A Back of the Envelope Estimation of the Effect of Soaring Food Prices on World Hunger

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Abstract

This paper suggests a methodology for estimating the effects of higher food prices on global undernourishment. The paper also presents the results of its implementation. The merits and drawbacks of this methodology are also discussed. The estimations of the number of new undernourished as a result of the current agricultural commodity price boom should not be taken as official FAO estimates, but rather as an illustration of the proposed methodology, and the promotion of an ongoing discussion.

Key Words: Food Prices, Undernourishment.

JEL: I3, Q18.

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Introduction

Food riots in Haiti, Egypt, Pakistan, Bangladesh, Mexico, and in many other countries during the course of the year have definitely caught the global attention on the problem of soaring food prices and hunger. For those for whom access to food is already precarious, increasing food prices can have dramatic effects on their purchasing power and ultimately in their nutritional status and their ability to live a healthy life. The human costs can be staggering, but we do not have a clear idea of the true dimensions of the problem. This is what this paper attempts, to provide a rough and imprecise estimate of the effects of soaring food prices on global undernourishment, but an estimate that can help the global community get an idea about the dimensions of the human costs of globally rising food prices.

Below we present a methodology that builds on the way how FAO estimates global hunger to include food price effects. The proposed methodology relies in country specific estimates of the effects of food prices on food consumption. We first present the FAO methodology to then show how we propose to use it to include food price effects. Next we show the results of using this methodology, and finally contrast it with alternative methods and discuss its merits and drawbacks.

The FAO Methodology

To understand the proposed methodology to estimate the effect of soaring food prices on world hunger it is necessary to be familiar first with how FAO measures at the national level undernourishment. The FAO approach is parametric. First the minimum dietary energy requirements (MDER) are calculated for each country. The MDER uses the energy requirements for a healthy life assuming light physical activity level for individuals in the bottom 5th percentile of the national height/weight (Body Mass Index, BMI) distribution[1]. Since these dietary energy requirements are obviously age and gender specific, the particular demographic composition of each country, as well as the different physical characteristics (BMI) of the population yield a country-specific MDER. It is then assumed that daily calories per capita (x) are distributed log-normally. The log-normal distribution is fully described with two parameters: $S^2 = \ln\left(Var(x)/\left(E\left[x\right]\right)^2 + 1\right)$ and $M = \ln\left[E\left[x\right]\right] - S^2/2$. S^2 is estimated by calculating the coefficient of variability from household consumption or budget surveys (see FAO Statistics Division (2003), for details). M, on the other hand is derived using the dietary energy supply (DES, also expressed in daily calories per capita) which provides the national average availability of calories obtained from national level food balance sheets[2], in other words, a national estimate of $E\left[x\right]$.

With all of the above information, the national estimate of the number of people undernourished for country *i* is simply:

$$U_i = POP_i \cdot \int_0^{MDER_i} \ell(M_i, S^2{}_i) \cdot dx, \qquad (1)$$

where POP_i is the national population and $\ell(\bullet)$ is the log-normal probability density function (pdf). Similarly, the national undernourishment (1) aggregates straightforwardly to produce a global hunger figure that is headlined in each issue of FAO's State of Food Insecurity in the World (SOFI):

$$WORLDHUNGER = \sum_i POP_i \cdot L(M_i, S^2{}_i; MDER_i), \qquad (2)$$

where $L(\bullet)$, is obviously the log-normal cumulative distribution function (cdf).

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[1] These energy requirements represent the agreement among the experts gathered by FAO, WHO and UNU (FAO (2004)) to assess human dietary energy needs.

[2] The food balance sheet for each crop is roughly equivalent to: production – net trade (exports - imports) – non-food uses (feedstock, seeds, etc.). This food available is converted to DES, by multiplying by its per volume energy content, and dividing by the national population.

The proposed Methodology to Measure the Soaring Food Prices Effect on World Hunger

In a separate report (Anríquez et al. (2008)) we make 8 country specific analyses exploring the effects of rising prices of tradable cereals on the prevalence of undernourishment. The sample of 8 countries (Bangladesh, Guatemala, Nepal, Peru, Tajikistan, Vietnam, Kenya, and Malawi) was not random, but carefully designed to represent the different developing regions, difference in the main tradable staple food, and its relative importance on diets, and differences in levels of development.

