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THE DETERMINANTS OF CHILD HEALTH IN PAKISTAN: AN ECONOMIC ANALYSIS

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ABSTRACT. This paper estimates linear structural models using LISREL and employs MIMIC models to find out factors determining child health in Pakistan. A distinction has been made in permanent and transitory health states that lend support to Grossman's (1972) stock and flow concepts of health. The paper addresses the issue of health unobservability and finds out that latent variables using MIMIC models best represent underlying child health states. To overcome problems of poor income data, factor analysis is applied to extract measures of housing and durables as indicators of socio-economic well-being of children in Pakistan. The results of the study show that child health states, both permanent and transitory, are affected significantly by factors such as parental education, socio-economic conditions, and health care variables.

KEY WORDS: child health, latent variables, MIMIC models, stock of health, unobservability

JEL CLASSIFICATION: 112

INTRODUCTION

This paper explores factors determining child health in Pakistan and estimates a special case of structural relations as presented by Joreskog (1971). Such structural relations are known as Multiple Indicators-Multiple Causes (MIMIC) models and are estimated with the help of (LISREL (Linear Structural Relations). Joreskog and Sorbom (1989, p. 142) show how the issue of health unobservability can best be captured by employing MIMIC models in which unobserved (latent) variables are caused by several observed *x*-variables and indicated by several observed *y*-variables.

THEORETICAL UNDERPINNINGS

Grossman (1972) presented a model of health determination where all individuals are born with an initial "stock of health capital" and has two important features (i) it depreciates overtime and (ii) it can be increased by acts of investment in health. The main parameters in Grossman's model are depreciation rate (represented by age), cost of health investments (e.g. price of medical care), wage rate and education. Grossman (1972, p. 45) explains that "the stock of health ... is a theoretical concept, one that is difficult to quantify empirically" but that in contrast to difficulty in measuring health capital, "healthy time output produced by health capital... could be measured easily." He estimated gross investment production function by employing two stage least squares (2SLS) and the main explanatory variables were medical care, education, gender and income per household member. The reduced form demand function for health was estimated by OLS and included wage rate, education, gender and family size as the explanatory variables. His results showed that a change in model's parameters (age, education, wage rate and prices of medical care) changes the optimal level of health. Hence, an increase in income, holding prices and other production activities constant, results in more health output. The income effect operates through more use of health inputs that produce good health output. On the other hand, the effect of education is that education increases technical efficiency: educated people are able to produce a better health outcome for a given use of health inputs or use fewer inputs for producing the same level of health output. A change in the price of medical care also brings changes in health: a fall in price of medical care results in more utilization of medical and health care services and results in better health outcome.

Empirical Issues

The inherent problem of health unobservability resulted in different estimation techniques for determining health. For example, Wagstaff (1986, 1993), Van Doorslaer (1987), Behrman and Wolfe (1987) and Shehzad (2004) estimated structural equation models employing latent variables. These studies also used multiple health indicators to represent underlying unobservable health states. Van Doorslaer (1987, pp. 49–64) distinguishes between different health states by employing latent variables techniques. He estimates Grossman's stock and flow concepts using MIMIC models and explores if a causal relationship exists between different health states. For this purpose, he assumes that initial permanent health is predetermined and has a significant and positive impact on transitory health deviations. Van Doorslaer explored the possibility of differentiating between health states at the empirical level, however, his results relating to transitory health turned out to be peculiar. The coefficients of determinants were mostly of the opposite sign, thus casting doubt about a causal relationship between permanent and transitory health states. However, more recent work by Shehzad (2004) shows that at the empirical level, Grossman's stock and flow concepts of health states can be estimated and differentiated successfully. Children who have better permanent health state are able to overcome temporary health distortion relatively more quickly. Hence, permanent health state has a positive and significant impact on transitory health state. This paper specifies equations in LISREL to explore a causal relationship between a set of explanatory variables and child's unobservable health states (permanent and transitory). A mixed demand-production function is estimated due to the nature of independent variables in the study.

DATA

This study uses the only available micro-level data, Pakistan Demographic and Health Survey (1990–1991), collected by IRD/ Macro-International Inc. as part of an international exercise to conduct DHS in more than 60 developing countries. The major characteristics of data are presented in Table I. In PDHS (1990–1991), information about income is missing. To overcome this problem, factor analysis is carried out to extract measures of housing and durables as reflecting household access to opportunities for health and health care. As a second measure, information on income earned from the occupations reported in the PDHS has been obtained from a secondary source. Pakistan Household Income and Expenditure Survey (1990–1991) contain full information relating to income from occupations and the occupational codes used in the two surveys are standard international codes. Therefore, it has been decided to attach this information to the PDHS households.

TABLE I

Description of variables

Variables	Description	Mean	S.D	Skewness
Explanatory variables				
Household Income per head	Income from occupations of husband and wife divided by the household size	129.03	304.67	−2.15
Household size	Total number of household members	8.725	4.032	1.489
Housing	Factor 1	−0.280	0.982	0.658
Durables	Factor 2	−0.058	0.845	2.776
Hospital beds facility in the area	No of hospital beds/1000 population of province and type	7.586	9.159	1.091
Mother's schooling	Total number of years of schooling	1.570	3.268	1.952
Father's schooling	Total number of years of schooling	4.176	4.528	0.539
Mother's age	Mother's age in years	29.027	6.556	0.567
Provinces				
Sindh		0.214	0.410	1.393
NWFP		0.134	0.341	2.149
Punjab		0.613	0.487	−0.462
Type	Urban = 1 Rural = 0	0.307	0.461	0.837
Age	Child's age in months	30.168	17.865	0.114
Gender	Male = 1, Female = 0	0.52	0.50	0.062

Source: PDHS (1990–1991).

