



AgEcon SEARCH
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search
<http://ageconsearch.umn.edu>
aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*



Food Insecurity and its Determinants

Peter Warr
Australian National University

Contributed paper prepared for presentation at the 58th AARES Annual Conference,
Port Macquarie, New South Wales, February 4-7, 2014

*Copyright 2014 by Authors names. All rights reserved. Readers may make verbatim copies of
this document for non-commercial purposes by any means, provided that this copyright notice
appears on all such copies.*

Food Insecurity and its Determinants^{*}

Peter Warr

Australian National University

Newly available evidence confirms that expansion of aggregate food supplies within developing countries themselves is strongly associated with reduced undernourishment. It is not sufficient to rely solely on aggregate economic growth or reductions in poverty incidence to deliver improved food security. But the evidence also shows that higher food prices significantly increase the rate of undernourishment. It is therefore important to stimulate agricultural output without raising domestic food prices. Improvements in agricultural productivity achieve that. But agricultural protection aimed at food self-sufficiency does not, because it operates through an increase in domestic food prices. It delivers benefits to those food insecure people who are net sellers of food. But in most countries their number is exceeded by the food insecure people who are net buyers of food and are made more food insecure by increased food prices. Food self-sufficiency does not imply food security.

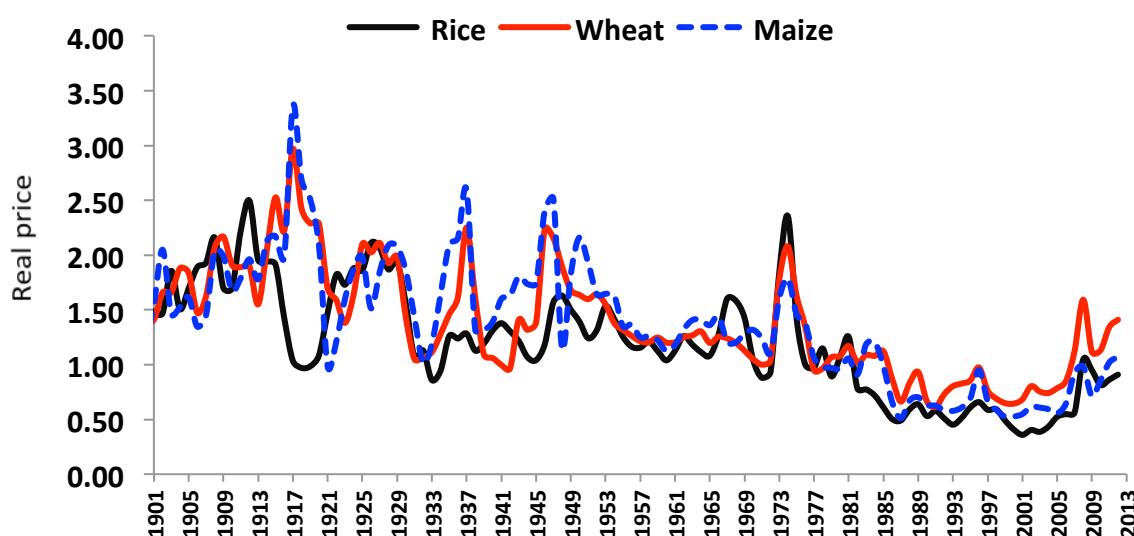
1. Introduction: Global food insecurity

Food (in)security is back on the global agenda, triggered by alarm over the international food price surges of 2007-08. The international price of rice temporarily tripled, and wheat and maize prices more than doubled. Data on these three international prices, deflated by the World Bank's Manufacturing Unit Value Index, are shown in Figure 1 for the period 1900 to 2013. Four points are notable. First, all three of these real commodity prices have declined significantly. Second, all three are highly volatile. Third, all three increased significantly in recent years. Fourth, even at the height of the recent price increases, the real prices of all three commodities were well below their levels a century before. Nevertheless, food price fluctuations like these are worrying. They raise the prospect that for some period at least large numbers of poor people may be unable to obtain the food they need.

^{*}Presidential Address, Australian Agricultural and Resource Economics Society, Port Macquarie, NSW, 5 February 2014. Dung Doan, Huy Nguyen Quynh and Ramesh Paudel provided excellent research assistance but are not responsible for any errors.

A central policy issue for food-insecure regions of the world, concentrated in Asia and Africa, is how best to respond to the reality of food insecurity. In this paper I want to present and analyse some recently available data on undernourishment that I think are useful for addressing this and many other related questions. I think the key underlying research questions for policy are: what drives changes in food security; and what does this imply for agricultural and food policy? Some underlying research questions of interest for analysts include: are the determinants of changes in food security different from the causes of reductions in poverty? Is the focus on food security redundant, and would a focus on poverty reduction be sufficient? I will attempt to provide some answers to these questions as well.

Figure 1. International real prices of rice, wheat and maize, 1900 to 2013



Note: Deflator: World Bank Manufacturing Unit Value Index.

Source: Author's calculations, using data from World Bank.

Section 2 briefly reviews the definition of food (in)security, including the possibility of developing quantitative measures for it. Section 3 summarizes recently available data from FAO on one such measure, undernourishment, and discusses its meaning and limitations. Section 4 uses data from this source on changes in undernourishment across countries to analyse, in turn, the effects of economic growth and relative food prices and the roles of changes in the supply of food (food availability) and changes in poverty incidence (food access). Section 5 concludes.

2. The meaning of food security

Why food is different

Food is not a ‘normal’ commodity. It has no substitutes. If we are unable to obtain adequate food we suffer, and soon die, regardless of how much we possess of other things. Moreover, because our bodies lack the capacity to store large amounts of energy and other essential nutrients, to live active lives we must have adequate food intake almost continuously. This applies most especially to children, whose development may be impaired permanently by prolonged dietary inadequacy. But for large numbers of poor people, the reliability of food supplies cannot be assumed. The prospect of genuine food insufficiency is frightening for anyone, even if the probability is small and even if the expected duration of inadequate intake is not long. For these reasons, it makes sense to speak of ‘food security’ in a way that we do not speak of, say, ‘clothing security’ or ‘entertainment security’. We can survive for a long time without a reliable supply of these things.

Food is different, but is it *uniquely* so? Clean drinking water, shelter, access to basic medical care and education for children are similarly essential, in addition to adequate nutrition. There are no substitutes for any of them. The cruel nature of poverty is that it compels households to make choices among these items, *all* of which are essential for a minimally adequate standard of living. It is therefore important that a focus on food security does not mean that other requirements for a decent life can be ignored. But there remains a basic difference between the requirement for food and most other ‘essentials’. Whereas there is usually scope for temporary postponement of acquisition of other essentials, there is very limited scope to postpone consumption of food, particularly in the case of children.

Defining food security

At the 1996 World Food Summit food security was defined as existing ‘when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life.’ The World Health Organization (WHO) adds to this definition a description that is widely cited and drawn upon in subsequent studies. It says that food security rests on three pillars:

- *food availability* (sufficient quantities existing);
- *food access* (households are able to obtain the quantities required); and
- *food utilization* (appropriate nutrition and hygiene).

The first two components of the WHO definition, food availability and food access, are generally understood to relate to the national level (aggregate supplies) and the household level (capacity to purchase). But there is another way of interpreting these two categories. Food availability may be thought of in terms, not of aggregate quantities of food, but of the prices at which food is available. This in turn depends on productivity in the production and distribution of food within the domestic economy, the capacity of international trade to augment domestic food supplies and supplementary measures to provide food to those otherwise unable to purchase it.

Food access, the capacity of households to obtain the food they require, depends on the level of household incomes relative to the price of food. But as noted above, food is not the only requirement for a decent life. The poverty line is a measure of the amount of income required to purchase the goods and services needed for a minimally adequate standard of living, and because food is so important it necessarily forms a large component of the poverty line. Poverty incidence measures the proportion of households whose incomes fall below this poverty line. Food access is therefore inversely related to poverty incidence. The lower the level of poverty incidence, the higher the proportion of households possessing adequate access to food. But is reducing poverty incidence enough? Some households may continue to be food-deficient even though poverty incidence falls, and unexpected disasters can also lead to temporary but widespread hunger. Improving food access is about making food more affordable, supplemented by food social safety nets.

