the household where the wife spends less time for gainful employment. In Korea, most low-income mothers are engaged in one form or another of income-earning activities in a formal or, more likely, in an informal sector. Most wives in high-income households have a college degree and are not employed in Korea.[11] A second explanation is that a paucity of opportunities for women to get access to high-paying jobs and cultural traditions that emphasize family values make Korean women's educational achievements a more important factor for their children's health. That is, a longstanding Korean socio-cultural tradition regarding the role of women, particularly that of those with a child or children, appears to induce them to prefer mothering to working at the market place.[12]

This study confirms the documented contention that improving the educational opportunity for women and enhancing the socio-cultural environment for mothers to have an incentive and motivation for a better education will promote child health and reduce the high infant and child mortality rate in developing countries. If one fails to notice the synergetic effects of mother's education and her time allocation, however, then we can warp the mother's productive and allocative role in her child's health in the household production activities. Research design efforts to examine this relationship in the future would be more rewarding.

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11 In this case, 74% of mothers with college degrees are not employed.

12 Whereas more educated mothers are likely to seek self-fulfillment in careers in Western cultures, Korean women with a high level of schooling still aim at self-fulfillment by becoming a skillful master of their households while their husbands are at work outside the home for long hours.

References

Arbuckle, J. and W. Wothke. 1999. *AMOS 4.0 User's Guide*. SmallWaters Corporation.

Becker, G.S. 1965. "A Theory of the Allocation of Time." *Economic Journal* 75: 493–517.

Becker, G.S. 1971. *Economic Theory*. New York: Alfred A. Knopf.

Becker, G.S. 1981. *A Treatise on the Family*. Harvard University Press, Cambridge, MA.

Behrman, J.R. and B.L. Wolfe. 1987. "How Does Mother's Schooling Affect Family Health, Nutrition, Medical Care Usage, and Household Sanitation." *Journal of Econometrics* 36(1/2): 185–204.

Chambers, R. 1992. "Rapid but Relaxed and Participatory Rural Appraisal: Towards Applications in Health and Nutrition." In N.S. Scrimshaw and G. R. Gleason, eds., *Rapid Assessment Procedures (RAP)*. Boston: International Nutrition Foundation for Developing Countries.

Denison, E.F. 1985. *Trends in American Economic Growth: 1929-82*. Washington: The Brookings Institution.

Fedorov, L. and D.E. Sahn. 2005. *Socioeconomic Determinants of Children's Health in Russia: A Longitudinal Study*. 53(2): 479–500.

Gronau, R. 1972. "The Intrafamily Allocation of Time: The Value of the Households' Time." *American Economic Review* 63(4): 634–51.

Gronau, R. 1977. "Leisure, Home Production, and Work – The Theory of the Allocation of Time Revisited." *Journal of Political Economy* 85(6): 1094–124.

Grossman, M. 1976. "The Correlation between Health and Schooling." In N.E. Terleckyj, ed., *Household Production and Consumption*. New York: Columbia University Press (for NBER).

Grossman, M. 2003. "Household Production of Health." *Review of Economics of the Household* 1(4): 331–42.

Haveman, R. and B. Wolfe. 1984. "Education and Well-being: The Role of Non-market Effects." *Journal of Human Resources* 19: 408–29.

Inman, R.P. 1976. "The Family Provision of Children's Health: An Economic Analysis." In R.N. Rosett, ed., *The Role of Health Insurance in the Health Services Sector*. New York: National Bureau of Economic Research.

Iram, U. and M.S. Butt. 2004. "Socioeconomic and Environmental Determinants of Child-care Patterns of Preschoolers in Pakistan." *International Journal of Social Economics*. 31(3/4): 218–38.

Joreskog, K. and D. Sorbom. 1983. *LISREL: Analysis of Linear Structural Relations by the Method of Maximum Likelihood*. Uppsala: University of Uppsala.

Juster, F.T. and F.P. Stafford. 1991. "The Allocation of Time: Empirical Findings, Behavioural Models, and Problems of Measurement." *Journal of Economic Literature* 29(2): 471–522.

Kenkel, D.S. 1991. "Health Behaviour, Health Knowledge, and Schooling." *Journal of Political Economy* 99(2): 287–305.