Data and Definition of Variables

Total household income is computed for both parents and where mother is not working; only father's income is reported. Household income is computed for all regions and type of residence and deflated by the relevant household size to get average income per household member. Medical and health care facilities are represented by an area level variable (hospital beds per thousand population). Information on total number of hospital beds is available only for provinces and by urban/rural area for 1994–1995 and is obtained from the Annual Report of the Director General of Health (1993–1995, p. 114). The population for the same year in thousands is the projected population taken from the Economic Survey of Pakistan (1994–1995) based on

TABLE II

Extracted factors, loading and eigen values

Variables	Factor 1: Housing characteristics	Factor 2: Household durables	Communality
Car/Van/Tractor	−0.138	**0.679**	0.480
Room cooler	0.192	**0.672**	0.488
Motor cycle	0.232	**0.600**	0.414
Water pump	0.315	**0.547**	0.399
Refrigerator	0.536	**0.541**	0.581
TV	**0.700**	0.319	0.592
Concrete roof	**0.686**	0.161	0.497
Electricity	**0.670**	0.009	0.449
Toilet	**0.780**	0.245	0.670
Piped water	**0.763**	0.106	0.594
Eigen values	3.939	1.229	–
Percentage of variance	39.4	12.3	–
Cumulative percentage	39.4	51.7	–
Kaiser–Meyer–Oklin measure of sampling adequacy 0.88161			
Bartlett test of sphericity		17784.942 Significance = 0.000	

Source: PDHS, 1990–1991.

the 1981 Census. For each household, respective information was attached to each child according to his/her location (rural/urban and province).

Household size represents average number of persons living in a household. Pakistani households tend to be large with an average of eight persons living together in a single household. Large household size is expected to have an adverse effect on child's health through congestion and over-crowding. Therefore, large household size not only affects child's permanent health but also contributes to transitory health deviations. When household size is large, children are more prone to communicable diseases.

To overcome problem of poor income data in PDHS, household's living characteristics and access to durables are used as indicators of economic well-being (Table III). Factor analysis using principal components and varimax rotation has been used to estimate the effects of housing and durables on child health. The choice of variables has been made on the basis of access to facilities determining quality of life and social status. They broadly include household possessions, such as

TABLE III

Principal extracted factors

Factor 1: Housing characteristics	Factor 2: Household durables
1. TV	1. Car/van/tractor
2. Concrete roof	2. Room cooler
3. Electricity	3. Motor cycle
4. Piped water	4. Water Pump
5. Toilet	5. Refrigerator

Source: PDHS (1990–1991).

ownership of TV, refrigerator, washing machine etc. and household facilities such as toilets, concrete roof, walls and piped drinking water. Factor analysis provides information about interdependence among selected set of variables, see details in Dillon and Goldstein (1984, pp. 53–63). Data set is reduced to form a new set of variables that are fewer in number than the original set of variables.[1] Following Dillon and Goldstein, define a set of variables $\boldsymbol{X_1}$, $\boldsymbol{X_2}$,........... $\boldsymbol{X_p}$, $p = 1$...........10 which load on certain unobservable common factors. The variables having high correlation with one another define the first factor and so on. A number of variables have been generated (by using the dummy variable technique) which are assumed to be linear combinations of the underlying variables. The analysis has utilised variables relating to ownership of durable items and living environment conditions including information on dwelling material, water and sanitation facilities. It uses characteristics pertaining to household durables, dwelling structure and electricity supply by creating dummy variables. The groupings are made based on the criterion of prominence in frequency in each category. Those variables were excluded that had a high correlation coefficient of above 0.5 with one or more variables. Other variables were retained to capture variability and analysis was carried out with 10 variables. To test the hypothesis that the correlation matrix is an identity matrix, for data that are based on a multivariate normal population, Bartlett' test of sphericity is applied.[2] The hypothesis is rejected, thus justifying the use of factor analysis. The Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy gives an index for comparing the magnitude of the observed correlation coefficients to the magnitude of the partial correlation coefficients. A very good value of 0.881 was obtained. Similarly, measures of sampling adequacy (MSA) for each variable from anti-image correlation matrix varied between 0.813 and 0.895 indicating reasonable strength of relationship among chosen variables. In deciding the number of factors to represent data, percentage of total variance explained by each factor is examined and total variance is the sum of each variable's variance. Total variance explained by each factor is named as Eigen value. Table II and Figure 1 gives Eigen values and explained variance for all the principal factors. The table shows that 51.7% of the variance is explained by 2 factors out of 10 variables and these have Eigen values greater than 1. Communality value provides squared multiple correlation coefficients between one variable and all other variables and is another indication of the strength of linear association among variables. A model with two factors seems adequate to represent the data as 51.7% variance is explained by these two factors. The first factor explains 39.4% of variance in the data and has five variables. All variables have positive loading and indicate the affordability of households. The second factor comprises of household durables. It has positive loading for all factors and represents well-off households. The two identified factors are broadly labelled as housing and durables.

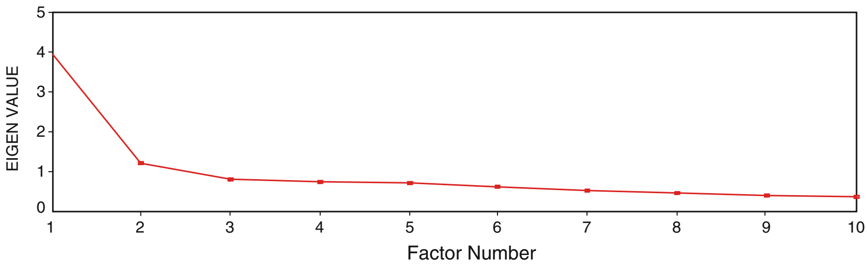

Fig. 1. Factor scree plot. *Source*: PDHS (1990–1991).