A problem with both the WHO and World Food Summit definitions is that they are non-quantitative. Our interest in the subject of food security derives from the fact that the stated conditions for food security do *not* always exist, as defined. But the degree of departure from these conditions varies. The focus on food security is motivated by the possibility of food *insecurity*, but there are degrees of food insecurity, some more severe than others. It is not obvious how varying degrees of departure from full food security could be quantified, based on the World Food Summit or World Health Organization definitions. An operational definition should support quantification (United States Department of Agriculture, 2000). It is not enough to know merely whether food

security does or does not exist. We need to be able to quantify the degree of departure from full food security. For example, the concept of poverty incidence has been precisely defined quantitatively, making it possible to study systematically the causes of changes in poverty incidence over time and across environments. We need to be able to do this for food insecurity.

It is helpful to distinguish between four levels of food security.

(i) *Global level* food security means whether global supplies are sufficient to meet aggregate global requirements. Reportedly, there are just fewer than 1 billion hungry people in the world and also a similar number of obese people. The amount of food currently produced is seemingly enough for everyone, leaving only a problem of distribution across individuals. But while arithmetically correct, this simplistic description does not necessarily provide a practical means of reducing hunger in poor countries.

(ii) *National level* food security is based on food security at the household level. If households are not food secure, it is hard to see how the nation could be.

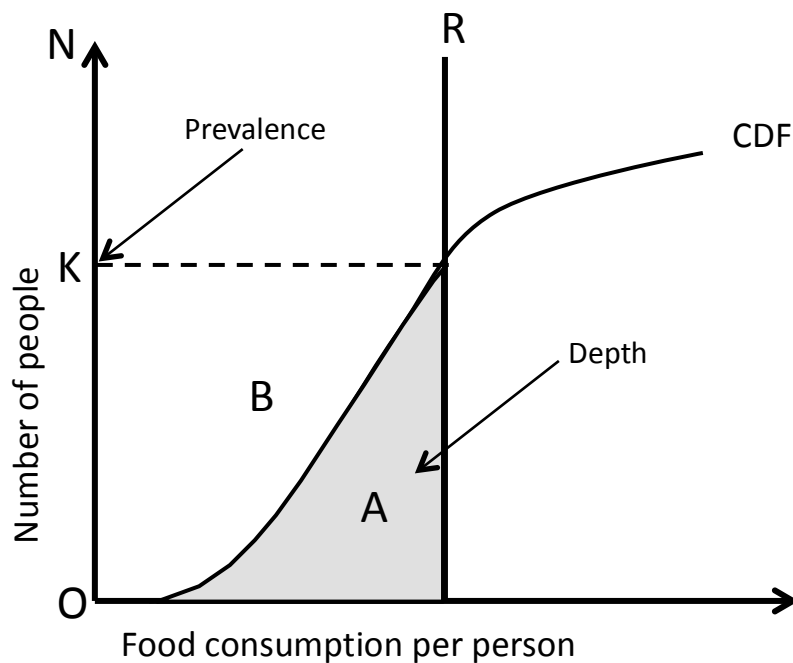
(iii) *Household level* food security refers to having access to adequate food at all times, roughly along the lines of the World Food Summit definition. But ‘security’ implies more than just the adequacy of food intake today. It implies something forward-looking, involving *expectations* of future circumstances and not simply present circumstances. It is an inherently probabilistic concept because it relates to the expected availability of sufficient food in the future, which inherently involves uncertainty.

(iv) *Individual level* food security is about the distribution of food within the household. When the household is short of food, individual members may be affected differently. The importance of this matter is beyond doubt, but few data sets available address it, focusing on consumption per person at the household level.

Data about current levels of food intake are useful as indicators of what expectations may be. Figure 2 draws upon the above concepts to show a hypothetical cumulative distribution function of food consumption per person at the national level. The population of size N is ordered from lowest food consumption per person (left hand side of the horizontal axis) to the highest (right hand side). The vertical axis shows the number of people whose consumption of food per person, measured say in calories, is less than or equal to the quantity shown on the horizontal axis.

If food requirement per person is R , the number of persons with intake less than R is given by K . The proportion of the population whose intake is expected to be inadequate is therefore K/N , corresponding to the *prevalence* of undernourishment. The total amount of food that K persons would need to consume for their intake to be adequate is given by the rectangle KR . Their actual consumption is the area B . Area A is therefore a measure of the degree to which actual consumption falls below the requirement, indicating the *depth of food insecurity*, or alternatively the magnitude of the *food security gap*. A measure that might be compared across countries is its magnitude relative to either total consumption or the total consumption that would occur if all persons consumed exactly R , given by RN .

Figure 2. Prevalence and depth of food insecurity: cumulative distribution function (CDF)



Readers familiar with the literature on poverty measurement will recognize that the prevalence of undernourishment is mathematically analogous to the headcount measure of poverty incidence, and the depth of undernourishment is analogous to the poverty gap. In the case of poverty measurement income or expenditure per person replaces food consumption per person and the poverty line replaces the food requirement per person, R . The diagram is otherwise the same.

Quantifying food insecurity: The FAO undernourishment data set

Considerable progress in the quantification of food security was made in a recent joint report of the Food and Agriculture Organization, the International Fund for Agricultural Development and the World Food Program, *The State of Food Insecurity in the World, 2012 and 2013* (FAO/IFAD/WFP 2012, 2013). The report presents improved estimates, for most countries of the world, of average availability of dietary energy supplies and average protein and fat supplies. The report contains important information on nutritional outcomes, including the prevalence of undernourishment, meaning the proportion of the population whose average daily intake of calories over a year is below the nutritionally-determined minimum daily requirement of calories and the ‘depth of the food deficit’ meaning the degree to which caloric intake of the undernourished falls below minimum dietary requirements. All of these data are available in downloadable form.¹

The FAO prevalence of undernourishment data are the flagship food security measure produced by FAO. These data are used by the United Nations system in monitoring progress towards Target 1 (Hunger) of the Millennium Development Goals and are used together with other data in both the IFPRI Global Hunger Index and the Economist Intelligence Unit’s Food Security Index. The meaning of this measure is not that people below the minimum level of caloric intake are starving (most are not), but that they are receiving insufficient caloric intake to lead a normal, active and healthy life.

FAO reports the prevalence of undernourishment for each country annually but over a three-year moving average, computed from the skew-normal distribution function. This function involves three parameters: the mean, the coefficient of variation and skewness. The values of these parameters are reported for each country, for each year, on the FAO’s website. The mean is computed from FAO’s food balance sheets, updated annually. The coefficient of variation and skewness are estimated from the food consumption component of household income and expenditure surveys conducted by the statistical agencies of individual countries. Because these surveys are seldom conducted on an annual basis, annual update of these two parameters would be

¹ The report also provides downloadable data on physical access to food in the form of paved roads relative to total roads, road density and the density of rail lines, and economic access in the form of food prices, though these prices are not related in the report to incomes, as is done in measures of poverty incidence.

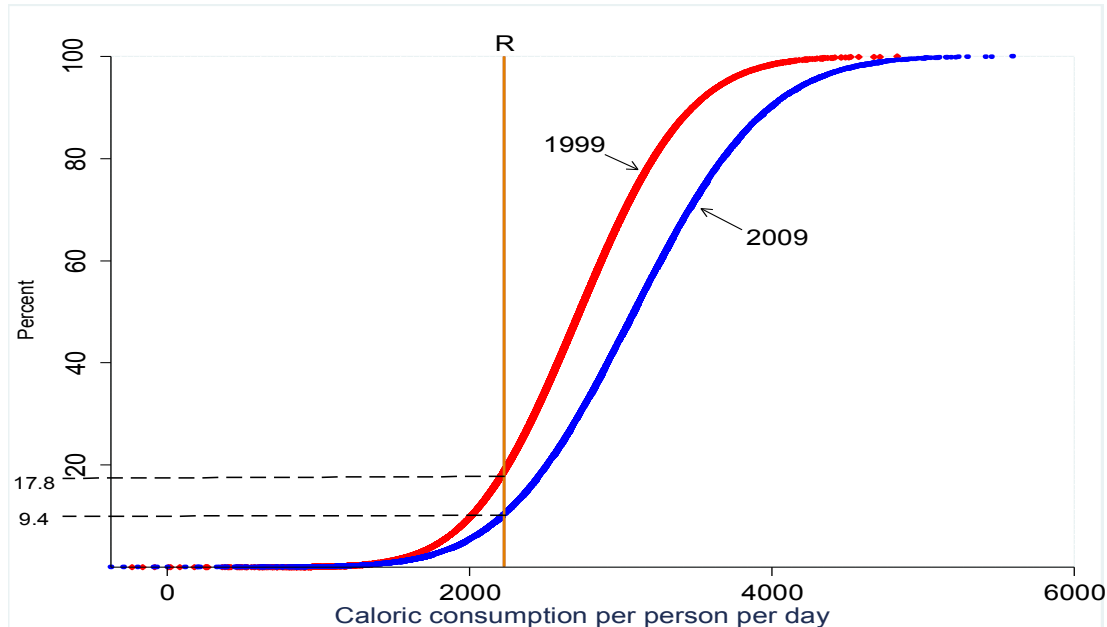
impossible. The FAO data for them are revised only intermittently. The calculation of the prevalence of undernourishment combines the above information with the minimum daily requirement, R .

