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REDUCING CHILD UNDERNUTRITION: HOW FAR DOES INCOME GROWTH TAKE US?

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ABSTRACT

How rapidly will child undernutrition respond to income growth? This study explores that question using household survey data from 12 countries. In addition, data on the undernutrition rates since the 1970s available from a cross-section of countries are employed in this investigation. Both forms of analysis yield similar results. Income increases at household and national levels imply similar rates of reduction in undernutrition. Using these estimates and better-than-historical income growth rates, we find that the Millennium Development Goal (MDG) of halving the levels of child underweight by 2015 is unlikely to be met through income growth alone. What is needed is a balanced strategy of income growth and investment in more direct interventions to accelerate reductions in undernutrition.

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1. INTRODUCTION

Great strides have been made in reducing child undernutrition over the past few decades. The prevalence of underweight in children under 5 in the developing countries was 37.4 percent in 1980. By 2000 this had dropped to 26.7 percent (ACC/SCN 2000). Nevertheless, 150 million children in the developing world remain underweight and 182 million remain stunted (low height-for-age). Moreover, progress in reducing prevalence rates has slowed in the past two decades, and in Africa the total number of underweight children has increased. Even the *prevalence* of underweight has risen in this region. At current trends it is clear that the goal of halving the prevalence of underweight children between 1990 and 2015—one of the Millennium Development Goal (MDG) indicator targets for poverty and hunger—will not be met (ACC/SCN 2000).

What is needed to accelerate reductions in undernutrition to meet this target?[1] It is well accepted that income growth should lead to a reduction in undernutrition (Strauss and Thomas 1998). Greater incomes at the household level means more can be invested in food consumption; access to clean water, good hygiene, and health care, and more effective childcare arrangements. At the community level, greater income leads to improved access to, and quality of, health care centers and water and sanitation systems. But is moderate-income growth alone enough to meet these targets? If the relationship between income growth and undernutrition reduction is not sufficiently strong, more direct investments will be required to accelerate declines in undernutrition. Candidates for such investment include nutrition programs such as community-based behavior

[1] We note Maxwell's (1999, 93) reminder that "international targets can over-simplify and over generalize complex problems…and distort public expenditure priorities." But even if one questions the analytical basis of such targets, the general question of how to hasten improvements in nutrition remains a concern.

change initiatives and micronutrient supplementation and fortification (Allen and Gillespie 2001).

The imperfect correlation between nutritional status and either national income levels or national income distribution is often used to distinguish those countries that are atypical or to motivate research to account for this. In places such as Sri Lanka or the Indian state of Kerala, higher levels of health status have been achieved than might have been expected, given their aggregate level of income or rates of poverty, often as a result of the provision of public actions that directly affect health or nutrition (Anand and Ravallion 1993). Correspondingly, in countries where nutritional status has not improved as rapidly as might have been expected, given income growth, there may be a need to make specific investments in human resources (Alderman and Garcia 1994).

The majority of studies addressing the causal link between income growth and malnutrition have, however, focused on the response of nutrient *consumption* to changes in income (Strauss and Thomas 1995; Bouis and Haddad 1992). Surprisingly, there has been no systematic multicountry analysis of the causal relationship between income and undernutrition. This paper helps fill that gap. Our goal is to answer the following question: How far does moderately rapid income growth take us toward reducing the rate of child undernutrition in line with the MDG? We use an anthropometric measure—low weight-for-age—of child nutritional status as an outcome of household decisions in health and childcare as well as in food consumption. We study the extent to which increased resources at household and national levels explain differences in this crucial outcome.

Using household survey data from 12 countries as well as aggregate data on a set of 61 developing countries, we model the relationship between child underweight and per capita income (proxied by total household consumption per capita in the micro studies and by per capita gross domestic product (GDP), 1987 purchasing power parity (PPP) in the cross-country regressions). We then use the model to predict the declines in undernutrition that can be expected from a sustained 2.5 percent annual increase in per capita income from the date of the survey (in the 1990s) to 2015. Despite these moderately rapid growth rates, declines in undernutrition rates fall short of the MDG target set above in 9 out of 12 countries. We conclude that income growth can play an important role in undernutrition reduction, but that it is not enough. We suggest (but cannot prove) that increases in the number and effectiveness of direct nutrition interventions have a crucial role to play if nutrition goals are to be met.

2. DATA SETS AND MODELS

This section describes the two data sources used to derive estimates of the response of child undernutrition to per capita income growth and outlines the models used to generate the results reported in Section 3.

THE HOUSEHOLD SURVEYS

We investigate how household resources affect the nutritional status of preschool children using household surveys from 12 countries.[2] The countries were selected from

[2] The age range was usually 0-60 months. In Kenya, the age range was 6-60 months and in Nepal it was under 3 years.

those with nationally representative household data available for the 1990s to cover a range of locations, spanning four continents. They differ appreciably in their economic position, including GNP per capita and rates of undernutrition at the national level (Table 1).[3] Nevertheless, there is a common thread in the available data, namely that for all of the countries studied, there has been a integrated household survey undertaken in the 1990s using a multipurpose, modular, living standards survey following a format utilized in over 20 countries (Grosh and Glewwe 2000). These surveys collect data on child heights and weights as well as information on total expenditures and other socioeconomic conditions of the household.

Table 1: Summary of Household Survey Datasets Used

Country	Number of preschool children used in regressions	Year of sample survey	Maternal heights coverage (yes/no)	GNP per capita[a] (Dollars) 1998	Annual % change in per capita GDP (PPP) 1975-1999[b]	Annual % change in per capita GDP (PPP) 1990-1999	Rates of malnutrition (%) Weight-for-age		
							Male	Female	All
Egypt	1,213	1997	Yes	1,290	2.9	2.4	10.3	11.1	10.7
Jamaica	752	1995	No	1,680	0.1	-0.6	4.9	5.2	5.0
Kenya	7,626	1994	No	330	0.4	-0.3	20.9	18.4	19.7
Kyrgyz	1,679	1997	Yes	350	-5.3	-6.4	13.4	13.1	13.3
Morocco	1,979	1990-1	Yes	1,250	1.4	0.4	14.7	15.4	15.0
Mozambique	3,268	1997	No	210	1.3	3.8	23.8	21.7	22.8
Nepal	1,560	1996	No	210	1.8	2.3	50.4	45.6	48.1
Pakistan	3,076	1991	Yes	480	2.9	1.3	48.4	43.2	45.7
Peru	3,075	1997	No	2,460	-0.8	3.2	7.5	5.5	6.5
Romania	3,625	1994	No	1,390	-0.5	-0.5	7.9	4.8	6.4
South Africa	4,132	1993	No	2,880	-0.8	-0.2	18.2	17.7	18.0
Viet Nam	2,637	1993	Yes	330	4.8	6.2	39.8	41.5	40.7

[a] Taken from *World Development Report 1999/2000.*

[b] Annual percent change in real per capita GDP data for both time periods are from UNDP's 2001 *Human Development Report* (UNDP 2001): (http://www.undp.org/hdr2001/back.pdf).

[3] For reasons of data availability, we were unable to cover the half of the developing world's population that lives in China and India.