The analysis consisted in estimating with a comparable and consistent methodology the household level dietary energy intake using household surveys, and using these consumption levels to measure undernourishment[3]. Defining these energy consumption and undernourishment levels as benchmark, we simulated a 10% increase in the real price of the main tradable cereal. The simulation included the negative real income effect for all households as food consumers, and also the positive nominal income effect for all households that produce the staple with the rising price. The net effect on food consumption for most households is negative, but it is ambiguous for farming households that produce the staple. The distribution of farm income, the distribution of energy consumption, preferences, and diets, all play a relevant role in determining the outcome in terms of both dietary energy consumption and measured undernourishment.

As a result of this exercise we indirectly simulated the effects in the distribution of daily per capita calories in each of these countries. We can therefore estimate an elasticity of the log-normal parameters to food price increases in each of these countries. In particular, we can predict the new log mean with:

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[3] Details of the methodology used are discussed in Anríquez et al. (2008), here we only describe the main features of the simulations.

$$d \ln M = \frac{\partial \ln M(p, y, \bullet)}{\partial \ln p} d \ln p \,, \qquad (3),$$

and the new log variance with:

$$d \ln S = \frac{\partial \ln S(p, y, \bullet)}{\partial \ln p} d \ln p \qquad (4)$$

where we are implicitly arguing that both M and S^2 are functions of food prices, national per capita income y, and other variables. In the case of the log mean we alternatively explored:

$$\frac{\partial \ln M(p, y, \bullet)}{\partial \ln p} = \frac{d \ln E[x]}{d \ln p} \frac{1}{M} - S^2 \frac{d \ln S}{d \ln p} \frac{1}{M} \,, \qquad (5),$$

which is mathematically identical to (3), but in terms of the estimated mean elasticities it provides some minor changes.

We simulated the effects of food price increases using FAO 2001-2003 undernourishment estimates FAO (2006)[4]. These provide a benchmark of 804 million undernourished from a sample of 149 countries that represent 6,243 million persons (i.e. almost the complete global population). We used the average elasticities obtained from the 8 countries analyzed, but we also considered the undernourishment estimated using the extreme values of the mean elasticities within a 90% confidence interval; i.e. the lowest log-mean elasticity (which is negative and large in absolute value) together with the highest log-variance elasticity (which would produce the highest estimated global hunger), and the highest log-mean elasticity with the lowest log-variance elasticity estimate (which would produce the minimum global hunger estimate).

The results of what we called the "simple" estimates are summarized in Figure 1. We used the average log-mean elasticity of -0.025 (with a confidence interval of -0.016,-0.035), and a log coefficient of variability elasticity of 0.033 (with a confidence interval of 0.009,

[4] We thank the statistics division of FAO for making the parameters used in their estimations of global hunger available to us.

0.059)[5]. Using the above estimates we calculate that a 1% increase in staple prices increases undernourishment by roughly 6 million people, which implies an elasticity of 0.8 of global undernourishment to food prices, as shown in Table 1.

The main drawback with this "simple" estimate is that the precision of the calculated average elasticities of log-normal parameters to food prices does not necessarily improve the precision of the global hunger estimates. Imagine that we continue adding elasticities to our averages from additional household level nutrition studies. Then our mean elasticities will continue converging to the true mean which would lie with a 90% confidence inside our narrowing estimated confidence intervals. Assume further that we have the true average elasticities, we would still be unable to estimate with precision global hunger, because the global hunger elasticity is highly non-linear, and it is relevant where the log-mean falls more or less, and ditto for the log variance. In mathematical terms we have:

$$\sum_i POP_i \cdot L(M_i^{\,*}, S^2{}_i^{\,*}; MDER_i) \neq \sum_i POP_i \cdot L(\bar{M}_i^{\,*}, \bar{S}_i^{*2}; MDER_i)\,, \tag{6}$$

where the asterisk indicates the "true" country-specific new parameters after the food price increase, and the bar over the parameter indicates country-specific parameter estimated using average elasticities (as described in (3)).