It is possible for researchers to check the FAO calculations, but it requires a good deal of work. The method actually used to compute estimates of the prevalence of undernourishment is not reported, but the calculation can be illustrated through a specific example. This is done in Figure 3, for the case of Indonesia. The figure shows the cumulative distribution function implied by the skew-normal distribution using the three parameters mentioned above and the value of R , each as reported by FAO. This is done for two illustrative years, 1999 and 2009. The value of the prevalence of undernourishment for each of these two years derived from the diagram replicates the values reported by FAO, 17.8 and 9.4 per cent, respectively.

The publication of the FAO measure in downloadable form, along with the data on which it is based, is a valuable contribution. The prevalence of undernourishment measure has many self-evident limitations, as FAO itself acknowledges. The annualized nature of the data may exclude many people who are hungry only in certain seasons. The measure looks at caloric consumption per person at the household level and ignores distribution within the household, a point that could be very important in the case of children. It looks only at people below the minimum daily intake of calories; people above but close to this level of caloric intake are vulnerable to negative shocks that might reduce their intake to welfare-reducing levels and their numbers are ignored. The measure ignores the degree to which consumption falls below the minimum, but the depth of undernourishment data also published in the same source do address this issue. The measure looks only at caloric intake, ignoring other important dimensions of nutritional requirements. Finally, daily requirements are sensitive to the level of physical activity. FAO also publishes estimates that attempt to take this matter into account, but imperfectly.

Undernourishment, as measured by FAO, is clearly one potentially useful indicator of nutritional status, at perhaps the most basic level, but only one. The fact that FAO publishes the results only in the form of a three-year moving average suggests a lack of confidence in the year-to-year variations in the annual calculations on which these moving averages are based. Changes in the resulting measure over extended time periods might be reliable, but presumably not the short-term (annual) changes that are reported.

Figure 3. Prevalence of undernourishment, Indonesia, 1999 and 2009



Source: Author's calculations based on data reported by FAO *Food Security Indicators*, 2013.

3. The prevalence and depth of undernourishment

Globally, undernourishment remains a serious problem, but impressive progress has been made. According to a recent FAO report (FAO 2013), summarized in Tables 1 and 2, over the two decades from 1990-92 to 2010-12 the total number of undernourished people in the world declined from a little over one billion to 854 million, a decline of 162 million. Essentially all of this decline occurred in Asia, where the number of undernourished people declined by 191 million, implying an increase in the rest of the world of about 29 million. In Latin America and the Caribbean the number of undernourished people fell by 16 million but in Sub-Saharan Africa undernourishment increased by 52 million people. Within Asia the largest decline was in East Asia (112 million), followed by Southeast Asia (71 million) and South Asia (17 million).

Table 1. Number of undernourished people (millions)

Region	1990-92	2000-02	2010-12
World	1,015.3	957.3	853.6
Asia	751.3	662.3	560.0
Central Asia	NA	11.6	6.1
East Asia	278.7	196.6	166.8
South Asia	314.3	330.2	297.4
South East Asia	140.3	113.6	69.7
Oceania	0.8	1.2	1.1
Latin America	57.4	53.8	41.1
Sub-Saharan Africa	173.1	209.5	224.6

Source: Data from FAO *Food Security Indicators*, 2013.

Despite the progress, food security remains a major concern for Asia. The first reason is the sheer size of Asia's undernourishment problem. Of all undernourished people in the world today, 560 million, or 66 per cent of the global total, reside in countries of Asia, a reduction from 74 percent two decades before. Undernourished people still constitute 14 per cent of the population of Asia, compared with 12 per cent of the world population (Table 2). While the prevalence of undernourishment in Asia is only half that of Sub-Saharan Africa (at 27 per cent), the population of Asia is so much larger that the absolute number of undernourished people in Asia is still more than double (at 563 million) the number in Sub-Saharan Africa (at 234 million). Of Asia's malnourished people, 297 million, 35 per cent of the global total, are in South Asia alone, itself exceeding the total number, 225 million, in Sub-Saharan Africa.²

A second reason is the dependence of much of Asia on a single crop. Rice is the staple food of most of Asia.³ For the majority of Asia's poor people expenditure on this one commodity accounts for a large proportion of their household budgets, a much larger proportion than for the non-poor.

² The problem is particularly significant in relation to children. World Bank data suggest that among several Asian countries the incidence of childhood stunting exceeds 40 per cent, a proportion comparable with Sub-Saharan Africa, though in Asia the absolute numbers of children affected are larger.

³ The most important exception is that wheat is the major staple in some parts of North India and Pakistan.

This, together with the first point above, explains why Asian countries were so greatly alarmed by the huge increases in the price of rice during the 2007-08 food price crisis. The global market for rice is particularly thin, making international price volatility more pronounced than for most other staple foods. In recent decades both supply and demand conditions for food have changed rapidly in Asia. A growing middle class has diversified its diet away from staple cereals such as rice and towards fruit, vegetables and livestock products. But at the same time rapid urbanization and accelerating non-agricultural demands for land have placed greater pressure on agricultural resources. Finally, agricultural production in much of Asia is especially vulnerable to climate change, requiring greater policy attention to the requirements of agricultural adaptation.

The most striking feature of the data is the variation in the rates at which undernourishment has declined in different parts of the world. The rate of improvement also varied widely within Asia. Figures 4 and 5 show the time path of the FAO undernourishment data for eight individual Asian countries: the giants of China and India (Figure 4) and six countries of Southeast Asia (Figure 5). In Southeast Asia the absolute number of undernourished people declined over the last two decades by more than 50 per cent and East Asia was not far behind, at 36 per cent. But the rate of decline was much lower in South Asia, at 7 per cent. There may be many reasons for the variation but the differences seemingly correlate with differences in rates of poverty reduction, themselves correlating with differences in rates of economic growth.

The relationship between undernourishment and poverty incidence is explored further in Figures 6 to 9, for the developing countries as a whole and for Asia, Latin America and Sub-Saharan Africa, respectively. For the developing countries as a whole, progress towards achieving the Millennium Development Goal target of halving by 2015 the 1990 rate of undernourishment is slightly behind schedule (shown by the dashed line), whereas for Asia and the Pacific as a whole the target has already been reached. These charts suggest that movements in undernourishment and poverty incidence are correlated, but that the relationship is far from perfect.

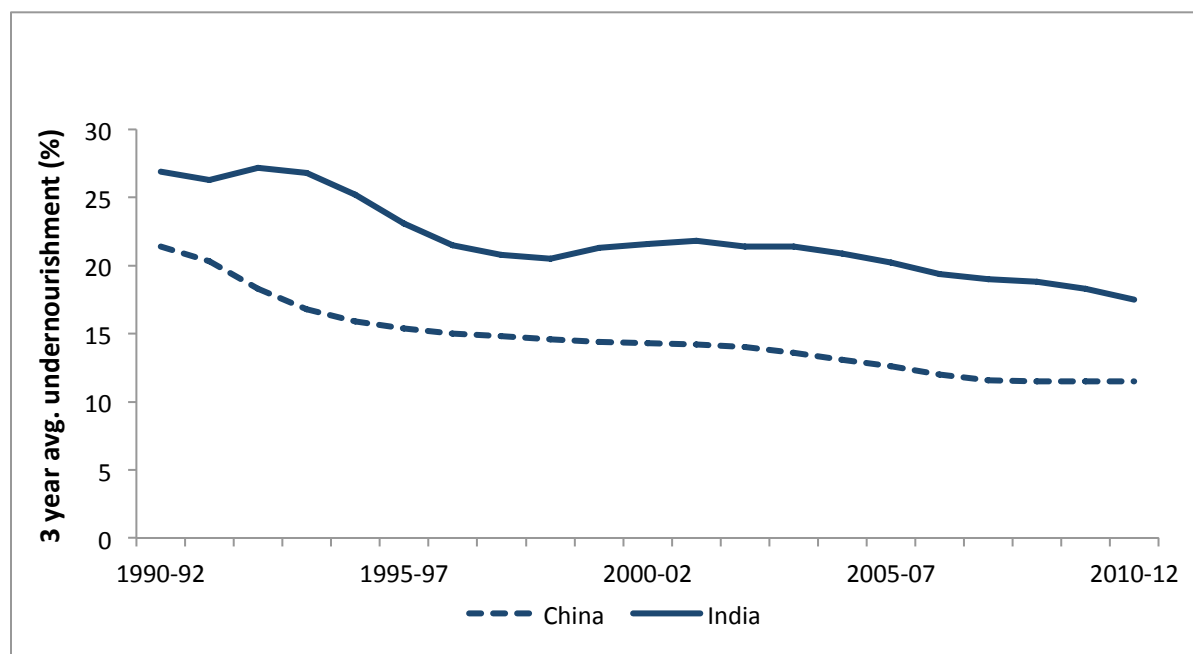
Table 2: prevalence and depth of undernourishment