The measure of nutritional status (N) that we study is weight-for-age, which is considered a general indicator of nutritional status of populations (Alderman 2000; WHO 1995). It is converted into standardized units called Z-scores after comparison with the U.S. data chosen as an international reference by the World Health Organization (WHO). The Z-scores are derived after subtracting the age- and gender-specific means from the reference data and after dividing by the corresponding standard deviation. In common with most of the literature, we pay particular attention to the proportion of children below two standard deviations from the median for the reference population. We refer to children with a weight-for-age Z-score below –2 as "underweight." In the reference population, 2.3 percent have Z-scores below -2, while 16.0 percent are below –1. These levels might be expected for a normal population, and provide a basis for comparison. However, as there is no sharp difference in risk of mortality or functional impairment at this or any other commonly used cutoff (Pelletier 1994), the regressions focus on nutritional status itself and not the probability of undernutrition as defined by a Z-score below –2.

It is apparent from Table 1 that countries with higher per capita income tend to have less undernutrition. However, there are exceptions—South Africa has the highest income in our sample, but its rates of undernutrition are the fifth lowest, little better than those of Kenya, whose per capita income is less than an eighth of South Africa's. However, our focus with the household data is on relations between household resources and nutritional outcomes across households within given countries. As is generally the case, we presume that expenditures reflect a household's long-run income potential.

Thus, we estimate regressions for nutritional outcomes as a function of the logarithm of household expenditures per capita (*Y*).

Additional regressors include the educational levels of the child's parents (or, where parentage is unknown, a proxy).[4] Over and above income earning ability, education captures—albeit imperfectly—the availability to each parent of information about appropriate caring practices and health services for the child. To account for different patterns of undernutrition by age, all the regressions contain six dummy variables for age brackets. In addition, to control for health- and sanitation-related correlates of income that may have an independent impact on nutrition, the regressions include indicators for the type of drinking water and toilet used.[5] Moreover, in countries where there are significant ethnic differences that relate to access to infrastructure—for example, South Africa or Peru—the regressions also include dummy variables for ethnic background.[6] The height of the mother—an indicator of genetic endowment and of growth and development in the womb—is included in the regressions when this information is available. Finally, all models include demographic variables such as household size and the percentage of household size in different age groups.

[4] If the child's father could not be identified, the education of the most educated adult male in the household was used. In Jamaica and Kenya, neither of a child's parents was identified, so the education of the household head and their spouse were used instead. Typically, education was measured in years, although this was not available for Kenya, in which case, dummy variables for educational level were used instead.

[5] Typically, the distinction was whether the household had piped drinking water available within the dwelling and whether it had a flush toilet (see Burger and Esrey 1995 for a discussion of the role of water and sanitation interventions in reducing undernutrition).

[6] However, WHO (1995) advocates having a single international reference for child growth. That is, there are few, if any, ethnic differences in growth patterns of young children; children from privileged or middle-class families in developing countries generally have height and weight distributions that do not differ from international references.

We undertake two specifications of the model. Model 1 includes expenditures, but excludes health, water, and sanitation infrastructure both external and internal to the household.[7] Model 2 controls for the infrastructure in the community that is external to the household (E) by including cluster-level fixed effects, i.e., the model includes a dummy variable for each sample cluster. The impact of common attitudes and resources in the community or special local circumstances are also picked up by this dummy variable. In addition, Model 2 includes the variables for infrastructure within the household (*I*) via access to piped water and sanitation. The two models can be labeled in the following way:

Model 1: N = N(Y),

Model 2: N = N(Y, E, I).

Model 2 can be considered as giving the short-term effect of increasing household income or consumption, holding external infrastructure and internal health infrastructure constant. Over a longer period, a household whose income increases may choose to invest in water and sanitation or may have such investments made on its behalf by the public sector. Model 1, for which the short-term interpretation of the coefficient on income is biased to the degree that health and sanitation effects that influence nutritional

[7] For both the household survey and the cross-country regressions we log the per capita expenditure variable. We do this to minimize the influence of extreme values of per capita expenditure. It also has the effect of increasing the marginal effect of resources on nutrition at lower income levels, since the marginal impact is the estimated coefficient on the log of expenditures divided by the observed level of expenditures. We conduct nonnested tests (Davidson and MacKinnon's J-test as outlined in Greene 2000) to determine the appropriateness of this specification versus a model linear in expenditures. In those cases where the test did prove conclusive, the log model was favored in seven and the linear in two cases. In 3 out of 12 cases the test proved inconclusive.

status are correlated with household income, may better represent the total effect of resources under a long-term scenario.[8]

It should be noted that there are several reasons to suspect the endogeneity of the income variable in both models. The most obvious reason is measurement error in income or in the expenditure variable used in this study in lieu of income. As is well known, if random measurement error is present in an explanatory variable, OLS estimates will be biased toward zero. Another potential cause of the endogeneity of income is time allocation decisions that affect both income generation via labor supply and child nutrition via childcare. Consequently we estimate the models using both ordinary least squares and instrumental variables, both with and without the community fixed effects. While there are differences in the nature and number of identifying variables in each data set, the basis of our approach is to use land and livestock holding as well as other assets and durable goods in per capita terms where available as identifying instruments. In all cases we test (1) the strength of our proposed identifying instruments in predicting expenditures per capita (an F-test), (2) whether it is valid to exclude the proposed identifying instruments from the undernutrition equation (a chi-squared test for overidentification), and (3) the significance of the difference between the consistent IV estimates on income and the efficient OLS estimates (a chi-squared Hausman test).[9]

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[8] However, Model 2 does not include changes in parental education that may also be driven by long-term income growth. In principle, the education coefficient can be used to derive that impact under any assumption of changes in education.

[9] The list of instruments and the full set of results of these tests are available from the authors. Further details on the tests are found in Bound, Jaeger, and Baker (1995) and Davidson and MacKinnon (1993).

THE CROSS-COUNTRY DATA FOR 61 COUNTRIES, 1970-1995

The dependent variable used in the cross-country analysis is the prevalence of children under 5 who are underweight for their age, i.e., whose weight falls more than two standard deviations below the median. All of these data are survey-based aggregates. The large majority of the underweight data, 75 percent, are from the World Health Organization's *Global Database on Child Growth and Malnutrition* (WHO 1997). These data have been subjected to strict quality control standards.[10] Other sources are ACC/SCN (1993) and the World Bank (1997), and we have subjected these data to similar quality checks. We match each weight-for-age survey year with the corresponding year's value of per capita GDP expressed in purchasing power parity (PPP)—comparable 1987 U.S. dollars. The data are from the World Bank's *World Development Indicators* (World Bank 1998).[11]

The data set covers 61 developing countries, accounting for over 80 percent of the developing world's population. Each country has at least two observations and many have three or four observations. The total number of country-year observations is 175, spanning the period 1970-1995 (Smith and Haddad 2000).[12]

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[10] The inclusion criteria are (1) a clearly defined population-based sampling frame, permitting inferences to be drawn about an entire population; (2) a probabilistic sampling procedure involving at least 400 children; (3) use of appropriate equipment and standard measurement techniques; and (4) presentation of data in the form of Z-scores in relation to the NCHS/WHO reference population (WHO 1997).

