Child Health and School Enrollment

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Abstract

This study use longitudinal data from South Africa to estimate the relationship between early childhood nutritional status and schooling outcomes 5 years later. Past nutritional status is treated as endogenous and instrumented using prior period price shocks as is consistent with dynamic household human capital decision rules. Preferred estimates from the full sample aged 0-5 in the base year show no impact of past nutritional status on current schooling. However significant estimates are found for children who were malnourished in the base year, as well as among children aged 0-30 months in the base year. These results suggest that the relationship between health and cognitive achievement is complex, and the effects may be highly sensitive to time between measurements and the timing of malnutrition itself.

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Child Health and School Enrollment: A Replication

1. Introduction

Infant and child health is an important policy issue in low-income countries because of the wide-ranging impact that early childhood health is thought to have on the subsequent development potential of the individual.[1] As a result, several studies have attempted to estimate the relationship between early childhood nutritional status and schooling (Jamison, 1986; Moock & Leslie, 1986; Behrman & Lavy, 1994; Glewwe, Jacoby & King, 2001). In a recent article in the JHR, Alderman, Behrman, Lavy & Menon (2001) (henceforth ABLM) argue that much of this existing literature does not establish a causal relationship between infant health and schooling because it fails to recognize and adequately control for the fact that child health and schooling are both the result of human resource investment decisions by households. Moreover, ABLM argue that existing evidence on the relationship between child health and schooling is quite sensitive to the underlying behavioral assumptions used to estimate the relationship. For example, estimates based on cross-sectional data which account for unobserved heterogeneity with respect to household and community variables lead to parameter estimates which are significantly *lower* than those that do not account for these variables (their so-called 'naïve' estimates), thus suggesting that the impact of child nutritional status on schooling is much *smaller* than otherwise believed [Behrman & Lavy, 1998; Glewwe & Jacoby, 1995]. Unfortunately, cross-sectional studies must use current prices to identify child health, and these are likely to be correlated with unobserved variables influencing both child health and schooling, thus rendering questionable the results based on these specifications.

Longitudinal data, on the other hand, permits the estimation of this relationship in a manner that is consistent with a dynamic model of human resource investment. Specifically, such data can be used to construct prior period price shocks to use as identifying instruments for early childhood health; these shocks are uncorrelated with subsequent period price shocks which influence schooling decisions in that (later) period, and thus permit consistent identification of the causal impact of child health on schooling.

[1] See Behrman (1996) for a discussion of the issue and related references.

Using this preferred approach with longitudinal data from Pakistan, ABLM report that the relationship between child health and subsequent schooling is actually much *larger* than those implied by naïve estimates which do not account for behavioral choices.[2] In addition, they show that alternative specifications which use current price levels as instruments, as is commonly used in the literature, lead to small and insignificant parameter estimates of the relationship between child nutritional status and schooling in their Pakistan data.

In this paper we assess the stability of the results in ABLM by replicating their estimation strategy using longitudinal data on children from South Africa for the years 1993 and 1998. Specifically, we investigate: 1) whether the identification strategy proposed by ABLM results in a larger positive relationship between nutritional status and schooling relative to naïve estimates as they report for Pakistan, and; 2) whether alternative (ad-hoc) identification strategies that use current price levels as instruments (as is common in the cross-sectional literature) lead to smaller estimates of this relationship, as they also report for Pakistan. We also investigate whether the preferred estimates are robust to several alternative specifications and/or samples: 1) the inclusion of mother's height as a control for genetic endowment or unobserved family background variables; 2) limiting the sample to children under age 31 months in 1993 based on the hypothesis that nutritional status up to around age 2 is the critical determinant of later life outcomes; 3) limiting the sample to malnourished children in 1993. A replication of ABLM is of value because of the significant difference in the approach and results reported by that study relative to the previous literature. In addition, the relationship between health and cognitive development is sufficiently complex (involving behavioral, environmental and biological influences) that it is important assess whether results from Pakistan can be generalized to other parts of the world. Finally, the data requirements to support the estimation strategy in ABLM are quite stringent, so that the existence of such data from another region presents a unique opportunity for researchers to learn about the relationship between early childhood nutrition and schooling.

2. Estimation Strategy

[2] Glewwe, Jacoby & King (2001) use the same approach as ABLM with data from the Philippines and report similar results—an increase in the estimated impact of early childhood nutrition on child cognitive development.