Region		1990-92	2000-02	2010-12
World	Prevalence	18.9	15.5	12.3
	Depth	128	106	85
Asia	Prevalence	24.1	18.3	13.8
	Depth	165	126	96
Central Asia	Prevalence	12.8	16.2	7.8
	Depth	NA	109	54
East Asia	Prevalence	22.2	14	11.5
	Depth	161	95	76
South Asia	Prevalence	25.7	21.1	17.2
	Depth	167	156	123
South East Asia	Prevalence	31.1	21.5	11.7
	Depth	218	150	83
Oceania	Prevalence	13.5	16	12
	Depth	82	99	74
Latin America	Prevalence	13.8	11	7.4
	Depth	87	70	51
Sub-Saharan Africa	Prevalence	32.7	30.6	25.6
	Depth	221	213	179

Note: Prevalence means the percentage of the population with daily average caloric intake over the year less than the minimum daily requirement. *Depth* means the mean difference between intake and minimum daily caloric requirement, in kcal per person per day, among those whose intake is below the minimum daily requirement.

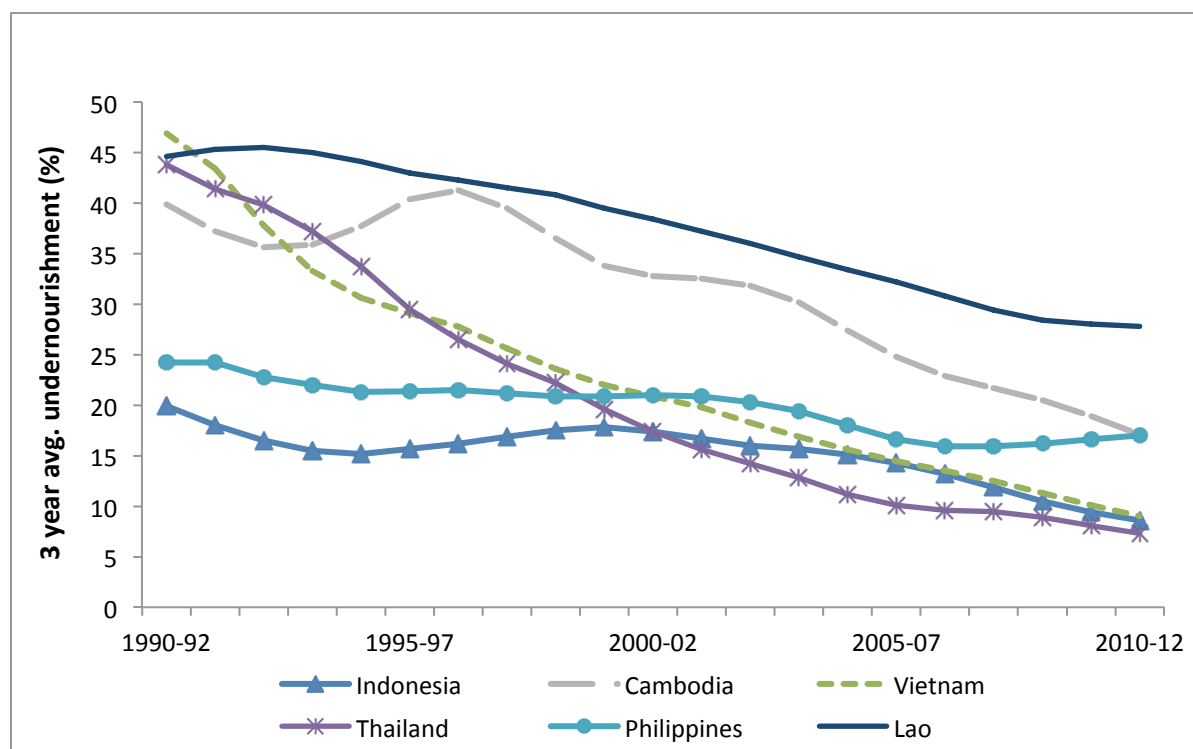
Source: Data from FAO *Food Security Indicators*, 2013.

Figure 4. Proportion of undernourished people: China and India



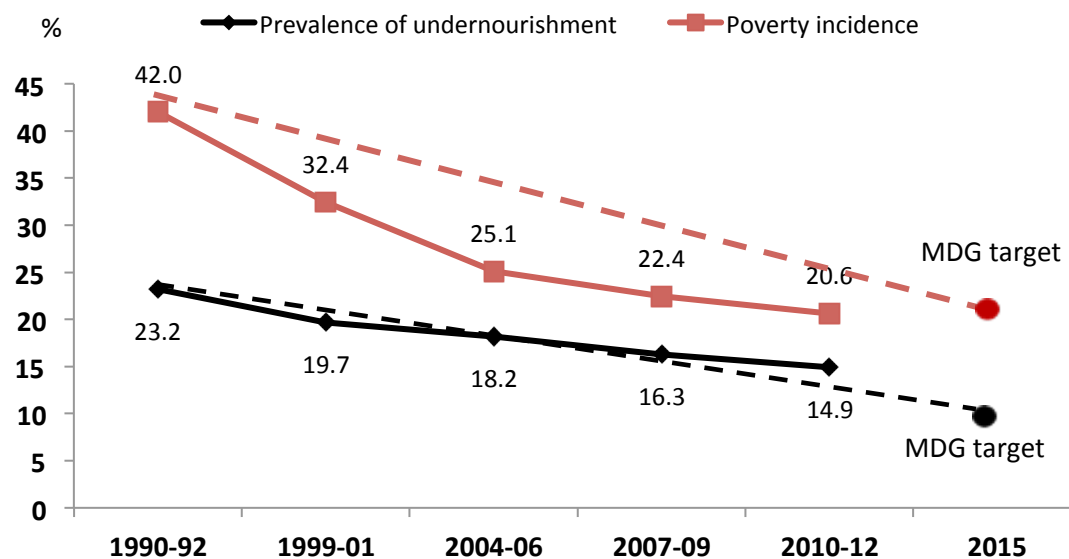
Source: Data from FAO Food Security Indicators, 2012.

Figure 5. Proportion of undernourished people: Southeast Asia



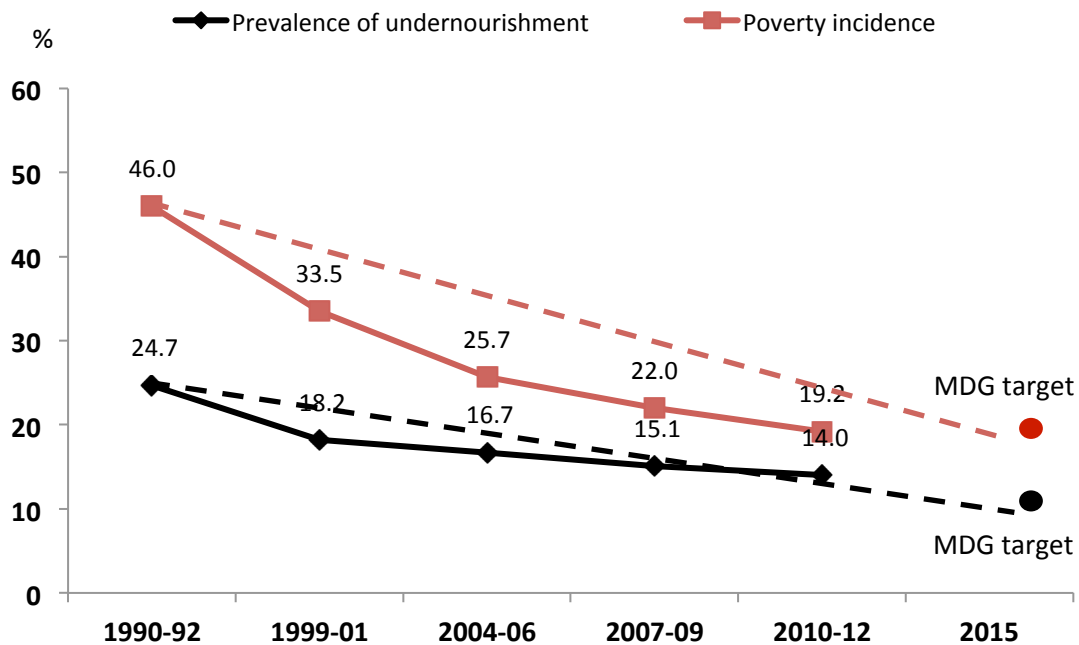
Source: Data from FAO Food Security Indicators, 2012.