[11] These data are only reported for 1980-present. To arrive at comparable PPP GDP per-capita figures for the 1970s data points, it was necessary to impute growth rates from the data series on GDP in constant local currency units and apply them to countries' 1987 PPP GDPs.

[12] Related work by Smith and Haddad (2001) indicates that instrumenting GDP per capita with the investment share of GDP and the foreign investment share of GDP does not allow us to reject the exogeneity of GDP per capita in the cross-country sample. Hence we do not instrument GDP per capita in the cross-country regressions.

3. RESULTS: WHAT IS THE IMPACT OF INCOME ON UNDERNUTRITION?

This section presents the regression results for the effects of income growth at household and national levels on child undernutrition. First, we describe the results from the 12 household surveys; then we describe the results from the 61 countries used in the cross-country analysis.

THE HOUSEHOLD SURVEY RESULTS: PER CAPITA INCOME AND CHILD UNDERNUTRITION

Table 2 presents estimates of the coefficient of the logarithm of per capita consumption (our proxy for per capita income) for Models 1 and 2.[13] OLS and IV estimates are presented, with and without mother's height when that variable is available. Several things are worth noting.

First, as expected, the logarithm of per capita household consumption has a positive relationship with the nutritional status of children as measured by weight-for-age in all of the countries studied. All the OLS estimates of Model 1 (i.e., without controls for infrastructure) are significantly different from zero, and most other estimates are too.

Second, the estimated coefficients on the log of per capita consumption are usually larger in Model 1 than in Model 2. The exceptions to this are Egypt and Romania. The general pattern is consistent with the interpretation that Model 1 captures the long-term impact of income on undernutrition.

Third, the IV estimates are, without exception, larger than the OLS estimates. The increases range from 500 percent in Peru to 29 percent in Romania. This is consistent

[13] Appendix Table 8 presents these summary results in more detail and lists the instruments used. The full set of results for each country is available from the authors upon request.

Table 2: Summary of estimates of the impact of per capita income on Z-score weight-for-age

	Model 1: N = N(Y)				Model 2: N = N(Y, E, I)			
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Results for log of per capita total expenditure (lnpcxp)	**with mother's height**		**without mother's height**		**with mother's height**		**without mother's height**	
Egypt								
Estimated coefficient, lnpcxp	0.1438	**0.3600**	0.1713	0.4007	0.1652	0.2977	0.1736	0.3176
t-statistic	2.09	2.00	2.47	2.21	1.98	1.30	2.07	1.38
Hausman Test, OLS vs. IV (chi-squared)	p = 0.1948		p = 0.1698		p = 0.5360		p = 0.5029	
Mozambique								
Estimated coefficient, lnpcxp			0.3127	**0.4595**			0.1860	0.3403
t-statistic			10.68	8.76			3.94	3.62
Hausman Test, OLS vs. IV (chi-squared)			p = 0.000746				p = 0.05807	
Morocco								
Estimated coefficient, lnpcxp	0.4274	**0.7174**	0.4857	0.7814	0.1879	0.6007	0.2333	0.6330
t-statistic	8.44	9.18	9.62	10.16	2.78	3.86	3.46	4.10
Hausman Test, OLS vs. IV (chi-squared)	p = 1.12e-06		p = 3.55e-07		p = 0.0032		p = 0.0040	
South Africa								
Estimated coefficient, lnpcxp			**0.2089**	0.2790			0.1780	0.0807
t-statistic			5.39	1.48			3.45	0.28
Hausman Test, OLS vs. IV (chi-squared)			p = 0.7048				p = 0.7327	
Kyrgyz								
Estimated coefficient, lnpcxp			**0.2157**	0.2893			0.1619	0.3553
t-statistic			3.48	1.68			2.19	1.81
Hausman Test, OLS vs. IV (chi-squared)			p = 0.6469				p = 0.2882	
Peru								
Estimated coefficient, lnpcxp			0.2504	**1.2001**			0.2056	0.8150
t-statistic			5.51	5.38			4.09	3.52
Hausman Test, OLS vs. IV (chi-squared)			p = 0.0000139				p = 0.0.0069	
Kenya								
Estimated coefficient, lnpcxp			0.137	**0.499**			0.142	0.417
t-statistic			8.02	7.38			6.36	4.64
Hausman Test, OLS vs. IV (chi-squared)			p = 0.000				p = 0.01	
Jamaica								
Estimated coefficient, lnpcxp			0.257	**0.742**			0.191	0.411
t-statistic			3.13	3.10			2.11	1.51
Hausman Test, OLS vs. IV (chi-squared)			p = 0.027				p = 0.393	
Nepal								
Estimated coefficient, lnpcxp			0.319	**0.971**			0.204	0.533
t-statistic			6.16	5.15			2.98	2.78
Hausman Test, OLS vs. IV (chi-squared)			p = 0.00				p = 0.068	
Pakistan								
Estimated coefficient, lnpcxp	0.231	**0.471**	0.240	0.478	0.075	0.400	0.085	0.405
t-statistic	4.77	3.29	4.96	3.36	1.34	2.25	1.52	2.28
Hausman Test, OLS vs. IV (chi-squared)	p = 0.073		p = 0.073		p = 0.053		p = 0.056	
Romania								
Estimated coefficient, lnpcxp			**0.140**	0.180			0.287	0.658
t-statistic			3.28	2.00			2.78	2.89
Hausman Test, OLS vs. IV (chi-squared)			p = 0.279				p = 0.066	
Viet Nam								
Estimated coefficient, lnpcxp	0.265	**0.437**	0.293	0.471	0.198	0.261	0.105	0.275
t-statistic	6.73	7.02	7.37	7.52	1.76	2.55	1.87	2.67
Hausman Test, OLS vs. IV (chi-squared)	p = 0.000		p = 0.000		p = 0.057		p = 0.049	

with a high degree of measurement error on the per capita consumption variable and may partially explain the differences between patterns in the literature by income using expenditures and those using wealth indices that have swept out measurement error.

Fourth, the IV estimates are significantly different from zero and significantly different at the 5-percent level from the OLS estimates in 8 of 12 countries. OLS estimates are preferred to the IV estimates in 3 of the 12 countries. In South Africa and the Kyrgyz Republic, we cannot generate significant IV estimates for either model. In Romania, IV estimates can be generated that are significantly different from zero; however, the Hausman test fails to reject the equality of OLS and IV estimates, even at the low threshold of 20 percent that we arbitrarily select to take into account the low power of the test. In the remaining country, Egypt, we selected the IV estimate (0.36) rather than the lower OLS estimate (0.1438) for the subsequent projections, despite the fact that the Hausman test only rejected the equality of OLS and IV estimates at the 19-percent level.

Fifth, the estimated coefficients on log of per capita consumption are larger in the absence of data on mother’s height. The increases (in our preferred specifications) range from 1 percent in Pakistan to 11 percent in Egypt. This is consistent with the hypothesis that failing to control for mother’s height will lead to an omitted variables bias (Alderman 2000). However, the bias appears modest in the four cases where we can test for this.

