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Short- and Long-Run Impacts of Food Price Changes on Poverty

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Abstract

This study uses household models based on detailed expenditure and agricultural production data from 31 developing countries to assess the impacts of changes in global food prices on poverty in individual countries and for the world as a whole. The analysis finds that food price increases unrelated to productivity changes in developing countries raise poverty in the short run in all but a few countries with broadly-distributed agricultural resources. This result is primarily because the poor spend large shares of their incomes on food and many poor farmers are net buyers of food. In the longer run, two other important factors come into play: poor workers are likely to benefit from increases in wage rates for unskilled workers from higher food prices, and poor farmers are likely to benefit from higher agricultural profits as they raise their output. As a result, higher food prices appear to lower global poverty in the long run.

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In the recent period of high and volatile food prices, there has been considerable concern about impacts of high food prices on global poverty. A number of analyses have concluded that, in most developing countries, higher food prices raise the poverty headcount in the short run because not enough poor farming households benefit sufficiently from higher selling prices to offset the negative impacts of higher food prices on net food consumers (Ivanic and Martin 2008; De Hoyos 2011; Ivanic, Martin, and Zaman 2012). This is despite the well-known stylized fact that three-quarters of the world's poor live in rural areas, and most depend on agriculture for their livelihoods. A simple explanation for this apparent contradiction is that many of the poorest farming households are actually net buyers of staple foods.

Deaton and Laroque (1992) describe the price behavior of storable commodities as being characterized by long periods in the doldrums, punctuated by intense but short-lived price spikes. Much of the concern about high food prices in recent years has arisen in a context of intense price spikes such as those in 2007–8 and 2010–11. If the poor are adversely affected by such surges in food prices, and if they have little ability to buffer the effects of these price shocks, then these periods of high prices—whether seen as a problem of high prices or as a problem of volatility—would appear to be a serious concern.

For some types of price changes, such as those resulting from sustained changes in the global agricultural supply-demand balance of the type that have occurred since 2000, the focus of attention needs to be on the longer-run impacts of price changes. In this case, if supply responses are sufficient and/or wage rates for unskilled labor change substantially, the poverty impacts of food price changes might be reversed. Clearly, this could have major implications for policy, with policy makers focused on reducing poverty perhaps welcoming, rather than fearing, high food prices. Whether this is the case is likely to depend heavily on the income sources of households and the responsiveness of household farm output to price changes, and can only be determined empirically.

Most of the available analyses of the impacts of food price impacts on poverty follow the classic Deaton (1989) study in taking into account the first-order impacts of higher food prices on household incomes as determined by the initial net-sales position of each household. Some, in addition, consider second-order impacts of food prices through changes in the quantities of food demanded, typically finding that including this channel of effect results in small impacts on the estimated poverty effects (Friedman 2002). Others have advanced further on the demand side, assessing the impacts of food price increases on overall spending as households attempt to smooth their consumption; and on the quality, as well as the quantity, of food consumed (Gibson and Kim 2011) and by comparing impacts on quantities of food consumed with impacts on calorie consumption (D'Souza and Jolliffe 2010). Only a few studies of the impacts of food price changes on poverty or nutritional outcomes—such as Mghenyi, Myers an Jayne (2011); Minot and Dewina (2013) and Van Campenhout, Pauw and Minot (2013)— appear to have examined the impacts of food price changes on food output, and hence the longer-term impacts of changes in food prices on the incomes that farmers receive from their farming activities. In innovative recent studies, Jacoby (2012) incorporates impacts of higher food prices on wages, while Headey (2013) estimates the total impacts of food price changes on poverty.

In the short term, we would expect consumers to be able to adjust their food consumption almost fully to minimize the impact on their cost of living but for producers to have relatively limited ability to adjust—if only because of the delays between decisions to commit resources and actual production. In the longer-run, farmers can be expected to respond to higher food prices in two distinct ways: (i) by switching agricultural land towards producing those items whose prices have risen relative to others, and (ii) by increasing overall agricultural output through increases in the amount of land allocated to agricultural uses and augmentation of the land available using intermediate inputs and non-land factors. In general, there seems likely to be greater flexibility in the response of individual commodities than in total aggregate agricultural output.

Ideally, we would estimate the parameters needed to take into account household responses to price changes. However, this has proved very difficult because most price changes observed in the data are very small and transient relative to the long-run price changes of key interest. Attempts at estimation are complicated by the undesirable distributional properties of the widely-used Nerlove model (Diebold and Lamb 1997). To understand the long-run adjustment options of the farmers who face changing output prices, we develop microeconomic simulation models which account for the changes in farmers' profits as a result of changes in output prices. These are specified for consistency with the well-known GTAP model of the world economy so as to allow us to use changes in factor prices generated in that model. With those models we are then able to compare short- and long-run poverty impacts of higher food prices, both in the case when the prices of individual crops rise independently and when all food prices rise together.

When considering the impacts of changes in food prices, it is very important to consider the source of the change. A change in food prices resulting from a shock such as a rise in demand for rich-country biofuels that is more or less exogenous to the agricultural sectors of developing countries is likely to be associated with quite different impacts on poverty than one that arises from a change in rates of productivity growth in developing countries—whether from investments in research and development, from weather shocks or from sustained changes in climate. For simplicity of interpretation we focus in this paper primarily on changes in poverty that result from price shocks modeled as border price changes not accompanied by changes in domestic agricultural productivity or other domestic policies.

The effects of price changes on household incomes and on poverty rates are nonlinear for two reasons: (i) because the effects of price changes on real household incomes are nonlinear once we take into account output adjustments, and (ii) the effects of changes in prices on poverty are nonlinear because of differences in the income and expenditure shares of different groups and changes in the number of people near the poverty line. Because of these nonlinearities, and because of uncertainty about the size of future price shocks, we consider the impact of price increases over a large range; in particular we consider shocks of 10, 50 and 100 percent. To investigate differences between the effects of changes in all agricultural prices and in prices for particular goods, we compare the impacts of increases in all agricultural products with the results obtained when some key prices are increased individually.

We believe that the approach that we use, involving both economy wide simulation models and household models, is an important complement to studies such as Jacoby (2013) and Headey (2014). It avoids the very real concerns about causality that plague any econometric analysis and allows exploration of the impacts of different sizes and scopes of price changes, and of the impacts through different channels on different types of households. If both methodologies provide broadly similar results on key impacts, then we can gradually begin to reduce the uncertainty we face about the important but challenging linkages between food prices and poverty. If they do not, then we need to look deeper for the causes of the discrepancies between the results emerging from these two different approaches.

In the next section of this paper, we first consider the methodology used in the analysis. Then we turn to the approaches and data used to implement this methodology. Next, we present simulations designed to answer key questions about the impact of price changes on poverty. Finally we present some conclusions.

Methodology and Data

To distinguish between the impacts of higher food prices in the short and the long run, we need to identify the sources of the differences between the two effects, and to develop expressions which represent each impact. In the short run, the first-order impact of a price change is typically captured by the net trade position of the household as specified by Deaton (1989). Even in the short term, however, this expression may need to be augmented to take into account the ability of households to substitute away from goods whose prices have risen, and towards those whose prices have fallen. Another factor to consider is the potential impact of higher food prices on the wage rates received by farm household members for labor sold off-farm. Since most of the available evidence (see, for example Ravallion 1990; Lasco, Myers and Bernsten 2008) suggests that it takes some time for wages to fully adjust to changes in food prices, this impact is generally not included in analyses focused on short term impacts. A third important factor to consider is the ability of farm households to adjust the quantity of food that they produce. While full adjustment of output will frequently take a year or more, the elasticities of output supply seem likely to be higher than for food demand, and so these supply-side impacts on income could be substantially larger.

We first consider the approach used to assess the impact of changes in prices and wage rates on the real income of each household. Then, we turn to the approach used to estimate the relationship between food price changes and wages.

Estimating real income changes at the household level

At the household level, we analyze the implications of changes in food prices through a series of micro simulations where we simulate the impact of food price changes and any mitigating responses on each household's real income. To measure the change in welfare of each household, we specify the cost to the household of achieving a given level of utility using a “full” cost function $e(\boldsymbol{p}, w, u)$ of the type discussed by Deaton and Muellbauer (1981). This specifies the minimum cost required by the household to reach utility level u at given a vector of commodity prices, $\boldsymbol{p}$, and prices for the factors that it sells, $\boldsymbol{w}$**.**

Conventional practice in this type of modeling (see, for example, the studies in Hertel and Winters 2006) is to consider the impacts of changes in prices on the factor returns accruing to households, and to compare these impacts with changes in the cost of living as measured using the expenditure function. Given our focus on the effects of changes in prices of the particular—and sometimes quite finely-specified—foods, we adopt a different approach more frequently seen in microeconomic studies of the impact of changing food prices on poverty (see, for example, Deaton 1989). Given the close links—and the substantial evidence of non-separability between firm and household decisions—between the small farm households of most concern to us and their farm businesses, we focus on the impact of price changes on the profits that farming households derive from their own farm firms and the impact of changes in food prices on the wage rates received by household members for sales of labor off-farm. While our national models allow for sales and purchases of both skilled and unskilled labor, we focus on changes in the wage rate for unskilled labor w and its quantity l.

Given that farm firms are price takers and operate subject to constant returns to scale, the revenues obtained from sales of output (including “sales” to the household for its own consumption) must equal the returns to the factors employed by the firm. We also consider the impacts of changes in factor prices on the returns that farm households obtain from their net sales of factors outside the farm firm.

A Dixit-Norman (1980) style money measure of household welfare W at given utility level, u, is given by:

(1) $$W = -e(\boldsymbol{p}, \boldsymbol{w}, u) + \pi(\boldsymbol{p}, \boldsymbol{w}),$$

where $e(\boldsymbol{p}, \mathbf{w}, u)$ is the full cost function of the household at any given vector of commodity prices, ***p*,** and factor prices, ***w*.**; and $\pi(\boldsymbol{p}, \boldsymbol{w})$ is a profit function representing the profits generated by the farm firm. While this measure does not allow for risk aversion, risk preferences could be introduced using a concave, cardinal utility function to evaluate the welfare effects of changes in this real income measure.