Figure 6. Undernourishment and poverty in the developing countries



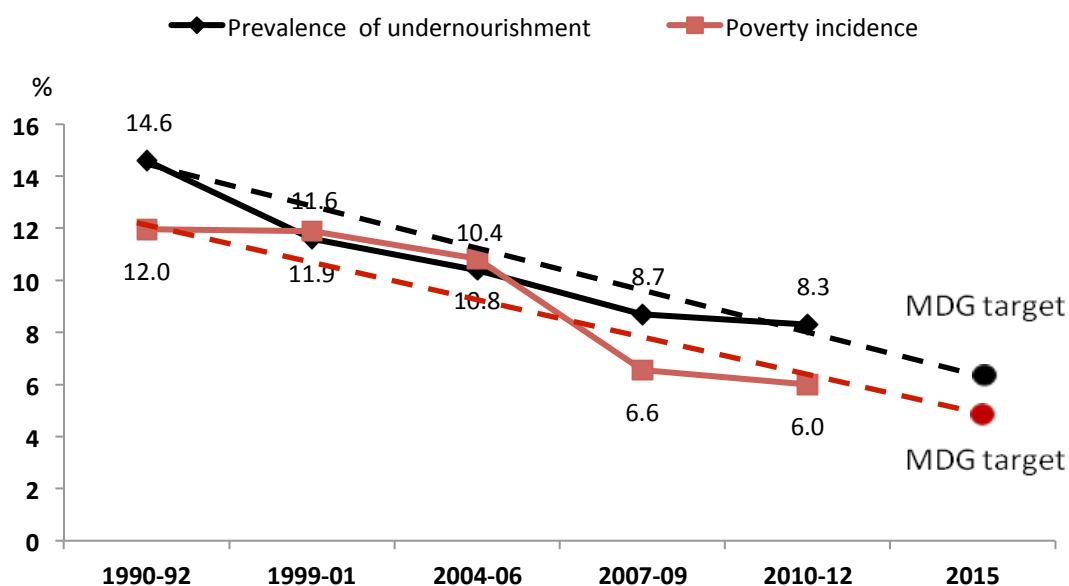
Source: Data from FAO Food Security Indicators, 2013 and World Bank, PovcalNet database. (<http://iresearch.worldbank.org/PovcalNet/index.htm>)

Figure 7. Undernourishment and poverty in Asia



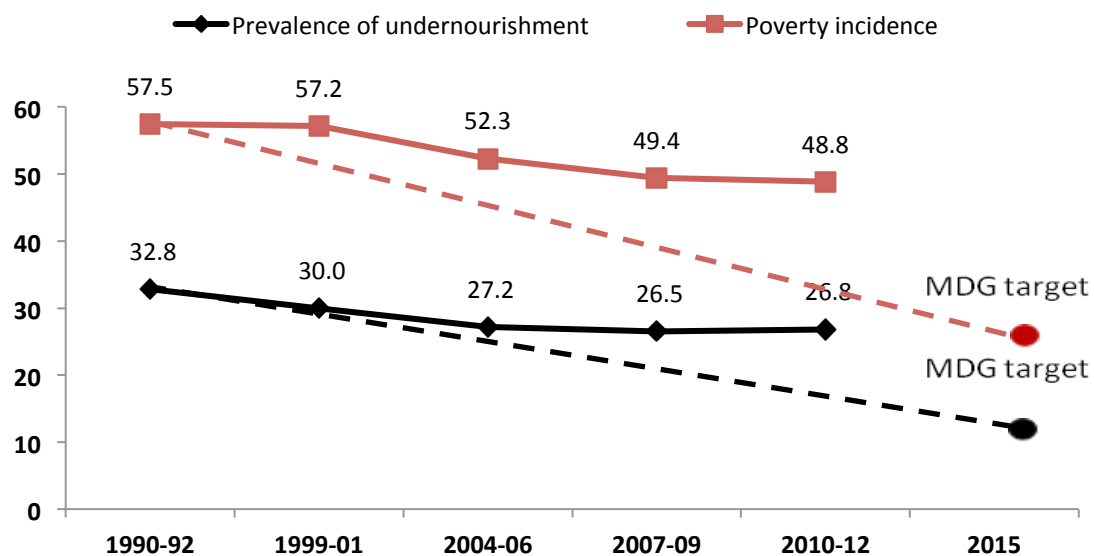
Source: Data from FAO Food Security Indicators, 2013 and World Bank, PovcalNet database. (<http://iresearch.worldbank.org/PovcalNet/index.htm>)

Figure 8. Undernourishment and poverty in Latin America and the Caribbean



Source: Data from FAO Food Security Indicators, 2013 and World Bank, PovcalNet database.
(<http://iresearch.worldbank.org/PovcalNet/index.htm>)

Figure 9. Undernourishment and poverty in Sub-Saharan Africa



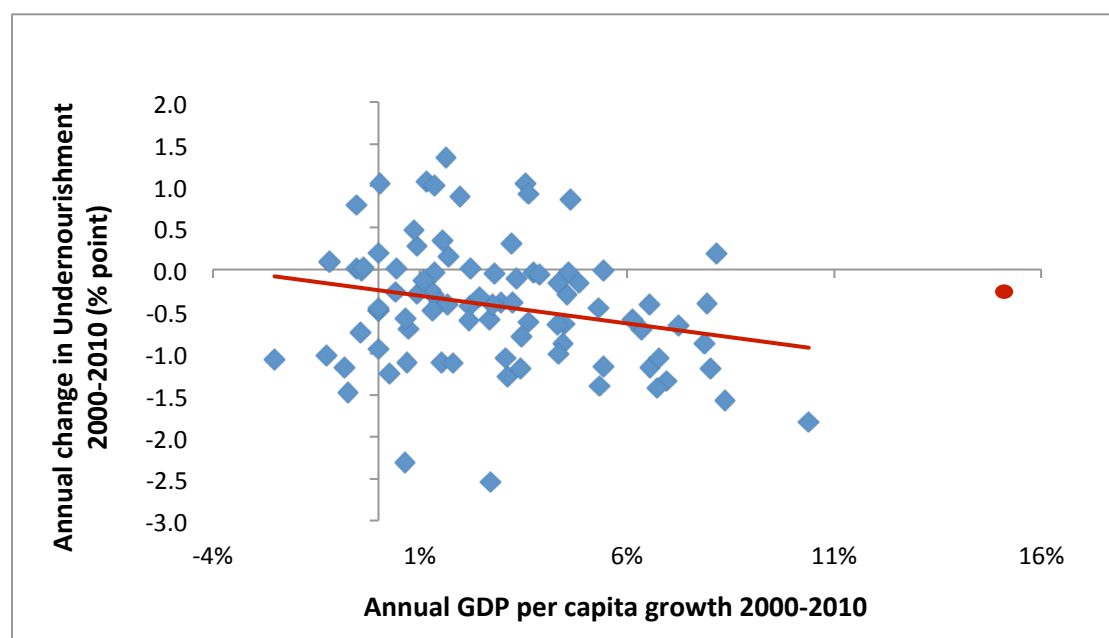
Source: Data from FAO Food Security Indicators, 2013 and World Bank, PovcalNet database.
(<http://iresearch.worldbank.org/PovcalNet/index.htm>)

4. Determinants of undernourishment

The FAO's landmark report, *State of Food Insecurity in the World 2012*, emphasizes the importance of economic growth, describing it in the report's subtitle as a 'necessary but not sufficient condition' for reductions in undernourishment—exactly what the World Bank says about poverty reduction. The relevance of economic growth is weakly supported by Figures 10 to 13. The line appearing in each chart is a regression equation fitted to the data, with statistical details provided in Table 3. The relationship is statistically significant for the developing countries as a whole and for Asia, but not for Africa or Latin America. The quality of fit is poor. There are numerous instances of positive economic growth coinciding with increased undernourishment, so economic growth is certainly not sufficient for reduced undernourishment. But there are also several instances of negative economic growth coinciding with reduced undernourishment. Evidently, economic growth is neither necessary nor sufficient and the correlation is weak. A better explanation for changes in undernourishment is surely possible.