Therefore to improve our estimates we try to predict what would be the country specific elasticity. Table 2 shows the equations we used to predict our country specific elasticities. The log-mean elasticity can be predicted with high precision with the share of cereals in national diets (data from food balance sheets). This correlation is not spurious, because the higher the share of the main cereals in national diets the larger the negative real income effect of the cereal price increases. It is hard to predict the change in the variability of the distribution, because this will depend on several factors like initial distribution, the

[5] There is much less precision in the mean elasticity of the change of the coefficient of variability. This is explained by the fact that the price increase increases or reduces inequality depending on the distribution of farm income.

distribution of farm income, and the composition of calories (relative importance of the cereal) across the calorie distribution. We make a raw attempt at predicting the log-variance elasticity using the income inequality (GINI, from the expanded Deininger and Squire (1996) database updated by UNU-WIDER)[6]. The hypothesis is that when income distribution is higher the changes in the variability of the distribution would be lower. The precision for this prediction is much lower, but our sensitivity analysis suggests that the results are much less sensitive to this elasticity, than to the log-mean elasticity.

The “educated” estimates of global undernourishment are summarized in Figure 2. They show that the “simple” estimates actually overestimate the effect of food prices on global undernourishment, and that the implicit elasticity of food prices to global hunger is closer to 0.65 than 0.8, as Table 1 also shows the differences between both estimates.

Regional Differences

Table 3 disaggregates the impact of higher tradable cereal prices by developing region. In terms of percentage increase, the developed countries would exhibit the highest increase in the prevalence of undernourishment, but this region is the one that starts from the lowest baseline. Next in percentage increase of the hungry is Middle East and North Africa region. In terms of the number of undernourished, most of the new hungry would be located in Asia, where the large countries have diets highly dependent on rice and are therefore more vulnerable to a given increase in the price of tradable cereals. Sub Saharan Africa is the region that would experience the lowest percentage increase in the prevalence of undernourishment. This result is driven, first by the fact that the sub-continent’s diets rely more heavily in non-tradables like starchy roots and tubers, and plantains, although maize is an important staple in Southern SSA. The second driving factor is the fact that the sub-continent already has the

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[6] We use regional average changes for countries for which we do not have information on diet composition or distribution of income.

highest prevalence of undernourishment. The fact the lowest proportional increase in the undernourished would come in SSA is also consistent with the early scattered evidence that indicates that the continent is mostly shielded to this agricultural commodity price boom. Many countries are not highly integrated to global markets, with transportation and transaction costs leaving them de-facto isolated from global cereal markets.

Comparison with other methodologies

There are basically two other approaches to estimate the effects of food prices rises on global hunger. There is the US Department of Agriculture (2000) / Senauer and Sur (2001) approach and the SOFI 2008 approach. Senauer and Sur (2001) estimate a caloric income elasticity with a simple regression of DES against per capita GDP (a calorie Engels curve). This equation is used to predict caloric consumption by quintiles using the Deininger and Squire (1996) income inequality database. Finally, they estimate the number of global undernourished by counting population that falls below the caloric hunger threshold (regional average dietary energy requirements), using their estimated country-level income to calorie curve. They simulate the effect of food price increases by shifting the calorie-income curve up by 10%. Irrespective of how precise the measure of global hunger is, the big drawback in terms of food price to hunger effect measurement is that the relationship of shift or slope change of the estimated income-calorie curve to food prices changes is assumed, and taken to be a constant shift across the income distribution.

The methodology has been criticized in general for calculating an Engel curve using national income averages, which given the concavity of the Engel curve would always underestimate the individual caloric consumption for any level of income Gabbert and Weikard (2005). Furthermore, although income/expenditures is the single most important economic variable in determining undernourishment, other determinants like access are essential in determining the outcome. To highlight this consider the case of Bangladesh, where expenditure poverty is considerably higher in rural areas, but undernourishment is lower in rural areas where food availability is higher[7]; and cases like these abound, the distribution of income and food are not necessarily similar. In other words for equivalent levels of income, substantially different levels of undernourishments are possible and observed.

