The Impact of Resource Inflows on Child Health: Evidence from Kwazulu-Natal, South Africa, 1993–98

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This paper investigates changes to the health status of young children (aged 0–5 years) in the Kwazulu-Natal province of South Africa during 1993–98. In our estimation we explicitly take into account the potential endogeneity of household resources in affecting child health. In particular, we examine whether the effect of resources is differentiated by the source, the age and the sex of the recipient. Finally, we also take into account the panel structure of the data and conduct (household level) fixed effects estimation of the determinants of child health. The estimation results show that the state of child health has experienced marked improvement following the dismantling of apartheid. Our results point to the role of household resources and health infrastructure availability in improving the health status of children.

1. INTRODUCTION

Has the dismantling of apartheid led to improved health status of black[1] children in South Africa? As that country came out of white minority rule in the early 1990s, there was widespread hope and anticipation that the end of apartheid and the restoration of democratic governance would lead to a rapid advance in the welfare of the dispossessed black majority. One of the principal components of that welfare is the health of children. An answer to the above question, that constitutes the principal motivation of this paper, will

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provide a significant pointer to the evidence on the wider issue of the welfare of black households in post-apartheid South Africa.

Health and nutrition have important effects on learning, on labour productivity and, more seriously, on child survival and mortality (see [*Strauss and Thomas, 1998*]). Consequently, the subject of child health, as measured by the child's nutritional status, is at the centre of the wider issue of household welfare in developing countries. There is now a large and still expanding literature on child health in developing countries. Examples using data from Africa include the studies by Alderman and Sahn [*1997*] on Mozambique, Hoddinott and Kinsey [*2001*] on Zimbabwe and Maluccio, Thomas and Haddad [*2001*] on South Africa. Studies using data sets from developing countries (predominantly Asia and Africa) consistently show that malnutrition in children raises the risk of death with underweight children contributing to 25 per cent to 50 per cent of childhood mortality. Pelletier [*1991*] observed a sharp increase in childhood mortality as nutritional status worsens (see [*World Development Report, 1993: Fig. 4.1*]). Malnutrition among children is widespread in developing countries.[2]

In an influential article, Waterlow *et. al*. [*1997*] established that a child's 'height for age' and 'weight for height' are good indicators of his/her nutritional status. Consequently, this study focuses on these concepts and uses them as dependent variables in the analysis of child health, and of its key determinants in South Africa. While a child's 'height for age' is an indicator of his or her long run nutrition status reflecting the child's past nutritional experience, 'weight for height' is an indicator of short run or current nutritional status. Malnutrition on account of low child 'height for age' causes *stunting*, while a low 'weight for height' is associated with *wasting*. The Z-score method, recommended by the World Health Organisation, is used to measure a child's 'height for age' and 'weight for height' as follows. The child's height is expressed as a number of standard deviations above or below the corresponding US median for a child of the same age and sex to obtain the Z-score of height for age. The 'weight for height', which is gender and height specific, is a ratio of the child's weight in kilograms to height in centimetres, expressed as a function of a norm which is also based on US measurements. The Z-score for 'weight for height' is then calculated as a multiple of its standard deviation similar to the Z-score for 'height for age'.

The primary focus of this paper is on the analysis of the determinants of the child's anthropometric status in South Africa. Of particular importance are the sign and magnitude of the coefficients of the key resource variables. Unlike most previous studies, we recognise the (potential) endogeneity of the income/resource variables appearing as regressors in the Z-score equations. Our estimation methodology therefore avoids the criticisms of Thomas, Strauss and Henriques [*1990*] who argue that the use of household income as an exogenous, explanatory variable is likely to generate simultaneity bias in the OLS estimated equations. The problem of endogeneity arises because the resource inflow variables could be correlated with the unobserved determinants of child anthropometric status leading to inconsistency in the OLS estimates. As a referee noted, however, one has to take care in choosing 'valid' instruments to tackle the problem of endogeneity. Valid instruments are those that are correlated with the outcome of interest, namely, child health in this paper. To confirm this point, we calculate and report the Sargan 'validity of instrument test', as outlined in Stewart and Gill [*1998: 143*], that checks the assumptions underlying the choice of instruments. As we report later, the Sargan test results provide support to the instruments used in the IV (2SLS) and the 3SLS regressions.

An additional feature of the present analysis is that it is consistent with the 'collective' model of intrahousehold resource allocation (see [*Thomas, Contreras and Frankenberg, 1997, Browning and Chiappori, 1998*], among others). In the spirit of such a framework, this paper distinguishes between the various components of household resources based on the source of the resource, the gender and age group of the resource recipient inside the household. The last distinction is of particular significance in the South African context in view of the tendency of three or more generations to live together as a 'household' in that country. Interestingly we are generally unable to reject the null hypothesis of 'unitary' household and find that the source and the recipient do not matter.

To be able to analyse whether the dismantling of apartheid has had any effect on child health we need data at least at two points in time – prior to the dismantling of apartheid and after. The ideal data set would have information on the same set of children at the two points in time – individual level panel data. However, such a data set is not available. What we have is a household level panel data. In 1993 the World Bank and the South Africa Labour and Development Research Unit (SALDRU) at the University of Cape Town conducted the South Africa Integrated Household Survey (SIHS) – a national survey of households in South Africa. Households that resided in Kwazulu-Natal were re-interviewed in 1998 as a part of the Kwazulu-Natal Income Dynamics Study (KIDS). While the households in the two data sets constitute a panel, this is not true of the children living in these households – the 1993 sample includes children born between 1988 and 1993 and the 1998 sample includes children born between 1993 and 1998. For estimation purposes we therefore restrict ourselves to data from Kwazulu-Natal.

The rest of this paper is organised as follows. Section II describes the data and presents the summary evidence on health care facilities and child health in South Africa. The framework for the estimation of the Z-score equations is discussed in Section III. The results are presented and analysed in Section IV. Concluding comments are presented in Section V.

II. DATA AND DESCRIPTIVE STATISTICS

The study is based on two data sets. The first is the South Africa Integrated Household Survey (SIHS) conducted in 1993, jointly by the World Bank and the South Africa Labour and Development Research Unit (SALDRU) at the University of Cape Town, as a part of the Living Standard Measurement study (LSMS) in a number of developing countries. These data will henceforth be referred to as the SIHS data. The survey was conducted in the nine months preceding the historic 1994 elections. The SIHS is the first survey that covers the entire South African population, including those in the predominantly black 'homelands'.[3] The complete sample consists of approximately 9,000 households drawn randomly from 360 clusters. The questionnaire and summary statistics used in SIHS are contained in SALDRU [*1994*]. Since the focus of this paper is on Kwazulu-Natal, we consider only the subset of households in the SIHS data set that resided in that province. Anthropometric data are available for children that were less than (or equal to) 60 months of age at the time of the survey. In addition because of reasons specified later, we include in our estimating sample only black children.

The second data set used in the study is the Kwazulu-Natal Income Dynamics Study (KIDS) data. Households in the SIHS data set that resided in the Kwazulu-Natal province were re-interviewed in 1998 for the Kwazulu-Natal Income Dynamics Study (KIDS).[4] More than 84 per cent of the original sample of black households from the SIHS data set residing in Kwazulu-Natal in 1993 were successfully reinterviewed in 1998. In comparison with panel data sets available elsewhere, for example Peru (Lima) and Indonesia, given the length of time between the SIHS and the KIDS data sets and, considering the mobility of the South African population in the post-apartheid period, a resurvey rate of 84 per cent appears quite satisfactory. Once again anthropometric data are available for children that were less than (or equal to) 60 months of age at the time of the survey. So the 1993 sample includes children born between 1988 and 1993 and the 1998 sample includes children born between 1993 and 1998. Therefore while the households in the two data sets constitute a panel, this is not true of the children living in these households. Following the suggestion of an anonymous referee, we restrict the sample to include children with Z-values between – 6 and + 6, that is, we omit outliers.[5]

One point regarding the data is worth noting. The Southern Africa Labour Development Research Unit in the School of Economics at the University of Cape Town (SALDRU), which implemented the South Africa Integrated

Household Survey in conjunction with the World Bank discovered during a follow up study in one of the provinces this year that data collected in two of the clusters in the 1993 study should be viewed as highly unreliable and therefore removed from the data set. The clusters are 217 and 218, in the Kwazulu province. Both clusters are in the rural area. Together they represent 39 households and 287 individuals. In our estimation we deleted households from these two clusters. When the first version of the paper was written (August 2001) we were unaware of this problem. However, for subsequent revisions (October 2001 and beyond) we re-estimated our model ignoring the fabricated data. The results however did not change significantly, a result that is consistent with previous work using the SIHS and KIDS data sets. See, for example, Maluccio, Haddad and May [*2000*].

We exploited the panel nature of the household level data by running household fixed effects regression of household means of height for age Z-scores, for the subset of Kwazulu-Natal households with children in both surveys (SIHS and KIDS), on the set of determinants. As an anonymous referee pointed out, the household level fixed effects regressions purge the results of time invariant characteristics, thus providing considerably improved estimates.[6] However, in this case we lose out on child specific variation.