MIMIC MODELS FOR CHILD HEALTH:

One Latent Variable Case

MIMIC models estimate the effects of multiple explanatory variables on child's permanent health state. The model can best be understood by means of a path diagram for one latent variable case.[3] In Figure 2, the unobservable η variable is enclosed in a circle and the observed

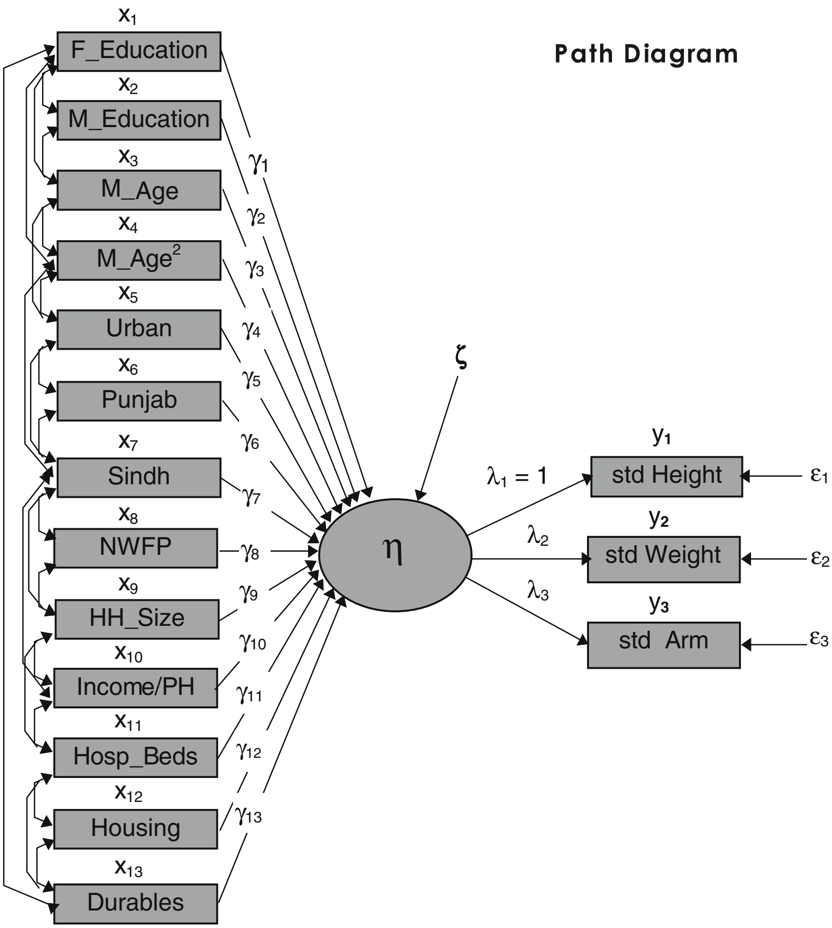

Fig. 2. MIMIC Model for child health.

x-variables are represented in the rectangles. The error terms are not enclosed. The arrows leading from x to the latent variable indicate the hypothesised direct effect on η. The arrows leading from η variable to the indicators on the right hand side represent hypothesised impact of unobservable variable on the indicators. The strength of the effects of variables is indicated by λ coefficients in the measurement model. Using the LISREL terminology, the model is as follows .

Empirical Estimates of MIMIC Models: One Latent Variable Case

Tables IV–VI present estimates of MIMIC models for child health in Pakistan. The tables present estimates of MIMIC models that depict

MIMIC model for child health in Pakistan

One Latent Variable Case

A. Measurement Model

$y = \Lambda_y \ \eta + \varepsilon$ $\varepsilon \sim N(0, \theta_\varepsilon)$

(3×1) (3×1) (3×1)

Assumptions:

$E(y) = E(\zeta) = E(\eta) = E(\varepsilon) = 0$

$E(\varepsilon, \eta) = 0$

$E(\zeta, \varepsilon) = 0$

B. Structural Equation Model

$\eta = \gamma' x + \zeta$

$\eta = \gamma_1 x_1 + \gamma_2 x_2 + \gamma_3 x_3 + \gamma_4 x_4 + \gamma_5 x_5 + \ldots\ldots + \gamma_{13} x_{13} + \zeta$

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the direct effect of the explanatory variables on child's permanent health. Models 4–6 are individual models estimating parental characteristics, area of residence, household's characteristics, and two factor analytic variables as shown by housing and durables. Model 5 is an overall model and model 6 is its variant including both income and factor analytic variables of housing and durables. The results show that the overall fit of all models is very good as indicated by adjusted goodness of fit index (AGFI), root mean squared residual (RMR), and the value of χ^2 in all other models, overall fit of the models is very good. A very high AGFI and significant χ^2 and low RMR suggest that all models fit the data very well. Signs in the measurement models are in the expected right direction and their effects are significant. In structural equations, mother's schooling, mother's age and age squared have significant effect on child's permanent health status. The effect of father's education is positive but not significant in model 2. The effect of household income and hospital beds is positive and significant at 99% level. Urban area residence and three provinces have a significant and positive effect on child health. Housing characteristics and household durables also positively affect child's permanent health state. Models 1–4 suggest that child's permanent health is affected positively by mother's education and age. More educated mothers demand more child health output and as income increases, more child health is demanded. Model 5 report results of all variables taken together and include area of residence, parental characteristics, income, household size and medical facilities. Results show that overall fit of the model is very

TABLE IV

Maximum likelihood LISREL estimates for child health: separate models, international standard: one latent variable case

