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TURNING ECONOMIC GROWTH INTO NUTRITION-SENSITIVE GROWTH

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Abstract

There is a growing consensus that reducing childhood malnutrition is a critically important goal, but far less consensus on what kind of strategies can best achieve that goal. Many nutrition programs focus on quite specific interventions (food supplements, or nutrition training), but many "non-nutrition" factors—such as household income (poverty), food availability, female education and health outcomes—can potentially have profound influences on nutrition outcomes. If economic growth can improve these intermediate factors, then this "nutrition-sensitive" economic growth might be the most effective means of sustainably reducing childhood malnutrition. To explore this hypothesis more systematically, this paper employs a rich cross-country dataset containing information on malnutrition outcomes, economic growth, food consumption patterns, and other social-sector determinants of malnutrition. The paper first looks at the productive sectors— agriculture, nonagriculture—as important mediating channels between overall economic growth and nutrition, before examining social-sector channels such as health, education, and family-planning outcomes. The econometric results indicate that economic growth is nutrition-sensitive if it increases food production (especially when food insecurity is high), reduces poverty, increases female education, improves health access, and reduces fertility rates (a proxy for various family planning outcomes). A non-econometric analysis of successful and unsuccessful nutrition episodes confirms the more formal econometric results, and perhaps even makes the stronger case that—for low-income countries, at least—economic growth is a necessary but insufficient condition for reducing malnutrition. It is necessary because there is no example of a low-income country making significant progress in reducing malnutrition without fairly rapid economic growth, but it is insufficient because there are several instances where rapid economic growth has produced little or no reduction in malnutrition (including India, where roughly one-third of the world's malnourished children reside). While these findings do not rule out an important role for more specific nutrition interventions, they do suggest that a nutrition-sensitive growth strategy would be an effective instrument for achieving both nutrition and non-nutrition goals (such as education, health, and poverty targets).

Keywords: Malnutrition, economic growth, agricultural growth, poverty, health, education, family planning.

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"Interventions outside the nutrition sector—indeed, even outside the health sector—can have profound effects on reducing child malnutrition. Indeed, it might be argued that, in the medium to long run, non-nutritional interventions, such as improving agricultural productivity, expanding female schooling, and bringing piped water and electricity to rural areas, might have larger effects on the reduction of child malnutrition than nutritional supplementation or fortification programs." Anil Deolalikar (2008)

"Successful strategies to improve the nutrition of communities are . . . based on two elements. First is nutrition-sensitive development across sectors – a consistent focus on nutritional outcomes and indicators within local and national initiatives to end hunger and improve food and nutrition security, to improve living conditions and to ensure social protection – among both rural and urban populations. Second is particular attention to the challenges faced by those most affected by under-nutrition – young children and women – through nutrition-specific interventions." David Nabarro (2010), Special Representative of the UN Secretary General for Food Security and Nutrition.

Turning Economic Growth into Nutrition-Sensitive Growth

DEREK HEADEY

1. Introduction

There are few visions of underdevelopment more disturbing than a severely wasted child. Yet science has increasingly shown that the reduction of malnutrition – including its less visible forms, such as stunting or micronutrient deficiencies - is not only an important normative goal, but also a vital instrumental goal. Malnutrition is associated with 30 percent of infant deaths; is the single largest factor contributing to the global burden of disease; has adverse effects on school attendance, school performance, and cognitive capacity; and reduces adult labor productivity and wage earnings, as well as overall economic growth (Behrman, Alderman, and Hoddinott 2004; Grantham-McGregor, Fernald, and Sethurahman 1999; Hoddinott 2009, Horton and Ross 2003, Maluccio, et al. 2009; Strauss and Thomas 1998; The World Bank 2006); and even adult happiness (Deaton 2009). The halving of childhood undernutrition is therefore rightly listed among the United Nation's Millennium Development Goals (MDGs).

Yet despite this growing consensus that reducing childhood malnutrition is a critically important development goal, there is less consensus on the best way forward. A considerable body of research in the nutrition and public health fields has focused on evaluating the impact of nutrition-specific interventions, such as food, mineral, and vitamin supplements or training and education programs. Many of these interventions have been shown to be very cost effective, and have therefore been advocated as important components of nutrition strategies (Horton, Alderman, and Rivera 2008). Yet as the above quotes suggest, non-nutritional interventions could have a larger impact on malnutrition over the medium to longer term, especially if these interventions could be made more "nutrition-sensitive" (Nabarro 2010). An extension of this argument is that broad-based economic growth has considerable potential to indirectly sustain large reductions in malnutrition.

What would this kind of "pro-nutrition growth" entail? In terms of the productive sectors, a plausible hypothesis is that agricultural growth typically has a larger effect on malnutrition than nonagricultural growth. This is because agricultural growth is generally pro-poor (Chen and Ravallion 2007; Christiaensen, Demery, and Kühl forthcoming; Datt and Ravallion 1998; de Janvry and Sadoulet 2010; Thirtle, Lin, and Piesse 2003), and poverty is obviously an important determinant of malnutrition. Moreover, one of the reasons agricultural growth is pro-poor is that food-based agricultural growth reduces food prices, which should also have a favorable impact on household food security and nutrition. Despite these important linkages (and there may be others), there are also plenty of caveats to the above-mentioned hypothesis. The impact of agriculture may be highly conditional. In some developing countries, for example, food security may be adequate to make additional food production ineffective at reducing malnutrition. In other countries, agricultural growth may be significantly based on nonfood cash crops, or the basket of foods produced may not be beneficial to nutrition (e.g., if there is insufficient dietary diversity in the bundle). Agricultural growth can also fail to be pro-poor under conditions of extreme land inequality because of limited wage growth for landless laborers (Christiaensen, Demery, and Kühl forthcoming). Open economy considerations are also important. If foods are fully tradable (which is rare in developing countries), then nonagricultural exports can fund food imports (e.g.,

Singapore would be an extreme case). Finally, as existing reviews demonstrate, agricultural growth can have an unfavorable effect on health (e.g., inappropriate pesticide use) or lead to worsening childcare outcomes, such as maternal neglect (Headey, Chiu, and Kadiyala 2010; Hoddinott 2011).

A second hypothesis is that, under certain conditions, economic growth could have a large effect on malnutrition through various social sector factors. A fundamental characteristic of nutritional outcomes is that they are caused by many different factors. The widely used UNICEF framework (1990), for example, groups a wide array of proximate factors into two broad categories: food intake (micro and macronutrients, including breast milk and fetal nutrient intake during pregnancy), and health-related factors (exposure to infectious diseases and vaccinations against them, sanitation and access to safe water, prevalence and treatment of diarrhea, feeding, and other care practices). However, underlying these two categories of proximate factors is a range of deeper factors related to household income, employment, geography and climate, infrastructure, parental education, maternal health, family planning decisions, nutrition and health programs, and cultural norms pertaining to feeding, childcare, and the intrahousehold distribution of resources.

This simple observation actually has some profound implications for nutrition strategies. On the one hand, it suggests that changes in any single proximate determinant of malnutrition might only have a marginal effect on malnutrition (an outcome regularly observed in statistical analyses of malnutrition). Alternatively, it also raises the possibility that underlying socioeconomic processes—including economic growth and perhaps improved governance—could conceivably have a large impact on malnutrition precisely because these factors can influence malnutrition through multiple channels. Economic growth, for example, could raise the incomes of the poorest and increase their food, health, and education expenditures. It could also raise government revenue and spur public expenditures on health, education, nutrition, and infrastructure. In addition, in the long run, growth could favorably alter social norms pertaining to gender and class roles, family planning, and the household distribution of food and other important resources. Of course, it is just as possible that in other contexts economic growth will be biased towards the rich (e.g., in mineral-rich economies), or towards urban areas where malnutrition is generally less of a problem (Smith, Ruel, and Ndiaye 2004). Alternatively, growth might lead to no improvements in infrastructure or social services because of poor governance or elite capture.

Whilst these two hypotheses—that agricultural growth and broader socioeconomic development matter more than their alternatives—are certainly plausible, there is no existing literature that explicitly tests them. For example, the long-standing microeconomic studies testing the effects of household income on anthropometric outcomes and calorie intake (Strauss and Thomas 1998) does not offer any systematic evidence on income-nutrition linkages because these studies adopt different methods and cover only a select group of countries where appropriate surveys have been conducted. The most prominent and widely cited work on this subject, by Haddad and Smith (2003), broaches the problem more systematically, but only estimates a long run relationship between economic growth and underweight prevalence.[1] Similarly, a recent cross-country study by Webb and Block (2010) estimates a long run relationship between economic growth and stunting prevalence, although these authors at least make note of the fact there results do not always carry over into the short run. Historical studies also focus on long run changes in adult heights as an indicator of nutrition (Cole 2003), and these invariably show that adult heights do increase as incomes rise.

However, in the current debate about nutrition strategies, it is the short to medium term that is of most interest, such as what rate of economic growth would suffice to reach the MDG target of halving childhood malnutrition. Another recent cross-country study by Heltberg (2009) does focus on the short run effect of economic growth on stunting prevalence, and uncovers a weaker relationship than the studies cited above. However, whilst methodologically more appropriate, the Heltberg study still stops short of examining variation around the mean, or in more intuitive terms, why some growth episodes are pro-nutrition whilst others are not.

This paper goes a step further by asking what makes an economic growth process "nutrition-sensitive". To that end, a relatively rich dataset (described in Section 2) has been constructed that contains several measures of malnutrition as well as a wide range of indicators of economic growth and changes in education, health, infrastructure, and poverty. Section 3 reports the results of testing the first of the two hypotheses stated above (that agricultural growth has a larger impact on malnutrition than nonagricultural growth). Section 4 examines some possible socioeconomic channels by which growth can influence malnutrition. Finally, Section 5 briefly explores case studies of success and failure in combating malnutrition to see whether these cases support or

1 Smith and Haddad review many other studies that look at relationships between nutrition and income, and there have been several studies since in addition to those discussed above, such as Apodaca (2008) and Gabriele and Schettino (2008). However, all of these studies look at cross-sectional "long run" relationships.

contradict the more formal econometric tests on the role of agricultural growth and social sector investments. Section 6 concludes with some policy implications for pro-nutrition development strategies.

2. Methodology and data issues

The following section outlines some relevant measurement issues for both the malnutrition and economic growth variables used in this paper and provides an estimation strategy.

2.1 Measurement issues

In this study, an unusually large and rich dataset on malnutrition and large number of potential determinants is used, which includes economic growth (including sectoral growth rates), food availability, monetary and asset-based measures of poverty, and various socioeconomic indicators, such as education, health, family planning, and infrastructure outcomes. More details of all the variables used in this study are presented in Table 1, while more specific measurement issues are discussed in the text below.

Existing studies have found different growth-nutrition elasticities depending on whether underweight prevalence (weight for age), wasting prevalence (weight for height), or stunting prevalence (height for age) is used as the dependent variable. The choice of dependent variable therefore appears to produce different statistical results, but the choice is not arbitrary, as these indicators represent different physiological processes. Conceptually, weight for height refers more to short-run malnutrition problems, whereas height for age is the best measure of the cumulative effects of various malnutrition processes (health problems and dietary deficiencies). Weight for age is the product of weight for height and height for age, and hence rather ambiguously combines the latter two indicators. Linking back to the aim of these tests, which is to test the effects of economic growth in the medium term (e.g., 5-10 years), height for age is therefore the preferred measure of malnutrition in a conceptual sense precisely because it captures the cumulative effects of processes that take place over the space of several years.[2] Ideally, it would also be informative to study the determinants of adult malnutrition, but the smaller sample is a significant constraint since only relatively recent Demographic Health Surveys only measure adult body mass index (BMI) or height. Nevertheless, for both underweight and low BMI prevalence, the stunting tests reported below are replicated, and these tests are included in the appendix as a further exploration of the sensitivity of the results.[3] The concluding section of the paper provides a summary of these sensitivity tests, and underweight prevalence is used as one of the indicators in Section 5 on success stories and failures.