Given the endowments of the poor, we focus only on a single factor price, the wage rate for unskilled labor. In the short run, a money measure of the welfare change resulting from a small change in commodity prices and unskilled wage rates is given by

(2) $$\Delta W = -e_p(\boldsymbol{p}, w, u)d\boldsymbol{p} - e_w(\boldsymbol{p}, w, u)dw + \pi_p(\boldsymbol{p}, w)d\boldsymbol{p} + \pi_w(\boldsymbol{p}, w)dw,$$

By the envelope theorem, we know that $e_p = \boldsymbol{q}$, $e_w = -l$, $\pi_p = \boldsymbol{x}$ and $\pi_w = -y$ where $\boldsymbol{q}$ is a vector of quantities consumed, $-l$ is household supply of unskilled labor, $\boldsymbol{x}$ is a vector of firm outputs and $-y$ is the farm firm's demand for labor. This allows us to write a first-order compensating variation measure of welfare change as:

(3) $$\Delta W = -\boldsymbol{q}d\boldsymbol{p} + ldw + \boldsymbol{x}d\boldsymbol{p} - ydw = (\boldsymbol{x} - \boldsymbol{q})d\boldsymbol{p} + (l - y)dw,$$

The first term in (3), $(\boldsymbol{x} - \boldsymbol{q})\mathrm{d}\boldsymbol{p}$, was used by Deaton (1989) and in many studies (e.g. Ivanic and Martin 2008) of the impacts of the 2006–8 food price spike on real household incomes in poor countries, and hence the impacts on poverty. The second term in (3), $(l - y)\mathrm{d}w$, has been used in studies such as Jacoby (2013) that take into account the impacts of food price changes on wages—and particularly wage rates for unskilled labor--resulting from those food price changes.

When price changes are large enough, and particularly when there is sufficient time for output to adjust, it may be important to take into account higher-order impacts of the price change. Expressing the net sale positions of the household for food and for labor as $\boldsymbol{z_p} = (\boldsymbol{x} - \boldsymbol{q})$, and $\boldsymbol{z}_w = (l - y)$ allows us to develop a second-order Taylor-Series expansion for the welfare change resulting from changes in food prices:

(4) $$\Delta W = \begin{bmatrix} z_p & z_w \end{bmatrix} \begin{bmatrix} \Delta \boldsymbol{p} \\ \Delta w \end{bmatrix} + \frac{1}{2} \begin{bmatrix} \Delta \boldsymbol{p} & \Delta w \end{bmatrix} \begin{bmatrix} z_{pp} & z_{pw} \\ z_{wp} & z_{ww} \end{bmatrix} \begin{bmatrix} \Delta \boldsymbol{p} \\ \Delta w \end{bmatrix},$$

This expression takes into account three second-order impacts in addition to the first-order impacts of price changes on welfare. The first, $\Delta \boldsymbol{p}' z_{pp} \Delta \boldsymbol{p}$, results from the effect of the output price changes on the supply of commodities. It takes into account the fact that the household's net sales position in a particular commodity will increase if the price of that commodity rises. The second, $\Delta w' z_{ww} \Delta w$, is the corresponding second-order impact of higher wage rates on the supply of labor to non-farm activities. The third, $\Delta w' z_{wp} \Delta \boldsymbol{p} + \Delta \boldsymbol{p}' z_{pw} \Delta w$, combines the impact of the change in commodity prices on the amount of labor sold off farm and the effects of the change in wage rates on farm output. To our knowledge, this third term has not previously been taken into account in measuring the impact of food prices on economic welfare.

Estimating wage impacts of food price changes

In order to link changes in food prices with the resulting changes in wage rates for unskilled workers, we use the assumptions, parameters and data of the GTAP model to replicate the GTAP-style nested CES production relationships at a national level with all prices kept exogenous. Following the standard GTAP model, we model output as a combination of inputs and value-added in the top nest, and value-added as a combination of factors in the bottom nest. Finally, we impose zero profit conditions at each nest and restrict the total quantity of factors available to each country.

To calculate the implications of the changes in output prices and wage rates on labor demand and outputs, we express the model equations in their log-linear form as: $[M_e|M_x]\begin{bmatrix}x_e\\x_x\end{bmatrix} = [0]$ where $\begin{bmatrix}x_e\\x_x\end{bmatrix}$ is a stacked vector of endogenous x_e and exogenous variables x_x and $[M_e|M_x]$ is a matrix of coefficients of the equations with block M_e corresponding to the endogenous variables and block M_x corresponding to the exogenous variables. By solving this equation, we obtain log-linear reduced-form relationships between all exogenous variables (output prices) and endogenous variables (wages etc.) as $x_e = \rho x_x$ where $\rho = -{M_e}^{-1}M_x$ is the elasticity matrix.

Because we are interested in medium- and long-run wage elasticities, we calculate ρ under two sets of assumptions. For the medium run, we assume a specific-factors model where capital, land and natural resources are fixed and labor is the only mobile factor. For the long-run scenario, we assume that both labor and capital are fully mobile and land is sluggishly adjustable, with an elasticity of transformation equal to one, as assumed in the GTAP model. We report the calculated sets of Stolper-Samuelson elasticities of unskilled wage rates with respect to output prices in Appendix tables 1 and 2.

Implementing the Approach

Ideally one would analyze the impacts of shocks such as food price changes on household incomes using a model in which demands for goods were determined as the total of demands from individual households, and supplies were similarly determined using models of individual producing firms. Unfortunately, the development of such a model for our purpose is very challenging at this point given the incomplete coverage of household surveys and differences in definitions between surveys and the data underlying global trade and production models. The alternative that we use links household models containing detailed information from household surveys with national general equilibrium models. Where our experiments involve indirect impacts—such as changes in wage rates brought about by changes in food prices—we use the national general equilibrium models to estimate the impacts of the relevant price shocks on factor prices in each region. These prices are then passed to the household models used to assess the impacts of the shock on the real income of each household.

In order to ensure consistency between the behavior of the household models and the national CGE models which we use to generate the changes in factor prices, we evaluate $\begin{bmatrix} z_{pp} & z_{pw} \\ z_{wp} & z_{ww} \end{bmatrix}$ for each household using the same expenditure and production structure as in the national model, but taking into account the specific resource endowments of the household and their initial allocation. Decomposing the net output effects $\begin{bmatrix} z_{pp} & z_{pw} \\ z_{wp} & z_{ww} \end{bmatrix}$ into the difference between production and demand effects $\begin{bmatrix} \pi_{pp} & \pi_{pw} \\ \pi_{wp} & \pi_{ww} \end{bmatrix} - \begin{bmatrix} e_{pp} & e_{pw} \\ e_{wp} & e_{ww} \end{bmatrix}$, we ensure consistency on both the production and consumption sides.

On the household factor supply side, we assume that the household's labor supply elasticity is zero, and hence $e_{ww} \equiv 0$. This is done for consistency with the national models, in which we do not allow for any adjustment in the quantity of labor supplied by households. As a consequence, $e_{pw} \equiv e_{wp} \equiv 0$. This means that the only way the household can change its supply of labor to non-agricultural activities is by reallocating household labor between farm and nonfarm activities. To specify e_{pp}, we use the semi-flexible Constant Difference of Elasticities (CDE) demand system with the household's expenditure shares and the estimated substitution parameters used in the GTAP database (Hertel 1997). This provides us with a set of calibrated own- and cross-price elasticities for each household and commodity that are broadly consistent with the substitution possibilities in our economy-wide model.

Following Hanoch (1975 p. 415), we define a matrix of compensated elasticities ϵ for CDE preferences as:

(5) $$\epsilon_{i,j} = (\alpha_i + \alpha_j - s^T \alpha) s_j,$$

when $i \neq j$, and

(6) $$\epsilon_{i,j} = (\alpha_i + \alpha_j - s^T \alpha) s_j - \frac{\alpha_i}{s_i},$$

when $i = j$, where $\boldsymbol{\alpha}$ is the vector of CDE substitution parameters used in the GTAP model and $\boldsymbol{s}$ is the vector of consumption shares. For each country represented in the GTAP database, we use the estimated parameter values for $\boldsymbol{\alpha}$ in the GTAP database (Dimaranan 2006). In the few cases where country estimates were not available in the GTAP database, we used the relevant regional estimates. The consumption shares $\boldsymbol{s}$ for each household were obtained directly from the household survey data by calculating the observed consumption shares for each commodity relative to total consumption. As an indication of the broad range of the own-price elasticities of demand implied by the CDE, we present own-price elasticities of demand for major commodities in each country in Appendix table 3. These values appear to be reasonable, with average absolute values generally between 0 and 0.3.

Using the elasticities obtained from (5) and (6), we express second-order changes in the cost of utility for each household as

(7) $$\Delta \boldsymbol{e} = [\boldsymbol{p} \circ \boldsymbol{x}]^{\boldsymbol{T}} \widehat{\boldsymbol{p}} + \frac{1}{2} [\widehat{\boldsymbol{p}} \circ \boldsymbol{p} \circ \boldsymbol{x}]^{\boldsymbol{T}} \epsilon \widehat{\boldsymbol{p}},$$

where the $\circ$ operator denotes element-wise multiplication, i.e. a Hadamard product; ϵ is a matrix of compensated demand elasticities, $\boldsymbol{p} \circ \boldsymbol{x}$ is a vector of expenditure values and $\widehat{\boldsymbol{p}}$ is a vector of percentage changes in prices. The first term on the right side of (7) is a first-order approximation of the change in expenditure needed to achieve a given level of utility, while the second term takes into account the ability of consumers to adjust their consumption patterns in response to changes in prices in the long run.