Variables	Model 1	Model 2	Model 3	Model 4
Measurement models				
Standardised height	1.00[a]	1.00[a]	1.00[a]	1.00[a]
Standardised weight	1.44*** (19.08)	1.35*** (22.69)	1.32*** (9.29)	1.54*** (18.20)
St. arm circumference	0.63*** (20.35)	0.63*** (20.61)	0.63*** (9.80)	0.64*** (20.36)
TE Height	0.64*** (28.20)	0.62*** (29.94)	1.61*** (29.11)	0.66*** (29.17)
TE Weight	0.25*** (6.72)	0.30*** (10.43)	1.32*** (16.77)	0.19*** (4.70)
TE arm circumference	0.86*** (42.54)	0.85*** (42.65)	1.85*** (41.19)	0.86*** (42.69)
Structural Equation Models				
Household size	−0.01 (0.46)	–	–	–
Household income per head	0.12*** (10.12)	–	–	–
Hospital beds/1000 pop	0.03** (2.52)	–	–	–
Father's education	–	0.00 (0.28)	–	–
Mother's education	–	0.21*** (13.04)	–	–
Mother's age	–	0.20** (2.41)	–	–
Mother's age squared	–	−0.17* (2.01)	–	–
Type (Urban)	–	–	0.07*** (6.26)	–
Sindh	–	–	0.02 (0.64)	–
NWFP	–	–	0.9** (2.45)	–
Punjab	–	–	0.13*** (3.40)	–
Housing	–	–	–	0.01*** (8.86)
Durables	–	–	–	0.07*** (6.45)
PSI	0.35*** (15.00)	0.34*** (16.82)	0.37*** (7.76)	0.33*** (14.41)

R	0.04	0.12	0.06	0.04
χ^2 + df	150.31*** (6)	153.88*** (8)	39.91*** (8)	84.32*** (4)
RMR	0.034	0.029	0.033	0.029
AGFI	0.96	0.97	0.99	0.97

[a]Normalised to be equal to 1.

Note: Values in the parentheses are *t* values, *** represents significant at 99% level, ** significant at 95 % and * at 90% level. When no *t* value is reported, this means that the parameter is equal to a fixed value.

TABLE V

Maximum likelihood LISREL estimates for child health: international standard, one latent variable case

Model 5		
Measurement model: Indicator relations	*Coefficients*	*TE*
Standardised height	1.00[a]	1.61*** (31.80)
Standardised weight	1.26*** (11.38)	1.37*** (21.71)
St. arm circumference	0.66*** (10.50)	1.83*** (41.01)
Structural equation model:		
Father's schooling	0.03*** (3.06)	
Mother's schooling	0.10*** (7.84)	
Mother's age	0.01 (1.03)	
Mother's age squared	0.01 (0.56)	
Type (Urban)	0.04*** (3.07)	
Punjab	0.20*** (3.93)	
Sindh	0.10** (2.09)	
NWFP	0.17 (3.44)	
Household size	−0.01 (1.01)	
Household income per head	0.01 (1.41)	
Hospital beds/1000 population	−0.01 (0.53)	
System estimates		
PSI	0.35*** (8.74)	
χ^2 and df	55.78*** (22)	
R^2	0.12	
Root mean square residual	0.024	
Adjusted goodness of fit index	0.99	

[a]Normalised to be equal to 1.

Note: Values in the parentheses are *t* values, *** represents significant at 99% level, ** significant at 95 % and * at 90% level. When no *t* value is reported, this means that the parameter is equal to a fixed value.

good; AGFI is 0.99 and χ^2 is highly significant. In the measurement model, all signs are in the expected right direction and are significant. As regards parental characteristics, parental education has positive significant impact on child's permanent health status. This implies that an increase in parental education significantly enhances child's permanent health state.

Educated parents take keen interest in child's health-related activities. They also adopt long-term measures needed to secure child's permanent health status by taking care of hygiene, proper food and nutrition that positively contribute to gains in weight, height and arm circumference of children. The effect of mother's age is positive:

TABLE VI

Maximum likelihood LISREL estimates for child health international standard: one latent variable case

Model 6		
Measurement model: Indicator relations	*Coefficients*	*TE*
Standardised height	1.00[a]	1.60*** (31.90)
Standardised weight	1 .26*** (11.49)	1.38*** (21.97)
St. arm circumference	0.66*** (10.54)	1.83*** (41.01)
Structural equation model		
Household size	−0.01 (1.18)	
Household income per head	0.01 (1.29)	
Hospital beds/1000 pop.	−0.01 (0.63)	
Type (Urban)	0.04** (2.54)	
Punjab	0.19*** (3.83)	
Sindh	0.09** (1.99)	
NWFP	0.17*** (3.32)	
Housing characteristics	0.02* (1.69)	
Household durables	0.02** (2.19)	
Father's schooling	0.03*** (2.73)	
Mother's schooling	0.10*** (7.31)	
Mother's age	0.01 (1.03)	
Mother's age squared	0.01 (0.56)	
System estimates		
PSI	0.35*** (8.79)	
χ^2 and (df)	56.12*** (26)	
R^2	0.13	
Root mean square residual	0.022	
Adjusted goodness of fit index	0.99	

[a]Normalised to be equal to 1.

