Household Exposure to Food Price Shocks in Rural Bangladesh *

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Abstract

Recent food price volatility has led to concern about the exposure of the rural poor in Bangladesh. Yet, improved terms of trade for agriculture should also lead to higher rural wages, which benefit the poor. Our evidence shows that rural wages in Bangladesh did indeed respond positively to higher crop prices over the last decade. Moreover, a general equilibrium consistent welfare index that accounts for such wage gains shows that the burden of higher food prices, far from falling hardest on the poor, is closer to being distributionally neutral.

*The findings, interpretations, and conclusions of this paper are those of the authors and should not be attributed to the World Bank or its member countries. The authors are grateful to Dean Jolliffe for comments and support.
1 Introduction

Prices of major food crops have surged in international markets over the past several years. From 2005-08, rice prices rose by 25 percent, wheat by 70 percent and maize by 80 percent (Ivanic and Martin, 2008) and, after a brief dip, grain prices began rising again in 2010. For Bangladesh, a low-income country dependent on food imports, these price trends have been alarming, raising concerns about increased poverty and food insecurity.

Of course, many rural households, even some poor ones, are food producers as well as consumers, and hence may be net beneficiaries of higher prices. Although such benefits are well-recognized (see Singh, Squire, and Strauss, 1986; Deaton, 1989; and a large subsequent literature), much less attention has been paid to potential adjustment in rural wages, which is likely to be important in Bangladesh (Ravallion, 1990). Indeed, we present evidence in this paper that rural wages in Bangladesh respond elastically to changes in agricultural prices. Moreover, unlike past empirical work on wages and prices in Bangladesh, which is based on aggregate time series data covering an era of foodgrain autarky (Boyce and Ravallion, 1991; Rashid, 2006), our results are less subject to endogeneity concerns.

Given these empirical findings, we offer a novel measure of households’ exposure to food price shocks, extending Deaton’s partial equilibrium analysis to allow for price adjustments that occur in general equilibrium (see also Jacoby, 2013). In particular, a rise in international agricultural prices should not only lead to higher nominal wages with attendant income effects but also to higher nontraded goods prices. Results for Bangladesh applying Deaton’s net consumption ratio methodology to household expenditure data show that the rural poor would suffer the greatest proportional welfare losses. By contrast, our general equilibrium

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1 A by no means exhaustive list includes Barret and Dorosh (1996) for Madagascar; Budd (1993) for Cote d’Ivoire, Klytchnikova and Diop (2006) and Vishwanath and Serajuddin (2010) for Bangladesh, Ferreira et al. (2011) for Brazil, along with the multi-country studies of Ivanic and Martin (2008) and Wodon et al (2008).

2 In their cross-country study, Ivanic and Martin (2008) incorporate the unskilled wage changes implied by a computable general equilibrium model, finding small poverty impacts of such adjustments.
exposure index, taking into account empirically validated wage adjustments, indicates that the welfare impacts are much closer to being distributionally neutral, with both rich and poor experiencing moderate welfare losses.

The remainder of this paper is laid out as follows. In the following section, we present a simplified discussion of general equilibrium effects of food price shocks, explain how the general equilibrium model can be validated empirically, and present alternative household exposure indices. Section 4 describes the survey data used for our analysis and provides basic summary, while Section 5 presents our findings. The last section concludes.

2 Methodology

2.1 Graphical exposition

Three familiar graphs summarize the welfare impact of price shocks in a two-sector economy consisting of agriculture and manufacturing: Figure 1 is the budget line-indifference curve diagram between the manufactured good and the agricultural good (food); Figure 2 illustrates the labor market equilibrium condition, which says that the rural wage must equal the value of marginal product of labor in each sector; Figure 3 diagrams the (value of) production function and optimal employment of labor in agriculture, on the vertical axis of which can be read off net income from agriculture.