Table 1 provides evidence on the changing picture of health care facilities in Kwazulu-Natal province between 1993 and 1998. Clearly, in most cases, where comparable figures are available, we see a marked improvement in

TABLE 1
PROPORTION OF CLUSTERS IN KWAZULU-NATAL WITH THE SPECIFIC PERSONNEL/FACILITY

	1993	1998
Hospital	0.80	
Public hospital		0.73
Private hospital		0.35
Dispensary	0.13	0.78
Pharmacy	0.17	0.72
Maternity clinic	0.13	0.67
Clinic	0.49	0.90
Family planning clinic	0.45	0.86
Doctor	0.40	
Private doctor		0.57
Nurse	0.55	
Pharmacist	0.19	
Midwife	0.28	
Family planning worker	0.36	0.30
Health worker	0.32	
Traditional healer	0.24	0.91

Notes: Sample consists of panel households from Kwazulu-Natal.

health care facilities. For example, there has been a manifold increase in the availability of dispensaries, pharmacies and maternity clinics.

Tables 2 and 3 present the summary evidence on changes to child health in Kwazulu-Natal during the five years, 1993–98, as measured by the mean Z-scores (Table 2) and by the distribution of children in the various categories of malnutrition (Table 3). Following Kassouf and Senauer [*1996*] we categorise children according to the following classification of malnutrition: (1) Severe: Z-score < -3; (2) Moderate: Z-score lies in the interval $(-3, -2)$; (3) Mild: Z-score lies in the interval $(-2, -1)$; (4) Normal: Z-score > -1.

It is clear that there has been a definite and significant improvement in the state of child health of black children, as confirmed by the statistically significant t-values reported in the last two columns. This is true of both boys and girls in the black households. Note, for example, from Table 3 that the percentage of black children in Kwazulu-Natal who do not suffer from malnutrition has increased significantly on account of both height for age (HAZ) and weight for height (WHZ). The indifferent or unsatisfactory performance of Indian children, in contrast, possibly reflects the small sample size, and should not be taken to be conclusive evidence. Because of the small sample size associated with the Indian sub-sample, for our estimation we restrict ourselves to black households only.

We also present the Kernel density estimates of the Z-scores for the black children residing in Kwazulu-Natal in 1993 and 1998, presented in Figure 1 (height to age Z-score – HAZ) and Figure 2 (weight to height Z-score – WHZ). The kernel density estimates show that the distributions are quite

TABLE 2
CHANGE IN CHILD ANTHROPOMETRIC STATUS, 1993–1998

	1993			1998			Difference between 1998 and 1993	
	Count	HAZ	WHZ	Count	HAZ	WHZ	HAZ	WHZ
All children	792	– 1.06	0.23	675	– 0.72	0.58	0.34 (3.64)	0.35 (4.18)
Girls	397	– 1.03	0.33	333	– 0.67	0.55	0.36 (2.77)	0.22 (1.95)
Boys	395	– 1.08	0.12	342	– 0.77	0.60	0.31 (2.39)	0.48 (3.90)
Black children	713	– 1.14	0.29	649	– 0.71	0.61	0.43 (4.44)	0.32 (3.68)
Indian children	79	– 0.29	0.32	26	– 0.89	0.58	– 0.60 (– 1.78)	0.26 (0.40)

Notes: t-values in parentheses.

TABLE 3
CHANGES IN THE PERCENTAGE OF CHILDREN BY Z-SCORE CATEGORIES, 1993–98

Z-Score interval	Degree of malnutrition	1993			1998			Difference between 1998 and 1993	
		All	Black	Indian	All	Black	Indian*	All	Black
Height for age (HAZ)									
< − 3	Severe	0.1199	0.1318	0.0127	0.0874	0.0832	0.1923	− 0.0325 (− 2.027)	− 0.0486 (− 2.880)
(− 3, − 2)	Moderate	0.1263	0.1374	0.0253	0.1378	0.1356	0.1923	− 0.0115 (0.650)	− 0.0019 (− 1.000)
(− 2, − 1)	Mild	0.2639	0.2679	0.2278	0.2385	0.2450	0.0769	− 0.0254 (− 1.115)	− 0.0229 (− 0.966)
> − 1	Normal	0.4899	0.4628	0.7342	0.5363	0.5362	0.5385	0.0464 (1.772)	0.0734 (2.705)
Weight for height (WHZ)									
< − 3	Severe	0.0379	0.0407	0.0127	0.0119	0.0108	0.0385	− 0.0260 (− 3.128)	− 0.0299 (− 3.434)
(− 3, − 2)	Moderate	0.0543	0.0533	0.0633	0.0222	0.0185	0.1154	− 0.0321 (− 3.142)	− 0.0348 (− 3.412)
(− 2, − 1)	Mild	0.1124	0.1024	0.2025	0.0696	0.0663	0.1538	− 0.0427 (− 2.814)	− 0.0361 (− 2.386)
> − 1	Normal	0.7955	0.8036	0.7215	0.8963	0.9045	0.6923	0.1008 (5.276)	0.1008 (5.229)

Notes: *: Sample size is very small.
Figures in parentheses are t-values.

FIGURE 1
KERNEL DENSITY ESTIMATES OF HAZ – BLACK CHILDREN

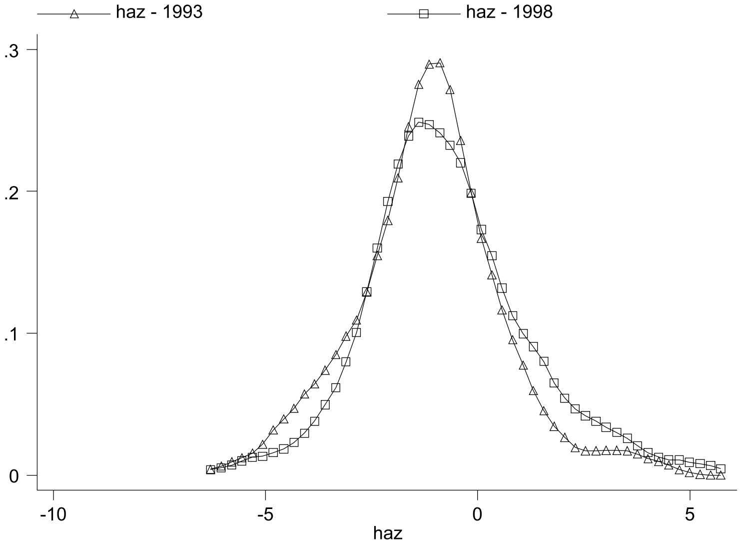
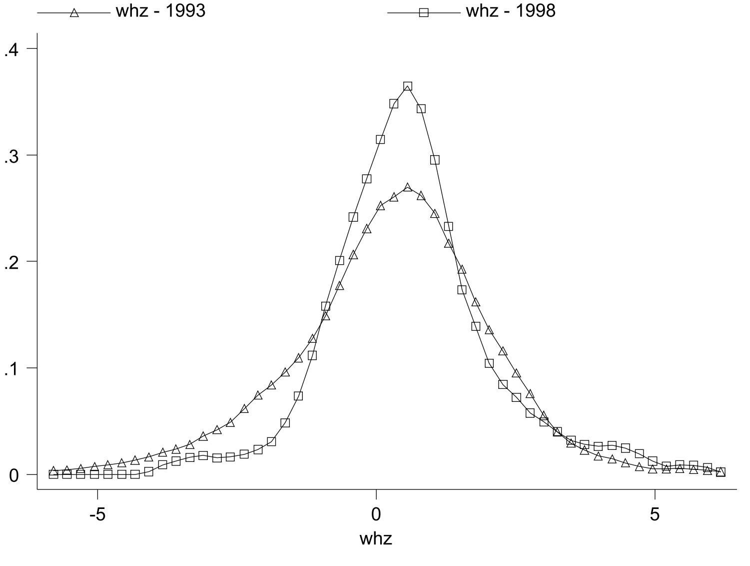


FIGURE 2
KERNEL DENSITY ESTIMATES OF WHZ – BLACK CHILDREN



different between the two years. This finding is confirmed using the Kolmogorov–Smirnov equality of distribution test. In both cases the equality of distributions is rejected. The associated p-values are 0.0001 (for HAZ) and 0.000 (for WHZ). Clearly therefore, not only has the mean state of child health changed but so has the distribution during the period 1993–98.