Sixth, if we focus on our preferred estimates of Model 1 (those in bold in Table 2), the mean coefficient is 0.54—implying that doubling household income will increase weight-for-age by half a standard deviation of the reference population. The median coefficient is 0.47. There is, however, considerable variation in the size of coefficients across countries, ranging from 0.14 in Romania to 1.20 in Peru.

The results reported in Table 2 are based on regressions that have nutritional status as a dependent variable. While this approach utilizes more information in the data sets than one that focuses on the probability of crossing a threshold, it does not allow us to directly infer the impact of income growth on undernutrition rates. However, under the assumption of a neutral distribution of income growth, it is relatively straightforward to simulate expected change in the level of undernutrition between the year of the respective surveys and 2015, the reference point for the MDG, using the coefficients in Table 2.

Table 3 indicates the expected proportional reduction in undernutrition following a sustained 2.5-percent per capita income growth rate using the bolded estimates in Table 2 (all from model 1, the long-term specification). Because we are forcing income growth to be the same across countries, any differences in the impact of this growth reflect the

Table 3: Projected underweight rates with 2.5 percent annual growth in per capita income from the 1990s to 2015

Country	Estimated coefficient on lnpcxp from Model 1	Low WAZ prevalence (%) in survey year	Projected low WAZ prevalence in 2015 (%)	Percent decline in WAZ prevalence	Arc elasticity
Egypt	0.3600(IV)	0.1080	0.0800	-25.95	-0.464
Jamaica	0.7415 (IV)	0.0505	0.0226	-55.26	-0.865
Kenya	0.4994 (IV)	0.1963	0.1138	-42.02	-0.618
Kyrgyz	0.2157 (OLS)	0.1328	0.1144	-13.90	-0.248
Morocco	0.7174 (IV)	0.1379	0.0611	-55.68	-0.670
Mozambique	0.4595 (IV)	0.2304	0.1643	-28.69	-0.513
Nepal	0.9710 (IV)	0.4808	0.2599	-45.94	-0.767
Pakistan	0.4705 (IV)	0.4573	0.3467	-24.18	-0.299
Peru	1.2001 (IV)	0.0732	0.0270	-63.11	-1.127
Romania	0.1396 (OLS)	0.0640	0.0554	-13.36	-0.197
South Africa	0.2089 (OLS)	0.1802	0.1554	-13.79	-0.191
Viet Nam	0.4372 (IV)	0.4065	0.2813	-30.78	-0.427

magnitude of the estimated coefficient on income and the density of the distribution of the nutritional status of the population slightly below the cutoff for undernutrition at a Z-score of –2. Note that the assumed growth rate in per capita income is relatively optimistic. For example, from Table 1 we can see that only 3 of the 12 countries meet this growth rate over the 1990s, although another 2 come close. Over the 24-year period to 1999, only three countries meet the 2.5 percent per capita growth rate. The cross-country data set we employ confirms that the income growth rates used in our simulations are optimistic. Using all observations available (61 countries, 175 observations), the mean growth in GDP per capita between the earliest and latest years for each country averages just 1 percent per annum. In the countries for which we have observations for all three decades, the growth of income per capita averaged only 0.65 percent per annum.

Table 3 presents the projections for the 12 countries. For only three of them—Jamaica, Morocco, and Peru—does a real per capita income growth rate of 2.5 percent result in a halving of the undernutrition rate by 2015. Of the 12 countries, these three rank first, third, and sixth in terms of the lowest initial rates of undernutrition, although there is no statistically significant correlation between initial undernutrition rate and the projected decline across the 12 countries. The relative decline for all 12 countries ranges from 13 percent in Romania to 63 percent in Peru, with an average decline across the 12 countries of 34 percent (the median decline is 30 percent).

It is worth noting that these projected declines are likely to be high-end estimates. This is due to several factors. First, by using estimates from Model 1, we assume that as household income improves, so, too, does the health and sanitation infrastructure that the household has access to, both internally and externally. If we assume that infrastructure and community fixed factors do not improve (basing our estimates on Model 2), the average reduction in undernutrition from sustained growth of 2.5 percent would be 27.4 percent by 2015.[14] Second, we assume that every household experiences the same rate of income increase, an assumption that forces growth to be broad-based. Third, we assume a fairly robust per capita income growth rate. If we assume a more modest rate of growth of 1.25 percent per annum (met by only half of the 12 countries over the 1990-1999 period), none of the 12 countries would meet the MDGs. Fourth, by using the estimated coefficients from the log specification on per capita consumption, regardless of what the nonnested tests conclude, we force the estimated impact of income on nutrition to be relatively high for the poorer households (which tend to contain proportionately more underweight children).

Before looking at the impact of GDP growth on cross-country regressions, we discuss the coefficients of the auxiliary variables included in the household regressions to reduce missing variable bias, such as parental education and the infrastructure terms, focusing our attention on Model 2.

Parental characteristics are often important determinants of anthropometric status (see Table 4). This is particularly true for the mother's height, which had a positive and significant relationship to the child's nutrition in all of the countries where the information was available. The variables for years of parental education are positive and significant determinants of anthropometric status in just over a third of all cases. The lack

[14] The percentage reduction in the prevalence of low weight-for-age, using Model 2 estimated coefficients on per capita income, are as follows: Egypt, 16.03; Jamaica, 15.79; Kenya, 36.10; Kyrgyz Republic, 11.66; Morocco, 49.81; Mozambique, 22.70; Nepal, 27.20; Pakistan, 19.11; Peru, 45.33; Romania, 58.19; South Africa, 7.76; and Viet Nam, 19.56.

Table 4: Coefficients on parental characteristics

Country	Model 2: N = N(Y, E, I)		
	Weight-for-age		
	Father's education	Mother's education	Mother's height
Egypt	-0.0106	0.0019	0.0240
	(1.29)	(0.20)	(3.50)
Egypt	-0.01049	0.0033	
	(1.27)	(0.34)	
Jamaica	0.0052	0.0165	n.a.
	(0.24)	(1.15)	
Kenya	0.0016	0.0144	n.a.
	(0.35)	(3.77)	
Kyrgyz	0.0024	0.0580	n.a.
	(0.14)	(2.99)	
Morocco	0.0006	-0.0358	0.0270
	(0.01)	(0.15)	(4.97)
Morocco	0.0076	-0.038	
	(0.13)	(0.16)	
Mozambique	0.0023	0.0261	n.a.
	(0.28)	(2.24)	
Nepal	0.0212	0.0146	n.a.
	(2.76)	(1.20)	
Pakistan	0.0198	0.0311	0.0060
	(2.68)	(2.79)	(2.38)
Pakistan	0.0218	0.0308	
	(2.97)	(2.76)	
Peru 1997	-0.0165	0.0284	n.a.
	(2.53)	(3.47)	
Romania	0.0480	-0.0185	n.a.
	(2.63)	(-0.89)	
South Africa	0.0167	0.0049	n.a.
	(1.48)	(0.62)	
Viet Nam	-0.0042	0.0182	0.0253
	(-0.53)	(2.10)	(6.15)
Viet Nam	-0.0048	.0190	
	(-0.61)	(2.17)	

Notes: The coefficients are OLS estimates from Model 2; n.a. means not available.

of significance may be surprising, given the conventional wisdom, although it mirrors the findings of Sahn, Stiffel, and Younger (1999) for Demographic and Health Surveys for nine African countries.[15] Note that the estimates of the coefficients are almost always positive and, taken together, make it unlikely that their true value is zero. On average, an

[15] In one specification, parental education variables were only significant determinants of height-for-age in 11 out of 32 cases studied by Sahn, Stiffel, and Younger (1999, see Table 14A).

extra year of maternal education raises Z-scores by around 0.013 of a standard deviation of nutritional status. Although it varies by country, paternal education generally has a somewhat smaller impact (averaging 0.007). On average, giving mothers and fathers an extra six years of schooling each would raise weight-for-age by 12 percent of a standard deviation. As a point of reference, this can be compared to the 54 percent average change predicted from doubling income.