In all instances, conventional cut-off measures are used for defining malnutrition: less than two standard deviations[4] from international norms in the case of stunting and underweight prevalence, and less than 18.5 in the case of BMI.[5] With regard to data sources, much of the data on malnutrition stems from the Demographic Health Survey's online database (DHS 2010), which also includes data on some other important indicators, including an asset-based extreme poverty measure (the percentage of households who do not own any of the measured assets); fertility rates; and access to improved water, sanitation, electricity, medically attended births, vaccinations and secondary and tertiary education (for adult women). All of these variables are used in Section 5 where some of the social sector channels through which economic growth could affect malnutrition are explored.

Since the regression framework described below uses a first differences approach, the preferred approach to measuring economic growth is to use percentage changes in local currency units of GDP per capita. The World Bank's *World Development Indicators* (World Bank 2010) is the source of the national accounts data and the aggregate population data, while agricultural and nonagricultural employment data are obtained from

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[2] One concern with using height as a measure of malnutrition is that it may be partially determined genetically. But whilst some authors still argue that genetics matter (Nubé 2007), the WHO Multi-Center Growth Reference Study has shown, through work in multiple countries, that ethnicity and genetics matter less than environmental circumstances related to child growth (see http://www.who.int/childgrowth/mgrs/en/). Moreover, long-run historical data (Cole 2003; Deaton 2008) verify that heights do increase with improvements in incomes, education, and healthcare, among other factors. Hence, at the very least, changes in stunting prevalence seems a good indicator of nutrition improvements.

[3] Body mass is also a less than ideal measure of longer-term adult nutrition. Adult heights—analogous to childhood stunting—would be the natural analog for an adult malnutrition indicator, but the problem here is that heights are determined in childhood, such that measuring the effect of growth on height would require the use of individual level data on current height and year of birth. See Deaton (2008) for such a study in the Indian context.

[4] Note that sensitivity of these cutoff lines is not examined (e.g., one could use one standard deviation or three standard deviations) because in most instances this would significantly reduce the sample sizes involved, which are not particularly large to begin with. However, future research to explore this sensitivity, in the vein of Bhagowalia (2008), would be useful.

[5] The international norms for stunting and underweight are mostly the WHO's Child Growth Standards reference population adopted in 2006, which are based on data from 11 different countries, including India. However, for some countries the norms pertain to the older NCHS/CDC/WHO standards, which are mostly based on U.S. data. This mixing and matching is done to maximize the sample, but makes little difference to the results because the estimating strategy relies solely on within-country changes in malnutrition, rather than cross-country comparisons (see below).

the Food and Agriculture Organization (FAO 2010). The FAO is also the source of more disaggregated data on agricultural production that distinguishes between food production and nonfood agricultural production. Likewise, the FAO also provides estimates of the availability of various food items based on domestic production, wastage, storage, and net food imports. These estimates are undoubtedly inferior to DHS data on the diets of children and mothers, but such data are not available for a sufficient number of countries.

Lastly, there are two important characteristics of this data set. First, for most of the tests conducted the indicators for India are reported at the state level rather than the country level. This not only increases the sample size, it also makes the sample much more representative at the global level, since India accounts for around one-third of the global population of malnourished children. With Indian states included, India accounts for 22.7 percent of the total number of observations (Table 2). Without Indian states included, India would only account for 1.5 percent of the sample. Of course, this solution is only piecemeal—East Asia is still heavily underrepresented in the sample—but the difficulties of finding subnational economic growth statistics for other countries make any further expansion of the dataset very challenging indeed. Second, another expansion is used in Section 4 where a nutrition-sensitive social development index is constructed that represents the rural and urban levels (in other words, we treat the rural and urban areas of each country as a separate economy). This doubles the sample size, whilst still allowing the ability to test for differences in rural-urban effects.

Table 1—Description of key variables used in the study

Variable name	Definition	Source
Stunting	Percentage of children aged 0-5 who are two standard deviations less than international height for age norms.	DHS (2010)
Underweight	Percentage of children aged 0-5 who are two standard deviations less than international weight for age norms.	DHS (2010)
Low BMI	Proportion of adult women who with body mass index (weight for height squared) of less than 18.5.	DHS (2010)
Growth	Percentage change in GDP per capita, measured in local currency units	WDI (2010)
Growth (ag.) Growth (nonag.)	The weighted percentage change in (non)agricultural GDP (value added) per capita, measured in local currency units. Two weights are used: (non)agricultural GDP shares and (non)agricultural employment shares. If the GDP shares are used then (non)agricultural GDP is divided by the total population. If employment shares are used then GDP is divided by the (non)agricultural population.	WDI (2010) for national accounts data, FAO (2010) for employment data. Indian state data are derived from national sources.
Growth (food prod.)	Percentage change in food production per capita, measured in 2002 international purchasing power units.	FAO (2010)
Daily energy supply (DES)	Mean availability of calories (kcal/day)	FAO (2010)
Cereals+roots as % of DES	The shares of DES accounted for by cereals and root crops (a crude measure of dietary diversity)	FAO (2010)
Protein consumption	Mean availability of proteins (grams/day)	FAO (2010)
Fat consumption	Mean availability of fats (grams/day)	FAO (2010)
Asset-based poverty	The percentage of household who do not own of the assets or consumer durables measured in the survey.	DHS (2010)
Female education	The proportion of adult women having attended secondary or tertiary educational institutions.	DHS (2010)
Fertility rate (general)	Births divided by number of women 15-44 multiplied by 1000) for the 3 years preceding the survey.	DHS (2010)
% children vaccinated	Percentage of children 12-23 months who had received nine specified vaccines.	DHS (2010)
% births in medical facility	Percentage of live births in the last five) years preceding the survey attended by a skilled medical staff.	DHS (2010)
% HHs with electricity	Percentage of households with access to electricity	DHS (2010)
% HHs with flush toilet	Percentage of households with access to a flush toilet	DHS (2010)
% HHs with piped water	Percentage of households with access to piped water	DHS (2010)

Table 2. Regional composition of the aggregate sample

	Number of observations of stunting	Percentage of total sample (percent)
All observations with Indian states	198	100.0
Indian states	45	22.7
South Asia with Indian states pooled together	16	10.5
East Asia	9	4.5
Latin America & Caribbean	34	17.2
Middle East & North Africa	18	9.1
Sub-Saharan Africa	63	31.8
Transition countries (former Soviet Bloc)	12	6.1

Source: Author's construction

2.2 Estimation issues

As noted in the introduction, much of the existing work on growth-nutrition relationships suffers from an important flaw in that relationships are estimated in levels rather than changes. The levels approach yields two problems. First, the interpretation of levels really pertains to the long run. For example, it tells us why countries in Europe and North America have lower malnutrition rates than countries in Africa and South Asia, with the income levels achieved being one of the explanatory factors. However, these differences have emerged over centuries rather than decades, and are really of no interest in assessing questions such as whether economic growth can help halve malnutrition in the space of 10–15 years. A second problem with looking at levels is that the approach only accounts for country fixed effects. However, if these fixed effects are correlated with the error term then the estimates are biased. A special case of this bias is that, in the long run, especially, nutrition changes could affect GDP per capita, rather than vice versa [as the work of Robert Fogel (1994) suggests]. Moreover, it is not only long-term fixed effects to account for, but time-series factors as well.

The recent literature on poverty has therefore used regressions expressed in percentage or first differences (sometimes called poverty episodes). This purges the estimation of fixed effects, although the regressions could still be biased by omitted variables that are correlated with economic growth but also affect nutrition outcomes (Christiaensen, Demerit and Kohl forthcoming; Deaton 2006). In some instances these omitted variables could be outcomes of growth (e.g., if growth funds health or nutrition programs), but in other instances there may be a genuine simultaneity bias (e.g., if good governance causes both growth and better nutrition programs, or HIV/AIDS causes lower growth and increases malnutrition). To overcome this problem, fixed effects have been added to the differenced regressions to control for unobserved country-specific trend factors that influence changes in malnutrition. To avoid confusion, this second type of a fixed effects model is called a country trend effect model (specifically, it is the linear trend between the last country observation and the first). Hence, the core specification takes the form:

(1) $$\triangle(N_{it})\varepsilon y\triangle\ln(Y_{it})+y_N N_{it-1}+c_i+u_{it}$$

where N is the malnutrition indicator, Y is the income indicator. Note that N_{it-1} appears on the right hand side. This is the initial level of poverty/malnutrition in the episode, which represents a convergence/divergence term.[6] Finally, *c* is the country-specific trend effect.

A key advantage of adding the country-specific trend effect is that it forces identification of the coefficients from the within country variation, strengthening any results because of the much lower signal-to-noise ratio (Christiaensen, Demerit, and Kühl forthcoming). However, in instances when the sample size is small it is also possible that the fixed effects drown out any true signals from the data. Hence, as a robustness test, the results of regressions that drop country trends effects are reported in the bottom row of each table [which makes the regression model similar to that of Heltberg (2009)].

In addition to the issue of fixed effects, there are some other important measurement and specification issues. Of particular importance is that the dependent malnutrition variable in first differences is tested, while economic growth and other right-hand side variables are typically expressed in percentage differences. This is in contrast to much of the poverty literature, in which the dependent variable is also expressed in percentage differences such that ε_Y represents a conventional elasticity (as opposed to a partial elasticity). However,

[6] Note that in the poverty regression I use both the initial Gini coefficient and the initial poverty rate in the episode, whereas the Gini coefficient is not available for the malnutrition regressions.

expressing poverty or malnutrition prevalence in percentage differences causes several problems. First, it reduces the sample size since differences in which one observation is equal to zero are omitted. Second, it increases the prevalence of outliers. Third, it arguably lacks intuitive appeal because poverty/malnutrition is already expressed in percentage terms.

To illustrate the second and third problems, consider the example of a country with high malnutrition and a country with low malnutrition. In the high-malnutrition country, suppose that malnutrition prevalence reduces from 42 percent at time t-1 to 40 percent in time t. This yields a first difference of two percentage points and a percentage change of around -4.7 percent (i.e. 2/40*100). Yet, an equally large reduction in malnutrition prevalence in the low malnutrition country from 4-2 percent yields a percentage change of 50 percent. Not only is a 50 percent change likely to be an outlier, it is also 10 times the value of the equally large reduction in malnutrition in the high malnutrition country. Of course, one could argue that this may not matter if percentage differences are applied to the right hand side variables, but in the case of income, this is not true, because the denominator is invariably large enough to produce more meaningful estimates of percentage change. Moreover, percentage changes in income make sense if there is a diminishing marginal impact of income on malnutrition; i.e., an extra $100 for a $400 per year individual (a 25 percent increase) should have more impact on malnutrition than a $100 for a $4000 income household (a 2.5 percent increase). Also, note that this decision to use absolute changes rather than percentage changes has an important precedent: Deaton (2006) discusses the same types of anomalies with respect to infant mortality rates.