III. ESTIMATION FRAMEWORK

Let us consider the static model of the household, where household welfare W depends on the utility of each member $n(=1,\ldots,N)$, so that the household welfare function can be written as:

$$W = W(\{U_n\}_{n=1}^{N}). \quad (1)$$

Each individual's utility function U_n depends on the commodity consumption of all household members X_{in}, where $i=1,\ldots,G$, goods, the consumption of leisure by each member of the household $\{L_n\}_{n=1}^{N}$ and also a vector of H home produced goods $\theta_{1n},\ldots,\theta_{Hn}$ $(n=1,\ldots,N)$, for example, health, education and nutrition of each household member. This paper focuses on one particular element of θ, namely, the health of children as measured by their anthropometric status. In addition, household utility is assumed to depend on a set of household specific characteristics λ_h so that each individual's utility can be written as $U_n=U_n(X_1,\ldots,X_G,L,\ \theta;\lambda_h,e)$, where e denotes unobserved heterogeneity. The individual utility functions can be aggregated to obtain the household welfare function. The household therefore maximises the welfare function given by equation (1), subject to the household budget constraint and a production function for each element of θ. The household budget constraint can be written as:

$$p'\,X = \sum_n I_n \quad (2)$$

where p denotes the price vector and I_n denotes the household resources accruing to individual $n(=1,\ldots,N)$. The production function for each component of θ can be specified as:

$$\theta = \theta\ (k, \lambda_n, \lambda_n, \lambda_c \vartheta) \quad (3)$$

where k denote inputs (that might either be purchased in the market or might be non-marketable), a set of observed individual, household and community characteristics (λ_n,λ_h,λ_c) and a set of unobservables (ϑ). For example, child health is produced by a set of inputs (time spent in child care, nutrient intakes, preventive and curative health care usage, sanitation practices), individual characteristics (age, sex, innate healthiness), a set of household characteristics (parental education, household income, household structure) and community characteristics (availability of health care facilities).

Maximising equation (1) subject to the constraints in equations (2) and (3) we get a demand function for each element of the commodity vector, leisure and each element of θ. The determinants of child health will therefore consist of child, household and community characteristics and also individual resource holdings within the household. The child's anthropometric status, measured by the Z-score, can therefore be written as

$$Z_n = f_n(\lambda_n, \lambda_h, \lambda_c, I_h; \varepsilon) \tag{4}$$

where I_h denotes total household resources and:

$$I_h \equiv U_h + E_h + P_h + R_h \tag{5}$$

where U, E, P, R denote, respectively, unearned income, earned income, pensions, and private transfers/remittances. In the context of South Africa, R is a significant component of total household resources, I.

OLS estimation of (4) will suffer from, principally, two problems:

(a) As already noted, it ignores the endogeneity of household income, I_h, which is jointly determined with child health and other household outcomes. Further, it is quite likely that household resources or at least some of the components of household resources are correlated with the unobserved determinants of child health. OLS estimates will therefore be inconsistent.

(b) It ignores the distinction between the various components of income (U, E, P, R) by assuming that these income flows are pooled in the achievement of household outcomes, such as child health, as the unitary model does. Equation (4) also ignores the distinction between resource inflows based on the gender of the recipient by assuming that men and women pool their resources in achieving the desired child health outcome.

This paper overcomes these restrictive features by adopting a simultaneous equation framework that treats the resource inflows as jointly endogenous with the Z-scores. We follow our earlier work [*Maitra and Ray, 2002b*] in distinguishing between the resource inflows based on the source of the resource and gender of the recipient.

Denoting *m, f* for male and female, respectively, we extend (4) and write the child health equation as follows:

$$Z_n = f_n(\lambda_n, \lambda_h, \lambda_c, \underline{U_{mh}}, \underline{U_{fh}}, \underline{E_{mh}}, \underline{E_{fh}}, \underline{P_{mh}}, \underline{P_{fh}}, \underline{R_{mh}}, \underline{R_{fh}}; \beta) \tag{6}$$

where *n* denotes the child, *h* denotes the household that the child comes from, the λs are the predetermined exogenous, vector of determinants, ε_n is the stochastic error term, β the parameter vector, and the other variables are as defined before. The endogenous resource variables appearing on the right-hand side of equation (6) have been underlined. The estimation procedure involves 3SLS estimation of the set of nine simultaneous equations consisting of the eight resource equations and the child health equation given by (6). Earned income and pensions are allowed to depend on one another, besides unearned income and the other household characteristics. Remittances received by males and females within the household are assumed to depend on both the earned income and social pensions received by the different members of the household, in addition to unearned income and other household characteristics. Note, therefore, that the estimation not only recognised the joint endogeneity and mutual dependence of the resource variables and child health, but also allowed mutual feedback between the nine equations via a non-diagonal covariance matrix of the errors. To the best of our knowledge, there are no papers that examine the relationship between the different components of household resources and child health as attempted here. The papers that are closest to the spirit of the present paper are due to Duflo [*2000a, 2000b*]. However, those papers examine the effects of the social pension programme in South Africa on child health and are not concerned with the other forms of resource flows into the household. In particular, these papers do not account for private remittances, which have been shown to be of significant importance in the South African context [*Maitra and Ray, 2002a*].

The validity of the instruments is essential for correcting the problem of inconsistency that affects the OLS estimates in case the resource variables are endogenous. The Sargan statistics, that we report to check on the validity of the instruments used here, is defined as the ratio of the weighted sum of squares that the IV estimator minimises and the IV estimator of the variance of the disturbance vector. Under the null hypothesis that the instruments are valid, the test statistic has an approximate χ^2 distribution with degrees of freedom given by the difference between the number of instruments and the

TABLE 4
OLS, 3SLS and IV ESTIMATES OF HAZ FOR BLACK CHILDREN, 1993 AND 1998

	1993						1998					
	OLS		3SLS		IVREG		OLS		3SLS		IVREG	
	Coeff.	t-val	Coeff.	t-val	Coeff.	t-val	Coeff.	t-val	Coeff.	t-val	Coeff.	t-val
Boy	– 0.0697	– 0.53	– 0.0783	– 0.55	– 0.1190	– 0.83	– 0.1000	– 0.68	– 0.0837	– 0.56	– 0.1198	– 0.71
Age in months	– 0.0108	– 2.74	– 0.0132	– 2.98	– 0.0120	– 2.77	– 0.0127	– 2.61	– 0.0141	– 2.79	– 0.0091	– 1.63
Male unearned income	0.0007	0.44	– 0.0279	– 3.80	– 0.0046	– 1.14	0.0002	1.38	0.0007	1.06	0.0009	1.17
Female unearned income	– 0.0005	– 0.73	0.0022	0.50	0.0031	0.72	0.0000	– 0.04	0.0076	1.97	0.0039	1.23
Male earned income	0.0001	0.10	0.0056	2.83	0.0002	0.22	0.0009	2.25	0.0018	1.17	0.0029	2.06
Female earned income	0.0003	0.45	– 0.0026	– 1.20	0.0023	1.24	– 0.0004	– 1.02	– 0.0001	– 0.07	– 0.0022	– 1.43
Male social pension received	0.0006	0.20	– 0.0281	– 2.14	– 0.0109	– 0.77	– 0.0032	– 0.83	– 0.0045	– 0.44	– 0.0003	– 0.03
Female social pension received	0.0001	0.05	0.0227	2.60	0.0084	0.82	0.0028	0.99	0.0137	1.22	0.0055	0.41
Male remittance received	– 0.0037	– 0.85	0.0479	2.08	0.0101	0.38	0.0027	0.51	– 0.0114	– 0.65	0.0039	0.19
Female remittance received	0.0017	0.99	0.0200	2.90	0.0026	0.35	– 0.0003	– 0.21	– 0.0092	– 1.77	0.0006	0.09
Total number of children in household	0.0250	0.87	– 0.7388	– 1.99	0.0538	1.56	0.0477	1.69	0.0550	1.56	0.0876	2.19
Total number of males aged 18–64	– 0.0547	– 1.08	0.0162	0.43	– 0.0279	– 0.45	– 0.0141	– 0.29	– 0.0213	– 0.32	– 0.0733	– 1.04
Total number of females aged 18–59	– 0.0822	– 1.46	– 0.0001	– 0.31	– 0.1345	– 1.77	0.0136	0.29	– 0.0034	– 0.06	0.0280	0.47
Total number of males aged 65 or higher	0.1371	0.52	0.1040	2.61	0.5393	0.99	0.2337	0.90	0.4830	0.97	0.3311	0.57
Total number of females aged 65 or higher	– 0.1223	– 0.62	– 0.1012	– 1.54	– 0.5315	– 1.00	0.0211	0.12	– 0.1225	– 0.26	– 0.0583	– 0.10
Male head of household	– 0.0642	– 0.36	– 0.1055	– 1.36	– 0.4569	– 1.21	0.2464	1.21	0.4858	1.26	0.1151	0.28

(continued)

TABLE 4 (*continued*)