The theoretical framework guiding ABLM's estimation strategy is presented in their paper and we do not discuss it in detail here. Their empirical approach relates child nutritional status (H) in the previous time period (period 1) to current schooling (in period 2) and is framed around equations (1) and (2) below where S_i is schooling in period i, H is health, A is assets or wealth, E is child endowment, T is a preference parameter and U is a within period shock:

$$(1) \quad S_2 = a_{11}P_2 + a_{12}P^* + a_{13}H_1 + a_{14}A_1 + U_2 + E + T$$

$$(2) \quad H_2 = a_{21}P_2 + a_{22}P^* + a_{23}H_1 + a_{24}A_1 + U_2 + E + T$$

In this framework price shocks are defined as the deviation of current price levels (P_i) from long run expected prices (P*) and are orthogonal across periods, unlike current prices which will contain a permanent long run component. The parameter of interest is a_{13}, the coefficient of previous period health status on current period schooling, but since H was determined in the previous period by E and T, naïve estimates of a_{13} which ignore this will lead to biased estimates of this parameter. The preferred estimation strategy is an instrumental variables approach where H_1 is first estimated using contemporaneous price shocks (P_1-P*) as identifying instruments and then S_2 is estimated using $\hat{H}_1$ from the first stage. The empirical implementation captures price shocks by including in the regression equation current prices (as measured contemporaneously at the village level in the survey) and regional dummies to control for long run differences in expected prices.

3. The Data

The data are a panel from the KwaZulu-Natal Income Dynamics Study (KIDS), a survey of approximately 1550 households in the KwaZulu-Natal province of South Africa conducted in 1993 and 1998. The survey was commissioned by the South African Government as part of the effort to understand the dynamics of poverty and inequity of apartheid and the changes which took place after the abolishment of apartheid in 1994, and was jointly directed by the International Food Policy Research Institute, University of Wisconsin and the University of Natal. The sample is a two-stage self-weighting design. In the first stage, clusters or villages were chosen proportional to population and percentage of the population ethnically African from census enumerator sub-districts, and in the second stage, all households in each chosen cluster were randomly selected on an interval which allowed on average 25 households or 125 individuals per village. See Carter et al. (2003) for further details on the survey methods and sample design.

Following ABLM we use height-for-age z-score to capture first period child nutritional status and current enrolment for second period schooling outcome.[3] We also present results for an alternative school outcome—whether the child had ever been enrolled in school.[4] Table 1 presents summary statistics of the main variables from the 1998 round of the survey. Current school enrolment in 1998 is 90 percent and the percent ever enrolled by age 7 is 88 percent. Mean z-score in 1993 is -1.16, with 25% of children moderately or severely malnourished (z-score<-2) and another 30% mildly malnourished (-2<z-score<-1). Among malnourished children (z-score<-1) mean per capita expenditure is significantly lower in 1993 (by 20 Rand) relative to other children, and mother's education is also lower (57 % with less than complete primary school among malnourished vs. 52% among other children), suggesting that there may be adverse family background factors affecting both health and nutrition. Note that the Pakistan data used in ABLM covers a 2 year period from ages 5 to 7. The South African data covers a much longer period and a wider age range of children (0-5 in 1993 and 6-11) in 1998. These differences in research design may influence the results and will be discussed below.

Figures 1 and 2 show the non-parametric relationship among past height-for-age, current enrolment (Figure 1) and ever enrolled (Figure 2) estimated using local linear regressions with a bandwidth of 0.8. The relationship between health and school enrolment appears to be strong at the extremes of the distribution of height but flat in the middle, with a z-score of -1 appearing to be the critical cut-off at the lower end of the distribution. Figure 2 shows a more consistent negative relationship through out the distribution of height, though again the slope appears to be especially steep at the lower tail of the height distribution. These graphs suggest that the relationship between health and schooling might differ along the height distribution.

4. Results

[3] Following the recommendation of WHO (1995), we exclude observations of children with height-for-age z-scores less than 4 z-scores below and greater than 3 z-scores above the sample mean.

[4] We define and estimate this outcome only for children age 7 and over since children of age 6 who are not in school may have simply missed the birth date cut-off.

For both our first and second stage regressions we try and mimic the specifications presented in ABLM as much as possible to ensure that any differences we find are not simply due to functional form. The first stage regression predicting height-for-age z-score in 1993 is estimated via OLS and reported in Table A1 in the appendix. Both the set of 12 current prices and the long run prices (proxied by district dummy variables) are jointly significant in this regression as we would expect. As in ABLM, the first stage regression also includes prices interacted with mother's education to allow the price responses to vary by the level of schooling of the child's mother—this set of interaction terms is also jointly significant. The school outcomes are binary and are estimated with a probit using the method of Rivers & Vuong (1988) to account for the fact that height is an endogenous regressor. As in ABLM, we use contemporaneous prices in 1998 and a regional dummy (Kwa-Zulu region) to capture price shocks, and these are jointly significant in the schooling regressions.