Suppose that the price of food rises in international markets. Ignoring general equilibrium effects – i.e., assuming zero wage adjustment – Figure 1 is sufficient to describe the welfare implications for a particular type of household. The budget line rotates through an endowment point that depends on the household’s initial production of food; in other words, what matters for welfare is net food consumption (as in, e.g., Deaton, 1989). Hence, net producers of food are made better off by the price increase and net consumers of food are made worse off.
While the partial equilibrium story ends there, in general equilibrium we observe additional income effects of the price change. Figure 2 shows that higher food prices increase the value of marginal product of labor in agriculture but not in manufacturing. As labor is drawn into agriculture, the wage, $W$, must rise to staunch the flow of workers out of manufacturing and restore labor market equilibrium. Insofar as they are suppliers of labor (to either sector), households benefit. There is a countervailing effect, however, for landowners, illustrated in Figure 3. Holding rural wages fixed, the rise in food prices increases the value of production, yielding greater profits from agriculture, but the rise in wages attenuates or even reverses these income gains for producers. The net income effect is thus heterogeneous, depending, for a particular household, on the relative importance of returns to labor or land. Figure 1 illustrates one of many possibilities for the general equilibrium welfare impact of a food price shock.

The addition of a nontraded (i.e., services) sector to the model introduces another consumption-side welfare channel. Higher food prices lead to higher wages, which leads to a higher price of services, which leads to lower welfare for consumers of services. In the technical appendix, we formally describe this model and derive the precise implications for wages and for the price of services. In particular, the elasticity of the wage with respect to the price of food is given by

$$\epsilon = \frac{\beta_A}{1 - \beta_S}$$

where $\beta_A$ and $\beta_S$ are the shares of labor in the economy allocated to agriculture and services, respectively.

To see why the wage-price elasticity depends on the sectoral labor shares, consider the special case $\beta_S = 0$, which can be analyzed using Figure 2. Compare equilibrium $A$, with a high share of labor in agriculture to equilibrium $B$ with a low agricultural share. At $A$
the value of marginal product curve in manufacturing is necessarily very steep; at $B$ it is very flat. Thus, in moving from $A$ to $A'$, a 50% increase in the agricultural price translates into an almost 50% increase in the wage, whereas, in moving from $B$ to $B'$, the same price increase leads to virtually no wage increase whatsoever (in proportional terms).

2.2 Empirical validation

Suppose that the model sketched out above applies to each rural district in Bangladesh. In other words, consider each district as an island with a fixed labor force, which can import or export agricultural and manufactured goods. Thus, to make this approximation valid, inter-district migration must be sufficiently limited across rural Bangladesh, at least in the short to medium run. If so, then each district $d$ has its own wage-price elasticity, $\epsilon_d$, following equation (1).

To test the validity of our model, we run the district-level regression in 5-year first-differences of the form

$$\frac{\Delta w_{dt}}{\epsilon_{dt-5}} = \zeta_t + \gamma \sum_j s_{d,jt-5} \Delta p_{jt} + u_{dt}$$

where $\Delta x_{dt} = \log X_{dt} - \log X_{dt-5}$, for any $X$, $s_{d,jt-5}$ is the district-level production value share of crop $j$ (see equation 3 in the technical appendix), and the parameters to be estimated are the price-change coefficient $\gamma$ and the year dummy coefficient $\zeta_t$. Under the null hypothesis $\gamma = 1$, equation (2) says that the magnitude of the wage response to price shocks is, on average, equal to the theoretically implied elasticity $\epsilon_{dt-5}$. Given the above arguments, $\epsilon_{dt-5} = \beta_{A,dt-5}/(1 - \beta_{S,dt-5})$ is specific to each district.
2.3 A household exposure index

Consider three alternative indices of household exposure to price shocks, in order of increasing
generality. Recall, first, Deaton’s (1989) net consumption ratio for crop $j$

$$D_j = \frac{P_j(Y_j - X_j)}{C},$$

which is the ratio of the value of production ($Y_j$) net of consumption ($X_j$) to total consump-
tion expenditures ($C$); in other words, $D_j$ is the welfare-price elasticity for good $j$ holding
factor prices fixed.

Next, we allow wages to adjust but we assume that prices in the nontraded sector are
inflexible, which is tantamount to assuming that $\epsilon = \epsilon^0 = \beta_A$. The welfare-price elasticity
in this scenario is

$$E^0_j = D_j + s_j \epsilon^0 \frac{W(l - h)}{C},$$

where $l$ is household wage labor supplied off the farm and $h$ is hired labor on the farm (see
Ravallion, 1990, for a similar formulation).