	1993						1998					
	OLS		3SLS		IVREG		OLS		3SLS		IVREG	
	Coeff.	t-val	Coeff.	t-val	Coeff.	t-val	Coeff.	t-val	Coeff.	t-val	Coeff.	t-val
Age of household head	−0.0167	−0.54	0.9924	1.98	0.0036	0.11	−0.0031	−0.08	0.0338	0.81	−0.0042	−0.10
Square of age of household head	0.0001	0.52	−1.1891	−2.59	0.0000	−0.08	0.0000	0.10	−0.0004	−1.08	0.0000	−0.10
Highest education of household head – primary school	−0.0479	−0.32	−0.1294	−0.73	−0.0931	−0.53	0.0307	0.17	−0.0760	−0.40	0.0675	0.32
Highest education of household head – middle school	−0.1853	−0.84	−0.4244	−1.38	−0.1054	−0.41	0.2024	0.85	−0.0853	−0.33	−0.1177	−0.41
Highest education of household head – secondary school	−0.1885	−0.44	−0.7252	−1.05	−0.3600	−0.69	−0.9614	−1.23	−0.9443	−1.05	−1.0828	−1.04
Doctor in cluster	−0.3604	−1.81	−0.3894	−1.89	−0.3046	−1.41						
Private doctor in cluster							−0.1284	−1.59	−0.0648	−0.78	−0.1037	−1.21
Nurse in cluster	0.4567	2.34	0.3062	1.25	0.2969	1.45						
Pharmacist in cluster	0.8761	1.54	0.9732	1.66	0.4412	0.90						
Midwife in cluster	−0.2421	−0.70	−0.2969	−0.78	−0.3792	−1.46						
Family planning worker in cluster	0.0064	0.02	0.0091	0.02	0.1088	0.32	0.0979	0.75	0.0583	0.39	0.3172	2.07
Health worker in cluster	0.3244	1.16	0.2031	0.70	0.4709	1.69						
Traditional healer in cluster	−0.2462	−1.43	−0.1788	−1.00	−0.2854	−1.55	−0.0162	−1.21	−0.0058	−0.34	−0.0077	−0.42
Number of hospitals in cluster	1.5690	2.13	1.4203	1.66	0.9860	1.67						

(continued)

TABLE 4 (*continued*)

	1993						1998					
	OLS		3SLS		IVREG		OLS		3SLS		IVREG	
	Coeff.	t-val	Coeff.	t-val	Coeff.	t-val	Coeff.	t-val	Coeff.	t-val	Coeff.	t-val
Number of public hospitals in cluster							0.1452	0.77	0.0342	0.17	0.0709	0.34
Number of private hospitals in cluster							– 0.0423	– 0.25	– 0.1116	– 0.59	0.0264	0.14
Number of dispensaries in cluster	– 0.7227	– 1.89	– 0.4514	– 1.08	– 0.5841	– 1.49	– 0.2855	– 1.34	– 0.0472	– 0.17	– 0.0768	– 0.40
Number of pharmacies in cluster	– 0.8657	– 0.84	– 0.5831	– 0.55	– 0.2514	– 0.87	– 0.1765	– 2.93	– 0.1692	– 2.69	– 0.1608	– 2.39
Number of maternity clinics in cluster	– 0.1270	– 0.50	– 0.1689	– 0.55	0.0317	0.10	0.1743	0.70	0.3536	1.08	0.4378	1.37
Number of clinics in cluster	– 0.2114	– 0.67	– 0.2759	– 0.79	– 0.0171	– 0.05	0.1011	0.71	0.0648	0.40	0.0285	0.19
Number of family planning clinics in cluster	– 0.0197	– 0.05	– 0.0633	– 0.15	– 0.2059	– 0.53	– 0.2390	– 1.12	– 0.5376	– 1.47	– 0.3864	– 1.19
New health service in cluster							– 0.3930	– 2.13	– 0.3361	– 1.67	– 0.3908	– 1.82
New health facility in cluster							– 0.1088	– 0.43	– 0.0430	– 0.16	– 0.2143	– 0.80
New immunisation centre in cluster							0.1490	0.43	0.0692	0.13	– 0.3349	– 0.64
Constant	– 0.0669	– 0.08	– 1.1200	– 1.12	– 0.5459	– 0.62	– 0.1917	– 0.17	– 1.1160	– 0.83	– 0.2559	– 0.19
Equality of male and female unearned income#	0.49		12.68***		1.33		0.18		2.92*		0.81	

(*continued*)

TABLE 4 (*continued*)

	1993						1998					
	OLS		3SLS		IVREG		OLS		3SLS		IVREG	
	Coeff.	t-val	Coeff.	t-val	Coeff.	t-val	Coeff.	t-val	Coeff.	t-val	Coeff.	t-val
Equality of male and female social pension received#	0.01		6.43**		0.74		1.61		0.86		0.07	
Equality of male and female remittances received#	1.43		1.45		0.08		0.32		0.02		0.03	
Joint significance of health service variables##	1.84**		22.74***		1.70		2.66***		22.19**		1.92**	

	1993	1998
Are children more than 36 months of age different? (Joint test of AGECAT+ and interaction terms) ###	29.41	47.67
Durbin–Wu–Hausman Test (F-test)	1.57	1.37
Breusch–Pagan Test for non-diagonal covariance matrix ($\chi^2(36)$)	31.939	70.666***
Sargan Test for overall validity of instruments####	13.55	14.34
Equation by equation test for significance of additional exogenous variables as instruments		
Male unearned income ($\chi^2(19)$ for 1993; $\chi^2(7)$ for 1998)	91.03***	8.22
Female unearned income ($\chi^2(19)$ for 1993; $\chi^2(7)$ for 1998)	83.82***	11.02
Male earned income ($\chi^2(17)$ for 1993; $\chi^2(14)$ for 1998)	91.02***	98.39***
Female earned income ($\chi^2(17)$ for 1993; $\chi^2(14)$ for 1998)	73.73***	78.25***
Male social pension received ($\chi^2(1)$ for 1993; $\chi^2(1)$ for 1998)	101.74***	169.83***
Female social pension received ($\chi^2(1)$ for 1993; $\chi^2(1)$ for 1998)	107.74***	39.21***
Male remittance received ($\chi^2(5)$ for 1993; $\chi^2(4)$ for 1998)	6.23	16.78***
Female remittance received ($\chi^2(5)$ for 1993; $\chi^2(4)$ for 1998)	5.83	32.97***

Notes: +: AGECAT = 1 if age of child < 6 months or age of child > 36 months, 0 otherwise.
#: F-test for OLS and IVREG, χ^2 test for 3SLS.
##: F-test for OLS and IVREG, χ^2 test for 3SLS.
###: $\chi^2(34)$ for the 1993 sample; $\chi^2(42)$ for the 1998 sample.
####: $\chi^2(15)$ for the 1993 sample; $\chi^2(21)$ for the 1998 sample. Significance: ***: 1%; **: 5%; *: 10.

number of regressors on the right-hand side of the equation to be estimated. See Stewart and Gill [*1998: 143*] for more details.

IV. RESULTS

Results Using Year Specific Regressions

Table 4 presents the OLS, 3SLS and IV (2SLS) estimates of the child health regressions in 1993 and 1998. The regression estimates of the resource variables corresponding to the 3SLS estimates in 1993 and 1998 are presented in the Appendix (Tables A1 and A2 respectively). A comparison of the OLS and 3SLS estimates allows us to examine whether ignoring the (potential) endogeneity of the resource variables results in incorrect predictions regarding the effect of the resource variables on child health. Because of space constraints, we have only reported the regression estimates of the height for age Z-scores (HAZ), which reflect the child's long run nutritional status. The corresponding estimates for WHZ are available on request. However, it is worth remembering that HAZ being a measure of long run nutrition status is a more important measure of child health status compared to WHZ, which is a measure of short run or current health status, given the observed relationship between health, productivity (as adults) and wages [*Strauss and Thomas, 1998*].

Both for the 1993 and the 1998 regressions, the OLS and 3SLS estimates are generally qualitatively similar, though it is worth noting that the effect of the household resource inflow variables is stronger in the 3SLS estimates. We estimated the Durbin–Wu–Hausman augmented regression to test for the joint exogeneity of the resource inflow variables. To do this, we regressed the (potentially) endogenous resource inflow variables on all the exogenous variables in the system and used the predicted values from these regressions as additional explanatory variables in the child health regressions. These variables turned out to be insignificant implying that the OLS estimates are close to being consistent. The Breusch–Pagan Test Statistic showed that the null hypothesis of diagonal covariance matrix is rejected for the 1998 sample, but not for the 1993 sample.[7] In other words, while cross equation feedback between the errors in the simultaneous equation system consisting of the child health and the resource inflow variables equations is of some importance on the 1998 data, the endogeneity of the resource inflow variables is not much of an issue on either of the two data sets. The latter observation is confirmed by the insignificance of the Durbin–Wu–Hausman statistic reported in Table 4. The Sargan test statistics, reported in Table 4, confirm the validity of the instruments used here. Moreover, the equation wise joint tests of the significance of the additional exogenous variables in the resource equations provide support for their use here as additional instruments. The overall message from our diagnostic checking is that the estimates in Table 4 do not suffer from any serious bias or inconsistency. The qualitative picture, though not the quantitative one, seems fairly robust to the estimation method. Table 4, also, shows that, using a χ^2 test by including a child age group dummy (AGECAT[8]) and interacting it with the explanatory variables, we found no evidence to suggest a structural shift in the estimated child health equation between very young children ($<$ 6 months) and older children ($>$ 36 months) and those in between.

There are several important differences between the sign and magnitudes of the estimated coefficients in 1993 and 1998. This suggests that not only did child health in Kwazulu-Natal in South Africa improve significantly between 1993 and 1998 (see Tables 2 and 3), there was also a change, both qualitatively and quantitatively, in the determinants of child health over this period.