After estimating equation (1), economic growth is also disaggregated into its sectoral components based on an approach from the poverty-growth literature that disaggregates economic growth by agricultural and nonagricultural sectors (Christiaensen, Demery, and Kühl forthcoming). In this approach, total GDP per total capital is disaggregated into agricultural GDP per total capita (subscript *a*) and nonagricultural GDP per total capita (subscript *n*). However, the impact of each sector's growth rate on malnutrition will obviously depend on the size of the sector, or what Christiaensen et al. (forthcoming) term the "participation effect." Hence, each sector's growth rate needs to be weighted by its initial GDP share, s:

(2) $$\triangle\left(N_{it}\right)\varepsilon_a s_{a,it-1}\triangle\ln\left(Y_{a,it}\right)+\varepsilon_n s_{n,it-1}\triangle\ln\left(Y_{n,it}\right)+y_N N_{it-1}+c_i+u_{it}$$

In equation (2) the estimated coefficient effect of a sectoral growth rate is therefore conditional upon participation in the sector, s. For example, a given agricultural growth rate will have a large effect in an agrarian economy like Ethiopia, but no effect in a nonagricultural economy like Singapore.

In addition to the approach of using sectoral GDP shares to capture participation effects, one can also use sectoral employment shares as weights and as the denominator in the per capita GDP measures In principle, this is a preferred approach, but in practice measurement error may be more of an issue with the employment estimates since labor force censuses are quite rare in developing countries, and because agricultural households regularly diversify their activities (Headey, Beemer, and Hazell 2010).

There are several problems that invariably plague cross-country regressions. First, in these relatively small samples, outliers are certainly a problem. Using differences in malnutrition prevalence rather than percentage differences reduces the incidence of outliers, but does not eliminate the problem altogether. In this study, outliers are manually screened through scatter plots and omitted when observed. This is a common enough approach, but there is no consensus on how to deal with outliers, and all approaches have their strengths and limitations.

Second, while I have discussed simultaneity biases, there is also a large literature testing whether nutrition improves economic growth, following Fogel (1994). While reverse causality is very obviously a problem with cross-sectional "long run" regressions, it is less likely that improvements in preschooler nutrition substantially affect economic growth over the much shorter nutrition episodes used here (e.g., five years). The country trend effects may also control for some potential sources of simultaneity bias. Moreover, addressing reverse causation through instrumentation strategies is not feasible with the current dataset. In cross-country settings it is virtually impossible to find plausible instruments, i.e., a factor that causes economic growth but not nutrition, and the time series panel techniques that rely on lag structures as instruments (e.g., dynamic GMM) are not feasible because of the unbalanced time series structure of the panel (i.e. nutrition episodes vary in length). These panel techniques also suffer from limitations when the time dimension of the panel is small relative to the cross-section (Roodman 2004), which is true of the datasets in this study.

Bearing these caveats in mind—and others that pertain to cross-country regressions (Durlauf, Johnson and Temple 2005)— it should be noted that this study includes more extensive sensitivity analyses than previous

research in this area, and that the empirical strategy adopted is substantially more rigorous than previous cross-country nutrition studies. Moreover, in Section 5, the cross-country empirics of Section 4 is complemented with an analysis of success stories and failures derived from this dataset, partly with the goal of ascertaining whether such studies are consistent with the econometric results derived below.

3. Productive sector dimensions of nutrition-sensitive economic growth

In this section, the results of testing the effects of aggregate GDP growth on stunting prevalence are presented, followed by the sectoral effects of economic growth. The section concludes with an exploration of why agricultural growth might matter in some contexts but not in others.

3.1 Core results

Regression 1 in Table 3 follows Heltberg (2009) in estimating the effect of aggregate GDP per capita growth on stunting prevalence, with the main differences being the inclusion of country trend effects, and the specification of the dependent variable as a first difference rather than a percentage difference. Bearing that in mind, the results are qualitatively similar to Heltberg's. Aggregate growth significantly reduces stunting prevalence, and the effect is reasonably large. A per capita growth rate of 5 percent per year would reduce stunting prevalence by around 0.9 percentage points per year. Alternatively, in the longer term, a doubling of GDP per capita would reduce stunting prevalence by around 18 percentage points.

Table 3—First differences in mean income significantly explain first differences in malnutrition, except for nonagricultural income

	Regression No.					
	1	**2**	**3**		**4**	**5**
Country trend effects?	Yes	Yes	Yes	Yes	Yes	Yes
Sector growth rate weights	Not applicable	GDP shares	Pop. Shares	Not applicable	GDP shares	Pop. Shares
No. of countries/states	89	89	78	89	89	78
No. Observations	160	160	140	160	160	140
Initial malnutrition, t-1	-0.11***	-0.11***	-0.11***	-0.11***	-0.12***	-0.11***
Growth (GDP per capita)	-0.18**			-0.19*		
Growth (ag.)		-0.35	-0.20		-0.79**	-0.38*
Growth (nonag.)		-0.16**	-0.26**		-0.12	-0.17
Growth (GDP per capita)*India dummy				0.04		
Growth (ag.)* India dummy					0.86#	0.56
Growth (nonag.)* India dummy					-0.01	0.14
R-squared	0.73	0.73	0.75	0.73		
Adjusted R-squared	0.37	0.37	0.41	0.37	0.75	0.76
Wald test indicates difference between agricultural & nonagricultural growth?	Not applicable	No	No		Yes, 5% level	No
Significant changes when country trend effects are excluded?	No	No	No		Yes	No

Source: Authors' estimates. See text for details.
Notes: These are fixed effects regressions with dependent variables in first differences and independent variables in percentage differences. *, **, *** indicate significant at the 10%, 5% and 1% levels, respectively.

In Regressions 2 and 3, aggregate growth is split up into its sectoral components, with Regression 2 adopting sectoral GDP shares as weights and Regression 3 adopting sectoral employment shares as weights. In both regressions, the coefficient on agricultural growth is negative but insignificant, whereas the coefficient on agricultural growth is both negative and significant. However, Wald tests reported at the bottom of Table 3 suggest that the difference between agricultural and nonagricultural growth effects is not statistically significant

since the standard errors on the agricultural growth coefficient are quite large. This suggests that the relationship between agricultural growth and malnutrition may be quite heterogeneous.

To see whether regional variations might explain this heterogeneity, the remaining regressions in Table 3 report interactions between economic growth rates and regional dummy variables. As noted in the Introduction, one of the two study hypotheses is that the nutritional effects of agricultural growth may be conditioned by inequality or other factors, such as health and education conditions. For example, high land inequality in Latin America and parts of South Asia might mean that agricultural growth has weak effects there. However, despite numerous tests (too numerous to report here), the only regional dummy of any significance pertained to Indian states, which comprise about 23 percent of the sample. The results in Regressions 5 and 6 suggest that agricultural growth has an insignificant effect on malnutrition in Indian states, but a highly negative on malnutrition in other developing countries.

Given that India accounts for about one-third of the world's malnourished children, this is potentially a critically important result, so it is important to consider whether the result is real or merely a statistical anomaly. Certainly several factors warrant some caution regarding the result. First, the result is not robust to the exclusion of country trend effects. Second, the result may be driven by measurement error, since state-level macroeconomic data for India is often regarded as being of poor quality (Deaton and Kozel 2005), although the same could be said of data for many other developing countries. Yet bearing those methodological caveats in mind, there are also good grounds to think that agricultural growth really is disconnected from nutrition in India. In Section 5 below, where outliers are presented, several Indian states number as failures in that they show high economic growth rates (including in agriculture) and no reduction in stunting rates (e.g., Gujarat, Rajasthan, Bihar). As for why agricultural growth has such a weak link with malnutrition, a complete answer to that question is beyond the scope of this paper, although it is already the subject of some existing research (Headey et al. 2010; Deaton and Dreze 2008).

3.2 Explaining variation around the mean: Where does agricultural growth matter most?

One of the main proposed linkages between agricultural growth and malnutrition is through increased food supply, where the latter could conceivably involve both increased calorie intake and greater dietary diversity. To test whether this channel is indeed important, Table 4 uses the FAO estimates of mean daily energy supply (a measure of food availability) and cereals and roots as a share of daily energy supply (a crude measure of dietary diversity). Both indicators are measured as 10-year differences from 1960 onwards. Regression 1 uses the population share-weighted measures of agricultural and nonagricultural growth to predict changes in calorie consumption (daily energy supply). However, calorie-income elasticities are likely to be nonlinear, so these sectoral growth measures are interacted with initial levels of calorie consumption.

Regression 1 shows that agricultural growth has a much stronger impact on calorie consumption than nonagricultural growth (indeed, nonagricultural growth has an insignificant coefficient); although the impact of agricultural growth diminishes as initial calorie consumption rises. Figure 1 shows this nonlinear relationship by simulating the impact of agricultural growth on calorie consumption at different levels of initial mean calorie intake and agricultural population shares.[7] At very low levels of calorie intake, agricultural growth appears to have a huge effect on calorie consumption, with an elasticity of around 0.5 to 0.8. However, these elasticities decline quite sharply as calorie consumption increases and agricultural population shares decline.

Of course, these elasticities come with an important caveat. By construction, the FAO estimate of mean daily energy supply is the residual of domestic production, changes in stocks, wastage, and imports, all of which are measured with considerable error. Indeed, existing research has found that FAO estimates of daily energy supply (DES) in Africa vary substantially from household survey estimates (Smith, Alderman, and Aduayom 2006). Even so, the result is quite plausible: the reality is that, on average, most of the calories poor people consume come from domestically produced foods. It is also plausible that as DES increases well beyond subsistence requirements, farmers diversify into nonfood crops or into higher value food crops (following Bennett's law of dietary diversification).

The remaining regressions in Table 4 test whether increased agricultural growth typically improves dietary diversity. The coefficients on agricultural growth are insignificant, although the removal of country trend effects tends to strengthen results. interestingly, though, nonagricultural growth tends to be more significant in raising dietary diversity, although the estimates are sufficiently imprecise to suggest that the difference between

[7] Specifically, agricultural population are regressed against daily energy supply (with a quadratic term) to yield a predicted relationship. The r-squared in this regression is 0.62 and both coefficients significant at the 1 percent level. As expected, agricultural population shares decline as DES increases.

Table 4—The impacts of sectoral growth rates on changes in daily energy supply and dietary diversity

	Regression No.			
	1	**2**	**3**	**4**
Dep. Var.(consumption measure)	in daily energy supply	in daily energy supply	cereals+roots as % of DES	cereals+roots as % of DES
Country trend effects?	Yes	Yes	Yes	Yes
Sector growth rate weights	Pop shares	GDP shares	Pop shares	GDP shares
No. of countries/states	114	114	114	114
No. Observations	270	268	270	270
Initial value of consumption measure	-0.25***	-0.30***	-0.45***	-0.59***
Initial agric GDP per capita, log	0.52***	0.54***	-0.31	-1.37**
Initial nonagric GDP per capita, log	0.14	0.18	-0.62	1.47
Growth (ag.)	1.07***	0.47**	-0.42	-0.19
Growth (nonag.)	0.06	0.02	-0.75***	-0.41**
Growth (ag.)*initial DES	-0.04***			
Growth (nonag.)*initial DES	-0.00			
R-squared	0.74	0.74	0.71	0.70
Adjusted R-squared	0.52	0.53	0.49	0.46
Wald test indicates difference between agric. & nonagric. growth?	Yes	Yes	No	No
Significant changes when country trend effects are excluded?	No	Yes	Yes	No