In all cases, the age bracket variables for the child were jointly significant and in most cases individually so. The anthropometric data show no evidence of bias against girls even in countries where it is commonly suspected, such as Pakistan and Nepal (see, also, Harriss 1995). Z-scores are almost always higher, on average, for girls than for boys, although the differences are often statistically insignificant.

THE CROSS-COUNTRY RESULTS: GDP PER CAPITA AND CHILD UNDERNUTRITION

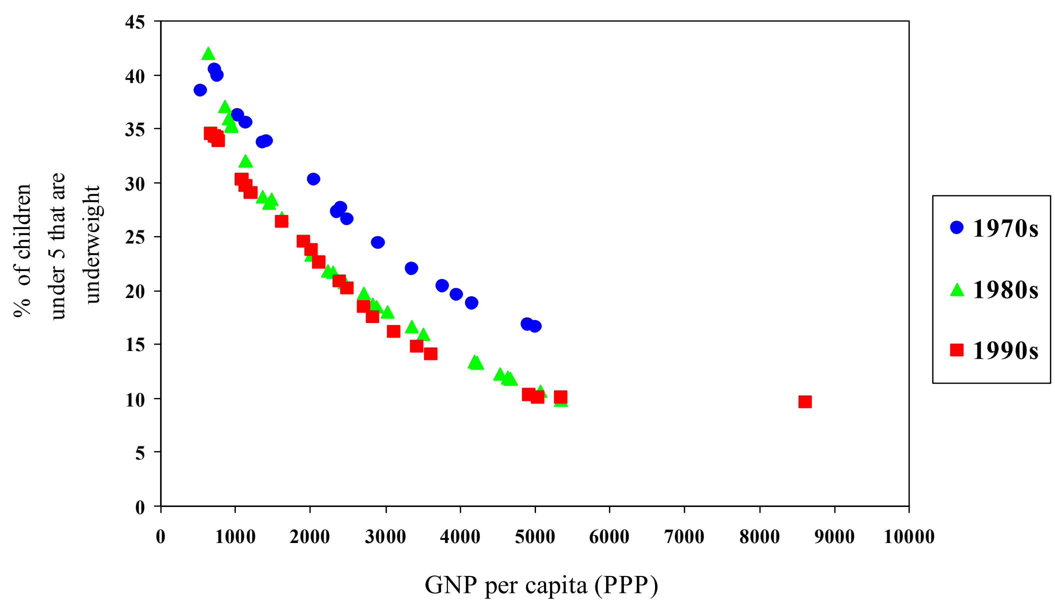
Table 5 presents the mean prevalence of undernutrition in our cross-country sample, both for all countries and for the subsample for which we have observations in each decade. We report both unweighted cross-country means and means weighted by country population. Comparisons of trends over time in undernutrition rates are complicated by the fact that we do not have observations for India in the 1980s or China in the 1970s. However, the data do illustrate the cross-sectional variation of undernutrition with national income.

Figure 1 plots the predicted negative relationship between smoothed undernutrition rates and per capita GDP based on the smoothed regression routine for

Table 5: Mean prevalence of low weight-for-age (< -2) in cross-country data

Decade	Mean prevalence		Observations
	Unweighted	Population weighted	
All countries			
1970	29.18	50.8	30
1980	24.23	29.0	74
1990	23.80	28.5	71
All	24.90		175
Countries with observations in all decades			
1970	27.07	33.9	18
1980	20.69	26.0	27
1990	19.65	24.5	22
All	22.06		67

Figure 1: The fitted relationship between child underweight rates and GNP per capita (PPP) by decade, developing countries



each decade.[16] Note that the association between GDP and nutrition has been fairly constant; the line on the graph for 1970 runs parallel to that for the next two decades. At any given level of GDP in the 1980s or 1990s, a country could expect a lower rate of undernutrition than in the 1970s. That is, even in countries with stagnant economies, the expected rate of undernutrition in 1980 was lower than in 1970. Plausible candidates that may account for this change between the 1970s and 1980s include a number of improvements in technology that are not strongly related to the income or investment in the countries in the sample, such as the promotion of oral rehydration salts and mass immunization. The average price of food was also higher in the 1970s. While it is also true that the average education of women (as well as men) improved in the period, this is less likely an explanation since—as discussed below—the 1970s imply higher undernutrition even in regressions that control for education. Moreover, the improvement in education continued and, indeed, accelerated in many countries into the 1990s, while the curve for 1990 is not appreciably below that for 1980.

In Table 6, we report models of undernutrition rates as a function of the log of per capita GDP, female secondary school enrollment, access to safe water, and decade dummy variables. Column (1) of Table 6 presents OLS results (without access to safe

[16] The ksm command in Stata (V7) with only GDP per capita as an explanatory variable was used to generate the smoothed curve. A bandwidth of 0.8 was used.

Table 6: OLS and country fixed-effects regressions: Dependent variable is prevalence of low weight-for-age (< - 2)

Explanatory variable	OLS (1)	Country fixed-effects (2)
Log of per capita GDP	-12.673	-7.44
	(8.00)**	(2.89)**
Female secondary school enrollment	-0.011	-0.088
	(0.19)	(1.13)
Percent with safe water access		-0.055
		(1.18)
Decade = 1980s	-4.411	-4.07
	(1.77)	(2.66)*
Decade = 1990s	-6.385	-4.18
	(2.52)*	(2.19)*
Constant	124.220	89.80
	(11.24)**	(4.92)**
Observations	175	175
Number of countries	61	61
R-squared	0.45	0.43

Notes: Absolute value of t-statistics in parentheses. * significant at 5% level; ** significant at 1% level.

water) that are analogous to Model 1, and column (2) presents the country fixed-effects estimates (with the access to safe water variable) analogous to Model 2.[17]

The temporal decline in underweight rates suggested in Figure 1 is confirmed by the negative signs of the dummy variables for the 1980s and 1990s (significant at 5 percent for the 1980s only in Model 2 specification) relative to the 1970s. Model 1 estimates indicate a negative and significant impact of per capita GDP on the percentage