Finally, we allow the price of services to be fully flexible, leading to

$$E_j = D_j + s_j \epsilon \left[ \frac{W(l - h) - P_S X_S}{C} \right],$$

where here we use the result (see technical appendix) that the elasticity of the price of
services with respect to the price of food is equal to the wage-price elasticity $\epsilon$. 

5
3 Data

Our analysis is primarily based on the 2010 Household Income Expenditure survey (HIES) for Bangladesh. The HIES10 is nationally representative and follows a sampling frame based on the Population and Housing Census 1991. A two stage stratified sampling design was followed and at the first stage, 442 primary sampling units (PSUs) were drawn from 14 different strata within all 64 districts of Bangladesh.

3.1 Wages and prices

To estimate equation (2), we use information on daily wages both inside and outside of agriculture. In the HIES10, 2567 individuals in rural areas report working as agricultural daily laborers along with 3458 in non-agricultural jobs. [What about numbers from other HIES? – need a table]. Rather than use their wages directly, however, we use the district fixed effects from a log-wage regression run separately for each HIES round, which includes in addition a quadratic in age, gender, the interaction between the age quadratic and gender, month of interview dummies, and a farm work dummy. Thus, $\Delta w_{dt}$ in equation (2) corresponds to the between round difference in district log-wage fixed effects, which nets out changes of time in the age-gender composition of the workforce. We also compute standard errors for the fixed effects following the procedure of Haisken-DeNew and Schmidt (1997), which we use as regression weights to correct for heteroskedasticity.

To complete our discussion of the dependent variable in equation (2), we use successive rounds of the labor force survey [acronym?? – describe this] to compute sectoral labor shares $\beta_{j,dt-5}$ (and hence $\epsilon_{dt-5}$) as the ratio of workers in district $d$ in sector $j$ to the total workforce in district $d$. Thus for $t = 2010$, we use the 2005 LFS, and for $t = 2005$ we use the 1999 LFS. For our purpose, construction and transport are included in the service sector.

As for prices, we use average farm-gate prices (in USD) of major crops (rice, wheat, and
jute) from the World Bank’s ‘Distortions to Agricultural Incentives’ database. In other words, the $\Delta p_{jt}$ that form the price index on the right-hand side of equation (2) vary only over time and crops (see Table x), not over districts. The price index itself varies over districts inasmuch as the value shares of the major crops (the $s_{d,jt-5}$), derived from the agriculture modules of the corresponding HIES, so vary. Thus, for example, a heavily jute-growing district would experience a large positive price shock between 2005 and 2010 relative to a predominately rice-growing district. The advantage of this construction is that price changes are exogeneous with respect to local wages; that is, a productivity shock in a particular district that directly affects wages cannot possibly affect the price of a major crop on international markets.

3.2 Exposure indices

We use HIES10 for calculating the household exposure indices developed above, confining our attention to rural households, of which there are 7,840 in the sample. Among the surveyed rural households, 6,681 households are directly involved in crop production. Table 1 provides a summary of area, production and median prices of five major crops produced in Bangladesh based on the agriculture module of the HIES10.

Notice in Table 1 the substantial fraction of cultivable area under land lease. Tenancy complicates the construction of $D_j$ because, in general, a tenant only receives a fraction of his agricultural production as income, either explicitly under sharecropping or implicitly in a fixed rental arrangement. Likewise, a landlord receives more than what he produces on his own cultivated land. Therefore, in computing $D_j$, we need to multiply $Y_j$ by an adjustment factor $\tau_i$ to correct for tenancy. Based on the information available in HIES10, let

$$
\tau_i = \begin{cases} 
\frac{(L^o_i + \mu_i L^r_i)}{(L^o_i + L^r_i)} & \text{if tenant} \\
\frac{L^c_i + (1 - \mu_i)L^r_i}{L^c_i} & \text{if landlord}
\end{cases}
$$
where \( L^k_i, k = o, c, r \), is, respectively, land area of household \( i \) owned, cultivated, and rented (in or out as the case may be), and \( \mu_i \) is the average tenancy share. For tenants, \( \mu_i \) is computed as the average [across plots?] share that tenant \( i \) pays as rent, whereas for landlords \( \mu_i \) is the average share of total district production received by tenants in that (the landlord’s) district. Note that for a pure sharecropper \( L^o_i = 0 \) and \( \tau_i = \mu_i \), while for owner-cultivators \( \tau_i = 1 \); in general, \( 0 < \tau_i < 1 \).