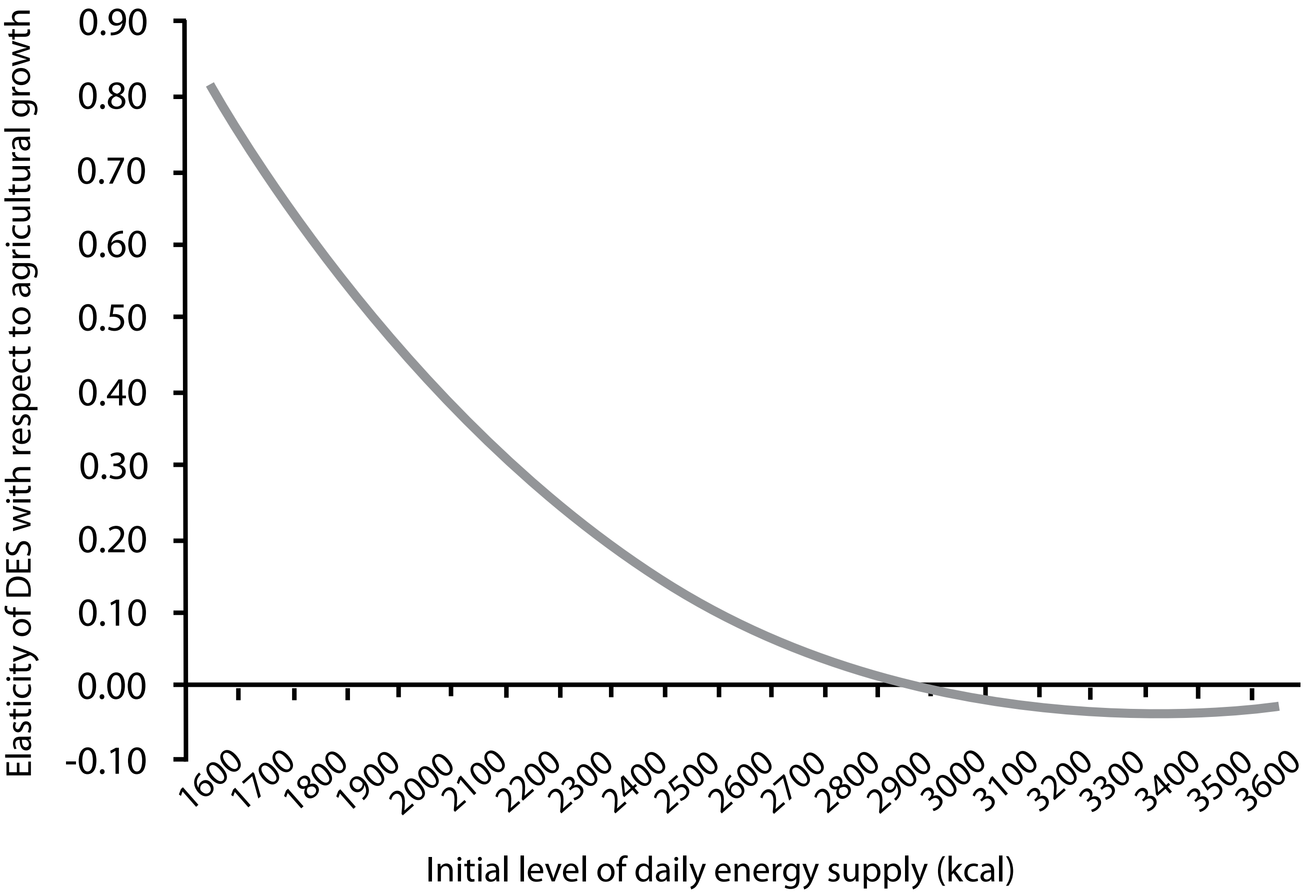
Source: Authors' estimates. See text for details.
Notes: These regressions are with dependent variables in first differences and independent variables in percentage differences. *, **, *** indicate significant at the 10 percent, 5 percent, and 1 percent levels, respectively.

nonagricultural and agricultural growth is quite weak. This result perhaps stems from the fact that nonagricultural growth becomes more important as incomes rise and consumer seek to diversify diets.

So perhaps unsurprisingly, agricultural growth has a strong effect on daily energy supply, but a weak effect on dietary diversity. Whether improved daily energy supply reduces childhood stunting is open to debate, however. In India, for example, it has been observed that regions with higher calorie availability also have worse malnutrition (Deaton and Dreze 2008). Regression 1 in Table 5 tests whether changes in daily energy supply typically reduce stunting. The coefficient on the percentage changes in DES is significant at the 10 percent level and reasonably large in magnitude: a 10 percent increase in DES is estimated to reduce stunting by 3.3 percentage points. Somewhat surprisingly, the effects of DES are not significantly conditional upon initial DES, initial levels of stunting, or initial dietary diversity (results not reported). Changes in dietary diversity also do not have a significant impact, although this may be because the measure of dietary diversity is far from perfect and also subject to substantial error. Survey-based measures of dietary diversity have been shown to explain childhood malnutrition, however (Arimond and Ruel 2006).

Another means of testing whether increased food availability is the main linkage between agricultural growth and nutrition is to use a measure of food production per capita. This measure may also do a better job of capturing both calorie availability and dietary diversity, since higher value foods get higher weights in this measure, as they are more expensive. In Regressions 2 and 3 of Table 5, the effect of growth in food production per capita is estimated. In this case, the effect of food production growth is significantly conditional upon initial levels of food production. This can be shown by breaking the sample up into different levels of initial food production per capita. Overall, per capita food production ranges from around $30 to $300, with a mean of around $150. The sample is split up into a group characterized by very low production (less than $75 per capita per year), a second group characterized by production levels that are somewhat higher but still below the sample mean ($75–150), and a relatively high production group of $150 plus. Regression 2 suggests that in the two groups with lowest food production, the coefficients are significant, large, and negative (but not statistically different from each other). However, when initial food production per capita exceeds $150 per person, there is no significant impact of more food production on changes in stunting.

Figure 1—Predicted elasticity of daily energy supply (DES) with respect to mean agricultural income per agricultural capita at various levels of initial daily energy supply



Notes: Estimates in this figure are based on taking the derivative of Regression 1 in Table 4 with respect to agricultural growth, which is a function of initial calorie consumption and the share of the agricultural population in the total population.

Another interesting observation is that the point estimates of the coefficients on food production growth at lower levels of initial food productions are quite similar to that of changes in daily energy supply in Regression 1, although the food production coefficients are more precisely estimated. Of course, the results do not reveal anything about the relative roles of macronutrients and micronutrients. The results also do not reveal to what extent the effect pertains to increased consumption by infants as opposed to increased consumption by mothers, or increased incomes for rural people (for whom food production is typically the largest source of income). All we can infer is that food production appears to be a very important linkage between agricultural growth and childhood malnutrition.

3.3 Summary

In summary, this section uncovers five important findings:

1. Total GDP growth does reducing stunting, and the effect is reasonably large.
2. Agricultural growth has a large and significant effect in reducing stunting, but only outside of India, where one third of the world's malnourished children reside. The effect of nonagricultural growth is not very robust, but the coefficients on nonagricultural growth are significant and negative when Indian states are included.
3. Agricultural growth has a very strong effect on increasing the daily energy supply, especially at low levels of initial daily energy supply.

Table 5—The conditional impacts of changes in food production per capita on childhood malnutrition

	Regression No.		
	1	2	3
Dep. Variable	Stunting (% points)	Stunting (% points)	Stunting (% points)
Country trend effects?	Yes	Yes	Yes
Sector growth rate weights	Not applic.	Not applic.	Not applic.
No. of countries/states	71	67	67
No. Observations	135	124	124
Initial malnutrition	-0.12***	-0.11***	-0.11***
Initial food production, log		-2.21	-2.73[#]
Growth (food prod.):		-0.07	
. . . if initial food production<$75			-0.35**
. . . if $75<initial food production<$150			-0.31**
. . . if initial food production>$150			-0.05
Initial daily energy supply (DES)	-0.19		
Change in daily energy supply (DES)	-0.33*		
R-squared	0.72	0.72	0.74
Adjusted R-squared	0.38	0.35	0.39
Significant changes when country trend effects excluded?	No		

Source: Authors' estimates. See text for details.
Notes: These regressions are with dependent variables in first differences and independent variables in percentage differences. *, **, *** indicate significant at the 10 percent, 5 percent, and 1 percent levels, respectively.

4. Agricultural growth may improve dietary diversity, but the effect is not robust. In contrast, nonagricultural growth seems to have a large and significant effect on improving dietary diversity.
5. Increased food production seems to be the most important linkage between agricultural growth and nutrition, although it is difficult to say much about the relative roles of micronutrients and macronutrients, or whether the impact is via direct food consumption by infants or improved nutrition of mothers, or increased rural income.

4. Social sector dimensions of nutrition-sensitive economic growth

One final explanation of why the impact of economic growth on malnutrition may be quite varied is that two equal national growth rates may have very different effects on social sector outcomes. In some areas, rapid economic growth could be driven by a resource boom (e.g., Angola) or could result in higher skilled individuals (e.g., India). In some areas, economic growth could be much more balanced across sectors and skill levels (e.g., Vietnam). This is the conventional notion of pro-poor growth. However, to decrease malnutrition, one needs to extend the concept of pro-poor growth to one of pro-nutrition growth, by which rising incomes and government revenues not only reduce poverty, but also result in increased non-income attainments, particularly improvements in health, education, and infrastructure. In this second context, economic growth could be said to have transformed people's lives in both income and non-income dimensions. To explore this hypothesis more formally, this section presents a "nutrition-sensitive social development index" (NUSSDI), and then presents results from tests of whether this index does a better job of explaining nutritional improvements across countries than overall economic growth.

4.1 Constructing a nutrition-sensitive social development index (NUSSDI)

To construct this NUSSDI, a number of variables taken from the Demographic Health Surveys (DHS 2010) were utilized. These included eight potential indicators, all of which have been used as explanatory variables in survey-based studies of malnutrition:

1. Proportion of households that own at least one of a country-specific list of assets (i.e. the converse of an asset-based poverty measure)
2. Proportion of households with access to piped water
3. Proportion of households with access to flush toilets
4. Proportion of households with access to electricity
5. Proportion of children aged 12–23 months having received all of a set of nine vaccinations
6. Proportion of births attended by skilled medical staff
7. Proportion of adult women having completed secondary or tertiary education
8. Average fertility rate

The list of variables could potentially be longer, but the set above was determined by two important considerations. First, there was an interest in policy-related variables rather than cultural or institutional variables, such as feeding practices or gender attitudes. These institutional factors are obviously very important, but their relation to policies—particularly growth-related policies—is much more indirect, and they would typically not change much in the short episodes considered here. Second, data limitations constrained a few other possible candidates (such as nutrition policies), and an important practical goal is to keep the sample size as large as possible. Yet, while it needs to be acknowledged that other variables may warrant future attention, the list above is still quite comprehensive in that it includes indicators of material poverty, infrastructure, sanitation, health access, education, and fertility.