Note: Values in the parentheses are *t* values, *** represents significant at 99% level, ** significant at 95 % and * at 90% level. When no *t* value is reported, this means that the parameter is equal to a fixed value.

mothers gains more experience with age and child's permanent health status enhances due to maturity and experience. The effect of urban area residence is strongly positive, suggesting greater opportunities in terms of health-care facilities, clean water, sanitation and education. In order to see the impact of area of residence on child health, dummy variables of the four provinces of Pakistan have been generated. The reference category is the province of Balochistan, which is though biggest in area, is the least developed province. Punjab is the most populated and developed province. The effect of residence in the provinces of Punjab, Sindh and NWFP has a positive and significant impact on child health. Three other variables have been added in the model. These are household income per head, household size and hospital beds. The effect of income earned from being engaged in different occupations is positive but not significant. In model 2, the effect of father's education was not significant but when all the variables are included the effect of father's education is positive and significant. Hence, father's education seems to substitute the effect of household income. In Pakistan, the role of father's education in child health is not as significant as that of the mother. The main reason is that, child-care is the primary responsibility of the mother, whereas, fathers are responsible for breadwinning and earning. However, an increment in father's education has a positive effect on child's permanent health. Therefore, an emphasis on parental education for improvements in child health should be integrated in the overall health system development. The effect of average household size on child's permanent health status is negative. The effect of household size on child's permanent health is negative because of congestion effects and lower income per member. Table shows the results of model 6 and shows the effect of all factors taken together. It adds in VI model 5 variables relating to housing characteristics and household durables and the effect turns out to be positive and significant. This is an important finding and confirms earlier results in literature. Permanent health enhances as a result of improved household facilities, proper sanitation and piped water. On the other hand, household durables as refrigerator and water pump may be related to nutrition enhancing variables and positively affect child's permanent health.

MIMIC Model for child health

Two Latent Variables Case

A. Measurement Model

$y = \Lambda_y \; \eta + \varepsilon$ $\qquad \varepsilon \sim (0, \theta_\varepsilon)$

(6×1) (6×2) (2×1) (6×1)

Assumptions:

$E(y) = E(\zeta) = E(\eta) = E(\varepsilon) = 0$

$E(\varepsilon, \eta) = 0$

$E(\zeta, \varepsilon) = 0$

B. Structural Equation Model

$\eta = \beta \; \eta \; + \; \Gamma \; \mathbf{x} \; + \; \zeta$

(2×1) (2×2) (2×1) (2×15) (15×1) (2×1)

The MIMIC model for child health in Pakistan (two latent variables case) is represented by means of a path diagram in Figure 3. In this diagram, unobservable η variables are enclosed in circles and the observed *x*-variables are represented in the rectangles. The error terms are not enclosed. The arrows leading from *x* variables to the latent variable(s) indicate their hypothesised direct effect on ηs. The arrows leading from η variables to the indicators on the right hand side represent hypothesised impact of latent variable on the child's health indicators. The strength of the effects of variables is indicated by the λ coefficients in the measurement model. In two latent variables case, following Van Doorslaer (1987, p. 59) permanent child's health state is assumed to have a direct positive effect on transitory health as depicted by $\beta 21$. In the two latent variables case, two other zero restrictions on γ11 and γ21 have been imposed for their effect on

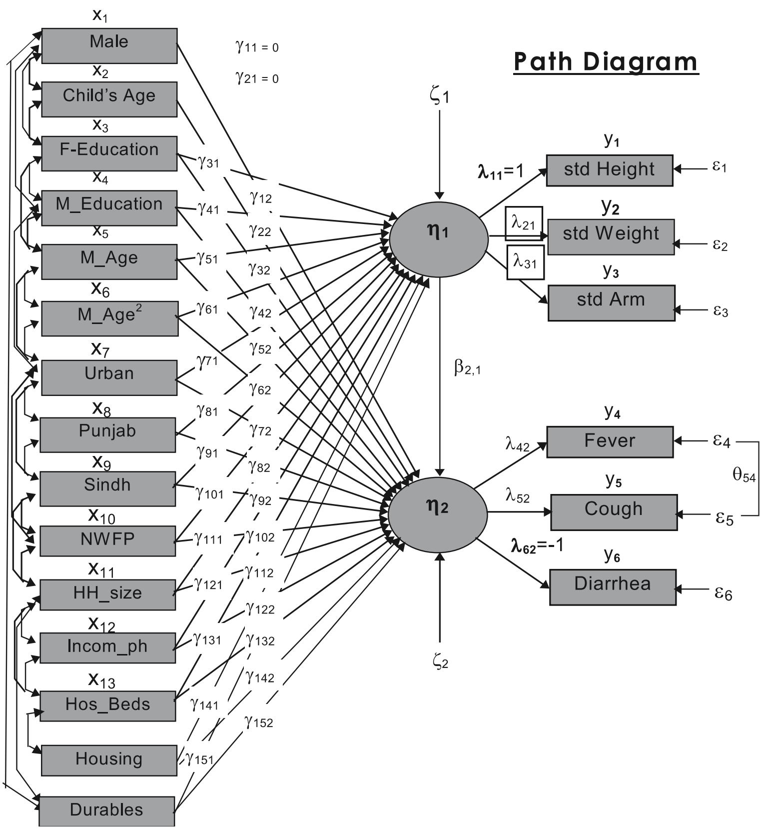

Fig. 3. MIMIC Model for child health.

η1. This is because child's permanent health indicators are age and gender standardised. However, for other health indicators, no such restriction has been imposed on γs and the effect of age and gender is also explored for transitory health.