Of particular interest in this study is the impact of the resource variables, distinguished by the gender of the resource recipient and the nature of the resource inflow, on child health. The 3SLS estimates show that, in 1993, most of the resource inflows have statistically significant impact on child health though, like most of the other determinants, the significance weakens in 1998. The pooling hypothesis that underlines the unitary model implies equality, across gender of the resource recipient, of the impact of the resource components on child health. Table 4 shows that in 1993 the pooling hypothesis is rejected at 5 per cent significance level for unearned income and social pensions, but not for remittances received. In 1998, however, the pooling hypothesis cannot be rejected at 5 per cent level for most of the resource components.

In most cases, the health service variables (for example number of clinics or dispensaries in cluster) do not exhibit significant impact on child health. It would be incorrect, however, to infer from this that the health infrastructure does not affect child health since, as Table 4 reports, under both the OLS and 3SLS, the health service variables are jointly significant at 5 per cent level of significance. The individual insignificance of the health service variables possibly reflects multicollinearity between their cluster level aggregates. Moreover, as an anonymous referee pointed out, there is likely to be correlation between the health service availability of health infrastructure variables and the disturbance term. Note that the fact that child health is only weakly correlated with the health infrastructure variables is neither surprising nor new. Indeed several studies (summarised in [*Thomas and Strauss, 1998*]) have argued that local infrastructure could be endogenous in the child health regressions. This could happen because of two reasons. First, individuals might choose their residence based on the availability of public health services (see [*Rosenzweig and Wolpin, 1988*]). Second, local infrastructure

TABLE 5

DOES ENDOGENEITY OF SOCIAL PENSION RECEIVED MAKE A DIFFERENCE? 3SLS ESTIMATES OF HAZ FOR BLACK CHILDREN, 1993 AND 1998

	1993				1998			
	Pension endogenous		Pension exogenous		Pension endogenous		Pension exogenous	
	Coefficient	t-value	Coefficient	t-value	Coefficient	t-value	Coefficient	t-value
Male unearned income	– 0.0278	– 3.79	– 0.0273	– 3.66	0.0007	1.06	0.0010	1.51
Female unearned income	0.0022	0.51	– 0.0049	– 1.17	0.0076	1.97	0.0072	1.88
Male earned income	0.0055	2.78	0.0034	1.86	0.0018	1.17	0.0022	1.55
Female earned income	– 0.0026	– 1.20	0.0021	1.05	– 0.0001	– 0.07	– 0.0001	– 0.07
Male social pension received	– 0.0284	– 2.16	0.0094	2.27	– 0.0045	– 0.44	– 0.0043	– 1.04
Female social pension received	0.0225	2.57	– 0.0008	– 0.27	0.0137	1.22	0.0018	0.61
Male remittance received	0.0484	2.10	0.0650	2.74	– 0.0114	– 0.65	– 0.0156	– 0.92
Female remittance received	0.0196	2.84	0.0234	3.46	– 0.0092	– 1.77	– 0.0098	– 2.05
Equality of male and female unearned income ($\chi^2(1)$)	12.64***		8.07***		2.92*		2.50	
Equality of male and female social pension received ($\chi^2(1)$)	6.44**		3.66*		0.86		1.39	
Equality of male and female remittances received ($\chi^2(1)$)	1.56		3.12*		0.02		0.13	

Note: Significance: ***: 1%; **: 5%; *: 10

itself might be placed selectively by public policy, perhaps in response to local health conditions (see [*Rosenzweig and Wolpin, 1986*]). Note that for the 1993 data set the first issue is unlikely to be particularly important because under the apartheid regime there were severe restrictions on the residential location and mobility of the black population of South Africa. It could be more of an issue for the 1998 data set, but even then selective migration in response to local infrastructure variables is unlikely to be particularly common in a developing country like South Africa.[9] Selective placement of health services is however potentially a much more important issue (particularly for the 1998 data). While we acknowledge this potential endogeneity of the local infrastructure variables we ignore this issue in our estimation because of the lack of good instruments.

Other Issues

An anonymous referee raised the question of whether, since social pensions in South Africa are age contingent, the treatment of pensions as an endogenous regressor in the 3SLS estimation of child health is a valid exercise. To examine this issue, Table 5 reports the sensitivity of the 3SLS estimates of resource impact on child health to the treatment of pensions as an endogenous/exogenous regressor. It is interesting to note that, in 1993, under the exogenous pensions specification, male pensions have a positive impact on child health, the exact reverse of that under the endogenous pensions specification. In 1998, however, under both specifications, pensions do not have any impact on child health.

Do household resources have differential impacts on child health based on the gender of the child? To examine this issue we conduct 3SLS estimation by gender. The results are presented in Table 6. While there are some interesting similarities and dissimilarities between the two sets of estimates, the results are generally supportive of the idea of pooling, underlying the unitary model, in the context of child health. This result is in sharp contrast to the rejection of pooling of household resources in the context of the household's expenditure allocation (see [*Maitra and Ray, 2002a, 2002b*]).

Regression on Panel Data

The estimations reported so far have not exploited the panel nature of the data at the household level. Moreover, since in the above regressions, the dependent variable is the child's age to height Z-score in the two years (1993 and 1998) rather than the change in the Z-scores between these years, the above evidence does not provide any explanation for the improvement in child health over the period 1993–98. Table 7 attempts such an explanation by reporting the results of OLS and fixed effects (difference) estimation of mean child height for age Z-scores for the panel of households that had

TABLE 6
3SLS ESTIMATES OF HAZ FOR BLACK CHILDREN BY GENDER, 1993 AND 1998

	1993				1998			
	Boy		Girl		Boy		Girl	
	Coefficient	t-value	Coefficient	t-value	Coefficient	t-value	Coefficient	t-value
Age in months	– 0.0112	– 1.65	– 0.0080	– 1.41	– 0.0097	– 1.49	– 0.0134	– 1.74
Male unearned income	– 0.0065	– 0.70	– 0.0131	– 1.54	0.0007	1.36	0.0040	3.46
Female unearned income	– 0.0059	– 1.62	– 0.0207	– 1.74	0.0045	1.56	0.0054	1.80
Male earned income	0.0008	0.35	– 0.0024	– 1.16	0.0039	1.90	0.0023	1.85
Female earned income	0.0058	1.99	0.0039	1.47	0.0002	0.11	– 0.0016	– 1.13
Male social pension received	0.0554	3.09	0.0066	0.37	0.0190	1.75	– 0.0095	– 0.71
Female social pension received	– 0.0273	– 2.10	– 0.0062	– 0.64	– 0.0143	– 1.11	0.0093	0.96
Male remittance received	– 0.0136	– 0.64	0.1636	4.86	– 0.0080	– 0.49	– 0.0231	– 1.07
Female remittance received	0.0257	2.40	0.0234	3.02	0.0006	0.12	0.0011	0.21
Total number of children in household	0.1306	2.44	0.1166	1.92	0.0054	0.11	0.0920	1.89
Total number of males aged 18–64	– 0.1172	– 1.18	– 0.1787	– 1.87	– 0.0354	– 0.43	– 0.0175	– 0.21
Total number of females aged 18–59	– 0.2137	– 1.97	– 0.2874	– 2.61	0.0755	1.08	– 0.0127	– 0.15
Total number of males aged 65 and higher	– 1.8646	– 2.52	0.1655	0.22	– 0.4221	– 0.93	0.8041	1.07
Total number of females aged 60 and higher	1.1173	1.75	– 0.4801	– 0.88	0.7831	1.40	– 0.1812	– 0.41
Male head of household	0.6747	1.27	0.6418	1.21	– 0.3033	– 0.63	0.2087	0.55
Age of household head	– 0.0226	– 0.36	– 0.0076	– 0.16	– 0.0587	– 1.06	0.0162	0.28
Square of age of household head	0.0003	0.44	0.0001	0.27	0.0006	1.12	– 0.0003	– 0.59
Highest education of household head – primary school	– 0.3797	– 1.36	– 0.4708	– 1.72	0.0550	0.18	– 0.2614	– 0.84
Highest education of household head – middle school	– 0.6124	– 1.20	– 0.4505	– 0.94	– 0.1905	– 0.54	– 0.0544	– 0.13

(continued)

TABLE 6 (*continued*)