a) Base results

Table 2 is similar to that reported in ABLM and presents the coefficient (and standard error) estimates for the height variable from the schooling probit for the two schooling outcomes, for the full sample and two restricted samples (z-score <= -1; age in 1993 less than 31 months), and for the alternative specifications reported in ABLM (full results shown in the appendix). The first row in each panel show results for the full sample of children for school enrollment (panel A) and ever enrolled (Panel B). The naïve specification in column 2, which assumes that past height is not a choice variable and treats it as exogenous, show positive and significant coefficients for both school outcomes. In this sample however, results based on the preferred estimation strategy (column 1), which use price shocks as identifying instruments, show no statistically significant relationship between the two outcomes of interest. This is in sharp contrast to the results reported in ABLM where the preferred estimates deliver a much stronger and statistically significant impact of past health on schooling. The alternative estimates in Table 2 are the same as those presented in ABLM and consist of the following: column 3 excludes current prices from the schooling regression, column 4 excludes all prices from the schooling regression and uses lagged price levels to identify prior health status, and column 5 excludes all prices from the schooling equation and uses current price levels to identify past health. These results show no relationship between health and schooling and are consistent with the results in ABLM and the previous literature which uses these ad-hoc identifying strategies. However in the South African case, these alternative ad-hoc specifications actually do quite well in reproducing the preferred estimates in column 1, which also show no relationship between health and schooling.

We mentioned earlier that an important difference between the South African and Pakistani data sets is that the latter use height measured at a specific age (5 years) while the former contain children between 0-5 years. There tends to be a distinct relationship between stunting and age in low-income countries, with a steady increase in stunting from birth to just after the weaning period (24-36 months) and then flattening out. This pattern also exists in the South African data as shown by the age coefficients in the height regression in Table A1. Thus in the South African data the exposure to infection and other nutritional insults (the 'treatment'), and subsequent nutritional status, varies widely among the sample relative to the Pakistani sample, which may confound the results of our replication exercise.[5] Moreover, some researchers have argued that the timing of early childhood nutritional status is important, and that it is nutritional status around age 2 that is the crucial predictor of subsequent cognitive development [Waber etal., 1981; Glewwe, Jacoby & King, 2001]. A further difference in research design is the time lag between surveys—only 2 years in Pakistan compared to 5 years in South Africa. Poor health may affect immediate schooling outcomes, but the possibility of catch-up growth[6] and/or sustained compensating behavior by parents could mitigate the adverse effects of poor health in the medium term, leading to a weaker estimated relationship between health and schooling as we report in Table 2.[7] To address these possible explanations for the difference in results from those of ABLM, we repeat the estimation procedure using two alternative samples of children from our South African data. First we restrict the sample to children who were 21/2 years old (30 months or younger) in 1993. This allows us to both control for the length of exposure to possible repeated nutritional insults as well as

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[5] Mean height-for-age z-score in the Pakistani sample used by ABLM is -1.86 compared to -1.16 in our data.

[6] For example, Adair (1999) presents evidence that Filipino children do exhibit significant catch-up growth in the pre-adolescent years.

[7] The lack of significance of the IV estimates is not due to weak instruments, as these are always jointly significant in the first stage regressions.

test the hypothesis, advanced by Glewwe, Jacoby & King (2001) and others that the timing of malnutrition matters for subsequent cognitive development. Second, we restrict our sample to children who displayed any form of malnutrition in 1993, defined as having a z-score equal to or less than -1; recall that Figures 1 and 2 suggested that the health-schooling relationship was stronger at lower levels of malnutrition. This approach also allows us to control for the intensity of the 'treatment' which may be driving some of the differences between our results and those of ABLM.

b) Extensions

The second row of panels A and B in Table 2 display results based on the 368 children in our sample who were malnourished in 1993. These results are consistent with the patterns reported in ABLM. The naïve estimates in column 2 show a significant and positive impact of lagged height on schooling while the preferred estimates (column 1) show an even stronger positive relationship, with the probit coefficient doubling for ever enrolled (panel B: from 0.453 to 0.913) and increasing by 55% for enrolment (panel A: from 0.292 to 0.449). In addition, the alternative estimates in columns 3-5 show no significant effects of lagged height on schooling as is reported in ABLM.