[17] While Pritchett and Summers (1996) present evidence that GNP can be treated as exogenous in cross-country health regressions, we explore potential concerns about measurement error on the explanatory variables. To do so, we undertake a procedure suggested by Griliches and Hausman (1986). For the 36 countries with more than two observations we generated two sets of fixed-effects estimates by differencing out the fixed effects in two different ways. First, we differenced observations $t1$ and $t2$; second, we differenced the first and last observations. The two sets of estimates were similar, especially for log per capita GDP [-6.13, $t = 1.29$ in the first case and –6.91, $t = 1.91$ in the second]. Because attenuation bias does not worsen appreciably with shorter time periods between observations, we conclude that measurement error in the explanatory variables does no major violence to our conclusions on the magnitude of the estimated coefficient on the log of per capita GDP (Johnston and Dinardo 1997). This approach incidentally also partially addresses a concern about the education variables, which are generally less useful in time series of aggregate data than in household data (Kruger and Lindhal 1999), but this is somewhat less a concern the longer the interval.

of underweight children. The coefficient corresponds to an elasticity at the mean of -0.51, comparable to the mean (-0.53) of the arc elasticities reported in Table 3 from the survey-based estimates. As expected, the inclusion of fixed effects and the safe water variable in Model 2 leads to a smaller estimate of the impact of income growth. In column (2) the coefficient on GDP per capita drops to 59 percent of its column (1) value. This general result holds for fixed-effect estimation with and without safe water access (the latter not reported here) and suggests that there are many time invariant unobservables that are positively associated with both high (low) income and low (high) undernutrition, biasing the OLS estimates upwards.

The estimated coefficient on the log of per capita GDP in column (2) of Table 6 implies that 2.5 percent growth per annum in GDP per capita between 1995 and 2015 would reduce the underweight rate by 8 percentage points, or 32 percent of the initial rate (compared to 34 percent, the mean relative decline for the 12 survey countries). The results refute a hypothesis that per capita GDP growth fails to improve the nutritional status of the most vulnerable. This improvement in nutrition that is related to GDP growth may be a direct effect of economic growth on income of households with malnourished individuals (presumably the poor), indirect effects of this growth on the infrastructure of the country, or a combination of both.

These results are remarkably similar to the percentage reduction in rate estimated using the survey data. Of course there is no automatic correspondence between the household regressions and the cross-country results. For one thing, income growth estimated using the national accounts that provide the GDP data in the cross-country regressions do not strongly track those using reported household expenditures in surveys

(Deaton 2001). Also the rate of income growth for those households at risk of undernutrition may differ from the national average, depending on whether inequality is increasing or declining. Moreover, the cross-country results might be biased downwards due to mismeasurement of PPP. Conversely, one might expect the cross-country results to give higher income elasticities than those based on household survey data, since the latter condition on time varying (as well as time invariant) country-level factors. For example, if all households in a survey are subject to the same national health system, then household-level estimates of income effects will not include the indirect effects of rising national income that influence the performance of the system. Thus, it is reassuring that our main results on the expected impact of income growth are fairly robust to the alternative source of our income data.

So far, our cross-country estimates have not explicitly addressed the issue of income distribution. This omission is important for two reasons. First, it is plausible that the inequality of a country affects the allocation of resources to basic health and similar services. Second, in order that our cross-country model is to be consistent with the semi-logarithmic specification at the household level, we need to accommodate the fact that the GNP per capita variable is not equivalent to the average of the logarithm of income. We cannot recreate the latter with the aggregate data available. However, the misspecification of the income variable when the true model is semi-logarithmic is explicitly related to Theil's inequality measure. This, too, is not available for the data sets on hand, but a related measure is found in the Gini coefficients in the Deininger and Squire Dataset.[18] We use this as a conditioning variable to reduce any error in the GNP

[18] World Bank (2002): www.worldbank.org/research/growth/dddeisqu.htm

per capita variable, albeit imprecisely. Note that because the Gini coefficient variable picks up the aggregation bias as well as the possible causal relationship between inequality on the impact of income growth on nutrition, there is no clear expectation for the sign.

From an examination of the Deininger and Squire Dataset, it is clear that inequality measures change over time and thus are not adequately controlled for in the fixed-effect estimates. Merging the self-declared "high quality" data on the Gini by country and year to our data set reduces the number of observations from 175 to 96 and the number of usable observations (i.e., the country has more than one observation) to 79 (or 31 countries). Table 7 presents regressions similar to those in Table 6—but on this

Table 7: OLS and country fixed-effects regressions with Gini coefficient: Dependent variable is prevalence of low weight-for-age (< - 2)

Explanatory variable	OLS	OLS	Country fixed-effects	Country fixed-effects
Log of per capita GDP	-17.216420	-15.196270	-10.165030	-9.242374
	(7.35)**	(5.53)**	(2.09)*	(1.94)
Female secondary school enrollment	-0.037638	-0.039394	0.026611	-0.005325
	(0.44)	(0.47)	(0.25)	(0.05)
Percent with safe water access			-0.119287	-0.146424
			(1.80)	(2.20)*
Decade = 1980s	-6.302293	-7.025049	-4.368369	-4.158866
	(1.71)	(1.89)	(1.93)	(1.88)
Decade = 1990s	-10.229940	-11.142620	-4.494456	-3.975101
	(2.60)*	(2.81)**	(1.57)	(1.41)
Gini coefficient		-0.301920		-0.342175
		(1.38)		(1.80)
Constant	165.400300	163.766200	113.282900	123.910700
	(9.74)**	(9.67)**	(3.20)**	(3.54)**
Observations	79	79	79	79
Number of countries	31	31	31	31
R-squared	0.56	0.57	0.54	0.56

Notes: Only for countries with more than one observation for the Gini coefficient. Absolute value of t-statistics in parentheses. * significant at 5% level; ** significant at 1% level.

much smaller data set—both with and without the Gini variable. The Gini coefficient is not significantly different from zero at the 5 percent level, either in the OLS or the country fixed-effects specification. It does have a negative coefficient, however. Importantly, the introduction of the Gini coefficient does not substantially alter the magnitude of the estimated coefficient on the log of per capita GDP.

4. CONCLUSIONS

The results presented here at both the cross-country and the household levels show that sustained income growth can produce a sizable reduction in undernutrition in the next decade or so. Even holding community and household infrastructure constant, undernutrition rates (in terms of low weight-for-age) are projected to decline by around 27 percent by 2015 if countries that can achieve per capita income growth of 2.5 percent per annum. Allowing the community and household infrastructure to change over time increases the impact of 2.5 percent per capita income growth to a 34-percent reduction in the national rates of underweight. Cross-country regressions imply similar reductions. The cross-country estimates add an additional dimension since they show that historical patterns of income distribution are consistent with income growth leading to marked improvements in nutrition.

While this is encouraging from the perspective of the role of broad-based income growth on undernutrition, there are some disturbing elements of these results as well. First, only 3 of the 12 countries sustained per capita economic growth rates greater than 2.5 percent in the 1990s. Second, even if all 12 countries grew at 2.5 percent over the approximate 20-year period to 2015, only 3 out of 12 countries would meet the MDG of reducing undernutrition rates by 50 percent. Third, among the countries that will not meet the MDG targets, even at a sustained 2.5 percent annual per capita income growth rate, are those with the highest current percentage of underweight preschool children: namely Viet Nam, Nepal, and Pakistan. Fourth, even if all economies managed to grow at a pace that would halve undernutrition rates by 2015, each year a different cohort of preschool children—particularly those less than 36 months of age—would be irreversibly harmed.[19] Do we need to wait this long for undernutrition rates to be halved?