	1993				1998			
	Boy		Girl		Boy		Girl	
	Coefficient	t-value	Coefficient	t-value	Coefficient	t-value	Coefficient	t-value
Highest education of household head – secondary school or higher	– 0.8807	– 0.75	– 1.5336	– 1.86	– 1.2745	– 0.91	– 2.2914	– 2.02
Doctor in cluster	– 0.8062	– 2.35	– 0.1070	– 0.35				
Private doctor in cluster					– 0.0941	– 0.88	– 0.1745	– 1.05
Nurse in cluster	0.7393	2.29	0.3145	0.97				
Pharmacist in cluster	1.5074	1.46	1.1691	1.33				
Midwife in cluster	0.4651	0.77	– 0.4513	– 0.85				
Family planning worker in cluster	– 0.8497	– 1.43	0.9022	1.68	– 0.0316	– 0.18	0.0025	0.01
Health worker in cluster	0.5556	1.14	– 0.3443	– 0.73				
Traditional healer in cluster	– 0.2837	– 1.01	– 0.0184	– 0.07	– 0.0388	– 1.72	– 0.0027	– 0.13
Number of hospitals in cluster	1.4281	0.97	1.0262	0.74				
Number of private hospitals in cluster					– 0.1076	– 0.46	0.0041	0.02
Number of public hospitals in cluster					0.1174	0.41	0.2875	0.99
Number of dispensaries in cluster	– 0.7098	– 1.16	– 1.3987	– 2.11	– 0.5846	– 1.65	0.3540	1.02
Number of pharmacies in cluster	– 1.2694	– 0.77	– 0.7522	– 0.49	– 0.2281	– 3.06	– 0.0147	– 0.13
Number of maternity clinics in cluster	– 0.5401	– 1.06	– 0.0711	– 0.18	0.1598	0.37	– 0.0669	– 0.16
Number of clinics in cluster	– 1.3294	– 2.23	0.0058	0.01	0.1414	0.74	– 0.0159	– 0.06
Number of family planning clinics in cluster	1.0207	1.41	0.0644	0.11	– 0.3548	– 0.75	– 0.4585	– 1.44
Constant	– 0.9231	– 0.61	– 0.5752	– 0.41	1.1234	0.61	– 1.3790	– 0.78
Equality of male and female unearned income ($\chi^2(1)$)	0.00		0.21		1.56		0.20	

(continued)

TABLE 6 (*continued*)

	1993				1998			
	Boy		Girl		Boy		Girl	
	Coefficient	t-value	Coefficient	t-value	Coefficient	t-value	Coefficient	t-value
Equality of male and female social pension received ($\chi^2(1)$)	8.36***		0.27		2.43		0.97	
Equality of male and female remittances received ($\chi^2(1)$)	2.88*		18.92***		0.24		1.27	
Joint significance of health services variables ($\chi^2(13)$ for 1993; ($\chi^2(10)$ for 1998)	21.72*		15.96		33.44***		7.02	

Notes: Significance: ***: 1%; **: 5%; *: 10%

children in the age group 0–5 years in both years. Since the household level fixed effects regression purges the results of time invariant characteristics, the fixed effects estimates are considerably more reliable than the OLS estimates. Note that while the fixed effects estimation controls for household fixed effects, we are forced (by definition) to ignore child specific variation. Table 7 also reports, for comparison, the instrumental variable fixed effects estimates (computed using the XTIVREG option in STATA).

The fixed effects estimation yields the following results:

(a) Increase in household resources has contributed significantly to the improvement in child health in Kwazulu-Natal over this period. Male remittance and females' social pensions record the highest positive contribution to the improvement in child health in both size and significance.

(b) Children in male headed households and those with large number of working age adults have done better than other children in the age group 0–5 years in improving their long run nutritional status during the post-apartheid period.

(c) The education of the household head has also made a positive contribution to improvements in child health in post-apartheid South Africa. With the dismantling of apartheid, there is now much greater opportunity for black adults to benefit from education and for the health of black children to improve as a consequence.

(d) The health service variables, namely, the number of dispensaries and clinics in the cluster, have also contributed significantly to the improvement in child health. This is reflected in the high joint significance of the health service variables under both sets of regressions.

(e) While the idea of pooling of unearned income by the male and female member in the household cannot be rejected at 5 per cent significance level, this principal implication of the unitary model is, however, conclusively rejected in case of social pensions and remittances received. In other words, the contribution of the pension or remittance inflow to the improvement of child health does vary significantly with the gender of the recipient.

(f) A comparison of the fixed effects and IV fixed effects estimates shows that, in general, the positive impact of resource inflows on child health holds in both cases. In other words, both sets of estimates point to increased resource inflows in to the household as explanations for the improvement in child health in Kwazulu-Natal over 1993–98. It is interesting to note that, though the statistical insignificance weakens, the estimated magnitude of the resource impact on child health

TABLE 7
OLS AND FIXED EFFECTS ESTIMATES OF MEAN HAZ AT HOUSEHOLD LEVEL

	OLS		Fixed effects		IV fixed effects	
	Coeff.	t-value	Coeff.	t-value	Coeff.	t-value
Male unearned income	0.0003	2.26	0.0002	0.32	– 0.0139	– 0.83
Female unearned income	– 0.0003	– 0.82	0.0003	0.80	0.0082	0.70
Male earned income	0.0007	2.77	0.0012	2.75	0.0015	0.08
Female earned income	– 0.0003	– 0.86	0.0010	1.75	0.0014	0.14
Male social pension received	– 0.0008	– 0.43	– 0.0007	– 0.21	– 0.0229	– 0.65
Female social pension received	0.0018	1.12	0.0095	3.34	0.0412	0.60
Male remittance received	– 0.0026	– 0.92	0.0140	3.33	0.1182	0.87
Female remittance received	0.0003	0.33	0.0017	1.12	0.0128	0.20
Total number of children in household	0.0324	1.94	0.0316	0.82	0.2206	0.99
Total number of males aged 18–64	– 0.0242	– 0.82	0.0730	0.79	0.3840	0.52
Total number of females aged 18–59	– 0.0088	– 0.30	0.1844	2.41	0.6051	0.80
Total number of males aged 65 or higher	0.1615	1.09	– 0.5373	– 2.08	1.3173	0.82
Total number of females aged 65 or higher	– 0.0168	– 0.16	– 0.0743	– 0.35	0.2102	0.10
Male head of household	0.0213	0.24	0.2607	2.53	1.2884	0.89
Age of household head	– 0.0158	– 0.79	– 0.0920	– 1.68	– 0.2941	– 1.43
Square of age of household head	0.0001	0.73	0.0008	1.55	0.0022	1.37
Highest education of household head – primary school	– 0.0016	– 0.02	0.7705	3.30	0.8206	0.94
Highest education of household head – middle school	0.0654	0.48	0.7848	2.52	1.9309	1.28
Highest education of household head – secondary school	– 0.0570	– 0.19	0.0318	0.05	– 1.3959	– 0.25
Family planning worker in cluster	0.1009	1.22	0.2144	1.58	0.5495	0.70
Traditional healer in cluster	– 0.0252	– 2.45	– 0.0058	– 0.33	0.0032	0.02

(continued)

TABLE 7 (*continued*)

	OLS		Fixed effects		IV fixed effects	
	Coeff.	t-value	Coeff.	t-value	Coeff.	t-value
Number of hospitals in cluster	0.1347	1.89	– 0.0154	– 0.12	0.0389	0.07
Number of dispensaries in cluster	– 0.2484	– 1.86	0.3588	1.21	2.4340	0.62
Number of pharmacies in cluster	– 0.1591	– 3.67	– 0.1513	– 2.70	– 0.1866	– 0.68
Number of maternity clinics in cluster	– 0.0241	– 0.20	0.0195	0.11	0.9782	0.65
Number of clinics in cluster	– 0.0572	– 0.62	0.7542	4.26	0.5748	0.61
Number of family planning clinics in cluster	– 0.1712	– 1.36	– 1.2570	– 5.15	– 2.4736	– 1.16
Year = 1998	0.8956	5.92	0.3965	1.47	– 2.0128	– 0.39
Constant	– 0.8368	– 1.56	– 0.3041	– 0.21	1.9731	0.29
σ_u			1.8587		5.5616	
σ_e			0.9908		1.9812	
ρ			0.7787		0.8874	
Equality of male and female unearned income#	2.39		0.07		0.69	
Equality of male and females social pension received#	1.06		5.30**		0.63	
Equality of male and female remittances#	1.01		8.25***		0.71	
Joint significance of health service variables#	5.18***		5.39***		10.06	
F-test for all $u_i = 0$			3.79***		0.95	

Notes: #: F-test for OLS and Fixed Effects Regression, χ^2 test for IV Fixed Effects Regression.
Significance: ***: 1%; **: 5%; *: 10%

increases as move from the fixed effects to the IV fixed effects estimates.

V. CONCLUSION

The end of apartheid and the restoration of democratic governance in South Africa have provided an opportunity to improve the welfare of the black households who suffered under decades of white minority rule. A key component of that welfare is the health of black children. In order to devise effective policies that improve child health in post-apartheid South Africa, it is important to identify the key determinants of child nutrition in that country. That has been the principal motivation of this paper. Though the immediate context of this study is post-apartheid South Africa, the results have wider application that extends far beyond South Africa.

Methodologically, this study has three features that distinguish it from most previous studies on child health. First, it recognises the endogeneity of the resource variables in the estimated child health equation by adopting a simultaneous equations estimation framework that jointly estimates the resource inflow and child health equations. Second, we depart from the conventional unitary model and adopt the ‘collective approach’ that distinguishes between the various resource components, based on the source, the gender and age group of the recipient. Interestingly though the null hypothesis of the unitary household model cannot be rejected. Third, the study exploits the panel nature of the data at the household level and reports the results of fixed effects estimation of mean child height for age Z-scores for the panel of Kwazulu-Natal households over the period 1993–98.