The third row of panel A in Table 2 shows the results estimated on the 276 children who were age 30 months or less in 1993—we do not present estimates for ever enrolled because that outcome is only defined for children at least 7 years old in 1998 leaving us with very few observations. The naïve estimate in column 2 delivers a positive and statistically significant coefficient for lagged height (0.165), and consistent with the results in row 2, an even stronger relationship in column 1 using the preferred estimation strategy, with the probit coefficient now increasing by 63 percent (to 0.269). Moreover, the alternative specifications in columns 3-5 show no relationship between lagged height and current schooling. Both sets of results based on the two samples are now consistent with the pattern of estimates reported in ABLM, suggesting that differences in research design may be responsible for the divergence in the full-sample South African results and those reported in ABLM.

c) Mother's height

A key determinant of children's human resource outcomes is parental height, both directly through inherited genetic endowment, and indirectly through its association with family background and socioeconomic status (Thomas, Strauss & Henriques 1993; Strauss & Thomas 1995). The exclusion of parental height is a potentially important omitted variable which could bias the estimated relationship between prior health and schooling if prior health status reflects unobserved genetic ability and family background, both of which also influence cognitive development. The South African data collected maternal height in the 1998 round of data, but there are only 227 children with information on maternal height because of missing values in the data. These children are slightly taller, more likely to go to school, and come from richer households than those for whom mother's height is missing. To assess the possibility that the exclusion of maternal height biases the estimated relationship between lagged height and schooling we repeat our estimates including mother's height in both the first stage height regression and the second stage schooling regression. For consistency we compare these results with the specifications over this same sub-sample (227) without including mother's height. For both school enrolment and ever enrolled we find no difference in the preferred probit coefficient with and without the inclusion of mother's height, and conclude that the exclusion of mother's height does not bias the estimated relationship between health and schooling in the South African data, although of course this is based on a rather small sample.[8]

5. Conclusions

Previous estimates of the relationship between child health and schooling have varied widely depending on the behavioral assumptions imposed on households. ABLM argue that some of these estimates are based on questionable identification assumptions that are not consistent with economic theories of household decision-making. Using panel data from Pakistan they show that theoretically consistent estimation of this relationship leads to *stronger* effects of health on schooling than previously reported. The present article replicates the estimation strategy of ABLM using panel data from South Africa to see if in these data, the preferred approach of ABLM also leads to stronger effects of health on schooling than that implied by theoretically less desirable approaches. Our results from the full sample of South African children using the preferred approach do not support the

[8] These results are available from the authors upon request. We also find no significant difference in the naïve estimates with and without the inclusion of mother's height.

results from ABLM, and indicate no relationship between past height and current schooling. This may be due to differences in research design. The ABLM study measures past height at a specific point in time (age 5) and schooling 2 years later. The South African data contains data on children ranging from age 0-5 and measures schooling 5 years later. These differences could affect the stability of the results because the impact of malnutrition on schooling may diminish over time, and because the pattern of malnutrition is highly correlated with age and thus varies more widely in the South African sample relative to the sample used by ABLM (due to different length of exposure to adverse health shocks).[9] We attempt to control for these differences in design by restricting our sample to the malnourished only, and to those children who were under 31 months in the base period. In these sub-samples, our estimates are consistent with those reported in ABLM, and show stronger (and statistically significant) effects of nutrition on schooling than those implied by a naïve approach, as well as alternative approaches that use ad-hoc identification assumptions to control for the endogeneity of health status.

The long term effects of child health on cognitive development are determined by the complex interaction of biology, behavior and environmental. Estimates of this relationship using prospective field surveys may vary widely, even when household behavior is accounted for in a theoretically consistent way, due to subtle differences in identification strategy, sample composition and the severity of malnutrition in the population. Research in this area must pay close attention to these details when specifying empirical relationships, interpreting coefficients, and generalizing results to other demographic groups and regions.

[9]Since the identification strategy uses price shocks to identify child health at the time of schooling decisions, the longer lag between survey rounds might weaken the ability of a shock to identify the relationship and thus increase the difference between the naïve and IV results even though the underlying relationship is the same.

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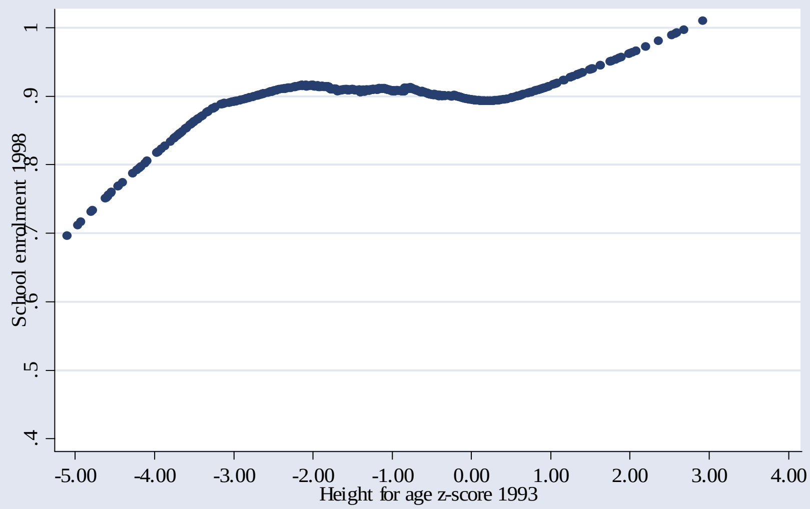