Table 4 shows the relevance of disaggregating GDP growth into its major sectoral components: agriculture, industry and services. The estimated equation draws upon the identity that the growth rate of GDP is equal to the sum of the sectoral growth rates, each multiplied by its share of GDP. The value of this decomposition of GDP is that if the composition of GDP growth matters for its effects on the reduction of undernourishment, the coefficients estimated for the various sectors will be significantly different. It is thus possible to study whether the sectoral composition of growth is important for undernourishment by testing the null hypothesis that the true sectoral coefficients are the same. An F-test for this restriction is provided in the final row of the table (*p*-value for null). The hypothesis is rejected for both the prevalence and depth of undernourishment. Growth of agriculture is overwhelmingly more important than growth of industry or services. Indeed, agriculture is the only component of GDP for which a significant effect can be found. The negative and significant coefficient for agriculture means that higher growth of agricultural output is associated with larger reductions in undernourishment.

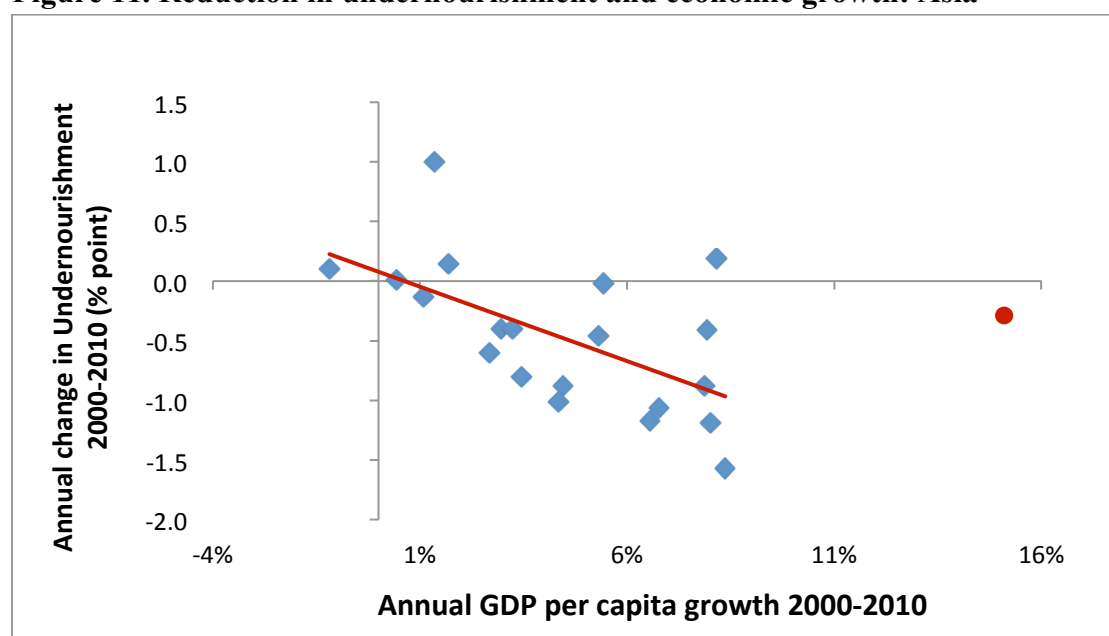
Figure 10. Reduction in undernourishment and economic growth: Developing countries



Note: The dot to the far right is China, which was excluded from the data used in the regression.

Source: Author's calculations using data from FAO *Food Security Indicators*, 2012 and World Bank, *World Development Indicators*, various issues.

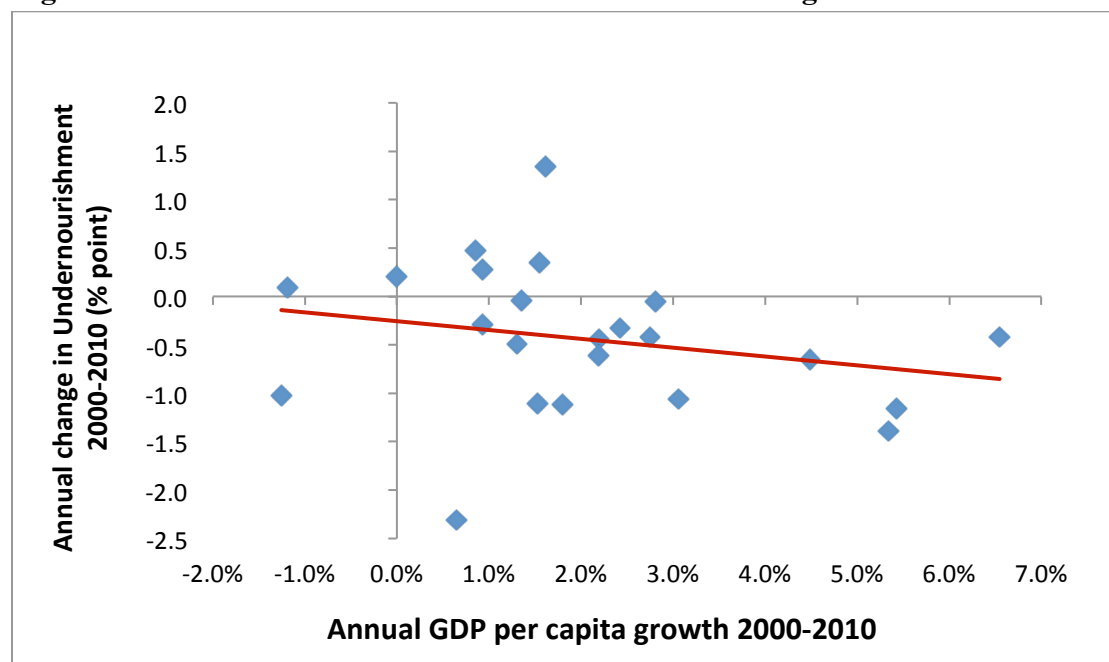
Figure 11. Reduction in undernourishment and economic growth: Asia



Note: The dot to the far right is China, which was excluded from the data used in the regression.

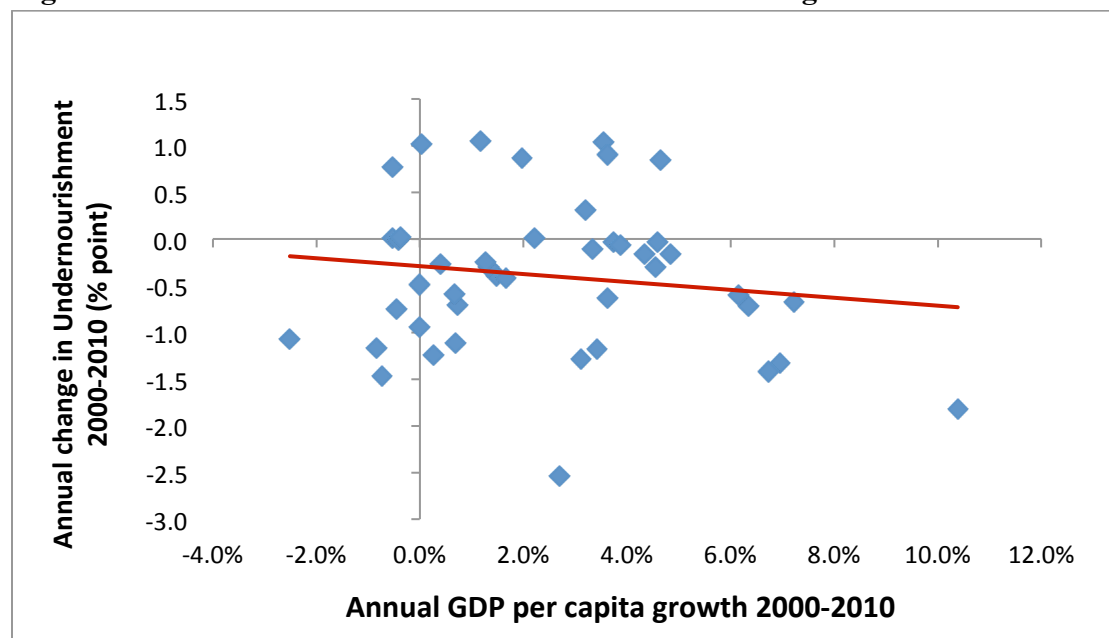
Source: Author's calculations using data from FAO *Food Security Indicators*, 2012 and World Bank, *World Development Indicators*, various issues.