One of the principal findings of this study, based on formal statistical tests, is that child health improved significantly in post-apartheid South Africa or, more precisely, in the Kwazulu-Natal province over the period 1993–98. We also provide statistical evidence that shows that the distribution of child health has changed significantly over this period. The former result is consistent with that obtained by Maluccio, Thomas and Haddad (2001) on the same data set. Note, however, that while their investigation focuses on household structure and child welfare, we attempt to explain child health in the two survey years (1993 and 1998) and, also, changes to it over the period 1993–98 through a host of determinants, including economic variables (for example, household resources), demographic factors (such as household size) and health service facilities in the cluster of residence of the child. We propose and provide formal tests of the idea of income pooling underlying the traditional unitary model based on tests, in the estimated child health regressions, of equality of the income coefficients between the men and women recipients of the resource inflows. The test results are mixed with the results on the pooling tests sensitive to the nature of the resource inflow and the year of the survey considered. Notwithstanding some rejections of equality of the income coefficients between men and women, the unitary household model seems to do much better in explaining child health outcomes than in the case of expenditure allocation. The results of fixed effects estimation, that exploits the panel nature of the household level data, show that household resources have contributed significantly and positively to the improvement in child health in post-apartheid South Africa. The other two contributory factors have been rising levels of education of the household head and improvements in the community infrastructure as measured by the cluster level health service variables.

Before concluding, let us note that, ideally for this study, we required panel data on the health of children for the period, 1993–98. Such a data set is not yet available. The black households in Kwazulu-Natal, who were interviewed in 1993 and reinterviewed in 1998, constitute a panel. This is, however, not true of the children, aged 0–5 years, living in such households. Note that the Z-scores are not available for the older children. Consequently, the number of children whose health data are available in both 1993 and 1998 is a small proportion of the total number of children (0–5 years) involved in both the data sets. It is important to include the health data of all children, aged 0–5 years, in the original sample, in the subsequent data sets. The results of this study suggest that there are some interesting dynamics at work in the child health variables (that is, Z-scores) in post-apartheid South Africa. Such dynamics require, for their study, the availability of panel data on child health, similar to the household level panel data that currently exist and are used in this study.

NOTES

1. During the apartheid era, the South African government delineated four racial groups: black (or African), Indian (or Asian), coloured (or mixed race) and white (or Caucasian). Our use does not signify acceptance of this terminology or the system of racial naming.
2. For example, according to the World Development Report [*1993*], Table A6, 39 per cent of children in the age group 24–59 months in sub-Saharan Africa suffer from stunting.
3. During the apartheid era the white government forced black South Africans into ‘homelands’ which were desolate regions incapable of sustaining a livelihood based on agriculture thereby creating a massive pool of unemployed black workers who were employed in the mines and in the white-owned agricultural farms. The migrant workers were forced to live away from their families, remitting home cash and goods to support their families. This was known as the ‘oscillatory migrant labour system’. These ‘homeland’ regions were semi-autonomous but were dependent on funds from the South African government for infrastructure development. Naturally, the apartheid era was characterised by severe disparities between the homeland and the non homeland regions of South Africa.
4. The KIDS data set is the outcome of a collaborative project between researchers at the University of Natal, the University of Wisconsin–Madison and the International Food Policy

Research Institute. Details of the KIDS data set have been described by its principal authors in May, Carter, Haddad and Maluccio [*2000*].

5. The referee also suggested that we further restrict the sample further to children aged between six and 36 months on the ground that 'children older than three years generally grow at the same rate as children in developed countries', as noted by Alderman and Sahn [*1997*]. Unfortunately, this suggestion could not be implemented since it sharply reduced the sample size leading to a large loss in degrees of freedom. Instead, we introduced in the regressions a child age dummy that distinguished between children in the 0–5 years range that lie between 6–36 months and the others (that is, < 6 months or > 36 months) and also interacted this dummy with all the explanatory variables. We conducted a joint test for the statistical significance of the age dummy and interaction terms and found it to be statistically insignificant for both the 1993 and the 1998 samples. What this essentially implies is that children aged less than six months or more than 36 months are not different from the rest of the sample. We, therefore, decided to base our estimation on all children in the age group 0 – 5 years.
6. Maluccio, Thomas and Haddad [*2001*] also use the same data and exploit its panel nature to study changes to child health in Kwazulu-Natal during the first five years of post-apartheid South Africa. However, unlike here, they do not investigate the determinants of that change, which is the main motivation of the present paper.
7. B-P test statistic distributed as χ^2 with 36 degrees of freedom. The associated values were 31.930 for the 1993 sample and 70.666 for the 1998 sample.
8. AGECAT = 1 if Age of Child < 6 months or Age of Child > 36 months, 0 otherwise.
9. Note that migration in this case would have to be correlated with the unobserved factors that are correlated with health in a location, such as availability of clinics, over and above other measures included in wage differentials. See Thomas and Strauss [*1998*].

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TABLE A1
RESOURCE INFLOW VARIABLES, 1993

	Male unearned income		Female unearned income			Male earned income		Female earned income	
	Coefficient	t-value	Coefficient	t-value		Coefficient	t-value	Coefficient	t-value
Male headed household	– 31.5786	– 8.24	30.0440	3.49	Male unearned income	1.0332	3.05	0.1574	0.58
Average age of working age males/females in household	0.0854	0.16	– 2.4861	– 1.94	Female unearned income	– 1.2742	– 4.17	0.3576	1.56
Square of average age of working age males/ females in household	– 0.0052	– 0.55	0.0380	1.71	Male social pension received	– 0.6496	– 0.93	– 3.9278	– 6.90
Highest education of most educated male/female in household – primary school	– 0.1261	– 0.30	1.0503	0.91	Female social pension received	0.3878	0.73	2.9517	6.95
Highest education of most educated male/female in household – middle school	0.7988	1.18	– 0.3842	– 0.24	Male headed household	19.6113	0.83	– 52.6433	– 3.07
Highest education of most educated male/female in household – secondary school or higher	0.1296	0.15	2.4901	1.41	Average age of working age males in household	– 1.2241	– 0.51	0.2196	0.09
Total number of children in household	0.5734	0.84	0.0191	0.01	Square of average age of working age males in household	0.0478	1.16	– 0.0016	– 0.04
Total number of males aged 18 – 64	– 0.6163	– 0.43	– 0.2430	– 0.09	Total number of children in household	– 3.9351	– 1.46	– 2.7786	– 1.33

(continued)

TABLE A1 (*continued*)

	Male unearned income		Female unearned income			Male earned income		Female earned income	
	Coefficient	t-value	Coefficient	t-value		Coefficient	t-value	Coefficient	t-value
Total number of females aged 18 – 59	0.7258	0.60	– 2.6690	– 0.83	Total number of males aged 18 – 64	– 3.4122	– 0.57	2.1103	0.62
Total number of males aged 65 and higher	5.5729	1.13	1.9692	0.18	Total number of females aged 18 – 59	– 10.6541	– 2.23	– 1.5507	– 0.39
Total number of females aged 60 and higher	2.1641	0.67	– 13.3690	– 1.60	Total number of males aged 65 and higher	– 9.7466	– 0.35	96.1654	4.29
House connected to electricity	– 0.7200	– 0.24	– 10.2008	– 1.45	Total number of females aged 60 and higher	– 63.1418	– 2.16	– 160.3145	– 7.90
Own house	– 2.9123	– 0.65	32.1402	3.22	Highest education of most educated male/female in household – primary school	1.1772	0.69	2.6970	2.19
Bond owed on house	– 0.0007	– 1.56	– 0.0007	– 0.65	Highest education of most educated male/female in household – middle school	3.7163	1.38	– 0.6108	– 0.36
Sale value of house	0.0006	6.20	0.0000	– 0.19	Highest education of most educated male/female in household – secondary school or higher	2.2405	0.64	1.8272	0.95
Constant	20.0012	2.11	– 2.8283	– 0.10	Constant	93.0095	2.74	50.4510	1.54
Male unearned income	0.1595	3.16	0.3376	5.55	Male unearned income	0.2756	6.88	0.4073	4.03
Female unearned income	0.1073	2.81	– 0.1470	– 3.18	Female unearned income	0.0222	0.71	0.0298	0.38
Male earned income	0.0204	1.72	– 0.0253	– 1.78	Male earned income	0.0110	1.12	– 0.1827	– 7.37
Female earned income	– 0.0796	– 4.35	0.1446	6.63	Female earned income	0.0010	0.06	– 0.0159	– 0.37

(continued)

TABLE A1 (*continued*)