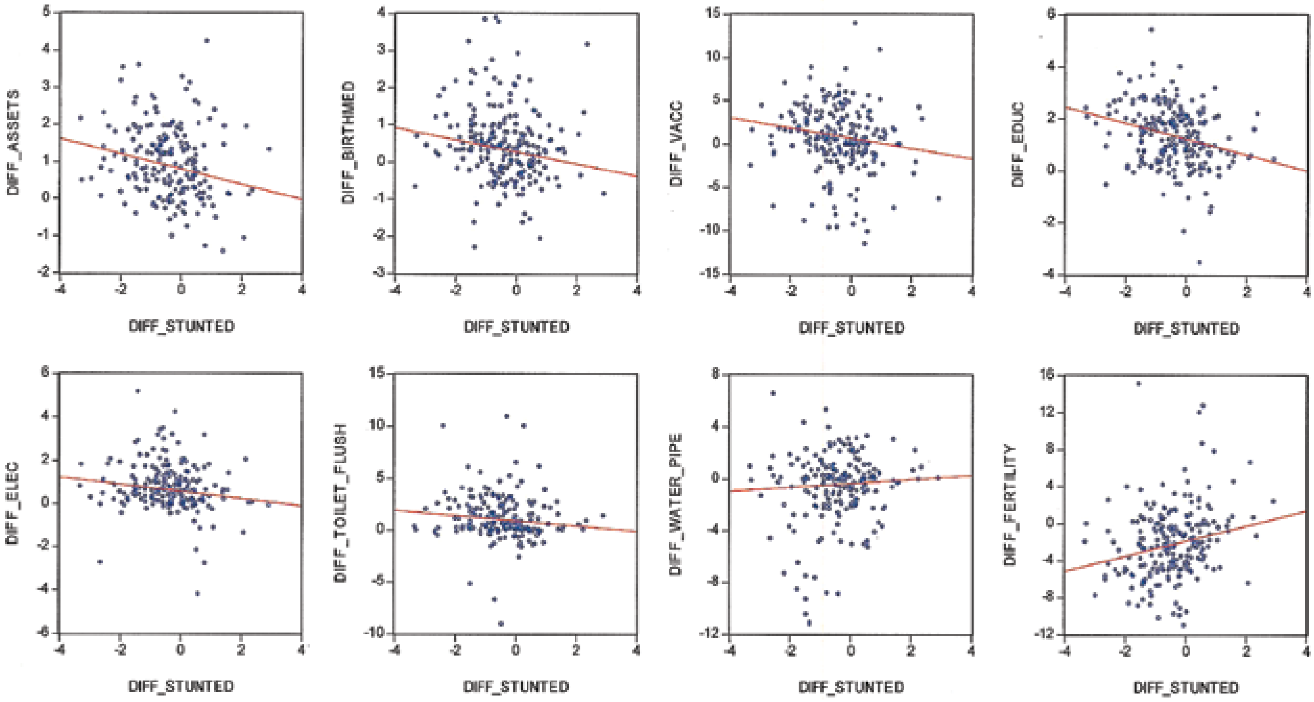
That most of these variables could influence stunting outcomes is obvious,[8] although there are two exceptions. First, the potential effects of electricity access are quite indirect. However, electricity could influence women's work and childcare habits, cooking methods, and access to information on the radio or television. Another variable that captures several effects is the fertility rate. This is associated with factors such as a mother's age at birth (younger marriages result in higher fertility rates), the duration of the interval between births (which is typically shorter in instances of higher fertility) and mean birth order, all of which are predictors of malnutrition in survey-based studies (Paul et al. 2011; Rutstein 2008).

In addition to the choice of candidate variables, there are also many different ways of constructing an index, such as using factor analysis to let the data decide on the weights attached to each component of the index. However, in this particular case it is of interest to know which of these variables are significantly associated with changes in stunting and which are not. To explore these relationships, scatter plots and general-to-specific regressions are performed. Figure 2 shows the scatter plots, with the x-axis always measuring changes in stunting, and the y-axis measuring changes in the variables listed above. Note that each scatter has a regression line, which iteratively places less weight on outlying observations. The results suggest that the strongest relationships hold for ownership of at least one asset (the poverty measure), medically attended births, women's secondary/tertiary education, and fertility rates. The percentage of young children vaccinated also has a negative slope coefficient, but the relationship is somewhat weak. Interestingly, the three infrastructure variables—piped water, flush toilets, and electricity—all show very weak relationships, suggesting their relationship to nutrition is not very robust.

Table 6 shows two regressions which confirm this pattern in a multivariate context (because of sample size constraints, the country trend effects in these regressions are dropped). The first equation shows the coefficients and associated p-values in a general regression model containing all of the candidate variables. By iteratively dropping the least significant variables (i.e., the general to specific method), and then dropping piped water—which is significant but has an unexpected sign—one arrives at a specific model containing two highly significant variables (changes in fertility and changes in asset-based poverty) and two marginally insignificant

[8] See the DHS website for any number of papers that estimate the determinants of malnutrition using these kinds of variables: http://www.measuredhs.com/pubs/

Figure 2—Scatter plots of changes in stunting against changes in candidate components of NUSSDI, with robust regression lines



Source: Author's estimates.
Notes: Regressions are performed with 10 robustness iterations to minimize the influence of outliers. This technique runs a regression, calculates residuals, and then uses the inverse of the absolute residuals as weights in the subsequent regression, etc.

variables (medical births and female education). Since all the coefficients follow the same scale (fertility rates have been adjusted to the 0-100 scale) one can also observe that the point estimates for the coefficients on the asset-based poverty measure and fertility rates are larger in magnitude that the other two variables. However, Wald tests suggest that none of the absolute values of the point estimates is statistically different from another (not reported).

Thus, these four variables seem to be good candidates for a nutrition-sensitive development index, especially as they neatly capture several different determinants of malnutrition: poverty (ownership of assets), health (medically attended births), education (women's), and family planning outcomes (fertility rates). Moreover, these variables may be good proxies for the broader socioeconomic dimension that they represent. For example, mothers who have births that are medically attended will also be more likely to have received antenatal care,[9] and their children are more likely to be vaccinated. Likewise, women's education may be a proxy for gender attitudes and female empowerment (Haddad 1999). As for the poverty index, this index is related to the widely used and validated DHS wealth indices (Filmer and Pritchett 2001; Sahn and Stifel 2003), as well as the multidimensional poverty index advocated by Alkire and Santos (2010). Finally, as noted, fertility rates represent a number of family planning factors.

Hence, all four measures are in the final NUSSDI, with equal weight applied to each after adjusting the fertility rate to range from 0–100:

(3) NUSSDI = (Non-poor)*0.25 + (Medical births)*0.25 + (Female education)*0.25 + (Fertility)*0.25

One final point is that the structure and composition of NUSSDI is actually quite similar to the United Nation's Human Development Index,[10] which also comprises measures of material well-being (GDP per capita), education (years of schooling), and health outcomes (life expectancy). The difference is that the NUSSDI incorporate poverty and distributional elements (asset ownership); education and health inputs, rather than outcomes such as life expectancy; as well as a "family planning" outcomes or the fertility rate. As for potential weaknesses, the measure obviously does not include the quality of education, health services, or assets.

[9] In the Indian DHS for 2005, for example, the correlation between antenatal care and medically attended births is 0.34, which is highly significant, while the correlation with having received any vaccination is 0.16, which is also significant.

[10] See http://hdr.undp.org/en/media/HDR_2010_EN_Complete.pdf

Table 6—Testing potential candidates for a nutrition-sensitive social development index (NUSSDI)

	Regression No.			
	1		2	
Dep. Variable	Stunting (% points)		Stunting (% points)	
Country trend effects?	No		No	
Outliers removed	Yes		Yes	
Sector growth rate weights	Not applic.		Not applic.	
No. of countries/states	113		115	
No. Observations	173		177	
	Coefficient	p-value	Coefficient	p-value
Change in asset-based poverty	-0.27***	0.01	-0.25***	0.002
Change in medical births	-0.12	0.17	-0.12#	0.17
Change in female education	-0.13#	0.13	-0.12#	0.14
Change in fertility	0.19**	0.04	0.20***	0.01
Change in vaccinations	0.002	0.90		
Change in electricity	0.02	0.82		
Change in flush toilets	0.001	0.98		
Change in piped water	0.05	0.07		
R-squared	0.16		0.15	
Adjusted R-squared	0.12		0.13	

Source: Authors' estimates. See text for details.
Notes: These regressions are with dependent and independent variables in first differences. *, **, *** indicate significant at the 10 percent, 5 percent, and 1 percent levels, respectively.

4.2 Testing the relationships between economic growth, NUSSDI's components, and changes in stunting

The regressions in Table 6 suggest that the four components of NUSSDI have sizeable effects on stunting prevalence, but it is worth comparing the size of these effects to the size of the growth effects reported in the previous section. In Table 7, the results from Regression 1 from Table 2 in the previous section are presented, where it was found that the coefficient on overall per capita economic growth was -0.18, an effect significant at the 5 percent level. In Regression 2 in Table 7, an analogous test for the percentage change in NUSSDI is run to estimate a coefficient that is comparable to the GDP coefficient. The point estimate of the coefficient on NUSSDI is much larger at -0.28, and is highly significant, suggesting that changes in NUSSDI provide a stronger explanation of changes in stunting that economic growth alone.

How large is this effect? Since NUSSDI is measured on a 0-100 scale, like stunting prevalence, it is actually more intuitive to measure changes in NUSSDI in first differences rather than percentage differences, which Regression 3 reports. The coefficient on the change in NUSSDI is -0.61, suggest that a 1-percentage point increase in NUSSDI predicts a 0.61 percentage point reduction in stunting. This is a large effect, indeed: consider that a 20-point increase in NUSSDI would reduce stunting prevalence by 12 percentage points. Finally, Figure 3 compares scatter plots for stunting, economic growth, and NUSSDI. The much tighter fit for changes in NUSSDI and stunting prevalence is also visually evident.[11]

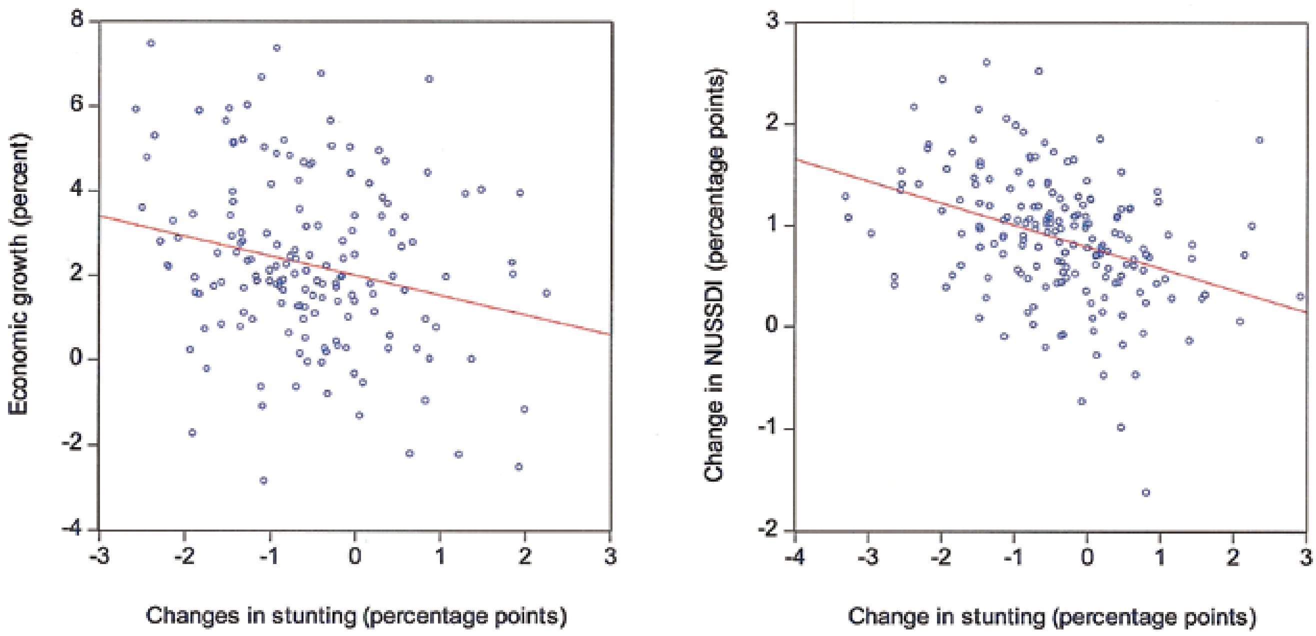
[11] Of course, this tighter relationship may well be an artifact of measurement error since both stunting and NUSSDI are derived from the same source (the DHS) while economic growth comes from national accounts sources. Even so, this consideration does not negate the importance of the four basic channels that NUSSDI captures.