The following matrices/ vectors have been specified in the MIMIC models estimated in LISREL

1. Λ_y ($p \times m$) is the matrix of coefficients, or loading, relating indicators of endogenous variables to latent exogenous variables (η).
2. Λ_x ($q \times n$) is the matrix of coefficients, or loading, relating indicators of exogenous variables to latent exogenous variables (ξ).
3. β ($m \times m$) is a matrix of coefficients of the effects of latent endogenous variables on latent endogenous variables.
4. Γ ($m \times n$) is the matrix of coefficient of the effects of latent exogenous variables on latent endogenous variables.
5. Φ ($n \times n$) is a variance–covariance matrix of the latent exogenous variables (ξ).
6. Ψ ($m \times m$) is a variance–covariance matrix of the residuals (ζ).
7. Pε ($p \times p$) is a variance–covariance matrix of errors of measurements of y's.
8. Pδ ($q \times 1$) is a variance–covariance matrix of errors of measurements of x's.
9. η ($m \times 1$) is a vector of endogenous variables.
10. ξ ($n \times 1$) is a vector of exogenous variables.
11. ζ ($m \times 1$) is a vector of error terms.
12. $\boldsymbol{y}$ ($p \times 1$) is a vector of indicators.
13. ε ($p \times 1$) is a vector of error terms.
14. **x** ($n \times 1$) is a vector of exogenous variables.

Here p is the number of y variables, m is the number of η variables, n is the number of ξ variables and q is the number of x variables. LISREL uses the following terms in estimating the models; **s** is observed covariance matrix of measured variables and T is model implied covariance matrix. The following assumptions hold (1) cov (ζ ξ) = 0 (2) cov (ε η) = 0 (3) cov (δ ξ) = 0 (4) cov (ζ δ) = 0 (5) cov (ζ ε) = 0 (6) cov (δ ε) = 0 ζ , ε, δ are mutually uncorrelated and (7) I–β is non singular. For details, see LISREL (1989, p. 143), A Guide to the Program and Applications.

RESULTS: CHILD HEALTH MODELS WITH TWO LATENT VARIABLES

Tables VII–XI present MIMIC models results for two latent child health variables. In these models, a distinction has been made in

TABLE VII

Maximum likelihood LISREL estimates for child health: two latent variables case

Measurement model	Model 1		
	PH	TH	$\theta\varepsilon$
$\beta_{2,1}$	–	0.32*** (10.97)	–
Standardised height	1.00[a]	–	0.74*** (31.96)
Standardised weight	2.01*** (14.55)	–	−0.06 (0.85)
St. arm circumference	0.64*** (20.00)	–	0.89*** (43.21)
Fever	–	−0.68*** (11.41)	0.71*** (24.21)
Cough	–	−0.61*** (11.18)	0.77*** (28.93)
Diarrhoea	–	−1.00[b]	0.37*** (6.74)
Structural Equation Model	*PH*	*TH*	
Gender (male)	–	−0.02* (1.59)	
Child age	–	0.17*** (11.57)	
System Estimates			
PSI	0.26*** (11.79)	0.57*** (10.36)	
R^2	–	0.09	
χ^2	245.40*** (17)		
RMR	0.11		
AGFI	0.79		

[a] Normalised to be equal to 1. [b] Normalised to be equal to minus 1.
Note: Values in the parentheses are *t* values, *** represents significant at 99% level, ** significant at 95 % and * at 90% level. When no *t* value is reported, this means that the parameter is equal to a fixed value.

child's permanent and transitory health states. Both these health states are unobservable, hence a two latent variables model. The indicators for permanent health status are as before, (standardised) height, weight and arm circumference. For transitory health, these include, fever cough (acute respiratory infections, ARI) and diarrhoea. The results show that being male has negative effect on transitory health state. This may be true as male children are more exposed to the outer environment and therefore, may become more prone to illnesses. A study conducted by Kurz and Johnson-Welch (1997) for the BASICS project, provides evidence from the developing countries for gender differences in health and nutrition among children under 5 years of age. Although, there are no conclusive results for the direction of gender bias, it is clear that girls are not as often taken to the health care facilities as boys and receive less attention from their parents. Present results also confirm that

TABLE VIII

Maximum likelihood LISREL estimates for child health: two latent variables case

Measurement Model	Model 2			Model 3		
	PH	TH	$\theta\varepsilon$	PH	TH	$\theta\varepsilon$
$\beta_{2,1}$	–	0.32*** (10.70)	–	–	0.32*** (10.19)	–
Standardised height	1.00[a]	–	0.65*** (30.22)	1.00[a]	–	0.63*** (31.53)
Standardised weight	1.48*** (20.27)	–	0.32*** (6.52)	1.39*** (23.50)	–	0.28*** (9.09)
St. arm circumference	0.64*** (20.50)	–	0.86*** (42.81)	0.64*** (20.78)	–	0.85*** (42.81)
Fever	–	−0.40*** (5.79)	0.83*** (23.98)	–	−0.48*** (7.00)	0.80*** (23.83)
Cough	–	−0.36*** (5.76)	0.86*** (28.31)	–	−0.43*** (6.95)	0.83*** (28.34)
Diarrhoea	–	−1.00[b]	−0.06 (0.35)	–	−1.00[b]	0.10 (0.76)
Structural Equation Model	*PH*	*TH*		*PH*	*TH*	
Household size	−0.01 (0.46)	−0.08*** (4.74)		–	–	
Household income per head	0.03** (2.46)	-0.07*** (3.95)		-	-	
Hos_Beds/1000 population	0.11*** (10.06)	0.05*** (3.04)		–	–	
Father's education	–	–		0.00 (0.26)	−0.03 (1.23)	
Mother's education	–	–		0.21*** (12.95)	0.02 (0.89)	
Mother's age	–	–		0.19*** (2.43)	0.59*** (4.95)	
Mother's age squared				−0.16** (2.03)	−0.53*** (4.47)	
System estimates						
PSI	0.34*** (15.42)	1.02*** (5.60)		0.33*** (16.98)	0.85*** (6.69)	
R^2	0.04	0.04		0.12	0.06	
$\chi^2$and df	288.17*** (19)			297.20*** (23)		
RMR	0.033			0.031		
AGFI	0.97			0.99		

[a]Normalised to be equal to 1.
[b]Normalised to be equal to minus 1.
Note: Values in the parentheses are *t* values, *** represents significant at 99% level, ** significant at 95 % and * at 90% level. When no *t* value is reported, this means that the parameter is equal to a fixed value.