Fig. 1: Lowess estimates of school enrollment and nutritional status

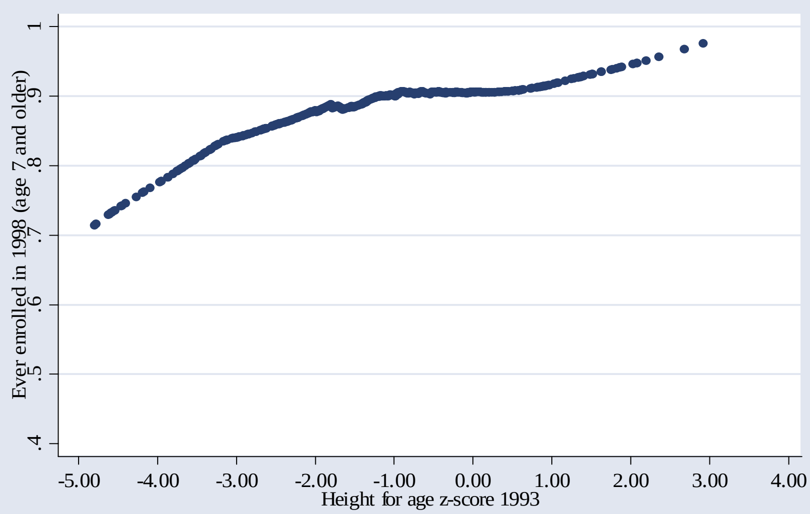

Fig. 2: Lowess estimates of ever enrolled and nutritional status

Table 1: Summary Statistics for Principal Variables used in Estimation

Variable	Mean	St. Deviation
Child's Characteristics		
School enrollment by age 6 (1 = yes)	.901	.299
Ever enrolled by age 7 (1 = yes)	.885	.320
Height z-score in 1993	-1.166	1.411
Age in years	8.294	1.689
Male (=1)	.503	.500
Mother's Characteristics		
Mother's age	29.959	7.220
Missing information on mother (=1)[1]	.132	.339
Has primary education or less	.500	.500
Household Characteristics		
Logarithm of per capita total expenditure[2]	4.749	.680
Community Characteristics		
Price per unit of bread (Rand)	2.836	.318
Price per unit of beans (Rand)	5.082	1.287
Price per unit of milk (Rand)	4.291	1.232
Price per unit of margerine (Rand)	13.756	8.628
Price per unit of sugar (Rand)	3.840	.802
Price per unit of vegetable oil (Rand)	6.480	4.224
Price per unit of cabbage (Rand)	3.898	2.003
Price per unit of samp (Rand)	2.485	.783
Price per unit of washing powder (Rand)	11.891	2.178
Mean village woman's wage	20.411	14.965
Mean village men's wage	22.518	19.287
Rainfall more than last year (=1)	.780	.401
Rainfall less than last year (=1)	.131	.337
Province Kwa-Zulu (=1)	.909	.287
Sample size	674	

[1]Missing if the child was orphaned, abandoned, not living with biological the mother. [2] All expenditure and prices are deflated to 1993 Rand. All variables are from 1998 unless stated otherwise.

Table 2: Estimated Effects of Lagged Child Nutritional Status on Schooling

	Preferred			Alternatives	
	(1)	(2)	(3)	(4)	(5)
Instruments	Lagged Price Shocks	None "Naïve" Model	Lagged Price Shocks	Lagged Price Levels	Current Price Levels
Schooling Probit Includes:					
Current prices	Yes	Yes	No	No	No
Long-run prices	Yes	Yes	Yes	No	No
		Panel A: School Enrollment			
Full sample	-.060	.105**	-.068	-.103	-.192
(N=647)	(.16)	(.05)	(.16)	(.15)	(.19)
Height-for-age ≤ -1	.449*	.292**	.285	.306	.090
(N=368)	(.24)	(.11)	(.19)	(.22)	(.22)
Age ≤ 30 months in 1993	.269**	.165**	.103	.057	-.105
(N=276)	(.13)	(.06)	(.76)	(.16)	(.18)
		Panel B: Ever Enrolled			
Full Sample	.208	.175**	.106	.106	.127
(N=546)	(.24)	(.05)	(.28)	(.24)	(.37)
Height-for-age ≤ -1	.913**	.453**	.175	-.024	.077
(N=313)	(.28)	(.18)	(.25)	(.27)	(.39)

* denotes significance at the 10% level, ** denotes significance at 5% or better. Probit coefficient estimates of lagged height variable with standard errors in parenthesis.