Table 7—Estimating the impact of changes in the nutrition-sensitive social development index (NUSSDI) on changes in malnutrition prevalence

	Regression No.		
	1	**2**	**3**
Dep. Variable	Stunting (% points)	Stunting (% points)	Stunting (% points)
Country trend effects?	Yes	No	No
Outliers removed	Yes	Yes	Yes
Sector growth rate weights	Not applic.	Not applic.	Not applic.
No. of cross-sections	89	117	117
No. of observations	160	188	188
Initial malnutrition level	-0.11***	-0.23***	-0.22***
Initial NUSSDI, log		-2.46[#]	-2.05
Percentage change in GDP per capita	-0.18**		
Percentage change in NUSSDI		-0.28***	
Change in NUSSDI			-0.61***
R-squared	0.73	0.85	0.85
Adjusted R-squared	0.38	0.60	0.60
Qualitative changes when country trend effects excluded/included?	No	No	No

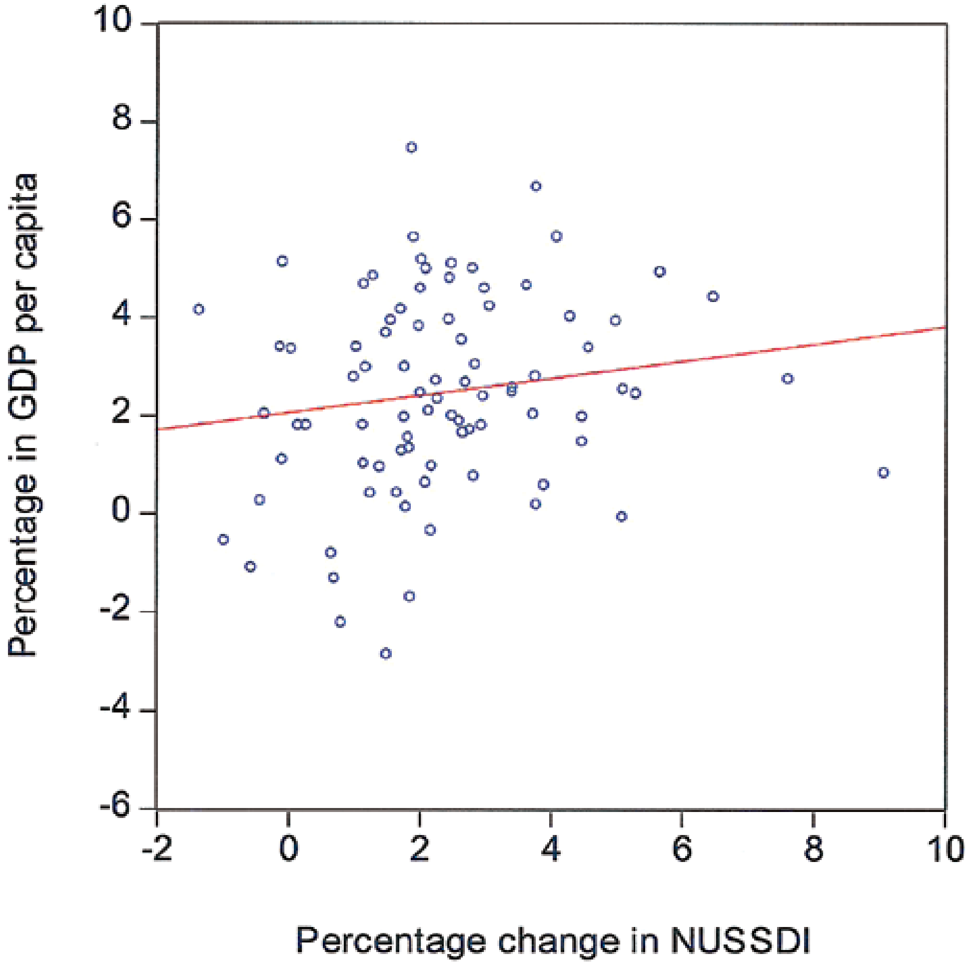
Source: Authors' estimates. See text for details.
Notes: These regressions are with the dependent variable in first differences and independent variables in percentage differences or first differences, as noted in the table. *, **, *** indicate significant at the 10 percent, 5 percent, and 1 percent levels, respectively.

Figure 3. Visually comparing growth-nutrition and NUSSDI-nutrition relationships



Source: Author's estimates.
Notes: Regressions are performed with 4 robustness iterations to minimize the influence of outliers.

Figure 4—Relationship between economic growth and changes in NUSSDI



Source: Author's estimates.
Notes: Regressions are performed with four robustness iterations to minimize the influence of outliers.

While it is interesting to show that changes in NUSSDI offer a powerful predictor of changes in stunting, the relevant question is whether changes in economic growth are typically a deeper determinant of changes in NUSSDI. Figure 4 show that while the relationship between economic growth and NUSSDI is positive and significant, there is tremendous variation around the mean, and the correlation between changes in NUSSDI and changes in economic growth is quite weak, at just 0.25. However, Table 8 estimates the effect of economic growth on NUSSDI, but also on each of the four components after controlling for initial levels of these components. The results suggest that economic growth has a positive effect on all four components of NUSSDI. For example, the point estimates suggest that a doubling of GDP per capita would increase women's secondary education by 14 percentage points, and access to medical births by 18 percentage points.

The direct effects of economic growth on fertility rates are weaker (Regression 4), but fertility rates are also driven by changes in female education (Schultz 1997). Hence, Regression 4 also includes changes in female education as an explanatory variable for changes in fertility. The coefficient on female education is large and highly significant, suggesting that when economic growth is allowed to influence fertility rates via changes in female education, the predicted impact of a doubling of GDP per capita is again about 16 percentage points (i.e., from the direct effect and the indirect effect of increase female education). Somewhat surprisingly, it is only asset-based poverty that is somewhat unresponsive to economic growth, although this could be related to the specific poverty measure used, which suffers from two deficiencies. First, being a measure of assets, it

Table 8—Estimating the impact of changes in the nutrition-sensitive social development index (NUSSDI) on changes in malnutrition prevalence

	Regression No.				
	1	2	3	4	5
Dep. Variable	Change in NUSSDI	Change in female education	Change in medical births	Change in fertility rates	Change in asset poverty
Country trend effects?	No	No	No	No	No
Outliers removed	Yes	Yes	Yes	Yes	Yes
Sector growth rate weights	Not applic.	Not applic.	Not applic.	Not applic.	Not applic.
No. of cross-sections	55	55	55	55	55
No. of observations	85	85	85	85	85
Economic growth	0.02	0.14***	0.18***	0.10**	0.08*
Initial level of dependent var.	0.72	0.02**	-0.01*	0.001	0.19***
Change in female education				-0.35***	
R-squared	0.06	0.24	0.15	0.29	0.31
Adjusted R-squared	0.05	0.22	0.13	0.02	0.30
Estimated change in dependent variable from a doubling of GDP per capita	2 points	14 points	18 points	16 points	8 points
Qualitative changes on growth coefficient when country trend effects included?	No	No	No	No	Yes, larger & more significant

Source: Authors' estimates. See text for details.
Notes: These regressions are with dependent variables in first differences and independent variables in percentage differences. *, **, *** indicate significant at the 10 percent, 5 percent, and 1 percent levels, respectively. Note that because of the small sample size, country trend effects were not included, although their inclusion did not materially alter results.

says nothing about food affordability, which is the dimension of household poverty that is most relevant to malnutrition. Second, since poverty is defined as the lack of ownership of any of any listed asset, the measure is really one of extreme poverty. Economic growth probably has much larger effects on less stringent measures of poverty.[12]

So in short, economic growth does typically have an effect on pro-nutrition development factors, but the relationship is not so strong as to rule out significant variation around the mean. In other words, the effect is clearly strong in some countries than in others.

4.3 Summary

In this section, how economic growth might influence malnutrition through social sector outcomes is explored. The results support the plausible hypothesis that economic growth reduces childhood malnutrition through four important channels: reductions in poverty, improvements in female education, improvements in medical access, and reductions in fertility. Other channels may be important, such as improved infrastructure, but the evidence supporting these channels is thus far not strong.

5. Insights from the outliers: Successes and failures in the war against childhood malnutrition

Among their flaws, cross-country regressions have a limited capacity to shed light on the variety of experiences within any given relationship. To garner a different kind of insight into the determinants of changes in malnutrition, this section looks at successes and failures in the fight against childhood malnutrition,[13] much in the vein of the general economic growth literature on this topic (Hausman, Pritchett and Rodrik 2005,

[12] Of course, a caveat here is that reverse causality is more likely a problem in these regressions than in the stunting regressions, since a factor like education might influence economic growth in the short run. The bias is not very large, but this caveat is worth bearing in mind.

[13] Women's BMI is not examined here because there is insufficient data and the episodes in question are generally very short.

Hausman, Rodriguez and Wagner 2006). The specific goal is to see whether successes and failures on the malnutrition front are consistent with the findings in previous sections on the conditional role of agriculture and the important role of nutrition-sensitive development.

There are three important caveats to this exercise. First, an analysis of specific countries is obviously highly sensitive to measurement error and selection biases. In several instances, for example, apparently successful episodes were not sustained over the long term (see below). Second, the analysis below is still highly aggregated, with only national-level data available and no examination of the growth patterns or nutrition programs of all the countries listed. Third, due to the caveats above, this is an exploratory analysis designed to identify successes that may not be well known, as well as failures, which invariably attract less attention than successes.

5.1 Criteria for successes and failures

Tables 9 and 10 list the most successful and least successful countries in the sample in terms of combating malnutrition. As for the basic criteria for success, these are twofold. First, a country (or Indian state) must show progress against at least one childhood malnutrition indicator that is faster than 1 percentage point per year. As it happens, this minimum speed of progress would usually ensure success in meeting the MDG target of halving malnutrition in 25 years, unless initial malnutrition prevalence was well above 50 percent. Second, there must at least be some progress against the other childhood malnutrition indicator (in other words, a country/state cannot show progression on one front and regression on another). Countries deemed as successes are also grouped into four categories:

1. Prolonged episodes of reducing childhood malnutrition and well-documented nutrition programs;
2. Prolonged periods reducing childhood malnutrition which coincide with Green Revolutions in cereal production;
3. Uncertain success stories, comprised of either shorter and more episodes that have not withstood the test of time; and
4. Unsustained successes, where reductions in malnutrition that were subsequently reversed by increases in malnutrition.

It should also be noted that, in order to expand the number of success stories, underweight prevalence as a malnutrition indicator is used since stunting prevalence is not available for many of the earlier success stories.

A "failure" is defined as a 0.4 point per year increase in at least one childhood malnutrition variable, and no progress on the other indicator. Countries deemed failures are grouped into two categories:

1. Those countries with failures that are obviously due to conflict and/or a severe decline in governance;
2. Those countries with failures that are less easily explained.

Regarding the explanatory variables, these are derived from previous sections in which it was shown that stunting reductions were explained by: (a) agricultural growth (outside of India); (b) increased food availability; and (c) changes in poverty, female education, medically attended births, and fertility rates. This reveals whether these case studies are consistent with the more formal econometric results derived above.

5.2 Successes

The first category of success listed in Table 9 includes those countries with long-term successes and well-documented nutrition programs. All of these countries/states also have well known, large-scale nutrition programs, although in some instances the success of these programs is still debated. For example, Bangladesh is not always deemed a success story because malnutrition levels are still very high (though Table 9 shows that the annual speed of the reduction has been very quick) and because the Bangladesh Integrated Nutrition Program has been rather controversial. Nevertheless, Bangladesh's success is consistent with broader nutrition-sensitive development, including large reductions in fertility and improved education and health outcomes. These nutrition-sensitive development factors also feature in all the other success stories in this category with the partial exception of Senegal. Thailand and Vietnam have had very strong rural development policies, for example, and Tamil Nadu state in India has achieved some of the best education and health outcomes in the country. For example, in 2005-06 almost 90% of births in Tamil Nadu were attended by professional medical staff, which is roughly double the country's average.