Kooreman, P. and A. Kapteyn. 1987. "A Disaggregated Analysis of the Allocation of Time within the Household." *Journal of Political Economy* 95(2): 223–49.

Lancaster, K. 1966. "Allocation and Distribution Theory: Technological Improvement and Progress." *American Economic Review* 56(2):14–23.

Leibowitz, A. 1974. "Home Investments in Children." In T.W. Schultz, ed., *Economics of the Family*. Chicago: University of Chicago Press.

Malathy, R. 1994. "Education and Women's Time Allocation to Nonmarket Work in an Urban Setting in India." *Economic Development and Cultural Change* 42(4): 743–60.

Michael, R.T. 1973. "Education in Nonmarket Production." *Journal of Political Economy* 81(2–1): 306–27.

Mueller, E. 1984. "The Value and Allocation of Time in Rural Botswana." *Journal of Development Economics* 15(1/2/3): 329–60.

Pokhrel, S. and R. Sauerborn. 2004. "Household Decision-making on Child Health Care in Developing Countries: The Care of Nepal." *Health Policy and Planning* 19(4): 218–33.

Psacharopoulos, G. and A.M. Arriagada. 1989. "The Determinants of Early Age Human Capital Formation: Evidence from Brazil." *Economic Development and Cultural Change* 37(4): 683–708.

Rosenzweig, M.R. and T.P. Schultz. 1981. "Education and the Household Production of Child Health." *Proceedings of American Statistical Association, Social Statistical Section*. Washington: American Statistical Association.

Rosenzweig, M.R. and T.P. Schultz. 1982a. "Market Opportunities, Genetic Endowments, and Intrafamily Resource Distribution." *American Economic Review* 72(4): 803–15.

Rosenzweig, M.R. and T.P. Schultz. 1982b. "The Behaviour of Mothers as Inputs to Child Health: The Determinants of Birth Weight, Gestation, and Rate of Fetal Growth." In V.R. Fuchs, ed., *The Economic Aspects of Health*. Chicago: University of Chicago Press.

Rosenzweig, M.R. and T.P. Schultz. 1983. "Estimating a Household Production Function: Heterogeneity, the Demand for Health Inputs, and their Effects on Birth Weight." *Journal of Political Economy* 91(5): 723–46.

Scrimshaw, S.C. 1992. "Adaptation of Anthropological Methodologies to Rapid Assessment of Nutrition and Primary Health Care." In N.S. Scrimshaw and G.R. Gleason, eds., *Rapid Assessment Procedures (RAP)*. Boston: International Nutrition Foundation for Developing Countries.

Senauer, B. and M. Garcia. 1991. "Determinants of the Nutrition and Health Status of Preschool Children: An Analysis with Longitudinal Data." *Economic Development and Cultural Change* 39(2): 371–89.

Strauss, J. 1990. "Households, Communities, and Preschool Children's Nutrition Outcomes: Evidence from Rural Côte d'Ivoire." *Economic Development and Cultural Change* 38(2): 231–61.

Thomas, D., J. Stauss and M. Henriques. 1991. "How Does Mother's Education Affect Child Height?" *Journal of Human Resources* 26(2): 183–211.

Wales, T.J. and A.D. Woodland. 1977. "Estimation of the Allocation of Time for Work, Leisure, and Housework." *Econometrica* 45(1): 115–32.

Wolfe, B.L. and J.R. Behrman. 1982. "Determinants of Child Mortality, Health, and Nutrition in a Developing Country." *Journal of Development Economics* 11: 163–94.

Yamada, T., T. Yamada and F. Chaloupka. 1998. "Nutrition and Infant Health in Japan." *Journal of Human Resources*. 33(4): 725–36.