On the farm profit side, we evaluate each segment of the second order matrix $\begin{bmatrix} \pi_{\boldsymbol{pp}} & \pi_{\boldsymbol{p}w} \\ \pi_{w\boldsymbol{p}} & \pi_{ww} \end{bmatrix}$ calculated separately with medium- and long-run assumptions, in each case following closely the production structure used in the GTAP model. For the medium-run elasticities, we assume that all factors but labor are immobile and the production structure is as in Figure 1. For the long-run elasticities, we follow the production structure in Figure 2, with all factors mobile except land and natural resources, which can be transformed between commodity-producing activities with an elasticity of transformation equal to one as in the GTAP model. While our calculation of the elasticities is based on the same parameters as used in the standard GTAP model, each household is considered to have its own specific set of endowments which are imputed from its observed outputs using the factor intensities provided by the GTAP database. In the short run, we assume that both the level and the mix of output from the household's farm firm are fixed, for consistency with Deaton (1989).

The actual calculation of the production elasticities is done in the same way as the calculation of the wage-price elasticities at the national level presented earlier—by representing the production of each household using the same structure as the GTAP model (e.g. substitution elasticities of inputs and factors, value-added and input shares in output costs, transformation elasticities of factors). Expressing all necessary equations for household production from the GTAP model (e.g. substitution between inputs and value-added, substitution between factors in the value-added composite, transformation of land between activities, zero profits) with the appropriate parameters, allows us to solve for all endogenous variables as functions of the variables that are exogenous to the household (output and input prices, and factor endowments) to obtain a production elasticity matrix μ specific to each household. To highlight the most important supply elasticities at the commodity level among the households in our country sample, we present their average values for the most important production commodities in for the medium and long run in Appendix tables 4 and 5. A striking feature of this table is just how high the long run elasticities of supply are, with elasticities of 5 and above being quite common.

As an example of our approach, we present the case of one of the households included in the Bangladeshi 2005 survey, whose production we observe in the data. In the case of this household, we present the matrix representation of the household model (transposed $[M_e|M_x]$) for the long-run assumption of an exogenous wage rate in Appendix table 7. As can be seen from the variables included in the matrix, this household produces both wheat and rice, as do 862 other households in our Bangladesh sample. While the key input composition is determined by the GTAP database (see for example entries in the column for the equation determining value added zero profits in wheat production). The key information that comes from the household survey is represented, albeit indirectly, by the separation of common inputs and factors across rice and wheat production (consider for example the entries in the row corresponding to the variable capturing the price of capital in equations determining zero profits for value-added in rice and wheat production.)

The actual process of obtaining the set of elasticities for output and input use involves separating from the original model matrix of size 24×28 the four columns corresponding to the exogenous variables (price of labor, price of inputs, price of wheat and price of rice) and forming matrix M_e corresponding to the endogenous variables and the remaining portion of the matrix M_x corresponding to the exogenous variables. We then obtain a matrix of elasticities as $\rho = -{M_e}^{-1}M_x$.

In terms of output and input elasticities, we express the change in profits following a change in prices using the second-order expression:

$$\Delta\boldsymbol{\pi} = \left[\begin{bmatrix}\boldsymbol{p}\\ w\end{bmatrix} \circ \begin{bmatrix}\boldsymbol{x}\\ l\end{bmatrix}\right]^{\boldsymbol{T}} \begin{bmatrix}\widehat{\boldsymbol{p}}\\ \widehat{\boldsymbol{w}}\end{bmatrix} + \frac{1}{2}\left[\begin{bmatrix}\widehat{\boldsymbol{p}}\\ \widehat{w}\end{bmatrix} \circ \begin{bmatrix}\boldsymbol{p}\\ w\end{bmatrix} \circ \begin{bmatrix}\boldsymbol{x}\\ l\end{bmatrix}\right]^{\boldsymbol{T}} \boldsymbol{\mu} \begin{bmatrix}\widehat{\boldsymbol{p}}\\ \widehat{w}\end{bmatrix}, \tag{8}$$

where $\begin{bmatrix}\boldsymbol{p}\\ w\end{bmatrix}$ represents a stacked vector of output prices $\boldsymbol{p}$ and the wage rate for unskilled labor, w, $\begin{bmatrix}\boldsymbol{x}\\ l\end{bmatrix}$ represents a stacked vector of output quantities $\boldsymbol{x}$ and labor input quantity l, μ is a matrix of own and cross-price elasticities. For each household firm, we specify the parameters of the μ matrix based on the production module of the GTAP model where we model the household's output by applying a two-level CES production system where, in the lower nest, the household is assumed to allocate factors into a value-added composite, and then combine this with inputs in the upper nest. In addition to that, the households are assumed to have the same factor mobility restrictions as found in the global model with the exception of labor which is assumed not to be fixed, but rather to adjust at the household level in response to the same changes in commodity prices and in wage rates as in the model.

Key elasticities used in the analysis are presented in the Appendix Tables. Key features of these elasticities are that the Stolper-Samuelson elasticities expressing the impact of food price changes on wage rates for unskilled labor tend to be quite low, ranging from 0.2 to 0.6, even when considering the frequently-large impact of composite goods such as "Other processed foods". However, when all food commodities are considered, the total elasticity is frequently unity or greater. In terms of the behavioral elasticities at the household level, the compensated elasticities of demand for individual foods tend to be very low in absolute value, with -0.2 being the highest absolute valued estimate appearing in Appendix Table 3. By contrast, the medium- and long-run elasticities of supply are positive and larger in absolute values (Appendix tables 4 and 5).

Measuring aggregate poverty levels

Aggregating across all households, we calculate poverty figures associated with each micro simulation for total population and various groups of households. The poverty lines used in our calculations, reported in the World Bank's PovCalNet, were introduced into our household surveys in order to replicate the most recent available published rates of extreme poverty.[1] Using an elasticity of 0.6 for the cost of living with respect to household size estimated by (Lanjouw and Ravallion 1995), we identified the effective per-capita expenditure level of the households at the poverty line and used this estimate as the poverty line throughout the study. If, as a result of a simulation, the effective per-capita expenditure of a household crosses the poverty line, we account for this and update the list of households in poverty. Using the survey household weights and household size information, we then translate the list of households in poverty into the corresponding poverty rate and poverty gap measures defined by Foster, Greer, and Thorbecke (1984).

Data

We base our work on an extensive dataset of household expenditure and income patterns which we have constructed using available household survey data for the 31 developing countries listed in Table 1 These 31 countries are the ones for which we have been able to obtain post 2000 household data for both expenditures on and income derived from the food commodities of interest. In terms of population, our sample covers about half of the low- and middle-income countries and includes some large developing countries (e.g. India) as well as a number of small ones (e.g. Belize, Albania). Due to the availability of suitable data, our sample covers best the regions of South Asia (nearly 100 percent coverage) with other regions being represented by a smaller fraction of countries; however, each World Bank developing country region is represented by at least one country.

The data collected in our data set include household-level production and expenditure data for 39 distinct food and agricultural items, and total household incomes and expenditure. The information on household finances is supplemented with a number of variables describing

[1] We used the PovCalNet web-based tool as at February 2012 to obtain estimates of the poverty rates at the $US1.25/person/day poverty line definition.

the characteristics of the household members which allows us to understand consumption and production patterns, and the impacts of any changes, on different socioeconomic and demographic groups.

To obtain estimates of the impacts of price changes on global poverty, we extrapolate from our sample of 31 countries to the world. This is done using the poverty results for countries for which we have household data as sample observations representing the income and regional groups from which they are drawn. Thus in addition to weighting countries' results by their populations, we also weight each country's result by the population weight which is necessary to make the countries used represent the region from which they are drawn. In the case of South Asia, where our sample covered more than 99 percent of the population living in the region, no regional weighting was necessary; however, in the case of MENA we had to raise the weight of the only country included in our sample, Yemen, to represent the whole region.

Simulations

In our first set of simulations, we measure the impacts on poverty of uniform changes in all food prices for 10, 50 and 100 percent. In these highly stylized simulations, we focus on identifying the relationship between the severity of the general food price increase and global poverty in the short, medium and long run in a situation where the prices of all food commodities increase to the same extent.

For our short-run scenarios we use the first and second-order impacts on the expenditure side and only the first-order terms in the equations determining income changes. This assumes that consumption adjusts fully to the price changes, while production volumes do not change in the short run. In the medium- and long-run scenarios wages and agricultural output adjust in response to the changes in food prices; however, in the long-run the ability of the supply side of the economy adjust and of households to adjust their output is greater since both capital and labor are assumed to be mobile between sectors. We add one additional simulation which captures both the short run impacts and the medium run impacts on wages to allow us to assess the relative importance of wage rate and output adjustment impacts in explaining the differences between short and medium run results.

In order to demonstrate the difference between the implications of general food price increases and increases in prices of individual commodities, we include another set of simulations in which we estimate the global poverty implications of increases in the prices of key commodities individually.

Poverty Impacts of Price Increases

In our first simulation, we compare the impacts of 10, 50 and 100 percent increases in food prices on the 1.25 USD/person/day poverty headcount under alternative assumptions about wage adjustment and the ability of producers and consumers to adjust their production and consumption quantities. Poverty results for each country for the four scenarios that we consider—first, a short-run scenario with all outputs fixed; second, a short-run scenario with wages responding as if labor were a mobile factor in production while ignoring the impacts of output changes on farm incomes; third, a medium-run scenario with labor mobile and the effects of the output change on incomes incorporated into the welfare calculus; and, fourth, a long-run scenario with labor and capital mobile and land transferable with an elasticity of transformation of unity—are presented in this order in Tables 2–5. The second scenario is included primarily to allow the effect of wage and output changes to be identified but it has an interpretation for a period in which inputs have time to adjust but the benefits in terms of output have not yet accrued. We also present projected global poverty implications in Table 6.

The short-run poverty impacts appear to be adverse for the poor in most countries. For some countries, these adverse poverty impacts—ignoring the effects of any social-safety net programs that may help to protect some of the poor—to be very large and to rise very sharply. Countries with particularly strong vulnerability to increases in poverty appear to include Guatemala, India, Indonesia, Pakistan, Sri Lanka, Tajikistan and Yemen.