However, apart from these social sector outcomes, the countries in this category vary in terms of the factors listed. For example, there were major dietary improvements in Bangladesh, Thailand, and Vietnam—three of the poorest countries in this subsample—but only modest improvements or compositional changes in diets for the other countries. This is fairly consistent with the idea that an increased availability of calories is probably only important at very low levels of initial calorie consumption. Another important observation is that rapid economic growth was only a characteristic of the low-income countries. Brazil, Mexico and Honduras – three middle-income Latin American countries – were able to implement nutrition-sensitive social sector policies and nutrition-specific programs without rapid economic growth. The remaining countries are all low income, and their nutrition success was accompanied by quite rapid economic growth.

As for the remaining three categories, six countries are grouped under the heading "Green Revolution episodes." These six countries, all in South Asia or South-East Asia, experienced increased cereal production as a result of improved agricultural technologies (principally seeds, irrigation, and fertilizers) and other investments (roads and marketing policies) (Hazell 2009). With the exception of Thailand, where reduction in underweight prevalence was extremely rapid, all of these countries experienced solid reductions in underweight prevalence of around 1.1 to 1.5 percentage points per year during periods when calorie supply increased quite markedly from very low levels. However, while the combination of increased rural incomes and lower food prices probably did play some role in reducing malnutrition, most of these countries also witnessed important improvements in health and education services (e.g., by 1987 medical attendance at birth was 87 percent in Sri Lanka), with India probably the main exception.[14] Consistent with the cross-country results presented above, one explanation of the reduction in malnutrition in India is that, at 71 percent in 1977, underweight prevalence was so high that food insecurity was almost certainly an important determinant of childhood malnutrition (partly because of maternal malnutrition). Overall, then, a plausible conclusion is that the Green Revolution did contribute to reduced malnutrition, but that social investments also played a role.

The final two categories among the successes include a number of episodes in which the documented success is either relatively short lived, perhaps because the data are so recent (for example, Ghana), or not obviously associated with well-known nutrition programs. In Angola, for example, underweight and stunting prevalence was reduced by 10 percentage points in just five years (1996-2001). Was this some kind of post-conflict recovery effect, or was it due to a doubling of medical births from 22–46 percent and the strong recovery of agriculture, which grew at 10 percent per year during this period? Indian states, including Rajasthan, Karnataka, New Delhi, Orissa, Punjab, and West Bengal also include short-lived successes. However, in several cases these successes were either not sustained (Karnataka, New Delhi), or were followed by periods of increased malnutrition (Rajasthan). This data perhaps does not go much further into unraveling the Indian enigma, but it does suggest that it is important to look at state-specific stories.

There are many other intriguing and poorly documented potential success stories in these two categories, but it is well beyond the scope of this paper to explore them further. Instead, I emphasize some of the basic patterns in the data. Three important features of many of these ambiguous success stories include:

1. Strong economic growth (only 2 of the 15 countries did not experience growth rates above 5 percent per year), often in agriculture (in 10 of 15 countries agricultural growth exceeded 3 percent per year);
2. Significant improvements in female education and medical births (in 11 of 15 cases); and
3. Much more mixed outcomes for fertility reductions (which were sizeable in only about half of the cases, perhaps because of the shorter time frames).

Table 10 includes those countries with failed attempts to fight malnutrition. Among these, four countries—Cote d'Ivoire, Sierra Leone, the Democratic republic of Congo (DRC), and Zimbabwe—saw particularly sharp increases in at least one malnutrition indicator. The causes for this seem obvious: conflict, poor governance, and the decline of social services. The remaining failures are more interesting, but also more puzzling. In Yemen in the 1990s, the increase in malnutrition was so spectacular that one wonders whether the data are accurate. That said, the FAO data suggest a sharp decline in food availability despite significant agricultural growth. This could be related to a switch towards cash crops (including the stimulant, *chaat*). The data also suggest that female secondary education and medical births in Yemen are about the lowest in the world: 7 percent and 15 percent respectively. However, stagnation in these indicators does not obviously explain a sharp increase in

[14] Limited data prevent strong conclusions here, but certainly by 1992 India had very low levels of medical attendance at birth, and very low levels of secondary education for women.

Table 9. Successful episodes in fighting malnutrition

Episodes	Change in underweight (points/p.a.)	Change in stunting (points/p.a.)	Better diets? (calories, proteins, fats)	Growth>5% p.a.? (agric.>3%/p.a.)	Favorable health, education, and fertility trends?
Long-term successes with well-documented nutrition programs					
Bangladesh 1994–05	-2.0	-2.0	Very rapid	Yes (agric)	Yes
Brazil 1986–96	-0.7	-1.9	Yes	No	Yes (very rapid)
Honduras 1996–01	-1.3	-1.8	Diversifying	No	Yes
Mexico 1989–99	-1.2	-1.9	No	No	Yes
Senegal 2000–05	-1.2	-1.9	Modest	Yes	Modest
Tamil Nadu 1992–98	-1.9	N.A.	Diversifying	Yes	Yes
Thailand 1982–90	-2.9	N.A.	Very rapid	Yes	Yes
Vietnam 1994–06	-1.5	-1.3	Very rapid	Yes (agric)	Yes
Green Revolution episodes with marked cereal production					
Bangladesh 1985–94	-1.1	N.A.	Very rapid	Yes (GDP=4.7%)	Yes
India 1977–92	-1.3	N.A.	Very rapid	Yes (agric)	No (exc. fertility)
Philippines 1973–82	-1.9	N.A.	Yes (cereals)	Yes (agric)	Yes (education)
Sri Lanka 1977–87	-1.8	-1.3	Yes (protein)	Yes (agric)	Yes
Thailand 1982–90	-2.9	N.A.	Very rapid	Yes	Yes
Vietnam 1994–06	-1.5	-1.3	Very rapid	Yes (agric)	Yes
Ambiguous short-term successes					
Angola 1996–01	-1.9	-2.2	Yes	Yes (agric)	Yes (exc. fertility)
Cambodia 1996–06	-1.4	-1.5	Yes	Yes (agric)	Yes
China 1992–02	-1.1	N.A.	Yes	Yes (agric)	Yes (exc. fertility)
Ethiopia 2000–05	-1.5	-1.3	Yes	Yes (agric)	Only fertility
Ghana 2003–06	-1.6	-2.5	Yes	Yes (agric)	Only education
Indonesia 2001–04	-1.2	-4.3	Diversifying	Yes (agric)	Yes (exc. fertility)
Kyrgyzstan 1997–06	-0.6	-1.6	modest	No	Yes (exc. fertility)
Mongolia 1999–04	-1.2	-1.3	No (decline)	Yes	Yes
Orissa 1998–05	-1.3	-0.6	No (decline)	Yes	Yes (exc. fertility)
Punjab 1992–98	-2.8	-1.5	No (decline)	Yes	Yes
Rajasthan 1998–05	-0.6	-1.8	No (decline)	No	Yes
Tanzania 1996–05	-1.5	-0.6	Diversifying	Yes (agric)	No
Uzbekistan 1996–06	-1.1	-1.9	No	Yes (agric)	Yes (exc. fertility)
West Bengal 1992–98	-1.4	-0.8	Diversifying	Yes (agric)	Yes
Zambia 2002–07	-1.8	-1.5	No	Yes (agric)	No
Unsustained successes					
Haiti 1995–00	-2.1	-1.8	Yes	No	Only education
Karnataka 1992–98	-1.7	-1.8	Diversifying	Yes (agric)	Yes
New Delhi 1992–98	-1.2	-1.1	Diversifying	Yes	Yes

Source: Author's construction.

malnutrition.[15] Zambia is interesting in that, like Rajasthan, it was a failure over 1992–1997, before recovering strongly. One feature of the 1990-97 period is some decline in medical births, perhaps related to Zambia's fiscal tightening under structural adjustment. The sharp increase in HIV prevalence in the 1990s may also explain the increase in malnutrition.

Egypt over 2000–2008 is perhaps the most puzzling failure. The country has experienced strong economic growth, increased food consumption and increased female education and medical births. Fertility rates reduced only modestly, but were not exceptionally high to begin with. Moreover, the most peculiar feature of Egypt's rapid increase in stunting is that it occurred in the higher wealth quintiles. Figure 5 shows stunting prevalence by wealth quintile for the 2005 and 2008 DHS data for Egypt. While in 2005, one observes a typically negative

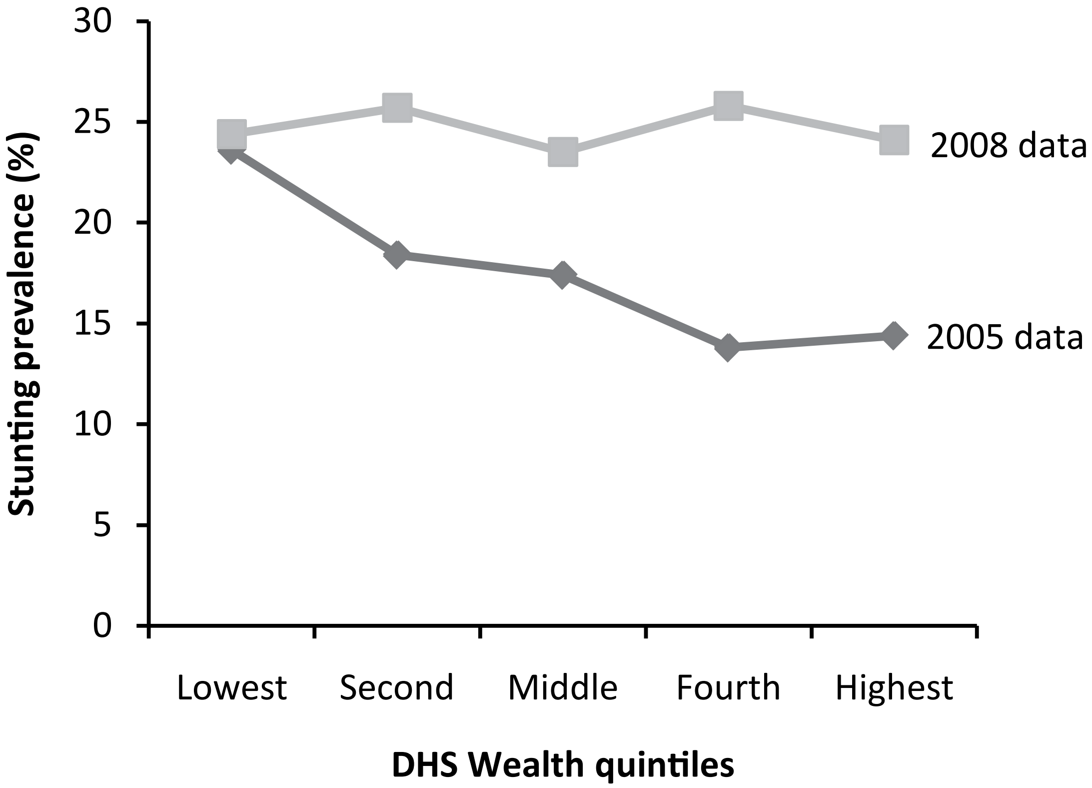
[15] Ecker et al. (2010) look at the Yemeni situation in more detail (see, also, Ecker's 2020 paper on Yemen).