TABLE IX

Maximum likelihood LISREL estimates for child health: two latent variables case

Measurement Model	Model 4			Model 5		
	PH	TH	$\theta\varepsilon$	PH	TH	$\theta\varepsilon$
$\beta_{2,1}$		0.32*** (5.64)	–	–	0.41*** (12.24)	–
Standardised height	1.00[a]	–	1.63*** (31.09)	1.00[a]	–	0.74*** (25.95)
Standardised weight	1.38*** (9.81)	–	1.30*** (16.79)	2.18*** (17.75)	–	0.21*** (2.75)
St. arm circumference	0.65*** (10.07)	–	1.84*** (41.22)	0.35*** (5.93)	–	0.97*** (39.95)
Fever	–	−0.48*** (4.98)	1.80*** (31.36)	–	−0.84*** (25.50)	0.62*** (22.34)
Cough	–	−0.43*** (4.91)	1.83*** (34.56)	–	−0.75*** (24.90)	0.69*** (26.46)
Diarrhoea	–	−1.00[b]	1.10*** (6.09)	–	−1.00	0.45*** (14.87)
Structural Equation Model	*PH*	*TH*		*PH*	*TH*	
Type (Urban)	0.07** (6.24)	0.01 (0.60)		–	–	
Punjab	0.12*** (3.40)	0.17*** (3.09)		–	–	
Sindh	0.02 (0.66)	0.14*** (2.61)		–	–	
NWFP	0.09*** (2.48)	0.24*** (4.48)		–	–	
Housing	–	–		0.06*** (7.63)	0.06*** (7.56)	
Durables	–	–		0.03*** (4.60)	0.06*** (8.34)	
System estimates						
PSI	0.35*** (7.98)	0.84*** (4.69)		0.25*** (13.82)	0.49*** (20.72)	
R^2	0.05	0.07		0.02	0.10	
χ^2	71.36*** (23)			238.12*** (15)		
RMR	0.034			0.059		
AGFI	0.99			0.97		

[a]Normalised to be equal to 1.
[b]Normalised to be equal to minus 1.
Note: Values in the parentheses are *t* values, *** represents significant at 99% level, ** significant at 95 % and * at 90% level. When no *t* value is reported, this means that the parameter is equal to a fixed value.

although, boys are more prone to temporary health illnesses due to more outer exposure, they may have better access to health care facilities as compared to girls to overcome temporary health deviations. In the World Health Report (2003), it is reported that countries like China, India, and Pakistan have higher mortality rates for girls as compared to boys. Hence, showing preferential treatment for boys as compared to girls. Present results complement these findings for preferential treatments for male children and besides the fact that boys are more prone to temporary illnesses due to outer exposure, such deviations are overcome through timely treatment for boys. Child's age has a significant positive effect on transitory health status implying that with age, transitory health deviations improve. Smaller children are likely to be more affected by fever, cough and diarrhea as compared to older children who develop some immunity with age. The effect of child's permanent health state as represented by B21 has a positive and significant effect on child's transitory health. This means that children with better permanent health can cope with transitory health deviations. Four other separate models have been estimated for parental characteristics, household income per head, household size and medical facilities, area of residence, housing characteristics and household durables. The separate models are then put together to estimate two variants of the overall models, with and without housing and durables. The results show that the effect of household size has a significant negative effect on child's transitory health state and the effect of medical facilities is positive. The effect of household income is positive and significant on permanent health but negative on transitory health. This is a peculiar result but this peculiarity is removed when total effects were estimated for this variable. In Pakistan, more health care facilities are located in urban areas and are well equipped with quality health services. In rural areas, health care facilities are mostly basic health units, or rural health centers that lack qualified or trained staff. In Pakistan, urban area residence and provision of medical facilities are closely related. Similarly, per head household income is closely related to household size. The larger the size of the household, the lower is the per head income and vice versa. A big household size has a negative effect on child health because resources get distributed over a large family and hence, and less is available for an individual's needs. However, if household size is small, more resources are available for child's health and education. The significant effects of these variables are evident but sometimes, may result in collinear effects. In structural equations models, a very high multi-collinearity is unlikely to happen (is assumed absent) as this will result in singular covariance matrices that cannot perform certain calculations (matrix inversion) and prevent SEM solution. However, in present results, multi-collinearity is not a significant problem. The results of estimates are unbiased, value of *R* squared is low and *t*-tests of coefficients are significant. However, in some cases, assessments of the relative strength of related variables (medical facilities and urban area residence) can be weak. The results of model 3 show that all coefficients have the expected right signs. Model 4 present results for area of residence that turns out to be positive and significant. In all models, the overall fit as represented by χ^2 and AGFI is very good. The measurement models are not affected, in their effect on child health indicators. All the measurement models have significant effect and expected right signs. The effect of permanent health on transitory health (B21) is positive and significant in all models. *R*-squared is the proportion of variance in the dependent variable predicted from the independent variables. In model 7, value of *R* squared predicted from the independent variables is 0.13. Although, the value is low, for an overall measure of the strength of association, it does not reflect the extent to which one particular independent variable is associated with the dependent variable. In present regressions, the powerful predictors turn out to be parental education, area of residence, and household's socio-economic conditions. These results have implications for social policy, where improvements in education and household's living conditions are positively linked to improvements in child health.