Figure 12. Reduction in undernourishment and economic growth: Latin America



Source: Author's calculations using data from FAO *Food Security Indicators*, 2012 and World Bank, *World Development Indicators*, various issues.

Figure 13. Reduction in undernourishment and economic growth: Africa



Source: Author's calculations using data from FAO *Food Security Indicators*, 2012 and World Bank, *World Development Indicators*, various issues.

**Table 3. The weak relationship between undernourishment and economic growth:
Regression results for fitted lines, Figures 11 to 14**

	Developing countries	Asia	Africa	Latin America
Real GDP growth p.c.	-7.068** (2.969)	-13.744** (5.789)	-4.958 (4.731)	-7.929 (8.207)
Constant	-0.223* (0.118)	0.157 (0.330)	-0.252 (0.176)	-0.303 (0.242)
<i>N</i>	85	17	42	23
<i>R</i> -sq.	0.064	0.273	0.027	0.043
adj. <i>R</i> -sq.	0.053	0.225	0.002	-0.003
<i>F</i> -stat	5.666	5.637	1.098	0.934
<i>p</i> -value for <i>F</i> -stat.	0.020	0.031	0.301	0.345

Standard errors in parentheses.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Note: The regressions for ‘Developing countries’ and ‘Asia-Pacific’ exclude China because it is an extreme outlier.

Source: Author’s calculations using data from FAO *Food Security Indicators*, 2012 and World Bank, *World Development Indicators*, various issues.

Table 4 also includes a variable for the real price of food, constructed from ILO consumer price data.⁴ The relevance of this variable is that whereas GDP and its sectoral components relate to incomes, undernourishment surely also depends on the consumer price of food relative to other goods. Undernourished people are likely to have high budget shares for food – higher than the national average. This implies that their consumption of food may be particularly sensitive to changes in food prices relative to other prices. The results in Table 4 strongly confirm the importance of this variable. On average higher food prices mean higher levels of undernourishment.

Table 4 shows, in the last two columns that very similar results are obtained if changes in poverty (the headcount measure of poverty incidence and the poverty gap measure) are used as the

⁴ *Source:* <http://laborsta.ilo.org>.

dependent variables instead. The poverty data used are from the World Bank's 'Povcal' database and relate to the \$1.25 per day poverty line at 2005 purchasing power parity. Growth of agriculture and lower food prices are strongly associated with reductions in both undernourishment and poverty.

Table 4. Undernourishment, poverty and economic growth

	Change in undernourishment		Change in poverty	
	Prevalence of undernourishment	Depth of undernourishment	Poverty incidence	Poverty gap
Agriculture	-0.445* (0.231)	-4.711** (2.006)	-0.998*** (0.346)	-0.593** (0.242)
Industry	-0.175 (0.191)	-1.595 (1.657)	-0.258 (0.286)	0.056 (0.200)
Services	0.168 (0.105)	1.839* (0.914)	0.029 (0.157)	0.041 (0.110)
Real price of food	4.815** (2.349)	36.342* (20.415)	7.495** (3.519)	1.867 (2.461)
Constant	-5.355** (2.415)	-39.973* (20.983)	-8.148** (3.617)	-2.372 (2.530)
<i>N</i>	41	41	41	41
<i>R</i> -sq.	0.252	0.289	0.368	0.182
adj. <i>R</i> -sq.	0.169	0.210	0.298	0.091
<i>p</i> -value for model	0.0299	0.0133	0.0020	0.1144
<i>p</i> -value for null	0.0259	0.0058	0.0217	0.0565

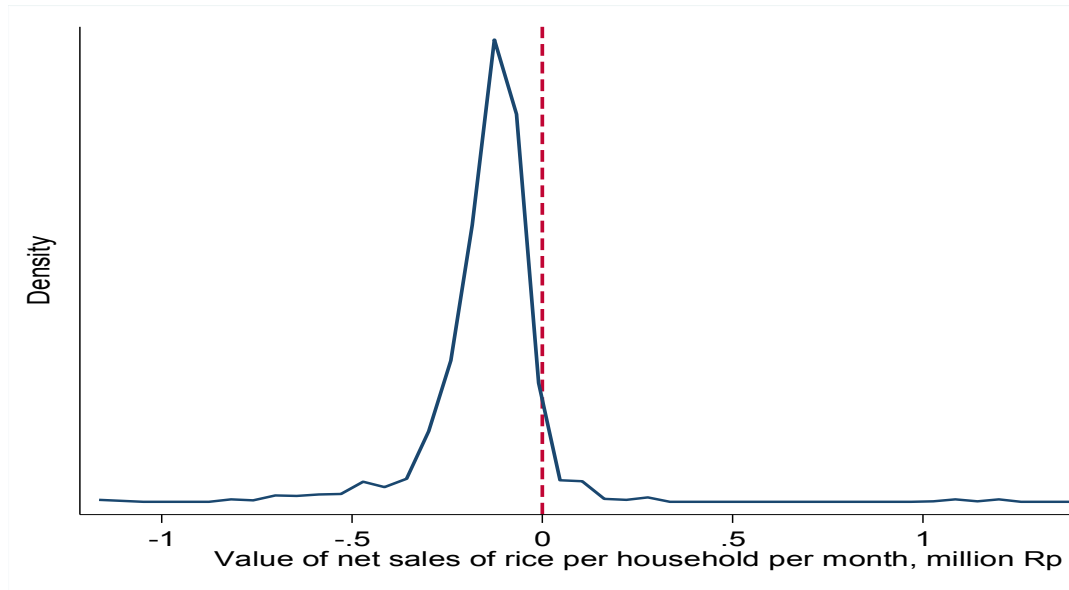
Source: Author's calculations using data from FAO, World Bank and ILO.

Why are higher food prices associated with greater undernourishment and poverty? At the simplest level, higher food prices would seemingly harm households who are net purchasers of food but benefit net sellers, including many undernourished and poor farmers. Data on the distribution of net sales of rice in Indonesia summarised in Figures 14 and 15 and these data help illustrate the point.⁵ The data come from the Indonesian Family Life Survey, which has the advantage of capturing

⁵ See also Ivanic and Martin (2008), who study nine poor countries, not including Indonesia, and find that net food purchasers outnumber net food sellers in most but not all cases.

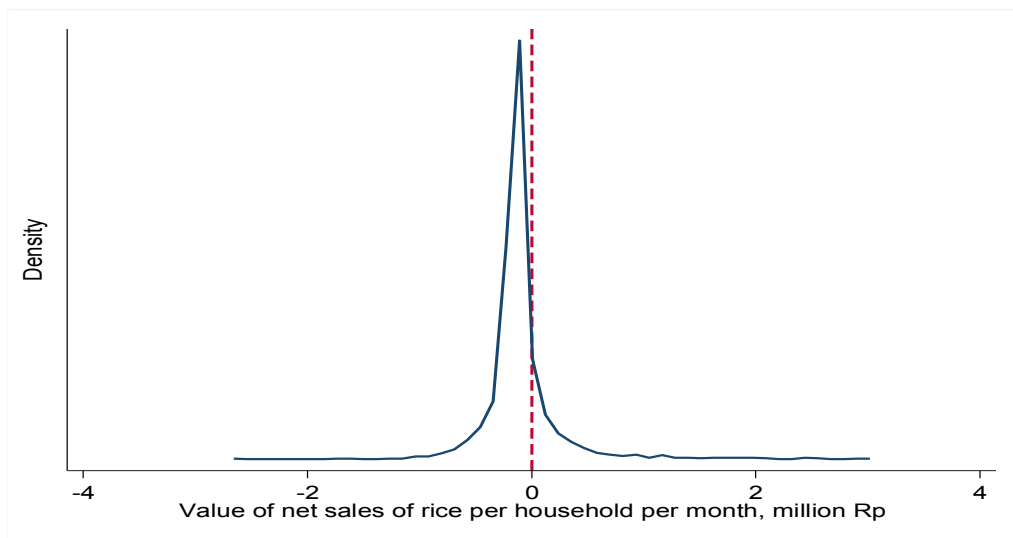
both household level production and consumption of food items. Net buyers of the staple food, rice, outnumber net sellers in both urban and rural areas, and therefore in the full population.

Figure 14. Distribution (PDF) of value of net sales of rice, urban households, 2007



Source: Author's calculations using data from *Indonesia Family Life Survey*, 2007.