Four countries —Albania, Cambodia, China and Vietnam—are exceptions to this general pattern with poverty declining in response to at least some of the simulated food price increases. In Albania and Vietnam, poverty reduction is only observed for the 10-percent price shock while larger price shocks result in poverty increases. This pattern of response is likely due to a group of net-selling farmers being lifted out of poverty by the initial increase in prices but another group of low-income net buyers dropping into poverty as the price rise continues. In the case of China, increasing the price shock to 50 and 100 percent is also observed to reduce poverty, but the decline in poverty is smaller for the 100 percent price increase than for the 50 percent rise. Only in the case of Cambodia do we observe a substantial poverty reduction in the short run in response to a 100-percent increase in the prices of all food.

Considering the global estimates shown in the first set of columns in Table 6, we find that global poverty rises in the short run with increases in food prices—for a 10 percent price increase, global poverty is estimated to rise by 0.8 percentage points with a standard error of 0.3 percent. The rate of increase appears to be increasing in the observed price range—when the food price shock increases fivefold to 50 percent, poverty is predicted to rise by 5.8 percentage points; further doubling the shock to a 100 percent more than doubles the global poverty estimate to 13 percentage points. The positive relationship between food prices and poverty reflects the fact that most poor people are net-food buyers—because wages or food production do respond to higher prices in the short-run scenario, poverty necessarily grows in this situation.

Looking at the household-group specific results in Table 6, the poverty implications of higher food prices in the short run are much more adverse for urban households than for rural households. This follows from the much smaller share of urban household income obtained from food production and occurs despite the fact that, in most countries, there are far fewer urban than rural households near the extreme poverty line. Worldwide, the urban poverty rate increases at nearly double the rate for rural households. The results for farmer-headed households are of interest. For this group, 10 or 50 percent increases in food prices lower poverty, although this group contains many net buying households. For non-farmer-headed households, the poverty rate rises in all scenarios and rises particularly sharply for a 100 percent increase in food prices. Finally, from a gender-perspective, we find little difference between the implications of short-run food prices for poverty among male- and female-headed households.

Adding labor mobility between sectors and wage changes to the results—while keeping outputs unchanged for consistency with the short-run results—has significant implications for the estimated poverty impacts. Comparing Table 2 with Table 3 makes clear that inclusion of wage impacts, calculated with this specific-factors model results in poverty impacts that are much more favorable. In India, the result is consistent with Jacoby (2013) in leading to a reversal in the sign of the impact—from adverse to favorable for poverty reduction. In roughly two-thirds of our 31 cases, poverty declines following a 10 percent increase in food prices. But, with a 100 percent increase in food prices, the situation is reversed, with nearly three-quarters of our countries experiencing an increase in poverty and only eight countries a decline in poverty.

The global results—shown in the second set of columns in Table 6—show that the addition of wages reduces poverty significantly for all categories of households relative to the case excluding wage impacts. For all households, the effect is to reduce global poverty, with a 5.7 percentage point poverty decline resulting from a 100 percent food price increase. The change in the poverty impact (an 18-percentage point reduction in poverty relative to the short-run case) is especially noticeable for urban households, while farmer-headed households and female-headed households appear to benefit slightly less because of their lesser reliance on sales of labor off-farm.

The poverty implications of higher food prices become more favorable in the medium-term scenario (Table 4) where we assume that wages respond to the simulated changes in food prices and that farmers are able to adjust their agricultural outputs in response to the price changes. As a result of these positive implications of higher food prices for poverty, in the medium run we observe a larger share of countries whose poverty declines with higher food prices. In the case of a ten-percent price shock, 22 out of 31 countries are estimated to experience a poverty reduction, even if a small one. As was the case in the short run plus wages case, the number of countries experiencing a reduction in poverty declines with increases in the size of the shock—only 12 countries of our sample are estimated to experience a poverty reduction following a hundred percent price shock.

At the global level—as shown in the third set of columns in Table 6—our estimate of poverty change following a ten-percent food price shock is a 1.2 percentage point decline and this decline deepens to 4.8 percentage points for both a fifty-percent price shock and to 7.6 percentage points for a hundred-percent shock. The improvement relative to the short-run plus wages simulation is sizeable, with, for instance, the reduction in poverty from a 100 percent increase in prices doubling relative to the short-run plus wages case. However, the difference between this and the previous case is much smaller than that resulting from adding wage effects to the initial short-run case.

All social groups considered benefit from the move to the medium-run scenario. However, the groups that include a larger proportion of farmers tend to benefit the most, because they benefit directly from the second-order effects added in this analysis as well as from higher wages on their sales of unskilled labor, and the ability to increase their supply of unskilled labor to off-farm markets. While poverty declines sharply for rural, and particularly, farmer-headed household groups, it continues to rise for urban, non-farmer and female-headed households when prices increase by 100 percent.

We finally turn to the long-run scenario results shown in Table 5. In this scenario we assume capital and labor to be fully mobile, allowing for potentially larger output responses and stronger wage impacts. For a uniform 10-percent food price shock, poverty is expected to fall in 24 of the 31 countries included in our sample. For greater price shocks, the number of countries for which we estimate a poverty reduction declines—for a 50-percent shock, only 19 countries are expected to experience a decline in poverty. This figure drops to 16 for a 100-percent price shock.

The global estimate of poverty change resulting from food price changes in the long run—shown in the last set of columns in Table 6—is estimated to be favorable to the poor. We estimate a reduction of 1.4 percentage points in the global poverty rate for a 10-percent shock. This reduction grows to 5.8 percentage points for a 50-percent shock and 8.7 percentage points for a 100 percent food price shock. Looking at the results for different household groups, we find that most household groups experience poverty reduction even for large food price increases. The only exceptions are female-headed households, which do not benefit from very large price increases, and urban households for which the poverty rate is likely to increase with large food price increases. For smaller food price increases, however, we find no household group whose poverty rate would be significantly negatively affected in the long run.

Poverty implications of individual food price increases

Our earlier simulations considered a uniform change in food prices, which is common in the discussions of the implications of food prices for poverty which often focuses on the changes in general food price indices, such as the World Bank's Food Price Index. However, focusing on an index like this raises two important concerns. First, only those commodities that are internationally traded— and hence have well defined international prices—are used in the construction of many such indexes, including the World Bank index, which often ignore important consumption items, such as dairy products and many fruits and vegetables. Second, we frequently observe that different commodities' prices rise at different rates, which means that the same changes in the food price index can be caused by very different underlying changes in the prices of the component commodities, which may have quite different impacts on poverty.

To characterize the relative importance of individual commodities, we first measure the implications of one hundred-percent price increases for key food commodities and present the results in Table 7. We also measure the poverty implications of changes in various food items that cause identical, 10-percent, changes in the World Bank's food price index. To do this, we multiply a 10-percent price increase by the reciprocal of that commodity's weight in the index. The list of the commodities and their respective weights are shown in Table 8. We report the resulting changes in global poverty in Table 9.

The results shown in Tables 7 and 9 confirm a large distribution of poverty impacts depending on which of the constituent commodities' prices increase. A 100-percent price increase would increase global poverty most in the short-run most when affecting rice, wheat and vegetable oils. This importance reflects both the sizeable weights of these commodities in the consumption baskets of poor households, and the extent to which many consumers are net buyers, and hence vulnerable to price increases. However, because rice and wheat are also important production items for many of the rural poor, a sustained increase in their prices is likely to reverse the short-run poverty increase into a considerable poverty reduction. In the case of vegetable oils, which are rarely produced by poor households, no such reversal of the poverty results is observed. This latter result may overstate the poverty impacts of higher vegetable oil prices because it is likely that some poor households produce some oilseeds whose prices would likely rise at the same time as the price of vegetable oils. Higher dairy product prices also have a substantial adverse impact on poverty in the short run, despite the offsetting impact of higher incomes from milk production. Finally, we note that higher prices of maize appear to lower global poverty, even in short run, which is largely caused by the fact that maize is primarily grown as an animal feed crop rather than food in the most populous countries in our sample, which results in underestimating its poverty impacts in the context of food prices. When considering only the countries in Africa and Latin America, the implication of higher maize prices is a poverty increase in the short-run.

Moving to the long run impact of increases in individual commodity prices, we see some very substantial changes in the impact. Perhaps the most striking change is in the impact for rice, which goes from 1.5 percentage points to minus 8.2 percentage points. The reversals for wheat and dairy products are also substantial, with wheat changing from 1.2 percentage points in the short run to minus 2.5 percentage points in the long run., while dairy products changes from 0.8

percentage points to minus 2.8 percentage points. As might be expected, these reversals at the commodity level are more striking than for food as a whole, because the elasticities of supply for individual commodities are larger than for agriculture as a whole.

We then move to a simulation in which the price impacts of the individual commodities are scaled up to yield a ten percent change in the World Bank's food price index. The key finding from this analysis is that the impact of a 10 percent change in this index may be associated with radically different poverty impacts, depending upon the source of the change. If the increase in the index comes from rice or wheat prices, the short-run impact is likely to be quite adverse, while it would be small for an increase coming from the price of beef, which has almost as large a share in the index as wheat. It would be much smaller for a rise in the price of vegetable oils, largely because this commodity has such a large share in this trade-focused index that a much smaller change in its price is required to generate a 10 percent increase in the index. A key implication of this analysis is that great caution is needed when using trade-focused indexes of commodity prices as indicators of the likely poverty impact of food price rises.

Conclusions

In this study, we address some of the issues regarding the differences between the short- and long-run impacts of higher food prices on global poverty. We find that even though short-run implications of higher food prices for poverty are adverse, raising poverty in most developing countries, the induced wage changes and the ability of farmers to adjust their production in response to changing output prices are able to largely offset these negative impacts, making the long-run implications generally favorable for poverty reduction. There is considerable heterogeneity in our country results, with Cambodia, China, Vietnam and Albania found to benefit from higher food prices even in the short run—most of our inferences for the global poor population have relatively low standard errors given the coverage of our country sample.

Even though we find that higher food prices in the short run generally tend to hurt the poor while the accompanying long-run adjustments in wages and agricultural profits appear to outweigh these losses and generate poverty reductions, we also note that these impacts are not distributed equally among all socio-economic groups. Most importantly, we find that even farm-headed households are hurt by sufficiently higher food prices in the short-run similarly to other household types; however, they benefit most from higher agricultural profits in the long run.