DISCUSSION

To explore the determinants of child health in an economic framework, it is important to see how decisions of households affect child health for given prices, assets and community endowments. Parents derive utility from good child health and disutility from ill-health or morbidity. In an economic framework, utility from health is maximised under two sets of constraints, e.g. (i) resource constraint and

(ii) production function constraint. The production function for health is a technical relationship and shows that health output is produced with the help of certain inputs. Grossman (1972, p. 2) shows that the arguments of the gross investment production function include medical care, time input and education. However, Behrman and Deolalikar (1988, p. 642) examine that "it is important to realise that our knowledge of the technical relations determining health...is quite primitive". This is because health output may be greater if productivity is greater in a production function context. A review of empirical work relating to health and child health reveals that three types of relationships can be explored: demand function, health production function and hybrid functions. Behrman and Deolalikar (1988, p. 646) examine that "reduced form demand relations do not provide much information about the structural coefficients (e.g. education, time inputs, birth control efforts, etc.), but provide a consistent framework within which to examine the impact of changes in market prices and endowments on health".

The present paper estimates a mixed demand-production relation for child health in Pakistan. This is because child health is assumed to be determined by some inputs from the structural production function (such as family size and medical care) and some variables from the reduced form demand relations such as income and household durables. The results show significant determinants of child health from both the relations. The results are not only compatible with other work but add to the understanding of the determinants of child health in Pakistan by using new techniques. Structural equation models have been estimated with unobservable variables. Such techniques have been successfully used among others by Wagstaff (1986, 1993), Van Doorslaer (1987), Behrman and Wolfe (1987) and Shehzad (2004). However, LISREL modelling is still believed to be very complex and not quite often taken up by the researchers. Joreskog and Sorbom (1989) show that LISREL uses confirmatory factor analysis and structural equations typically associated with econometrics to explain latent (unobservable or theoretical) variables. A special case of these relations is MIMIC models that links the two parts of structural relations estimated in LISREL (i) the measurement part and (ii) the structural part. The estimation of MIMIC models for child health enables to capture complex relations in the measurement model and see how their validity is affected after the introduction of the structural equation model. The method of estimation is maximum likelihood (ML) that provides consistent estimates of parameters under the assumption of multivariate normality and is quite robust against departures from normality, see Cuttance (1987). Results of MIMIC models show that unobservable child health states can be represented by several observable health indicators. The measurement model uncovers complex and diverse relationships that exist between observable health indicators but unobservable health states. Other studies that estimate child health for example, Thomas et al. (1991), Barrera (1990), Alderman and Garcia (1994) use a single health indicator as height or weight for age as the dependent variable. However, as Behrman and Deolalkar (1988, p. 650) observe, "the measures differ significantly in regard to their costs and measurement errors and may represent different dimensions of health status". Hence, they urge the need to use multiple indicators to represent health status in an empirical analysis. Present results show that the use of MIMIC models lead to a more comprehensive understanding of the determinants of child health as compared to other studies that rely on single health measures. As results are based on standardised measure, they can now be compared across populations. The unobservability of child health can be overcome successfully with the use of latent variables. PDHS contains rich information on relevant child health indicators and results identify significant effects of family size, household income, and housing characteristics on transitory health distortions. Child illnesses such as diarrhoea, acute respiratory infections and fever are affected by family size, housing and parental education. Results imply that incidence of these illnesses can be reduced by improving housing characteristics (piped water, sanitation and electricity etc.). Child's permanent health has a significant positive impact on child's transitory health deviations. A good permanent health status enables the children to overcome morbidity and helps in quick recovery. However, factors like family size can produce more respiratory infections through increased person-to-person contact. The results support the view that children from large families have deteriorated permanent health and the effect operates through lower per head income; see Birdsall (1988, p. 497). The effect of family size is expected to be negative for child's permanent health and positive for transitory health.

Present results lend support to Grossman's technical efficiency hypothesis: education acts as an efficiency increasing factor in producing health. This is because more educated parents are able to produce more health output for a given level of use of health inputs. Educated parent produce better child health because of their improved awareness of health related matters. They are more capable of using the medical advice when children are sick and can help in quick recovery by taking care of nutrition and food intake of children. Similarly, results lend support to the Chicago-Columbia school for the productivity effects of education. More educated mothers are better producers of child health. The effect of education works through increased awareness and scientific understanding of disease causation. Better-educated mothers appear to demand fewer high quality (healthy) children as compared to more unhealthy children. Demand for child quality is therefore, positively related to parental education. However, the schooling effects of parents do not show the taste formation effect as in the Pennsylvania school. The effect can be captured indirectly by area of residence (urban/rural) that influences taste formation of parents but no real measure (as community endowments) is available to confirm taste formation hypothesis.

The income effect works through increased use of health inputs. More income enables parents to spend more on health-related and other consumption opportunities. The results confirm the Chicago–Columbia school that child quality is a normal good: as income increases, parents demand more child health services. Parents tend to invest more in child quality when income increases. Economic theory suggests that if more income is available to spend on child quality (health), this can result in lower fertility. Birdsall (1988, p. 501) observes a "strong association between low parental income and high fertility and that high fertility is then associated with lower parental spending on children's human capital". She further notes "it is possible to imagine a syndrome of poverty and large family size extending from one generation to the next, producing a kind of underclass...that would become ever-larger and poorer". Therefore, a strong positive effect of income reveals that in a country like Pakistan, increase in income can be taken to discourage child quantity and encourage parent to demand more child quality in terms of better child health.

NOTES

[1] The present exercise uses SPSS Program for carrying out factor analysis. For details of tests and method see SPSS User's Manuals.
[2] It requires that value of the test statistic is large and associated significance level is small, meaning that it is unlikely that the population matrix is an identity.
[3] For useful introduction to path diagrams see: Sorbom and Joreskog (1981) and Joreskog (1982).

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