Figure 15. Distribution (PDF) of value of net sales of rice, rural households, 2007



Source: Author's calculations using data from *Indonesia Family Life Survey*, 2007.

The food security literature emphasizes the distinction between the *availability* of food, meaning aggregate supplies available, and *access* to food, meaning the capacity of households to purchase food. These two variables are used in Table 5 as explanatory variables for changes in undernourishment. Availability of food is measured by FAO data on domestic supplies of available food (output plus imports minus exports minus non-food uses minus wastage minus storage). Access to food is measured as the relative price of food using ILO consumer price data, as above.

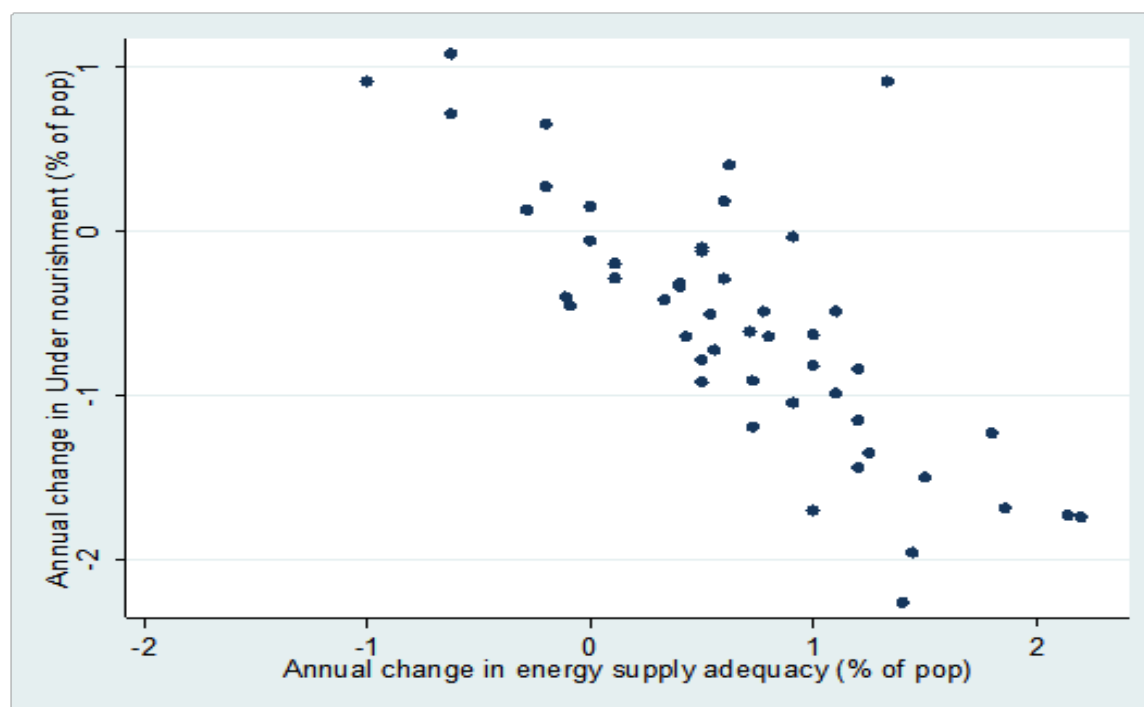
The results indicate that an increase in food availability and a reduction in food prices are associated with a reduction in undernourishment. When changes in poverty incidence are included as explanatory variables, they have the expected positive coefficient but the coefficient is not significantly different from zero. The relationship between reductions in undernourishment and changes in food availability (measured as calories supplied as a proportion of the requirements for dietary adequacy) is apparent from the scatter diagram in Figure 17. The results point to the value of improved agricultural productivity as a driver of reductions in undernourishment because it contributes to both expanded availability of food and possible reductions in food prices.

Table 5. Undernourishment, food availability and food access

Dependent variable: Change in Undernourishment				
	Prevalence	Prevalence	Depth	Depth
Independent variables:				
Food <i>availability</i> (change in aggregate supplies)	-0.410*** (0.152)	-0.464*** (0.107)	-3.838*** (1.134)	-4.154*** (0.973)
Food access (relative price of food)		4.175*** (1.657)		25.029** (9.697)
Constant	-0.265 (0.105)	-4.425*** (0.108)	-1.057 (0.938)	-25.591** (10.127)
<i>N</i>	49	48	49	48
<i>R</i> -sq.	0.339	0.540	0.403	0.500
adj. <i>R</i> -sq.	0.325	0.519	0.390	0.478
<i>p</i> -value	0.010	0.000	0.000	0.000

Source: Author's calculations using data from FAO (food availability) and ILO (relative price of food).

Figure 17. Undernourishment and food availability



6. Conclusions

The evidence clearly indicates that expansion of agricultural output within developing countries themselves is strongly associated with reductions in the rate of undernourishment and the rate of poverty incidence. It is not sufficient to rely solely on aggregate economic growth or reductions in poverty incidence to deliver improved food security. But the evidence also shows that higher food prices significantly increase the rate of undernourishment. What are needed are means of raising agricultural output without at the same time raising food prices.

Two policy strategies are available and both are currently in use, to varying degrees. The first is investment in the infrastructure and knowledge required to raise agricultural productivity. The second is policy interventions designed to raise agricultural product prices. In food importing countries this is frequently associated with a policy drive for food self-sufficiency. Both policies are capable of increasing agricultural output. But the first does so without raising food prices. The second uses increased food prices as its central instrument.

Agricultural protection aimed at achieving food self-sufficiency is often described as a policy for improving food security. It is not that. It delivers benefits to many food insecure people who are net sellers of food. But these numbers are exceeded, on average, by the number of food insecure people who are net buyers of food and are thereby made more food insecure by increased food prices.

The policy implication is that food security can be improved by raising agricultural productivity through investments in infrastructure and research, supplemented by food safety nets to assist those unable to benefit from market based economic development. Agricultural protection produces a net increase in food insecurity.

References

- Julian M. Alston and Philip G. Pardey (2014). 'Agricultural R&D, Food Prices, Poverty and Malnutrition Redux', University of Minnesota, Dept. of Applied Economics Staff Papers P14-01.
- Kym Anderson, Maros Ivanic and Will Martin (2012). 'Food Price Spikes, Price Insulation, and Poverty' Paper presented at NBER conference "The Economics of Food Price Volatility" Seattle, WA, 15–16 August.
- Olivier Ecker and Clemens Breisinger (2013). 'Revisiting Food and Nutrition Security: A Comprehensive Overview', *Journal of Agricultural Economics and Development*, 2 (7): 280-289.
- Derek Heady and Shenggan Fan (2008). 'Anatomy of a Crisis: The Causes and Consequences of Surging Food Prices', *Agricultural Economics*, 39 (3): 375-391.
- Maros Ivanic and Will Martin (2008). 'Implications of Higher Global Food Prices for Poverty in Low-income Countries', *Agricultural Economics* 39, 405–416.
- Will Martin and Kym Anderson (2011). 'Export Restrictions and Price Insulation During Commodity Price Booms', *American Journal of Agricultural Economics*, 94 (2): 422-427.
- Mark W. Rosegrant, et al (2010). 'Food Security, Farming, and Climate Change to 2050,' International Food Policy Research Institute, Washington DC.
- C. Peter Timmer (2008). 'Causes of High Food Prices'. ADB Economics Working Paper Series, No. 128, Asian Development Bank, Manila.
- C. Peter Timmer (2010). 'Behavioral Dimensions of Food Security'. *Proceedings of the National Academy of Sciences (PNAS)*, Agricultural Development and Nutrition Security Special Feature.
- United States Department of Agriculture, *Guide to Measuring Household Food Security* (Revised 2000), <available at: <http://www.fns.usda.gov/fsec.files.fsguide.pdf>>
- Peter Warr (2005). 'Food Policy and Poverty in Indonesia: A General Equilibrium Analysis', *Australian Journal of Agricultural and Resource Economics*, 49 (4): 429-451.
- Peter Warr (2008). 'World food prices and poverty incidence in a food exporting country: A Multihousehold General Equilibrium Analysis for Thailand', *Agricultural Economics*, 39 (3): 525-537.
- Peter Warr (2011). 'Food Security vs. Food Self-Sufficiency: The Indonesian Case' *The Indonesia Quarterly*, vol. 39, no. 1 (First Quarter), 56-71.
- Peter Warr and Arief Yusuf (2014) 'Food Prices and Poverty in Indonesia', *Australian Journal of Agricultural and Resource Economics*, vol. 58, no. 1 (January 2014), 1-21.