The SOFI 2008 methodology consists in using predicted DES for 2007, to re-estimate hunger with the FAO methodology. This will certainly produce the best estimate of the number of hungry in 2007. However, it does not disentangle what is the effect of rising cereal prices with other concomitant effects like demographic changes, supply of non-tradables (important staples like cassava, tubers and plantains are non-tradables with prices that follow independent trajectories to the tradables price boom; and some have growth cycles longer than a year like cassava), and others. Also, the huge boom in tradable food prices has occurred in the last 8 months (10/2007 – 06/2008) and should not be reflected in the 2007 hunger estimates.

The methodology proposed in this note has the big advantage of precisely isolating the effects of soaring food prices from other effects, it is micro founded, and is consistent with the FAO methodology for measuring undernourishment globally. It has the advantage of working with the distribution of calories, which is what determines undernourishment and not with the distribution of income which is related, but not the same as the distribution of calories. Some drawbacks worth mentioning are: first, that it is only a short-term estimate, it overestimates the medium and long-term hunger effects as it ignores employment and wage effects as a result of an expansion of agricultural output (reallocation of resources to agriculture).

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[7] Poverty figures available from World Bank (2002), and undernourishment figures using the same survey are available in Anríquez et al. (2008).

Another limitation of the proposed methodology is that it requires a known change of the real price of food. The FAO food price index converted to real terms by deflating by the Manufacturing Unit Value index (MUV)[8] has increased by nearly 19% in 2007, and from January 2008 to April/May 2008, the same index deflated by the US CPI has increased by a whopping 39.4%. So spikes in the real indexes of tradable cereals in the magnitude of 60% are within what is currently being observed. However, it would be a huge mistake to assume that these are the level of changes in prices that consumers are facing. First of all the transmission of international prices into domestic prices is not complete. Due to exchange rate variations, and domestic policies like trade and monetary policies, the expansion of national prices has been much more modest. Dawe (2008), for example estimates that the international transmission of the price of rice for six large Asian economies has only been between 6 and 64%.

Furthermore, the consumer price does not only depend exclusively on the price of the agricultural commodity, the final price that consumers pay contains all the retail mark-up which pays transportation, processing, and the capital and labor of the retail industry. This markup obviously depends on the good and the country, but to get an idea consider that in Europe the ratio of retail to farm-gate prices ranges between 1.5 (eggs) to 6-7 (wheat/flour) London Economics (2004), and on average is 5 in the US, ERS (2008). The spreads are likely to be lower in developing countries where the retail industry is less capital intensive, and food items contain less processing; the poor, also, are more likely to consume less processed food. However, one also needs to account the fact that energy prices have increased dramatically raising also the price of the retail component of final food goods. Altogether this means that with price transmissions that are in the range of 10 to 70% and farm-gate to retail price

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[8] UNCTAD, available at http://www.unctad.org/templates/page.asp?intitemid=1890&lang=1 .