Table A1:First Stage Regression for Height-for-Age Z-score 1993

	Coefficient	St. Error
Child Characteristics:		
0-6 months (omitted)		
6-12 months in 1993 (=1)	-.01	(.29)
12-24 months in 1993 (=1)	-.92	(.28)
24-48 months in 1993 (=1)	-.68	(.21)
48-60 months in 1993 (=1)	-.64	(.12)
Male (=1)	-.05	(.12)
Mother's Characteristics		
Mother's age	-.023	(.053)
Mother's age squared (x 100)	.034	(.079)
Missing information on mother (=1)	-.042	(.22)
Has primary education or less	.46	(2.4)
Household Characteristics		
Logarithm of per capita total expenditure	.40	(.15)
Community Characteristics		
Price per unit formula (Rand)	-.005	(.021)
Price per unit milk (Rand)	.26	(.15)
Price per unit rice (Rand)	.23	(.21)
Price per unit cereal (Rand)	.059	(.053)
Price per unit apple (Rand)	.08	(.23)
Price per unit flour (Rand)	-1.50	(.42)
Price per unit bread (Rand)	.88	(.44)
Price per unit sugar (Rand)	.33	(.25)
Price per unit eggs (Rand)	.214	(.091)
Price per unit soap (Rand)	-.18	(.11)
Price per unit maize (Rand)	.72	(.26)
Price per unit chicken (Rand)	-.095	(.040)
Rainfall more than last year (=1)	.13	(.52)
Rainfall less than last year (=1)	-.10	(.31)
Missing observations on Rainfall (=1)	-.75	(.23)
Mother's education * price of formula	-.025	(.024)
Mother's education * price of milk	.04	(.14)
Mother's education * price of rice	-.01	(.26)
Mother's education * price of cereal	-.063	(.026)
Mother's education * price of apples	-.45	(.18)
Mother's education * price of flour	.157	(.080)
Mother's education * price of bread	.26	(.35)
Mother's education * price of sugar	-.33	(.31)
Mother's education * price of eggs	-.09	(.13)
Mother's education * price of soap	.13	(.16)
Mother's education * price of maize	-.28	(.37)
Mother's education * price of chicken	.106	(.038)
P-value of significance of district coefficients, F(25,52)		0.000
P-value of significance of twelve price coefficients, F(15,52)		0.000
P-value of significance of price interactions F(12,52)		0.000

Constant and district dummy variables included but not reported. Sample size 674.

Table A2: School Enrollment Probit (full sample)

	Preferred						Alternatives			
	(1)		(2)		(3)		(4)		(5)	
Height z-score in 1993	-.06	(.16)	.105	(.045)	.07	(.16)	-.10	(.15)	-.19	(.19)
Height z-score in 1993 residual	.19	(.17)			.19	(.17)	.24	(.15)	.33	(.19)
Age in years	1.87	(.52)	2.09	(.44)	1.65	(.50)	1.52	(.52)	1.42	(.50)
Age in years squared	-.080	(.031)	-.093	(.027)	-.069	(.030)	-.062	(.031)	-.055	(.030)
Male (=1)	.36	(.17)	.37	(.17)	.35	(.17)	.35	(.17)	.34	(.17)
Mother's age	-.213	(.074)	-.213	(.075)	-.216	(.077)	-.203	(.075)	-.206	(.074)
Mother's age squared (x 100)	.36	(.12)	.36	(.12)	.36	(.12)	.33	(.12)	.34	(.12)
Missing information on mother's variables	-.15	(.26)	-.12	(.26)	-.13	(.25)	-.11	(.25)	-.11	(.25)
Mother has primary education or less (=1)	-.22	(.18)	-.19	(.18)	-.23	(.17)	-.22	(.18)	-.25	(.18)
Logarithm of per capita total expenditure[1]	.19	(.15)	.16	(.16)	.24	(.18)	.25	(.18)	.25	(.18)
Price per unit of bread (Rand)	-.16	(.35)	-.12	(.35)						
Price per unit of beans (Rand)	-.20	(.12)	-.19	(.12)						
Price per unit of milk (Rand)	.101	(.064)	.093	(.064)						
Price per unit of margerine (Rand)	.016	(.013)	.018	(.013)						
Price per unit of sugar (Rand)	.03	(.20)	.06	(.19)						
Price per unit of vegetable oil (Rand)	.023	(.028)	.021	(.027)						
Price per unit of cabbage (Rand)	-.200	(.069)	-.208	(.066)						
Price per unit of samp (Rand)	-.06	(.10)	-.048	(.098)						
Price per unit of washing powder (Rand)	-.049	(.057)	-.050	(.056)						
Mean cluster woman's wage	.006	(.026)	.002	(.026)						
Mean cluster men's wage	-.007	(.019)	-.006	(.019)						
Rainfall more than as last year (=1)	.38	(.45)	.37	(.45)						
Rainfall less than last year (=1)	.41	(.47)	.44	(.47)						
Province Kwa-Zulu (=1)	-.45	(.32)	-.33	(.29)	-.37	(.32)				
Sample Size	647		674		674		674		674	