	Male unearned income		Female unearned income			Male earned income		Female earned income	
	Coefficient	t-value	Coefficient	t-value		Coefficient	t-value	Coefficient	t-value
Male headed household	– 11.4566	– 3.55	12.1181	3.09	Male social pension received	0.1521	1.80	– 0.6857	– 3.17
Age of household head	0.2027	0.62	– 0.2346	– 0.61	Female social pension received	0.0410	0.65	0.2069	1.28
Square of age of household head	– 0.0032	– 1.10	0.0003	0.08	Male headed household	5.1923	1.85	– 10.9017	– 1.57
Total number of children in household	– 0.5585	– 1.55	– 0.1032	– 0.23	Age of household head	– 0.2470	– 0.88	0.7968	1.11
Total number of males aged 18 – 64	– 0.4537	– 0.70	– 1.3232	– 1.65	Square of age of household head	0.0017	0.68	– 0.0077	– 1.20
Total number of females aged 18 – 59	– 0.3081	– 0.43	– 1.2268	– 1.40	Total number of children in household	– 0.6851	– 2.45	– 2.0745	– 3.07
Total number of males aged 65 and higher	21.6216	7.00	– 7.5921	– 2.00	Total number of males aged 18–64	0.5856	1.16	1.8488	1.51
Total number of females aged 60 and higher	– 7.4234	– 3.71	39.9930	16.26	Total number of females aged 18–59	1.3482	2.46	– 2.0128	– 1.51
Household head is pensioner	25.5397	10.05	31.7046	10.41	Total number of males aged 65 and higher	– 4.2739	– 1.27	20.9798	2.48
Highest education of household head – primary school	2.9376	1.85	3.1011	1.66	Total number of females aged 60 and higher	– 1.5842	– 0.46	– 10.5827	– 1.21
Highest education of household head – middle school	– 2.2415	– 0.87	– 3.9030	– 1.28	Highest education of household head – primary school	– 2.2128	– 1.66	8.8583	2.57

(continued)

TABLE A1 (*continued*)

	Male unearned income		Female unearned income			Male earned income		Female earned income	
	Coefficient	t-value	Coefficient	t-value		Coefficient	t-value	Coefficient	t-value
Highest education of household head – secondary school or higher	– 8.7834	– 1.72	– 10.8035	– 1.78	Highest education of household head – middle school	– 3.4926	– 1.62	21.5285	3.88
Constant	5.5802	0.64	3.3935	0.33	Highest education of household head – secondary school or higher	– 9.4836	– 2.19	50.3267	4.54
					Any member of household unemployed	– 3.5334	– 0.71	1.8761	0.14
					Any member of household unable to work because of sickness	1.0890	0.79	3.3503	0.93
					Any woman in household pregnant	0.9567	0.47	10.5467	1.97
					Constant	4.8570	0.60	18.0799	0.86

TABLE A2
RESOURCE INFLOW VARIABLES, 1998

	Male unearned income		Female unearned income			Male earned income		Female earned income	
	Coefficient	t-value	Coefficient	t-value		Coefficient	t-value	Coefficient	t-value
Male headed household	110.5306	2.56	– 27.1316	– 2.21	Male unearned income	– 0.3713	– 7.02	– 0.2707	– 4.34
Average age of working age males/females in household	12.3181	1.49	– 1.6396	– 0.37	Female unearned income	0.7112	3.86	0.3648	2.08
Square of average age of working age males/ females in household	– 0.1372	– 1.47	0.0314	0.52	Male social pension received	– 2.2086	– 2.79	– 1.2348	– 1.54
Years of schooling of the most educated male/ female in the household	12.6489	2.02	5.9049	3.07	Female social pension received	1.5651	2.23	0.3599	0.47
Total number of children in household	– 7.1095	– 1.17	– 1.1658	– 0.67	Male headed household	177.6043	6.08	77.3556	2.54
Total number of males aged 18–64	4.4406	0.37	2.0319	0.64	Average age of working age males/females in household	1.7964	0.47	– 7.4128	– 1.07
Total number of females aged 18–59	34.2239	3.27	– 2.5059	– 0.77	Square of average age of working age males/ females in household	– 0.0369	– 0.86	0.0867	0.90

(continued)

TABLE A2 (*continued*)

	Male unearned income		Female unearned income			Male earned income		Female earned income	
	Coefficient	t-value	Coefficient	t-value		Coefficient	t-value	Coefficient	t-value
Total number of males aged 65 and higher	66.0012	1.33	– 15.5034	– 1.13	Highest education of most educated male/female in household – primary school	47.0032	0.73	29.9038	0.55
Total number of females aged 60 and higher	– 64.3284	– 2.17	– 9.2794	– 1.05	Highest education of most educated male/female in household – middle school	68.5595	1.06	66.8230	1.21
Number of rooms in house	4.0005	1.50	4.1089	1.51	Highest education of most educated male/female in household – secondary school or higher	167.9098	2.25	216.1851	3.07
Own house	29.7858	0.98	19.2327	0.61	Total number of children in household	– 1.4142	– 0.45	– 3.5157	– 1.21
Main source of drinking water	82.8133	2.49	119.1549	3.60	Total number of males aged 18–64	7.5127	1.30	– 5.1464	– 1.03
Time taken to fetch water	– 81.1658	– 3.53	– 33.9001	– 1.49	Total Number of females aged 18 – 59	4.4327	0.80	10.3676	1.98
Toilet type	29.5588	1.54	8.8251	0.47	Total number of males aged 65 and higher	118.2125	2.97	73.4702	1.86
Location of toilet	– 37.0925	– 1.87	5.0908	0.25	Total number of females aged 60 and higher	– 108.5050	– 3.20	– 60.0437	– 1.60
House connected to electricity	49.3697	2.97	42.5713	2.61	Total Lobola/Total Umbondo	– 0.0010	– 0.54	0.0370	2.18
Main material of house	60.7671	3.06	– 9.5326	– 0.47	Male/female share of durables	120.1323	4.18	34.8911	1.26

(*continued*)

TABLE A2 (*continued*)

	Male unearned income		Female unearned income			Male earned income		Female earned income	
	Coefficient	t-value	Coefficient	t-value		Coefficient	t-value	Coefficient	t-value
Constant	– 424.7465	– 2.32	37.5714	0.46	Share of durables jointly owned	46.8915	1.77	24.9664	1.08
					Male/female share of gifts at marriage	– 69.5206	– 1.21	20.3926	0.67
					Share of gifts at marriage jointly owned	195.1723	2.68	124.1796	1.71
					Male/female share of financial assets	204.0282	2.69	208.0810	2.95
					Share of financial assets jointly owned	51.8585	1.20	– 75.0156	– 1.33
					Constant	– 186.9435	– 1.67	60.1383	0.44
Male unearned income	– 0.0165	– 3.51	0.0237	3.65	Male unearned income	0.0099	2.54	0.0312	2.22
Female unearned income	0.0619	3.78	0.0518	2.29	Female unearned income	– 0.0131	– 1.04	– 0.0709	– 1.56
Male earned income	– 0.0409	– 4.91	0.0106	0.91	Male earned income	– 0.0062	– 0.89	– 0.0875	– 3.48
Female earned income	0.0300	3.31	– 0.0088	– 0.68	Female earned income	0.0017	0.23	0.0261	0.95
Household head is a pensioner	28.2969	13.03	19.1764	6.26	Male social pension received	0.0920	1.60	– 0.5079	– 2.47
Male headed household	20.7292	9.01	– 12.7644	– 4.03	Female social pension received	– 0.1117	– 1.80	0.3125	1.40
Age of household head	0.4062	1.18	– 0.1939	– 0.38	Male headed household	– 0.1655	– 0.07	4.6112	0.54
Square of age of household head	– 0.0027	– 0.86	0.0062	1.35	Age of household head	0.4276	1.50	1.4642	1.43
Highest education of household head – primary school	– 1.5181	– 0.91	– 2.4124	– 0.99	Square of age of household head	– 0.0027	– 1.04	– 0.0134	– 1.44

(continued)

TABLE A2 (*continued*)

	Male unearned income		Female unearned income	
	Coefficient	t-value	Coefficient	t-value
Highest education of household head – middle school	0.4239	0.18	– 2.5484	– 0.73
Highest education of household head – secondary school or higher	4.1655	0.57	– 18.5862	– 1.76
Total number of children in household	– 0.2023	– 0.72	– 0.9926	– 2.58
Total number of males aged 18–64	0.8492	1.61	– 0.0843	– 0.12
Total number of females aged 18–59	– 0.3481	– 0.69	– 1.9374	– 2.78
Total number of males aged 65 and higher	32.1480	13.81	– 11.9104	– 3.72
Total number of females aged 60 and higher	– 7.5086	– 5.04	35.4009	17.26
Constant	– 23.8269	– 2.45	14.5875	1.02

	Male earned income		Female earned income	
	Coefficient	t-value	Coefficient	t-value
Highest education of household head – primary school	0.5878	0.42	– 2.8304	– 0.57
Highest education of household head – middle school	2.0190	1.02	– 7.9585	– 1.12
Highest education of household head – secondary school or higher	– 0.9086	– 0.15	16.8288	0.78
Total number of children in household	– 0.3086	– 1.37	– 1.3542	– 1.66
Total number of males aged 18–64	– 0.0156	– 0.04	2.8131	1.89
Total number of females aged 18–59	– 0.4794	– 1.23	– 3.5861	– 2.53
Total number of males aged 65 and higher	– 3.9240	– 1.36	9.8195	0.94
Total number of females aged 60 and higher	2.3510	0.89	– 0.4900	– 0.05
Number of negative shocks	1.0514	1.84	– 10.6549	– 5.21
Value of negative shocks	0.0000	– 0.58	0.0002	3.53
Number of positive shocks	3.0303	2.86	7.1783	1.89
Value of positive shocks	0.0000	– 0.35	0.0003	2.01
Constant	– 10.0414	– 1.22	21.4594	0.73