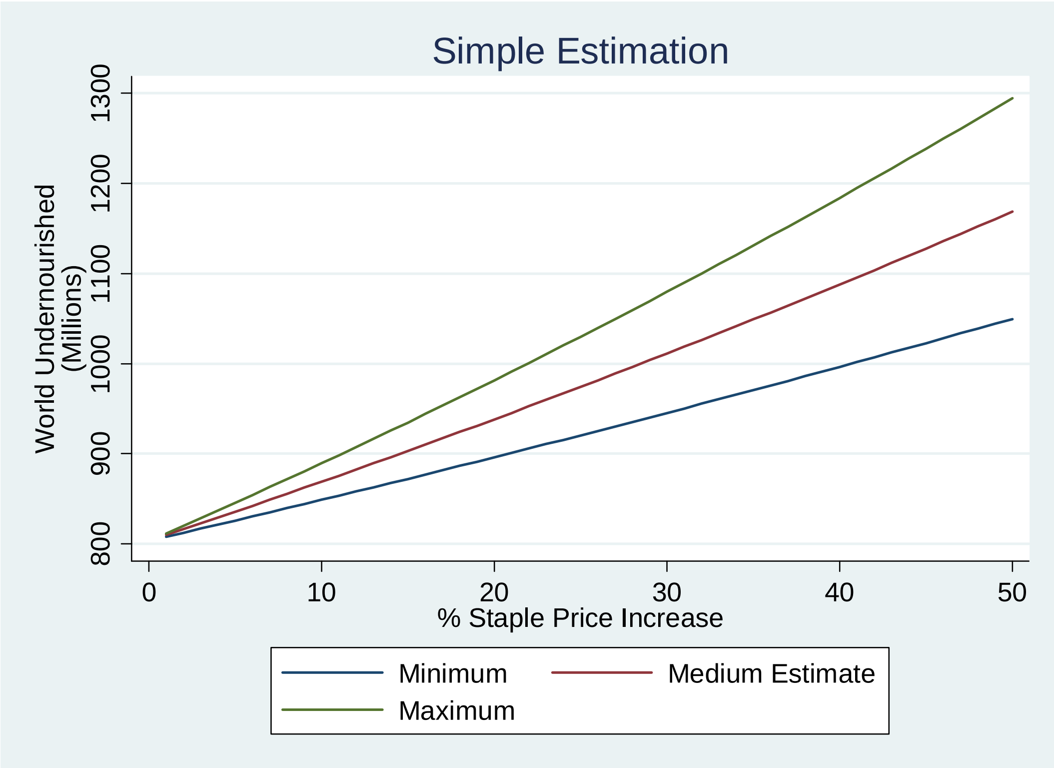
spreads of 2 to 5, it makes sense to talk about consumer price increases in the range of 5 to 15% when the international price indices have soared by as much as 60%.

Closing Remarks

This paper has presented a methodology to estimate the global effects of soaring food prices on hunger. This methodology relied on country-specific estimates of the effects of food prices on dietary energy consumption. We used this methodology to get an estimate of global undernourishment using perhaps the minimum acceptable number of country estimates: 8. We could clearly get more precise estimates of global undernourishment if we had more country estimates. However, these rough estimates provide us a broad idea about the human costs of the current agricultural commodities price boom. Provided that consumer prices of tradable cereals have increased by 10 to 15% we have that global undernourishment has increased in one year just due to food price increase by 50 to 70 millions, that is roughly 3 times the population of Australia, or more than the population of Great Britain, which add to the already 804 million chronically undernourished.