Non-farming households are found not to benefit from higher agricultural profits in the long-run, but they benefit from higher wages at a sufficient level to make their long-run poverty outcomes favorable. The only group of households that does not benefit from large food price shocks in the long run is the urban households who experience no significant change in poverty as a result of large food price shocks even though they appear to benefit from shocks that do not exceed 100 percent.

Our results also suggest that poverty impacts of price increases affecting wheat and rice tend to have the largest adverse impacts on poverty in the short run. However, the impacts of large price increases in these commodities are quite sharply reversed in the long run, when there is the opportunity for wage rate changes and output adjustments to come into effect. The analysis of the effects of changes in the World Bank food price index makes clear that the poverty impact based on indices of this type—i.e. constructed using trade shares—is likely to depend heavily on the specific commodity whose price has increased.

Table 1: Household Surveys Used in This Study

Country name	Year	Survey name	Number of households
Albania	2005	Living Standards Measurement Survey	3,664
Armenia	2004	Integrated Survey of Living Standards	6,815
Bangladesh	2005	Household Income-Expenditure Survey	10,080
Belize	2009	Household Income and Expenditure Survey	1,948
Cambodia	2003	Household Socio-economic Survey	14,984
China	2002	Chinese Household Income Project	5,783
Cote d'Ivoire	2002	Enquete Niveau de Vie des Menages	10,798
Ecuador	2006	Encuesta Condiciones de vida – Quinta Ronda	13,581
Guatemala	2006	Encuesta Nacional de Condiciones de Vida	13,686
India	2005	India Human Development Survey (IHDS)	41,554
Indonesia	2007	Indonesia Family Life Survey	12,999
Malawi	2004	Second Integrated Household Survey	11,280
Moldova	2009	Cercetarea Bugetelor de Familie	5,532
Mongolia	2002	Household Income and Expenditure Survey	3,308
Nepal	2002	Nepal Living Standards Survey II	5,071
Nicaragua	2005	Encuesta Nacional de Hogares sore Medicion de Nivel de Vida	6,619
Niger	2007	Enquete National sur Le Budget et la Consommation des Menages	4,000
Nigeria	2003	Nigeria Living Standards Survey	19,121
Pakistan	2005	Pakistan Social and Living Standards Measurement Survey	15,453
Panama	2003	Encuesta de Niveles de Vida	6,362
Peru	2007	Encuesta Nacional de Hogares	22,201
Rwanda	2005	Integrated Household Living Conditions Survey	6,900
Sierra Leone	2011	Sierra Leone Integrated Household Survey	6,737
Sri Lanka	2007	Household Income and Expenditure Survey	4,633
Tajikistan	2007	Living Standards Measurement Survey	4,644
Tanzania	2008	National Panel Survey	3,264
Timor-Leste	2007	Poverty Assessment Project	4,477
Uganda	2005	Socio-Economic Survey	7,425
Vietnam	2010	Household Living Standard Survey	9,399
Yemen	2006	Household Budget Survey	13,136
Zambia	2010	Living Conditions Monitoring Survey	19,398
Total			314,852

Table 2: Short-Run Poverty Impacts of General Food Price Rises, $1.25 Per Day, % Points

Country	10 pct	50 pct	100 pct
Albania	-0.1	0.7	4.8
Armenia	0	1.3	4.9
Bangladesh	1.4	9.7	18.1
Belize	0.5	3.2	8.6
Cambodia	-3	-10.1	-14.9
China	-1.3	-4	-3.2
Cote d'Ivoire	1.1	7.2	17.6
Ecuador	0.3	2.3	7.2
Guatemala	1.4	9.7	27.2
India	2.6	14.2	25.8
Indonesia	1.7	10.2	25.2
Malawi	0.7	3.1	5.7
Moldova	0	1.1	7.9
Mongolia	1.4	8.7	21.6
Nepal	0.5	3.2	6.8
Nicaragua	1.1	5.8	17.4
Niger	0.6	6.9	17.1
Nigeria	1	5.6	9.8
Pakistan	2.7	14	27.5
Panama	0.3	2.5	8
Peru	0.2	1.5	6.9
Rwanda	1.1	4.4	8.5
Sierra Leone	2.4	12.5	22.1
Sri Lanka	1.8	11.6	29.1
Tajikistan	0.8	8.7	28.1
Tanzania	1.9	8.2	14.5
Timor-Leste	1.9	10	20.1
Uganda	0.7	3.8	8.7
Vietnam	-0.4	2.1	12.8
Yemen	2	13.4	33.2
Zambia	1.1	6	12.5

Table 3: Short-Run Poverty Impacts of General Food Price Rises with Medium-Run Wage Impacts, $1.25 Per Day, %Points

Country	10 pct	50 pct	100 pct
Albania	-0.1	0.6	3
Armenia	-0.3	0.1	1.1
Bangladesh	0	3.1	6.2
Belize	-2	-4	-4.2
Cambodia	-4.5	-13.3	-18.2
China	-1.9	-7	-9.3
Cote d'Ivoire	-0.7	-1.3	-1.8
Ecuador	-0.7	-0.2	2.7
Guatemala	-0.3	0.7	5.1
India	-1.1	-4.8	-9.1
Indonesia	0.8	4.4	10.3
Malawi	-0.5	-3.1	-8.2
Moldova	-0.1	0.5	4.3
Mongolia	0.3	2.3	6.6
Nepal	-0.5	-2.3	-4.7
Nicaragua	-0.1	1.3	5.1
Niger	0.5	6.1	16
Nigeria	0.9	5.2	8.9
Pakistan	-1.5	-8.2	-14.2
Panama	-0.1	0.7	3.6
Peru	-0.1	0.5	4
Rwanda	0.8	3.6	4.1
Sierra Leone	1.6	7.4	13.1
Sri Lanka	0	0.5	3.9
Tajikistan	-1.2	-1.4	1.4
Tanzania	0.4	2.3	2
Timor-Leste	0.4	4.3	9.9
Uganda	0.1	1.2	3.5
Vietnam	-2.1	-5.3	-4.4
Yemen	-0.5	0.3	4.5
Zambia	-0.4	-0.9	-1.7

Table 4: Medium-Run Poverty Impacts of General Food Price Rises, $1.25 Per Day,% Points

Country	10 pct	50 pct	100 pct
Albania	-0.1	0.4	2.6
Armenia	-0.3	0.1	1.1
Bangladesh	-0.4	-0.1	0.1
Belize	-2	-4.1	-4.2
Cambodia	-4.6	-14.6	-20
China	-2.1	-7.6	-10.2
Cote d'Ivoire	-0.8	-2.9	-4.4
Ecuador	-0.7	-1.3	-0.5
Guatemala	-0.3	-0.6	1
India	-1.2	-5.8	-12.2
Indonesia	0.8	4	9
Malawi	-0.5	-3.2	-5.9
Moldova	-0.1	0.5	3.9
Mongolia	0.3	0.9	4.5
Nepal	-0.6	-2.5	-5.6
Nicaragua	-0.1	1.1	4.3
Niger	0.3	4.4	9.6
Nigeria	0.9	5.2	10
Pakistan	-1.5	-8.4	-14.6
Panama	-0.1	0.5	2.9
Peru	-0.1	0.1	2.1
Rwanda	0.7	0.9	-5.7
Sierra Leone	1.2	2.4	0.5
Sri Lanka	0	0.5	3.9
Tajikistan	-1.2	-1.5	1.5
Tanzania	0.3	0.5	0.1
Timor-Leste	0.4	3.9	9.9
Uganda	-0.1	0.4	3.5
Vietnam	-2.2	-6.6	-8.2
Yemen	-0.5	-0.1	3.2
Zambia	-0.4	-1.1	-1.5

Table 5: Long-Run Poverty Impacts of General Food Price Rises, $1.25 Per Day, % Points

Country	10 pct	50 pct	100 pct
Albania	-0.1	0.4	2.6
Armenia	-0.4	0	1.1
Bangladesh	-0.6	-2.9	-4.3
Belize	-2.4	-5.4	-4.8
Cambodia	-4.8	-15.8	-21.1
China	-2.2	-8	-10.8
Cote d'Ivoire	-0.3	-3.9	-4.7
Ecuador	-0.3	-0.6	-0.5
Guatemala	-0.1	-0	1.6
India	-1.4	-7.7	-14.4
Indonesia	1	4.8	10.6
Malawi	-2	-11.2	-13.2
Moldova	-0.1	0.4	3.7
Mongolia	-0.6	-1.1	1.3
Nepal	-0.6	-3.3	-7.2
Nicaragua	0.3	1.2	4.6
Niger	0.4	0.9	0.7
Nigeria	0.8	5.1	10.6
Pakistan	-1.3	-7.8	-14.1
Panama	0.1	0.1	2.3
Peru	-0.2	-0.1	2
Rwanda	0.3	-4.3	-16.2
Sierra Leone	-0.5	-14.9	-16.8
Sri Lanka	-0.6	-0.8	3.3
Tajikistan	-1.2	-2.3	-0.8
Tanzania	-1.2	-1.2	-3.4
Timor-Leste	0.4	3.3	8.5
Uganda	-0.4	-0.4	8.4
Vietnam	-1.9	-6.3	-8.3
Yemen	-3.1	-5.4	-0.3
Zambia	-0.9	-3.2	-4.8