[1] All expenditure and prices are deflated to 1993 Rand

Table A3: School Enrollment Probit (height-for-age <= -1)

	Preferred						Alternatives			
	(1)		(2)		(3)		(4)		(5)	
Height z-score in 1993	.45	(.24)	.29	(.11)	.28	(.19)	.31	(.22)	.09	(.22)
Height z-score in 1993 residual	-.20	(.29)			-.05	(.25)	-.05	(.26)	.21	(.26)
Age in years	1.92	(.66)	1.79	(.68)	1.63	(.62)	1.63	(.63)	1.52	(.63)
Age in years squared	-.085	(.038)	-.078	(.040)	-.070	(.036)	-.071	(.036)	-.063	(.037)
Male (=1)	.50	(.24)	.51	(.24)	.48	(.25)	.49	(.24)	.50	(.24)
Mother's age	-.13	(.10)	-.135	(.099)	-.10	(.10)	-.09	(.10)	-.10	(.10)
Mother's age squared (x 100)	.23	(.18)	.25	(.17)	.19	(.18)	.18	(.18)	.19	(.17)
Missing information on mother's variables	-.28	(.35)	-.36	(.36)	-.39	(.31)	-.41	(.32)	-.51	(.31)
Mother has primary education or less (=1)	.12	(.24)	.08	(.22)	-.03	(.21)	-.05	(.20)	-.13	(.20)
Logarithm of per capita total expenditure[1]	.12	(.17)	.11	(.17)	.10	(.19)	.10	(.19)	.09	(.19)
Price per unit of bread (Rand)	.43	(.45)	.34	(.44)						
Price per unit of beans (Rand)	-.16	(.16)	-.16	(.16)						
Price per unit of milk (Rand)	-.055	(.078)	.031	(.063)						
Price per unit of margerine (Rand)	.014	(.016)	.015	(.016)						
Price per unit of sugar (Rand)	-.01	(.21)	-.01	(.21)						
Price per unit of vegetable oil (Rand)	.031	(.030)	.031	(.030)						
Price per unit of cabbage (Rand)	-.134	(.078)	-.135	(.080)						
Price per unit of samp (Rand)	.18	(.13)	.14	(.13)						
Price per unit of washing powder (Rand)	.037	(.053)	.035	(.050)						
Mean cluster woman's wage	.035	(.023)	.034	(.024)						
Mean cluster men's wage	-.030	(.016)	-.030	(.017)						
Rainfall more than as last year (=1)	.52	(.57)	.50	(.58)						
Rainfall less than last year (=1)	.43	(.57)	.37	(.58)						
Province Kwa-Zulu (=1)	-6.3	(3.9)	-6.4	(4.0)	-5.3	(3.7)				
Sample Size	368		368		368		368		368	

[1] All expenditure and prices are deflated to 1993 Rand

Table A4: Ever Enrolled Probit (full sample)