Appendix

The model estimates the unknown coefficients in a set of linear structural health production equations included the imperfectly measured health status, nutrition, healthcare, home environment and hereditary traits. The matrix form of the structural equation model is:

$$\mathbf{Y} = \Gamma\mathbf{Y} + \Delta\mathbf{X} + f\mu \tag{A1}$$

where $\mathbf{Y}' = (H, N, C, E, T_{MW}, T_{ML})$ is a vector of endogenous variables of which the first four variables are imperfectly observed.[13] $\mathbf{X}' = (G, S_M, A_M, A_M^2, I)$ is a vector of exogenous variables and the first variable is also latent. It is assumed that $f\mu = (f\mu_1, f\mu_2, \ldots, f\mu_6)$, as vector of errors in equations, is uncorrelated with $\mathbf{X}$ and that $\mathbf{I} - \Gamma$ is non-singular. Γ and Δ are coefficient matrices. In this study, Γ and Δ have the following matrix forms:

$$\Gamma = \begin{bmatrix} 0 & \gamma_{12} & \gamma_{13} & \gamma_{14} & \gamma_{15} & \gamma_{16} \\ 0 & 0 & 0 & 0 & \gamma_{25} & \gamma_{26} \\ 0 & 0 & 0 & 0 & \gamma_{35} & \gamma_{36} \\ 0 & 0 & 0 & 0 & \gamma_{45} & \gamma_{46} \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix} \tag{A2}$$

$$\Delta = \begin{bmatrix} \delta_{11} & \delta_{12} & \delta_{13} & \delta_{14} & \delta_{15} \\ 0 & \delta_{22} & \delta_{23} & \delta_{24} & \delta_{25} \\ 0 & \delta_{32} & \delta_{33} & \delta_{34} & \delta_{35} \\ 0 & \delta_{42} & \delta_{43} & \delta_{44} & \delta_{45} \\ 0 & \delta_{52} & \delta_{53} & \delta_{54} & \delta_{55} \\ 0 & \delta_{62} & \delta_{63} & \delta_{64} & \delta_{65} \end{bmatrix} \tag{A3}$$

13 Housework time is not included in the analysis because it is highly correlated with leisure time and also because our concern is focused on leisure time, which includes time spent for playing with a child or children.

As in the health production function in (4), the first row of Γ means the effects of nutrition, healthcare usage, home environment and time allocation on the production of child's health. The first column of Γ has zero elements because the time and other health-related inputs are assumed not to be influenced by health outputs. Also, the second to fourth rows of Γ show the effects of time allocation on nutrition, healthcare usage and home environment. The first row of Δ represents the impact of hereditary traits, mother's schooling, her age and household income. And, the first column of Δ indicates the hereditary traits variable that is considered as a control variable. The remaining zero restrictions imposed on Γ are based on the assumption that the health inputs have no two-way influences.

Vectors $\mathbf{Y}$ and $\mathbf{X}$ are not observed, but instead vectors $y' = (y_1, y_2, \ldots, y_p)$ and $x = (x_1, x_2, \ldots, x_q)$ are observed. The measurement model for y and x is:

$$y = \Lambda_y \mathbf{Y} + \varepsilon \tag{A4}$$

$$x = \Lambda_x \mathbf{X} + \delta \tag{A5}$$

where Λ_y and Λ_x are a regression matrix of y on $\mathbf{Y}$ and x on $\mathbf{X}$ respectively and $\varepsilon(\delta)$ is a vector of error term in $y(x)$ that is uncorrelated with $\mathbf{Y}(\mathbf{X})$, $f\mu$, and $\delta(\varepsilon)$.[14] The model uses the maximum-likelihood estimation method based on the assumption that the observed variables have a multi-normal distribution.

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14 Before an attempt is made to estimate a model, the identification problem must be resolved. Let $m(n)$ and $p(q)$ be the number of latent dependent (independent) variables and the number of observed indicators on latent dependent (independent) variables, respectively. For identification of our model, a necessary condition is that the number of independent observed moments $[(p + q)(p + q + 1)/2]$ is equal to or greater than t being the total number of free parameters in the model. t is $mn + pm + qn + m(m + 1)/2 + n(n + 1)/2 + p(p + 1)/2 + q(q + 1)/2$. In this case, as the number of independent observed moments is 300 and t is 360, we need at least 60 restrictions. To satisfy the condition, we impose as follows: firstly, we normalized each of the five latent variables to be one. Next, Γ, Δ, Λ_y and Λ_x put 25, 5, 70 and 40 zero restrictions, respectively. Also, covariance matrix of ε and δ implied 91 and 45 zero restrictions, respectively. Therefore, our model is identified.