Table 10—Failures in the fight against malnutrition

Episodes	Change in underweight (points/p.a.)	Change in stunting (points/p.a.)	Better diets? (calories, proteins, fats)	Growth>5% p.a.? (agric.>3%/p.a.)	Favorable health, education & fertility trends?
Failures (conflict or poor governance)					
Cote d'Ivoire 1999-06	-0.2	1.2	No	No	No (exc. fertility)
Zimbabwe 1999-06	0.4	0.3	Yes	No	No
DRC 1989-01	0.7		Sharp decline	No	No
Sierra Leone 2000-05	0.7	1.7	Very rapid	Yes	No
Failures—others					
Yemen 1992-97	3.4	1.9	Sharp decline	Yes (agric)	No (exc. fertility)
Zambia 1992-02	0.5	0.4	Sharp decline	No (only agric)	No
Egypt 2000-08	0.4	0.8	Yes (proteins)	Yes (agric)	Yes
Gujarat 1998-05	0.7	0.3	No	Yes (agric)	Yes
Kazakhstan 1999-06	0.2	0.5	Very rapid	Yes	Yes (exc. fertility)
Mali 1987-96	1.0	0.4	No	No	No
Nicaragua 2001-06	1.3	0.9	Very rapid	No	No
Rajasthan 1992-98	1.5	1.5	No	Yes	Yes (exc. fertility)

Source: Author's construction.

Figure 5—The strange case of rising malnutrition among better off Egyptian households



Source: Authors' estimates from DHS data.

gradient between stunting and wealth, in 2008, there is no gradient at all: rich Egyptian children are now just as likely to be stunted as poor Egyptian children! That this large and peculiar increase in stunting among better-off households should also occur in the space of three years suggests that measurement errors may be involved. In any event, this is certainly a case to look into.

Another puzzling case is Gujarat in India. This state had one of the fastest growth rates in India, comprised of both agricultural and manufacturing growth. Agriculture in Gujurat is particularly well known for its rapid growth in cash crops, including cotton and high-value fruits and vegetables. Although previous research has

highlighted the possibility that cash crop income growth may not improve malnutrition (von Braun 1995), the disconnect in Gujarat seems exceptionally stark, particularly as there were very large increases in female secondary education and medical births.

Kazakhstan is also a puzzle. Although it is true that malnutrition prevalence increased only marginally, the country experienced very strong economic growth over 1999–2006 (14.2 percent per year). However, most of this growth was driven by energy exports (agriculture is still a very small sector despite significant potential), so it is possible that this income simply did not trickle down to the poor. Indeed from 1996 to 2003, survey data suggest that mean income actually declined slightly. One other plausible hypothesis is a decline in healthcare quality (since initial levels were very high).

5.3 Summary

Do the success stories and failures presented in this section confirm or contradict the findings of the previous sections regarding the nature of pro-nutrition growth? The short answer is "Yes", since the overall patterns in the data on successes and failures are consistent with the findings of previous sections, but there are some important contradictions.

For example, relatively strong economic growth—including growth in agricultural production—is a prominent dimension of successful nutrition episodes in most cases. The only significant exceptions to this conclusion are middle-income countries like Brazil, Mexico, and Honduras. In terms of failures, growth collapses are a common feature of nutrition failures, but there are also examples of nutrition failures occurring in environments of strong economic growth, with Egypt, Gujarat, and Kazakhstan being the most prominent examples. The success stories therefore suggest that economic growth may well be a necessary condition for sustained reductions in malnutrition (at lower levels of income), while some of the failures suggest that growth is nevertheless not a sufficient condition for nutritional improvements.

In terms of the role of food availability, the conclusions are somewhat more nuanced. Among the more famous success stories, there were indeed substantial increases in macronutrient supplies, and some dietary diversification. However, among the lesser-known and shorter-lived success stories, the pattern is less clear. Among the failures, there is a suggestion that decreased food consumption is an important cause of nutrition failures in some countries, but there are again one or two apparent exceptions.

In terms of the social development factors that make up the nutrition-sensitive social development index in Section 4, the success stories tend to confirm that these are important factors, perhaps even necessary factors. A possible exception is reductions in fertility. Although this factor features prominently in the more famous success stories, there are short-run successes where fertility rates were largely unchanged (even so, reductions in fertility may be a precondition for longer-term success). In contrast, education and health investments, as proxied by female secondary/tertiary education and medically attended births, remain strong predictors of nutrition improvements, even over shorter periods.

6. Conclusions

This section summarizes the main results, identifies some key knowledge gaps, and emphasizes some of the implications of the findings of this study for development strategies.

6.1 A summary of key findings

The main question posed in this paper is "What is nutrition-sensitive development?" The perspective taken is a comparative one based on cross-country econometrics and an analysis of success stories and failures. The main findings of that analysis can be succinctly summarized in three points:

Rapid economic growth is a necessary condition for sustainably reducing malnutrition at lower levels of development. Formal econometric tests confirm that economic growth does have a significant effect in reducing malnutrition, while the analysis of individual success stories appears to strengthen the result, in that economic growth is a pervasive dimension of sustained success against malnutrition among lower income countries.

In terms of the productive sectors, agricultural growth tends to be a more integral part of nutrition-sensitive development than nonagricultural growth, but the effect of agricultural growth on nutrition is conditional upon the size of the sector, the extent to which food insecurity is a problem, and the extent to which agricultural growth delivers increased food availability. The main exception to this statement is that the result does not appear to apply in India.

In terms of social sectors, pro-nutrition development requires poverty reduction and social investments in health, education, and family planning. As with overall economic growth, the analysis of successes and failures suggests that these kinds of investments are a necessary but not sufficient condition for sustained reductions in malnutrition. Infrastructure investments may also be important but the evidence thus far is somewhat weak.

There is an important caveat to all of these conclusions, in that both cross-country econometrics and the analysis of successes and failures are methods that are undoubtedly vulnerable to numerous problems, including simultaneity or reverse causality biases, misspecification issues (including omitted variables), selection biases (e.g., under-representation of Asian countries), small sample size (especially for case studies) and measurement error.

6.2 Results from using other indicators of malnutrition

Appendices B and C report the results of conducting the same econometric tests featured in Sections 3 and 4 for underweight prevalence of children and low BMI prevalence of adult women, although it should be noted that the sample size of low BMI prevalence is quite small, thus weakening the power of the tests for that indicator. The results in Appendix B suggest that overall economic growth has no significant effect on changes in underweight prevalence, but a significant negative effect on low BMI prevalence (although the point estimate is smaller than in the case of stunting). However, agricultural growth tends to significantly reduce underweight prevalence, with results again suggesting that this is not the case in Indian states. Growth in food production also significantly reduces underweight and low BMI prevalence, but the effects for underweight prevalence are much more modest than was the case with stunting. Finally, a lagged structure was also considered for the regressions testing economic growth rates (Section 3) since nutrition indicators apply to all children born in the previous five years. However, the lagged structure mostly tended to produce less significant results, perhaps suggesting it was not an improvement on the non-lagged specification.

A sensitivity analysis was also conducted with respect to the nutrition-sensitive social development index since this was derived based on a preliminary econometric analysis (Appendix C). Had the study used underweight prevalence to test which candidate variables were most significant, a broadly similar index would have been derived, with childhood vaccinations replacing medical births, and piped water replacing fertility rates, which had no effect on underweight prevalence. For that reason, the impact of NUSSDI on underweight prevalence is somewhat more modest than was the case with stunting, although still highly significant. This reinforces the point made earlier, that there is no doubt many different ways one could construct such an index.

Overall, the results in Appendices B and C are qualitatively very similar to the results reported above, even if a number of the point estimates (unsurprisingly) differ in magnitude.

6.3 Knowledge gaps and future research questions

Two important knowledge gaps have emerged from this study. Firstly, and most importantly, it appears that the growth-nutrition relationship in India is unusually weak. This is evidenced not only by the econometric results of Section 3, but also by the analysis of case studies in Section 5, in which Indian states appear as both successes and failures, sometimes in succession (success then failure, or failure and then success). While there is a significant literature on malnutrition in India, there are still no wholly satisfactory answers to this puzzle. The usual suspects include: stagnation of the agricultural/food sector in much of India; decreased calorie consumption; high levels of inequality that also appear to be rising; and the limited reach, poor targeting, and poor quality of health, education, and nutrition services (Deaton and Dreze 2008; Haddad and Zeitlyn 2009; Headey, Chiu, and Kadiyala 2010; Jha and Laxminarayan 2009; The World Bank 2006). With the possible exception of decreased calorie consumption (Deaton and Dreze 2008; Headey, Chiu and Kadiyala 2010), there are good reasons to suspect each of these factors, although still no obvious means of quantifying these various constraints. One suggestion that clearly emerges from the previous section, however, is that one needs to delve beyond the aggregate levels to look at state-level trends in India. India is an enormous and very diverse country, after all.

A second key knowledge gap pertains to some of the successes and failures. Among the less well validated successes are some recent episodes showing positive indications of successful nutrition programs as well broader nutrition-sensitive development (for example, Ghana). But there are also many less well-known examples where quite rapid progress has been made. It may turn out that some of these successes are short lived and will not be sustained, but it could also be the case that many are genuine. Do these countries have largely unknown successful nutrition programs, or are "non-nutrition" policies driving their success? Finally, while there are only a handful of enigmatic nutrition failures – like Egypt, Kazakhstan and several Indian states – there

is scarcely any research on these failures. Yet if the data are correct, these failures are non-trivial, amounting to several million children.

6.4 Implications for development strategies

The findings of this paper go to the heart of the debate about whether nutrition-specific strategies should be pursued, or whether broader development strategies suffice. This is partly a matter of perspective. In the short run, targeted nutrition interventions (e.g., food, vitamin, and mineral supplements; or education and training programs) could have high returns even in the absence of economic growth or broader social sector development (World Bank 2006). In the longer term, however, a pro-nutrition growth strategy is undoubtedly the best means of sustainably eradicating malnutrition. This is because rising national incomes provide the resources to make sustained investments in health, education, and infrastructure, whilst rising household incomes also improve food security and reduce fertility rates (along with female education). It is also the case that there are potentially strong synergies between nutrition and non-nutrition interventions, such as women's education and nutrition-specific education programs (Webb and Block 2004). Overall, then, this paper provides empirical support for the notion that nutrition-sensitive social development strategies are the foundation for sustained reductions in malnutrition (Nabarro 2010).

As for how to go about developing better pro-nutrition growth strategies there are obviously important impediments that need to be overcome. Firstly, malnutrition is often misperceived by policymakers as a basic food problem, rather than a complex multisectoral problem. Welcome efforts to raise awareness of the problem mostly focus on outcomes—such as the Global Hunger Index—but more emphasis is needed on inputs, such as the components of the nutrition-sensitive development index, as well as better tracking of more specific nutrition policies.

Secondly, researchers and policymakers need to encourage more cross-country learning. Despite notable success stories, remarkably few countries have large-scale nutrition strategies in place, and there is consequently little evidence of cross-country learning. Yet, two prominent examples show that cross-country knowledge sharing can be done. In Thailand, the main champions of the nutrition program pushed other policymakers into receiving nutrition education and training from overseas (Heaver and Kachondam 2002). In Bangladesh, the learning was more explicit, since Bangladesh's Integrated Nutrition Program (BINP) was adapted from Tamil Nadu's program (TINP).[16] However, these examples are far too few, suggesting it is essential for researchers to facilitate more cross-country learning, and for policymakers to provide the political impetus to translate knowledge into action.

[16] Yet the Tamil Nadu program also provides an example of un-learning, since the program was subsumed into India's national level Integrated Child Development Scheme (ICDS), which is generally regarded as unsuccessful (Haddad and Zeitlyn 2009).

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