While income growth can take us a long way toward meeting the MDG underweight target, it is unlikely, by itself, to ensure that it is met. What can ensure that these targets are reached and at a more rapid pace? Many effective nutrition- and health-related interventions are available to accelerate reductions in undernutrition in the short run (Allen and Gillespie 2001). Within this set of interventions some—particularly vitamin A supplementation to children under 5, some types of nutrition education/behavior change, and iron supplementation of pregnant women—are more cost-effective than others (Gillespie and Haddad 2001). The effectiveness of such instruments has been shown using impact evaluations and other project-level assessments. The long-term income estimates that we use from the surveys do allow for improvements in health-related infrastructure, but only in a "business as usual" rate. Unfortunately, given data constraints, it is impossible to compare the cost-effectiveness of current health infrastructure captured by the surveys with that of the "best practice" set of nutrition interventions, especially when the health infrastructure is broadly defined and can fall within other sectors, such as education, infrastructure, and agriculture.

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[19] Moreover, even if MDG goals are met in countries with high initial levels of undernourishment, this is no cause for complacency—they will still be home to many undernourished preschoolers.

We do, nevertheless, feel able to echo the conclusions of Berg (1981) as well as Reutlinger and Selowsky (1976), who noted that undernutrition would persist in the face of rapid income growth in the absence of additional direct measures, whatever they may be. That is, the results point to the crucial importance of pursuing a balanced strategy to accelerate reductions in undernutrition, though they do not identify which investments are more effective (see Gillespie, Mason, and Martorell 1996 for examples).

However, we also stress that income growth is also part of this balanced strategy. Sustained per capita income growth will go a long way toward the goal of halving child undernutrition rates by 2015. Indeed, despite the potential of direct nutrition investments, their impact is likely to be hampered in the absence of the income growth.

APPENDIX TABLES

Table 8: Countries used in the cross-country tables

Region	Number of countries	Regional coverage (number of countries)	Regional coverage (population)	Number of observations	Countries
South Asia	5	71%	98%	16	Bangladesh (82, 85, 89, 96), India-rural (77, 91), Nepal-rural (75, 95), Pakistan (77, 85, 90, 95), Sri Lanka (77, 80, 87, 93).
Sub-Saharan Africa	26	58%	83%	65	Benin (87, 96), Burkina Faso (87, 92), Cameroon (77, 91), Comoros (91, 95), Congo, Rep. (77, 87), Congo, Dem. Rep. (75, 86, 89, 94), Côte d'Ivoire (86, 94), Ethiopia-rural (83, 92), Ghana (87, 93), Guinea (80, 95), Kenya-rural (82, 87), Lesotho (76, 81, 94), Madagascar (83, 92, 95), Malawi (81, 92, 95), Mauritania (81, 87, 90), Mauritius (85, 95), Niger (85, 92), Nigeria (90, 93), Rwanda (76, 92), Senegal (86, 92), Sierra Leone (74, 77, 90), Tanzania (87, 91, 96), Togo (76, 88), Uganda (77, 88, 95), Zambia (72, 85, 88, 92, 96), Zimbabwe (84, 88, 94).
East Asia	8	57%	94%	26	China (87, 92, 95), Indonesia (78, 87, 95), Laos (84, 94), Malaysia (83, 86, 90, 95), Myanmar (80, 83, 90, 95), Philippines (73, 82, 87, 93), Thailand (82, 87, 90), Viet Nam (80, 87, 94).
Near East and North Africa (NENA)	4	25%	36%	12	Algeria (87, 92, 95), Egypt (78, 88, 92, 95), Morocco (87, 92), Tunisia (74, 88, 94).
Latin America and the Caribbean (LAC)	18	75%	84%	56	Bolivia (81, 89, 93), Brazil (75, 89, 96), Chile (78, 82, 86, 95), Columbia (77, 86, 89, 95), Costa Rica (78, 82, 89, 94), Dominica (86, 91), Guatemala (77, 80, 87, 95), Guyana (71, 81, 93), Haiti (78, 90, 94), Honduras (82, 87, 93), Jamaica (78, 85, 89, 93), Mexico-rural (74, 79, 89), Nicaragua (80, 93), Panama (80, 92), Peru (75, 84, 91, 96), Trinidad and Tobago (76, 87), Uruguay (87, 92), Venezuela (81, 87, 90, 94).
TOTAL	61	56% of developing countries	88% of the developing-country population	175	

Note: Population percentages are calculated from countries' 1995 populations. Source of population data: United Nations (1998).

Table 9: Full results on per capita consumption: Dependent variable is Z-score weight-for-age