Table 6: Estimated Global Poverty Impacts of General Food Price Rises, % Points

Scenario	Household group	Short run	Short run + wages	Medium run	Long run
10 percent	All	0.8 (0.3)	-1.1 (0.2)	-1.2 (0.2)	-1.4 (0.2)
50 percent	All	5.8 (1.3)	-3.9 (0.7)	-4.8 (0.7)	-5.8 (0.7)
100 percent	All	13 (2.2)	-5.7 (1.2)	-7.6 (1.2)	-8.7 (1.3)
10 percent	Urban	1.5 (0.2)	-0.3 (0.2)	-0.4 (0.2)	-0.4 (0.2)
50 percent	Urban	9.2 (0.9)	0.2 (0.8)	-0.4 (0.8)	-0.6 (0.8)
100 percent	Urban	22.5 (1.6)	3.2 (1.2)	1.1 (1.2)	0.9 (1.3)
10 percent	Rural	0.5 (0.5)	-1.4 (0.3)	-1.6 (0.3)	-1.8 (0.3)
50 percent	Rural	4.3 (2.2)	-5.7 (1)	-6.7 (1)	-8 (1)
100 percent	Rural	8.9 (3.6)	-9.5 (1.7)	-11.4 (1.7)	-13 (1.8)
10 percent	Farmer headed	-0.5 (0.4)	-2.1 (0.2)	-2.3 (0.3)	-2.5 (0.3)
50 percent	Farmer headed	-0.8 (1.8)	-8.6 (0.9)	-9.6 (0.9)	-10.9 (1.1)
100 percent	Farmer headed	0.1 (2.8)	-13.8 (1.8)	-15.2 (1.8)	-16.8 (2.2)
10 percent	Non-farmer headed	1.6 (0.3)	-0.5 (0.2)	-0.5 (0.2)	-0.7 (0.2)
50 percent	Non-farmer headed	9.8 (1.3)	-1 (1)	-1.8 (1)	-2.6 (1)
100 percent	Non-farmer headed	20.8 (2)	-0.7 (1.8)	-2.9 (1.8)	-3.8 (1.9)
10 percent	Male headed	0.8 (0.5)	-1.2 (0.3)	-1.3 (0.3)	-1.5 (0.3)
50 percent	Male headed	5.7 (2.2)	-4.3 (1.1)	-5.2 (1.1)	-6.3 (1.2)
100 percent	Male headed	12.7 (3.6)	-6.4 (1.9)	-8.4 (1.9)	-9.6 (2.1)
10 percent	Female headed	1.1 (0.2)	-0.3 (0.1)	-0.3 (0.1)	-0.4 (0.1)
50 percent	Female headed	6.7 (0.9)	-0.4 (0.5)	-0.8 (0.5)	-1.3 (0.5)
100 percent	Female headed	15.8 (1.3)	0.5 (0.8)	-0.4 (0.9)	-1.1 (0.9)

Table 7: Global Poverty Impacts of Hundred-Percent Price Increases, % Points

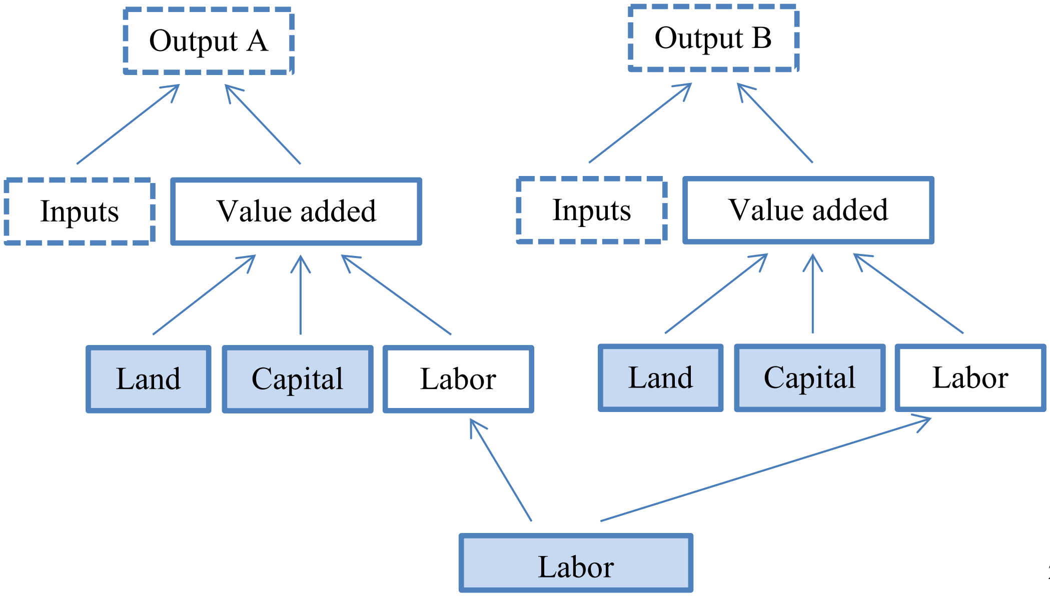
Scenario	Household group	Short run	Short run + wages	Medium run	Long run
Beef	All	0.1 (0.1)	-0.1 (0.1)	-0.1 (0.1)	-0.2 (0.1)
Chicken	All	0 (0.1)	-0.2 (0.1)	-0.3 (0.1)	-0.8 (0.2)
Dairy	All	0.9 (0.2)	-2.1 (0.4)	-2.2 (0.4)	-2.5 (0.5)
Maize	All	-1.1 (0.3)	-1.2 (0.3)	-1.6 (0.3)	-3.4 (0.7)
Vegetable oils	All	1.5 (0.2)	-0.2 (0.2)	-0.3 (0.2)	1.3 (0.4)
Rice	All	1.9 (0.6)	-1.1 (0.3)	-3.2 (0.4)	-5.9 (0.6)
Soybeans	All	-0.1 (0)	-0.2 (0)	-0.2 (0)	-0.1 (0)
Wheat	All	1.3 (0.4)	1 (0.3)	0.6 (0.4)	-1.3 (0.6)

Table 8: Weights of Food Components in the World Bank's Food Price Index, in Percent

	Share
Rice	8.5
Wheat	7.1
Maize	11.5
Soybeans	10.1
Vegetable oils	30.7
Sugar	9.8
Beef	6.8
Chicken	6

Table 9: Global Poverty Impacts of Global Price Increases Which Would Raise the World Bank's Food Price Index by Ten Percent, Percentage Points

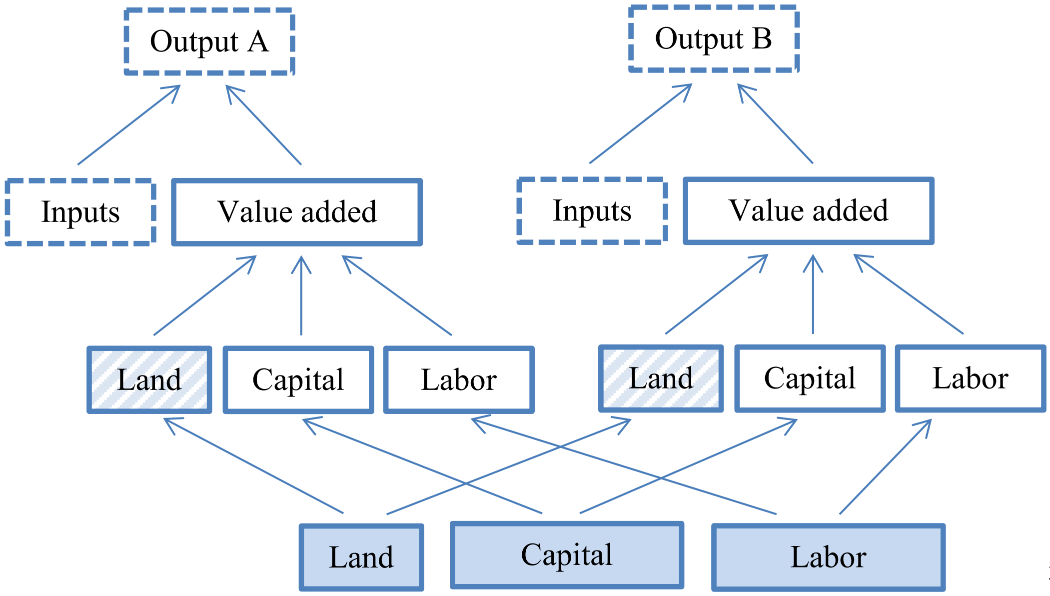
Scenario	Household group	Short run	Short run + wages	Medium run	Long run
Beef	All	0.2 (0.1)	-0.1 (0.1)	-0.1 (0.1)	-0.2 (0.1)
Chicken	All	-0.1 (0.1)	-0.4 (0.1)	-0.6 (0.1)	-1.3 (0.2)
Maize	All	-1 (0.2)	-1.1 (0.2)	-1.3 (0.3)	-3 (0.6)
Vegetable oils	All	0.5 (0.1)	-0.1 (0)	-0.1 (0)	0.5 (0.1)
Rice	All	2.3 (0.7)	-1.3 (0.3)	-3.9 (0.5)	-6.5 (0.6)
Soybeans	All	-0.1 (0)	-0.2 (0)	-0.2 (0)	-0.1 (0)
Wheat	All	1.8 (0.5)	1.3 (0.5)	0.7 (0.5)	-1.7 (0.8)



[2]

Figure 1: Diagram of household output in the medium run

[2] Shaded rectangles denote fixed quantities; broken border denotes fixed prices



[3]

Figure 2: Diagram of household output in the long run

[3] Shaded rectangles denote fixed quantities; hatched rectangles denote sluggishly adjusting quantities; broken border denotes fixed prices