	Preferred						Alternatives			
	(1)		(2)		(3)		(4)		(5)	
Height z-score in 1993	.24	(.24)	.175	(.051)	.12	(.28)	.11	(.24)	.13	(.37)
Height z-score in 1993 residual	-.04	(.24)			-.01	(.28)	.01	(.24)	-.02	(.37)
Age in years	1.54	(.68)	1.56	(.70)	.97	(.71)	.93	(.70)	.91	(.67)
Age in years squared	-.053	(.038)	-.058	(.039)	-.032	(.039)	-.030	(.039)	-.030	(.037)
Male (=1)	.10	(.21)	.10	(.21)	.06	(.18)	.04	(.18)	.04	(.17)
Mother's age	-.42	(.12)	-.42	(.12)	-.25	(.12)	-.25	(.11)	-.25	(.11)
Mother's age squared (x 100)	.72	(.20)	.72	(.20)	.46	(.19)	.46	(.19)	.46	(.18)
Missing information on mother's variables	-.24	(.27)	-.25	(.28)	-.00	(.25)	-.01	(.25)	-.01	(.25)
Mother has primary education or less (=1)	-.11	(.21)	-.12	(.19)	-.30	(.19)	-.29	(.19)	-.28	(.19)
Logarithm of per capita total expenditure[1]	.15	(.22)	.16	(.21)	.23	(.16)	.23	(.15)	.23	(.16)
Price per unit of bread (Rand)	1.09	(.33)	1.08	(.31)						
Price per unit of beans (Rand)	-.38	(.25)	-.37	(.24)						
Price per unit of milk (Rand)	-.25	(.12)	-.25	(.12)						
Price per unit of margerine (Rand)	.075	(.026)	.075	(.026)						
Price per unit of sugar (Rand)	.78	(.37)	.77	(.36)						
Price per unit of vegetable oil (Rand)	.15	(.18)	.14	(.17)						
Price per unit of cabbage (Rand)	-.48	(.12)	-.48	(.11)						
Price per unit of samp (Rand)	-.04	(.20)	.05	(.19)						
Price per unit of washing powder (Rand)	-.039	(.047)	-.038	(.047)						
Mean cluster woman's wage	.053	(.035)	.054	(.035)						
Mean cluster men's wage	-.024	(.029)	-.026	(.029)						
Rainfall more than as last year (=1)	.30	(.47)	.30	(.46)						
Rainfall less than last year (=1)	-.69	(.47)	-.71	(.47)						
Province Kwa-Zulu (=1)	-.27	(.39)	-.29	(.37)	-.45	(.43)				
Sample Size	546		546		546		546		546	

[1] All expenditure and prices are deflated to 1993 Rand

Table A5: Ever Enrolled Probit (height-for-age <= -1)

	Preferred						Alternatives			
	(1)		(2)		(3)		(4)		(5)	
Height z-score in 1993	.91	(.28)	.45	(.18)	.17	(.25)	-.02	(.27)	.08	(.40)
Height z-score in 1993 residual	-.54	(.28)			.01	(.27)	.27	(.31)	.14	(.39)
Age in years	.82	(1.2)	.95	(1.2)	.80	(.93)	.94	(.88)	.89	(.91)
Age in years squared	-.014	(.068)	-.018	(.068)	-.023	(.052)	-.030	(.049)	-.028	(.050)
Male (=1)	.24	(.26)	.27	(.26)	.12	(.23)	.12	(.24)	.12	(.24)
Mother's age	-.43	(.11)	-.42	(.11)	-.12	(.10)	-.13	(.096)	-.12	(.096)
Mother's age squared (x 100)	.70	(.19)	.70	(.19)	.24	(.16)	.25	(.15)	.24	(.15)
Missing information on mother's variables	-.54	(.37)	-.71	(.34)	-.36	(.34)	-.49	(.33)	-.42	(.34)
Mother has primary education or less (=1)	.24	(.24)	.14	(.25)	-.22	(.19)	-.28	(.19)	-.24	(.19)
Logarithm of per capita total expenditure[1]	.17	(.27)	.16	(.26)	.20	(.16)	.20	(.16)	.20	(.16)
Price per unit of bread (Rand)	1.71	(.48)	1.43	(.40)						
Price per unit of beans (Rand)	.13	(.18)	.10	(.17)						
Price per unit of milk (Rand)	-.69	(.17)	-.56	(.15)						
Price per unit of margerine (Rand)	.125	(.030)	.11	(.029)						
Price per unit of sugar (Rand)	1.13	(.53)	.83	(.46)						
Price per unit of vegetable oil (Rand)	.31	(.15)	.29	(.16)						
Price per unit of cabbage (Rand)	-.410	(.094)	-.43	(.099)						
Price per unit of samp (Rand)	.16	(.21)	.041	(.22)						
Price per unit of washing powder (Rand)	-.092	(.050)	-.106	(.046)						
Mean cluster woman's wage	.097	(.037)	.082	(.036)						
Mean cluster men's wage	-.055	(.023)	-.052	(.023)						
Rainfall more than as last year (=1)	.20	(.68)	.28	(.68)						
Rainfall less than last year (=1)	-1.27	(.69)	-1.25	(.70)						
Province Kwa-Zulu (=1)	-.95	(.35)	-1.02	(.33)	-.66	(.49)				
Sample Size	313		313		313		313		313	

[1] All expenditure and prices are deflated to 1993 Rand