Figure 1. "Simple" Estimates

a) Global Prevalence of Undernourishment



b) Implicit Undernourishment to Staple Price Elasticity

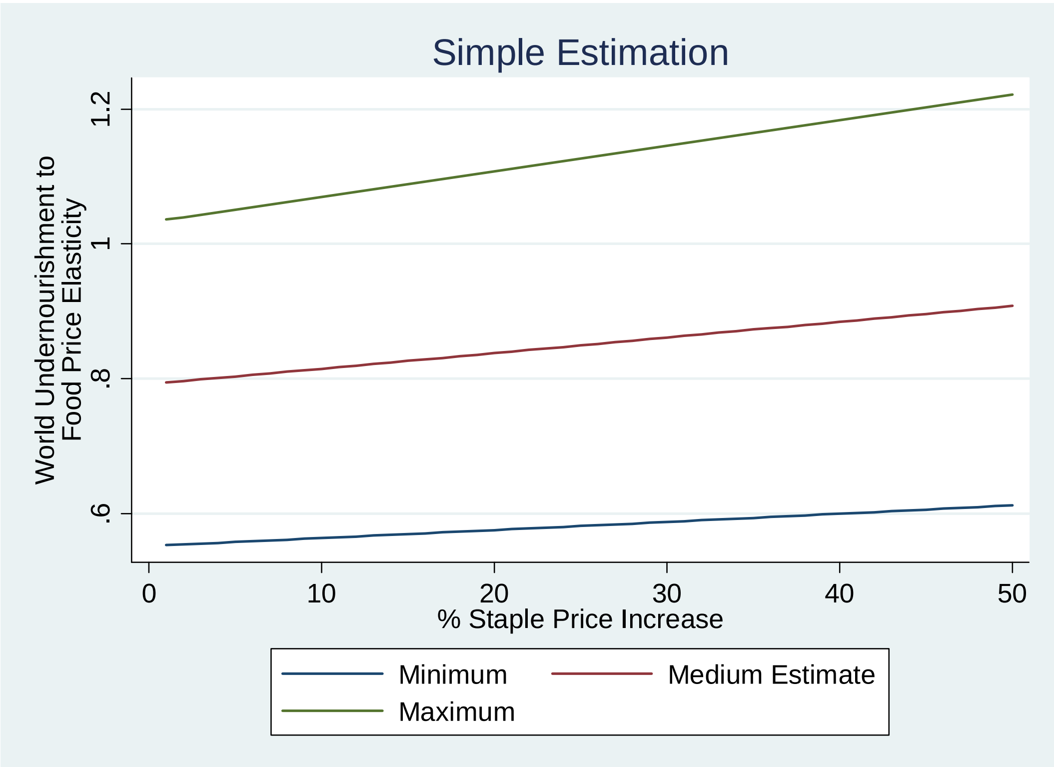
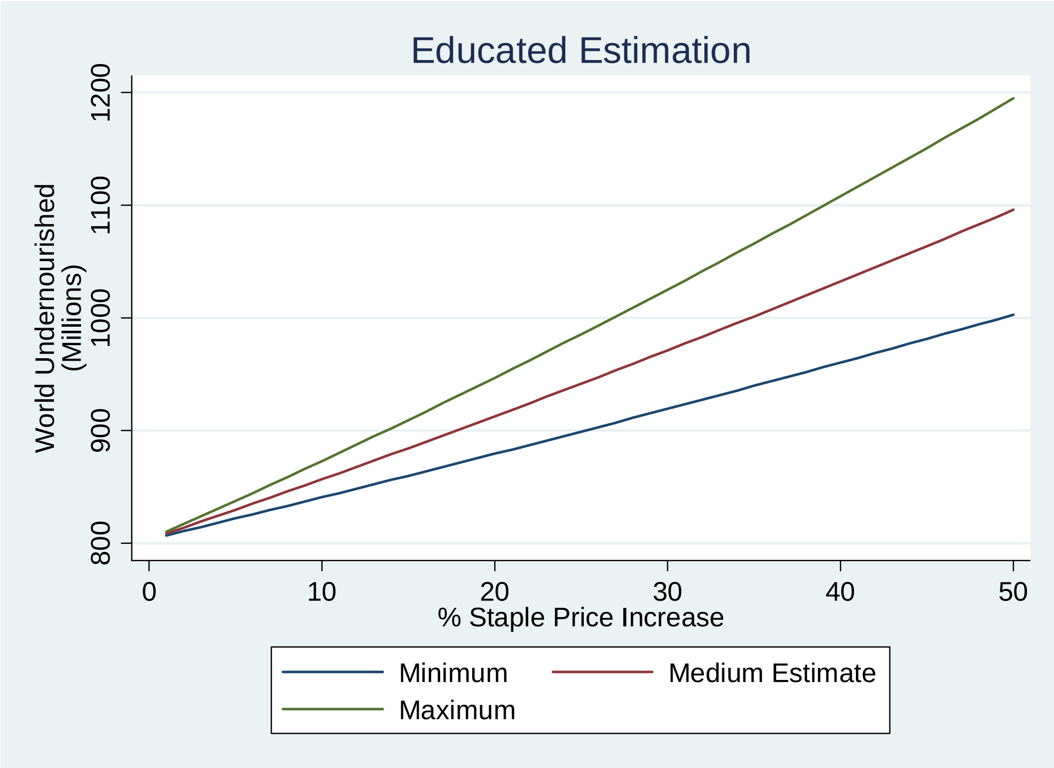