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Appendix

Appendix table 1: Medium-Run Wage Elasticities with Respect to Output Prices

Country	Year	Top commodity	Second commodity	Rest
Albania	2005	milk, 0.2	oth. prc. food, 0.2	rest, 0.4
Armenia	2004	milk, 0.4	oth. prc. food, 0.3	rest, 0.2
Bangladesh	2005	rice, 0.6	sugar, 0.2	rest, 0.4
Belize	2009	oth. prc. food, 0.4	sugar, 0.2	rest, 0.3
Cambodia	2003	oth. prc. food, 0.3	rice, 0.2	rest, 0.2
China	2002	oth. prc. food, 0.3	oils and fats, 0.1	rest, 0.2
Cote d'Ivoire	2002	oth. prc. food, 0.3	coffee, tea, 0.2	rest, 0.8
Ecuador	2006	oth. prc. food, 0.4	rice, 0.2	rest, 0.5
Guatemala	2006	oth. prc. food, 0.4	sugar, 0.1	rest, 0.4
India	2004	oth. prc. food, 0.3	rice, 0.2	rest, 0.5
India	2005	oth. prc. food, 0.3	rice, 0.2	rest, 0.5
India	2905	oth. prc. food, 0.3	rice, 0.2	rest, 0.5
Indonesia	2007	oth. prc. food, 0.3	oils and fats, 0.2	rest, 0.3
Malawi	2004	raw tobacco, 0.3	oth. prc. food, 0.2	rest, 0.6
Moldova	2009	oth. prc. food, 0.4	oils and fats, 0.2	rest, 0.6
Mongolia	2002	sheep, goats, 0.1	wool, 0.1	rest, 0.2
Nepal	2002	rice, 0.3	raw milk, 0.1	rest, 0.5
Nicaragua	2005	oth. prc. food, 0.3	milk, 0.1	rest, 0.4
Niger	2007	oth. veget., 0.2	oils and fats, 0.2	rest, 0.7
Nigeria	2003	cassava, 0.5	oth. veget., 0.2	rest, 0.5
Pakistan	2005	raw milk, 0.2	sugar, 0.2	rest, 0.7
Panama	2003	oth. prc. food, 0.2	rice, 0.2	rest, 0.2
Peru	2007	oth. prc. food, 0.3	milk, 0.1	rest, 0.3
Rwanda	2005	oth. prc. food, 0.2	milk, 0.2	rest, 0.4
Sierra Leone	2011	oils and fats, 0.2	oth. prc. food, 0.1	rest, 0.8
Sri Lanka	2007	oth. prc. food, 0.4	rice, 0.3	rest, 0.4
Tajikistan	2007	plant-based fibers, 0.2	milk, 0.2	rest, 0.9
Tanzania	2008	oth. prc. food, 0.5	maize, 0.1	rest, 0.4
Timor-Leste	2007	oth. prc. food, 0.4	rice, 0.3	rest, 0.2
Uganda	2005	oth. prc. food, 0.6	milk, 0.1	rest, 0.5
Vietnam	2004	oth. prc. food, 0.4	rice, 0.3	rest, 0.2
Vietnam	2010	oth. prc. food, 0.4	rice, 0.3	rest, 0.2
Yemen	2006	oth. prc. food, 0.3	milk, 0.2	rest, 0.3
Zambia	2010	oth. prc. food, 0.6	oils and fats, 0.1	rest, 0.4

Appendix table 2: Long-Run Wage Elasticities with Respect to Output Prices

Country	Year	Top commodity	Second commodity	Rest
Albania	2005	oth. prc. food, 0.4	raw milk, 0.1	rest, 0.2
Armenia	2004	milk, 0.8	oth. prc. food, 0.6	rest, 0.2
Bangladesh	2005	rice, 0.4	sugar, 0.4	rest, 0.4
Belize	2009	oth. prc. food, 0.8	sugar, 0.1	rest, 0.3
Cambodia	2003	oth. prc. food, 0.5	rice, 0.2	rest, 0.1
China	2002	oth. prc. food, 0.3	oils and fats, 0	rest, 0.2
Cote d'Ivoire	2002	oth. prc. food, -0.7	coffee, tea, 0.4	rest, 1.1
Ecuador	2006	sugar, -0.3	oils and fats, 0.3	rest, 0.9
Guatemala	2006	milk, 0.3	oils and fats, 0.2	rest, 0.4
India	2004	oth. prc. food, 0.5	rice, 0.2	rest, 0.2
India	2005	oth. prc. food, 0.5	rice, 0.2	rest, 0.2
India	2905	oth. prc. food, 0.5	rice, 0.2	rest, 0.2
Indonesia	2007	oils and fats, 0.2	rice, 0.2	rest, 0.3
Malawi	2004	oth. prc. food, 0.8	sugar, 0.5	rest, 1.1
Moldova	2009	oth. prc. food, 0.3	oils and fats, 0.3	rest, 0.8
Mongolia	2002	sheep, goats, 0.2	wool, 0.1	rest, 0.2
Nepal	2002	rice, 0.3	oth. prc. food, 0.1	rest, 0.5
Nicaragua	2005	oth. prc. food, 0.7	milk, 0.3	rest, 0.3
Niger	2007	oth. prc. food, -0.6	oth. veget., 0.3	rest, 1.1
Nigeria	2003	cassava, 0.7	oth. veget., 0.3	rest, 0.5
Pakistan	2005	raw milk, 0.2	oth. prc. food, 0.2	rest, 0.5
Panama	2003	oth. prc. food, 0.3	rice, 0.1	rest, 0.3
Peru	2007	oth. prc. food, 0.5	milk, 0.2	rest, 0.4
Rwanda	2005	milk, 0.4	oth. prc. food, 0.1	rest, 0.6
Sierra Leone	2011	oth. prc. food, -0.6	plant-based fibers, 0.3	rest, 1.1
Sri Lanka	2007	oth. prc. food, 0.4	rice, 0.4	rest, 0.5
Tajikistan	2007	plant-based fibers, 0.4	oth. veget., 0.2	rest, 0.9
Tanzania	2008	oth. prc. food, 0.7	rice, 0.1	rest, 0.6
Timor-Leste	2007	oth. prc. food, 0.6	rice, 0.3	rest, 0.1
Uganda	2005	oth. prc. food, 0.9	oils and fats, 0.2	rest, 0.6
Vietnam	2004	rice, 0.3	oth. prc. food, 0.2	rest, 0.2
Vietnam	2010	rice, 0.3	oth. prc. food, 0.2	rest, 0.2
Yemen	2006	oth. prc. food, 0.7	milk, 0.6	rest, 0.2
Zambia	2010	oth. prc. food, 0.7	oils and fats, 0.2	rest, 0.5

Appendix table 3: Average Own-Price Elasticities of Demand by Country

Country	Year	Top commodity	Second commodity	Third commodity
Albania	2005	beef, -0.2	oth. prc. food, -0.2	oth. veget., -0.1
Armenia	2004	oth. prc. food, -0.2	raw tobacco, -0.1	wheat, -0.1
Bangladesh	2005	rice, -0.1	oth. prc. food, -0.1	fishing, -0.2
Belize	2009	oth. prc. food, -0.2	proc. tobacco, -0.2	chicken meat, -0.2
Cambodia	2003	oth. prc. food, -0.1	rice, -0.1	fishing, -0.1
China	2002	proc. tobacco, -0.2	pork, -0.2	oth. prc. food, -0.2
Cote d'Ivoire	2002	rice, -0.1	cassava, -0.1	fishing, -0.2
Ecuador	2006	oth. prc. food, -0.2	oth. beverages, -0.2	oth. veget., -0.1
Guatemala	2006	maize, -0.1	oth. prc. food, -0.2	oth. veget., -0.1
India	2005	rice, -0.1	milk, -0.2	oth. prc. food, -0.1
Indonesia	2007	oth. prc. food, -0.2	rice, -0.1	proc. tobacco, -0.2
Malawi	2004	maize, -0.1	oth. veget., -0.1	pork, -0.2
Moldova	2009	oth. prc. food, -0.1	milk, -0.2	oth. veget., -0.1
Mongolia	2002	sheep meat, -0.2	milk, -0.2	oth. prc. food, -0.2
Nepal	2002	rice, -0.1	milk, -0.2	oth. veget., -0.1
Nicaragua	2005	oth. prc. food, -0.1	milk, -0.2	proc. tobacco, -0.1
Niger	2007	oth. prc. food, -0.1	oth. grains, -0.1	beef, -0.2
Nigeria	2003	rice, -0.1	cassava, -0.1	oth. veget., -0.1
Pakistan	2005	milk, -0.2	wheat, -0.1	oth. oil seeds, -0.1
Panama	2003	oth. prc. food, -0.2	milk, -0.2	chicken meat, -0.2
Peru	2007	oth. prc. food, -0.2	wheat, -0.1	milk, -0.2
Rwanda	2005	oth. veget., -0.1	oth. prc. food, -0.1	proc. tobacco, -0.1
Sierra Leone	2011	rice, -0.1	fishing, -0.1	oth. oil seeds, -0.1
Sri Lanka	2007	oth. prc. food, -0.2	rice, -0.1	fishing, -0.2
Tajikistan	2007	oth. prc. food, -0.1	oth. veget., -0.1	oth. fruits, -0.1
Tanzania	2008	oth. prc. food, -0.1	maize, -0.1	oth. veget., -0.1
Timor-Leste	2007	oth. veget., -0.1	rice, -0.1	maize, -0.1
Uganda	2005	oth. veget., -0.1	plantains, -0.1	oth. prc. food, -0.1
Vietnam	2010	oth. beverages, -0.1	rice, -0.1	pork, -0.2
Yemen	2006	proc. tobacco, -0.2	wheat, -0.1	oth. veget., -0.1
Zambia	2010	oth. veget., -0.1	oth. prc. food, -0.1	fishing, -0.2

Appendix table 4: Medium-Run Supply Elasticities by Commodity, Medians over Households