	Model 1: N = N(Y)				Model 2: N = N(Y, E, I)			
	OLS	**IV**	**OLS**	**IV**	**OLS**	**IV**	**OLS**	**IV**
Results for log of per capita total expenditure (lnpcxp)	**With mother's height**	**With mother's height**	**Without mother's height**	**Without mother's height**	**With mother's height**	**With mother's height**	**Without mothers height**	**Without mothers height**
Egypt								
Estimated coefficient, lnpcxp	0.1438	**0.3600**	0.1713	0.4007	0.1652	0.2977	0.1736	0.3176
t-statistic	2.09	2.00	2.47	2.21	1.98	1.30	2.07	1.38
F-test on significance of identifying instruments	F(10,1188)=20.45 (p=0)		F(10,1189)=20.72 (p=0)		F(10,1061)=16.17 (p=0)		F(10,1062)=16.24 (p=0)	
Overidentification Test (chi-squared)	6.31 (df=9) (pass)		6.31 (df=9) (pass)		3.158 (df=9) (pass)		3.518 (df=9) (pass)	
Hausman Test, OLS vs. IV (chi-squared)	p=0.1948		p=0.1698		p=0.5360		p=0.5029	
Instruments (10)	PC Value -animals owned (and x rural-urban dummy), PC Value – acres owned (and x rural-urban dummy), PC value Other Savings, bank deposits, PC value - other property not in use, PC value durables, PC value - hhold enterprise, PC value- Agricultural machinery (tractors, threshers) (and x rural-urban dummy)							
Mozambique								
Estimated coefficient, lnpcxp			0.3127	**0.4595**			0.1860	0.3403
t-statistic			10.68	8.76			3.94	3.62
F-test on significance of identifying instruments			F(16,3279)=92.26 (p=0)				F(16,2513)=53.20 (p=0)	
Overidentification Test (chi-squared)			19.28 (df=15) (pass)				21.90 (df=15) (pass)	
Hausman Test, OLS vs. IV (chi-squared)			p=0.000746				p=0.05807	
Instruments (16)	PC land area- Ha, PC livestock value, 1-own refrigerator, 1-own fan, 1-Own Sewing Machine, 1-own loom, 1- own iron, 1-own radio, 1-own television, 1-own color TV, 1-own air conditioner, 1-own clock, 1-own Telephone, 1-own car, 1-Own Motor bike, 1-own bicycle							
Morocco								
Estimated coefficient, lnpcxp	0.4274	**0.7174**	0.4857	0.7814	0.1879	0.6007	0.2333	0.6330
t-statistic	8.44	9.18	9.62	10.16	2.78	3.86	3.46	4.10
F-test on significance of identifying instruments	F(5,1956)=291.38 (p=0)		F(5,1957)=304.76 (p=0)		F(5,1814)=86.72 (p=0)		F(5,1815)=87.93 (p=0)	
Overidentification Test (chi-squared)	7.718 (df=4) (pass)		8.1139 (df=4) (pass)		4.35 (df=4) (pass)		2.97 (df=4) (pass)	
Hausman Test, OLS vs. IV (chi-squared)	p=1.12e-06		p=3.55e-07		p=0.0032		p=0.0040	
Instruments (5)	1-own cooker, 1-own refrigerator, 1-own stove w/gas, 1-own TV- colored, 1-own TV b/w							
South Africa								
Estimated coefficient, lnpcxp			**0.2089**	0.2790			0.1780	0.0807
t-statistic			5.39	1.48			3.45	0.28
F-test on significance of identifying instruments			F(5,4108)=36.02 (p=0)				F(5,3755)=24.67 (p=0)	
Overidentification Test (chi-squared)			5.372 (df=4) (pass)				0.0001 (df=4) (pass)	
Hausman Test, OLS vs. IV (chi-squared)			p=0.7048				p=0.7327	
Instruments (5)	Number of wage earners per household, Per capita Land Area owned (ha), Per Capita Vehicle value, Per Capita value of Other machinery--motorised pumps, etc, PC Value of Other Immovable assets- e.g. Land not in use							
Kyrgyz								
Estimated coefficient, lnpcxp			**0.2157**	0.2893			0.1619	0.3553
t-statistic			3.48	1.68			2.19	1.81
F-test on significance of identifying instruments			F(6,1657)=41.0 (p=0)				F(6,1602)=44.13 (p=0)	
Overidentification Test (chi-squared)			2.351 (df=5) (pass)				0.672 (df=5) (pass)	
Hausman Test, OLS vs. IV (chi-squared)			p=0.6469				p=0.2882	
Instruments (6)	PC value of durables, PC Livestock Value, PC value of Business owned, PC value –housing and properties owned, PC Other assets- savings, etc, PC land value							
Peru								
Estimated coefficient, lnpcxp			0.2504	**1.2001**			0.2056	0.8150
t-statistic			5.51	5.38			4.09	3.52
F-test on significance of identifying instruments			F(4,3055)=66.23 (p=0)				F(4,2680)=67.22 (p=0)	
Overidentification Test (chi-squared)			0.0001 (df=3) (pass)				0.0001 (df=3) (pass)	
Hausman Test, OLS vs. IV (chi-squared)			p=0.0000139				p=0.0.0069	
Instruments (4)	PC value of durables (and squared term), PC value of house (and squared term)							

Table 9 (continued)

WAZ	**No CFE, no infrastructure**				**With CFE, Infrastructure**			
	OLS	**IV**	**OLS**	**IV**	**OLS**	**IV**	**OLS**	**IV**
	With mother's height	**With mother's height**	**Without mother's height**	**Without mother's height**	**CFE + infra with mother's height**	**CFE + infra with mother's height**	**CFE + infra without mother's height**	**CFE + infra without mother's height**
Kenya								
est. coeff on lnpcxp			0.137	**0.499**			0.142	0.417
t-stat			8.02	7.38			6.36	4.64
Relevance Test			F(6,7603)=92.29 (p=0)				F(6,6481)=73.24 (p=0)	
OverID Test (chi-sq)			6.01 (df=5) (pass)				1.53 (df=5) (pass)	
Hausman Test on lnpcxp			p=0.00				p=0.01	
instruments (6)	log PC cattle, 1- no cattle, log PC number of rooms in house, 1- head is commercial farmer; 1 – head is in business, 1 - iron roof							
Nepal								
est. coeff on lnpcxp			0.319	**0.971**			0.204	0.533
t-stat			6.16	5.15			2.98	2.78
Relevance Test			F(6,1539)=23.22 (p=0)				F(6,1539)=30.32 (p=0)	
OverID Test			5.14 (df=5) (pass)				9.04 (df=5) (pass)	
Hausman Test on lnpcxp			p=0.00				p=0.068	
instruments (6)	log value of consumer durables, log PC land value, log PC livestock value, log PC value of farm enterprise assets; log PC value of non-farm enterprise, 1 – electric lighting							
Romania								
est. coeff on lnpcxp			**0.140**	0.180			0.287	0.658
t-stat			3.28	2.00			2.78	2.89
Relevance Test			F(10,3597)=107.95 (p=0)				F(10,1216)=31.97 (p=0)	
OverID Test			13.77 (df=9) (pass)				2.175 (df=9) (pass)	
Hausman Test on lnpcxp			p=0.279				p=0.066	
instruments (10)	log PC value of consumer durables, log PC value of domestic currency savings, wage earners as proportion of household size; log PC own house value; log PC private rent; log PC public rent; dummies for private renting, public renting and for missing monetary information on housing							
Pakistan								
est. coeff on lnpcxp	0.231	**0.471**	0.240	0.478	0.075	0.400	0.085	0.405
t-stat	4.77	3.29	4.96	3.36	1.34	2.25	1.52	2.28
Relevance Test	F(6,3051)=66.61 (p=0)		F(8,3052)=62.26 (p=0)		F(6,2759)=51.26 (p=0)		F(6,2760)=51.34 (p=0)	
OverID Test	8.613 (df=6) (pass)		8.305 (df=6) (pass)		.615 (df=6) (pass)		0.308 (df=6) (pass)	
Hausman Test on lnpcxp	p=0.073		p=0.073		p=0.053		p=0.056	
instruments (6)	log PC land; log PC rooms; 1 – mud floor; 1 – iron roof; 1 – no land; 1 – missing data on housing							
Jamaica								
est. coeff on lnpcxp			0.257	**0.742**			0.191	0.411
t-stat			3.13	3.10			2.11	1.51
Relevance Test			F(6,730)=17.02 (p=0)				F(6,716)=14.53 (p=0)	
OverID Test			0.752 (df=6) (pass)				0.075 (df=6) (pass)	
Hausman Test on lnpcxp			p=0.027				p=0.393	
instruments (5)	log PC value of durables; log PC unearned income; log PC rooms; 1 – receives food stamps; 1 – applied for food stamps; 1 – owns house							
Viet Nam								
est. coeff on lnpcxp	0.265	**0.437**	0.293	0.471	0.098	0.261	0.105	0.275
t-stat	6.73	7.02	7.37	7.52	1.76	2.55	1.87	2.67
Relevance Test	F(4,2616)=441.64 (p=0)		F(4,2617)=447.10 (p=0)		F(4,2317)=244.98 (p=0)		F(4,2318)=245.35 (p=0)	
OverID Test	7.120 (df=4) (pass)		7.120 (df=4) (pass)		0.791 (df=4) (pass)		0.791 (df=4) (pass)	
Hausman Test on lnpcxp	p=0.000		p=0.000		p=0.057		p=0.049	
instruments (4)	log PC value of durables; log PC land; log PC value of livestock; 1 – no land							

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