Figure 2 "Educated" Estimates

a) Global Prevalence of Undernourishment



b) Implicit Undernourishment to Staple Price Elasticity

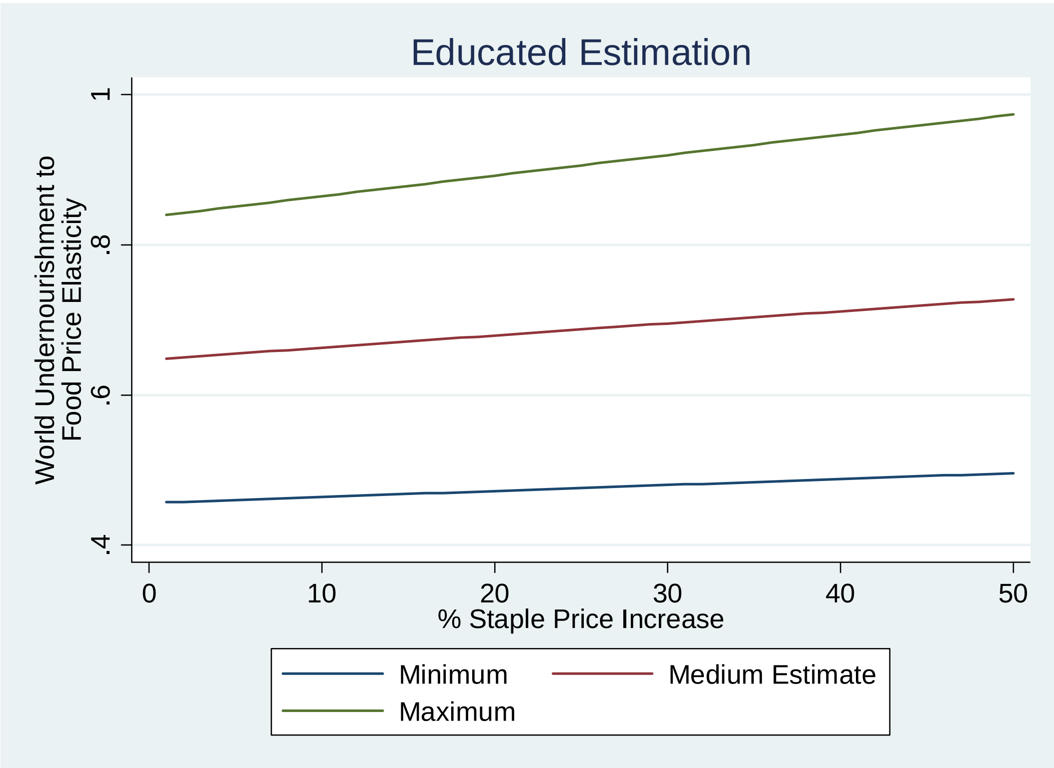


Table 1. Global Undernourishment Estimates

	Undernourishment to Food Price Elasticity		Global Undernourishment (millions)	
Simulated Food Price Change (%)	"Simple" Estimate	"Educated" Estimate	"Simple" Estimate	"Educated" Estimate
1	0.79	0.65	810	809
5	0.80	0.65	836	830
10	0.81	0.66	869	857
15	0.83	0.67	903	884
20	0.84	0.68	938	913
35	0.87	0.70	1,049	1,001
50	0.91	0.73	1,168	1,096

Table 2. Educating the Country Specific Elasticities

Log-Mean Elasticity

	Coefficient	**Std. Error**	**t-Stat**
Share Cereals in DES (%)	-0.0004337	0.0001526	-2.84
Constant	-0.0000676	0.0077652	-0.01
Std. Error of Regression	0.0092		
R^2	57.4		
Observations	8		

Log-Variance Elasticity

	Coefficient	**Std. Error**	**t-Stat**
Income Distribution GINI	-0.0016179	0.0005341	-3.03
Constant	0.0858083	0.0329944	2.70
Std. Error of Regression	0.0139		
R^2	27.3		
Observations	8		

Table 3. Regional Distribution of Hunger (millions)

		Price Increase	5%		10%		15%	
Region	***Population***	**Baseline Under-nourishment**	**Simple**	**Educated**	**Simple**	**Educated**	**Simple**	**Educated**
Asia	3,325	492	512	510	534	530	555	549
LAC	530	45	47	46	50	47	52	48
MENA	405	31	32	32	33	34	35	35
SSA	655	209	215	213	221	216	227	220
Transition	408	19	21	20	22	21	23	22
Developed	920	8	9	8	10	9	11	10

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