Country	Year	Top commodity	Second commodity	Third commodity
Albania	2005	raw milk, 0.8	cattle, 0.8	oth. veget., 0.4
Armenia	2004	cattle, 0.9	raw milk, 0.7	oth. fruits, 0.4
Bangladesh	2005	rice, 1	fishing, 0.1	oth. veget., 0.3
Belize	2009	rice, 1.3	fishing, 0.1	oth. fruits, 0.4
Cambodia	2003	oth. crops, 0.2	rice, 1.3	fishing, 0.1
China	2002	fishing, 0.5	swine, 0.7	rice, 1.7
Cote d'Ivoire	2002	cassava, 0.9	coffee, tea, 1	oth. veget., 0.9
Ecuador	2006	oth. crops, 0.4	oth. veget., 0.5	oth. fruits, 0.5
Guatemala	2006	maize, 0.4	cattle, 0.4	oth. veget., 0.4
India	2005	rice, 1.7	wheat, 0.4	raw milk, 0.2
Indonesia	2007	rice, 1.1	oth. crops, 0.2	oth. fruits, 0.2
Malawi	2004	maize, 0.5	oth. veget., 0.5	raw tobacco, 1
Moldova	2009	poultry, 1.3	oth. veget., 0.8	raw milk, 0.8
Mongolia	2002	raw milk, 0.5	sheep, goats, 0.4	oth. anim. prod., 0.5
Nepal	2002	rice, 1.1	raw milk, 0.6	oth. veget., 0.4
Nicaragua	2005	oth. crops, 0.3	oth. veget., 0.3	rice, 1.3
Niger	2007	sheep, goats, 3.5	oth. grains, 1.7	oth. veget., 1
Nigeria	2003	cassava, 0.8	oth. veget., 0.8	fishing, 0
Pakistan	2005	raw milk, 0.3	wheat, 0.3	cattle, 0.4
Panama	2003	cattle, 0.3	raw milk, 0.3	poultry, 0.3
Peru	2007	oth. fruits, 0.5	raw milk, 0.9	rice, 1.9
Rwanda	2005	oth. veget., 0.9	sorghum, 1.1	cattle, 1.8
Sierra Leone	2011	rice, 4.8	oth. oil seeds, 2	fishing, 0.4
Sri Lanka	2007	rice, 0.8	coffee, tea, 0.2	oth. veget., 0.2
Tajikistan	2007	oth. crops, 0.5	oth. veget., 0.8	oth. fruits, 0.8
Tanzania	2008	maize, 0.5	oth. veget., 0.4	rice, 2
Timor-Leste	2007	oth. veget., 0.2	maize, 0.2	coffee, tea, 0.2
Uganda	2005	oth. veget., 0.8	plantains, 0.8	maize, 0.7
Vietnam	2010	rice, 1.5	fishing, 0.1	swine, 0.4
Yemen	2006	oth. crops, 0.5	fishing, 0.1	sheep, goats, 0.7
Zambia	2010	oth. veget., 0.4	maize, 0.6	oth. crops, 0.5

Appendix table 5: Long-Run Supply Elasticities by Commodity, Medians over Households

Country	Year	Top commodity	Second commodity	Third commodity
Albania	2005	raw milk, 6.2	cattle, 4.4	oth. veget., 2.8
Armenia	2004	cattle, 5.6	raw milk, 3.6	oth. fruits, 2.1
Bangladesh	2005	rice, 5.2	fishing, 0.4	oth. veget., 2.3
Belize	2009	rice, 7.3	fishing, 0.3	oth. fruits, 2.1
Cambodia	2003	oth. crops, 1.5	rice, 5	fishing, 0.4
China	2002	fishing, 0.5	swine, 5.9	rice, 7.3
Cote d'Ivoire	2002	cassava, 8.5	coffee, tea, 8.4	oth. veget., 11.2
Ecuador	2006	oth. crops, 3	oth. veget., 6.5	oth. fruits, 7
Guatemala	2006	maize, 2.8	cattle, 4.7	oth. veget., 5.5
India	2005	rice, 5.3	wheat, 4.6	raw milk, 1.3
Indonesia	2007	rice, 2.9	oth. crops, 1.2	oth. fruits, 1.4
Malawi	2004	maize, 5.1	oth. veget., 6.7	raw tobacco, 17.9
Moldova	2009	poultry, 12.3	oth. veget., 7.1	raw milk, 6.5
Mongolia	2002	raw milk, 3.2	sheep, goats, 2.6	oth. anim. prod., 3.2
Nepal	2002	rice, 5	raw milk, 5.1	oth. veget., 3.7
Nicaragua	2005	oth. crops, 2.9	oth. veget., 4.2	rice, 9
Niger	2007	sheep, goats, 27.9	oth. grains, 14.2	oth. veget., 7.6
Nigeria	2003	cassava, 5.4	oth. veget., 7.9	fishing, 0.1
Pakistan	2005	raw milk, 1.4	wheat, 3.3	cattle, 3.9
Panama	2003	cattle, 3.7	raw milk, 3.6	poultry, 4.5
Peru	2007	oth. fruits, 2.5	raw milk, 5.7	rice, 5.9
Rwanda	2005	oth. veget., 9.6	sorghum, 10.1	cattle, 13.7
Sierra Leone	2011	rice, 51.2	oth. oil seeds, 23.8	fishing, 0.5
Sri Lanka	2007	rice, 2.4	coffee, tea, 0.8	oth. veget., 0.9
Tajikistan	2007	oth. crops, 2.5	oth. veget., 6.6	oth. fruits, 6.5
Tanzania	2008	maize, 6.6	oth. veget., 5.1	rice, 11.6
Timor-Leste	2007	oth. veget., 1.8	maize, 1.9	coffee, tea, 2.2
Uganda	2005	oth. veget., 8.2	plantains, 8.6	maize, 7.7
Vietnam	2010	rice, 4.8	fishing, 0.4	swine, 3.2
Yemen	2006	oth. crops, 6.2	fishing, 0.3	sheep, goats, 7.2
Zambia	2010	oth. veget., 5	maize, 8	oth. crops, 6.7

Appendix table 6: Median Aggregate Agricultural Supply Elasticities, at Household Level

Country	Year	Medium-run	Long-run
Albania	2005	0.8	0.8
Armenia	2004	0.6	0.8
Bangladesh	2005	0.4	0.8
Belize	2009	0.4	0.4
Cambodia	2003	0.4	0.8
China	2002	0.6	0.8
Côte d'Ivoire	2002	1.3	3.5
Ecuador	2006	0.4	0.8
Guatemala	2006	0.3	0.4
India	2005	0.3	0.5
Indonesia	2007	0.2	0.3
Malawi	2004	0.5	0.6
Moldova	2009	0.8	1.4
Mongolia	2002	0.5	0.5
Nepal	2002	0.4	0.6
Nicaragua	2005	0.3	0.3
Niger	2007	1.4	3.4
Nigeria	2003	0.8	0.9
Pakistan	2005	0.2	0.3
Panama	2003	0.3	0.3
Peru	2007	0.6	0.7
Rwanda	2005	1	1
Sierra Leone	2011	1.9	11.7
Sri Lanka	2007	0.2	0.2
Tajikistan	2007	0.9	2.1
Tanzania, United Republic of	2008	0.4	0.5
Timor-Leste	2007	0.2	0.3
Uganda	2005	0.5	1.4
Viet Nam	2010	0.4	0.6
Yemen	2006	0.6	0.7
Zambia	2010	0.4	0.7

Appendix table 7: Example of a Household Model (a Sample Household From Bangladesh, 2005 Survey)

variable	Equation for capital supply	Equation for labor supply	Equation for land supply	Equation for land transformation in rice production	Equation for land transformation in wheat production	Equation for natural resources supply	Equation for natural resources transformation in rice production	Equation for natural resources transformation in wheat production	Equation for output zero profits in rice production	Equation for output zero profits in wheat production	Equation for value added zero profits in rice production	Equation for value added zero profits in wheat production	Equation for quantity of capital in rice production	Equation for quantity of capital in wheat production	Equation for quantity of inputs in rice production	Equation for quantity of inputs in wheat production	Equation for quantity of labor in rice production	Equation for quantity of labor in wheat production	Equation for quantity of land in rice production	Equation for quantity of land in wheat production	Equation for quantity of natural resources in rice production	Equation for quantity of natural resources in wheat production	Equation for quantity of value added in rice production	Equation for quantity of value added in wheat production
Price of capital	.	.	.	.	.	.	.	.	.	.	-.38	-.18	-.68	-.25	.	.	.	.	.	.	.	.	.	.
Price of inputs	.	.	.	.	.	.	.	.	-.69	-.75	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Price of labor	.	.	.	.	.	.	.	.	.	.	-.31	-.38	.	.	.	.	-.68	-.25	.	.	.	.	.	.
Price of land in everything	.	.	.	1.	1.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Price of land in rice production	.	.	.	-1.	.	.	.	.	.	.	-.31	.	.	.	.	.	.	.	-.68	.	.	.	.	.
Price of land in wheat production	.	.	.	.	-1.	.	.	.	.	.	.	-.44	.	.	.	.	.	.	.	-.25	.	.	.	.
Price of natural resources in everything	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Price of natural resources in rice production	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	-.68	.	.	.
Price of natural resources in wheat production	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	-.25	.	.
Price of output in rice production	.	.	.	.	.	.	.	.	1.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Price of output in wheat production	.	.	.	.	.	.	.	.	.	1.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Price of value added in rice production	.	.	.	.	.	.	.	.	-.31	.	1.	.	.68	.	.	.	.68	.	.68	.	.68	.	.	.
Price of value added in wheat production	.	.	.	.	.	.	.	.	.	-.25	.	1.	.	.25	.	.	.	.25	.	.25	.	.25	.	.
Quantity of capital in rice production	.97	.	.	.	.	.	.	.	.	.	.	.	-1.	.	.	.	.	.	.	.	.	.	.	.
Quantity of capital in wheat production	.03	.	.	.	.	.	.	.	.	.	.	.	.	-1.	.	.	.	.	.	.	.	.	.	.
Quantity of inputs in rice production	.	.	.	.	.	.	.	.	.	.	.	.	.	.	-1.	.	.	.	.	.	.	.	.	.
Quantity of inputs in wheat production	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	-1.	.	.	.	.	.	.	.	.
Quantity of labor	.	-1.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Quantity of labor in rice production	.	.93	.	.	.	.	.	.	.	.	.	.	.	.	.	.	-1.	.	.	.	.	.	.	.
Quantity of labor in wheat production	.	.07	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	-1.	.	.	.	.	.	.
Quantity of land in rice production	.	.	.93	1.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	-1.	.	.	.	.	.
Quantity of land in wheat production	.	.	.07	.	1.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	-1.	.	.	.	.
Quantity of natural resources in rice production	.	.	.	.	.	.5	1.	.	.	.	.	.	.	.	.	.	.	.	.	.	-1.	.	.	.
Quantity of natural resources in wheat production	.	.	.	.	.	.5	.	1.	.	.	.	.	.	.	.	.	.	.	.	.	.	-1.	.	.
Quantity of output in rice production	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1.	.	.	.	.	.	.	.	1.	.
Quantity of output in wheat production	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1.	.	.	.	.	.	.	.	1.
Quantity of value added in rice production	.	.	.	.	.	.	.	.	.	.	.	.	1.	.	.	.	1.	.	1.	.	1.	.	-1.	.