To calculate the households net labor supply \( l - h \), which we require for \( E_j^0 \) and \( E_j \), we ...

We use per capita household expenditures as our measure of household living standards, which excludes lump sum expenditures like house extension, pilgrimage (haj), marriage etc. The nontradable consumption subaggregate consists of expenditures on all items listed in appendix Table A.1. Figure 1 shows the nonparametric regressions of the food and services consumption shares on log per-capita expenditures. Rural households at the bottom of the expenditure distribution have food shares in excess of 40, declining to a trivial share for households at the top end. An opposite pattern is evident for services, with expenditure shares rising from below 20% to nearly 30%.

4 Results

4.1 Wage response to price shocks

Table 5 presents least squares estimates of equation 2 weighted by the inverse variance of \( \Delta w_{dt} \) as described above [are standard error clustered on district?]. Both specifications (1) and (2) assume inflexible prices of services, so that the dependent variable is \( \Delta w_{dt} / \epsilon^0 \), whereas only specification (2) controls for the lagged share of labor in agriculture as a robustness check. The estimate of \( \gamma \) in either case is very similar, greater than unity but not significantly
so. Of course, given the size of the standard errors, the power of this test is not high.

Specifications (3) and (4) allow for flexible prices of services, thus scaling log-wage changes by the elasticity $\epsilon_{dt-5} = \beta_{A,dt-5}/(1 - \beta_{S,dt-5})$. In this case, $\gamma$ is much closer to one, though, once again, power is not ideal. Our interpretation of this result is that on average district wages respond to agricultural price shocks in a manner consistent with our three-sector general equilibrium model.

### 4.2 Household exposure to food price shocks

[BASAB: better to combine figures 2 & 3 and drop the food grain share line] Figures 2 illustrate the welfare and distributional consequences of an increase in price of all major crops and of rice only using alternative indices. In particular, we compare (i) Deaton’s index without tenancy adjustment; (ii) Deaton’s index with tenancy adjustment; (iii) the exposure index refers to $E_0$, in which the price of services is fixed; and (iv) the exposure index $E$, which allows for flexibility in the services price. On the figure, the upper poverty line is represented by a vertical line.

The main conclusions from Figure 2 are as follows: (1) Despite pervasive land tenancy in rural Bangladesh, the tenancy adjustment factor $\tau_i$ makes little difference for the welfare impacts of price shocks. (2) Deaton’s index is the least poor-friendly, in the sense that the poorest households experience as much as a 0.4 percent drop in welfare for a one percent increase in agricultural prices. By contrast, either of the exposure indices, $E_0$ or $E$, exhibit a welfare loss among the poorest of only about a quarter as that of Deaton’s. This is due to the fact that the former factor in the benefits of higher rural wages (3) With the exception of $E$, all indices show slight gains for the wealthier households. Recall that $E$ is unique in allowing for a rise in the price of services in response to higher agricultural prices. Since the rich spend a larger share of their income on service than the poor, they are made worse off on balance [Basab: this seems like a large effect coming from a relatively small increase in
the services share with income – pls. check]. (4) Accounting for general equilibrium effects renders the welfare impact of a price shock more distributionally neutral inasmuch as it makes the poor better off and the rich worse off relative to the partial equilibrium story.

5 Conclusion

References


Figure 1: Budget Line - Indifference Curve Diagram
Figure 2: Labor Market Equilibrium Diagram
Figure 3: NET FARM INCOME DIAGRAM
Technical Appendix

Consider an economy with three sectors: agriculture \((A)\) and manufacturing \((M)\), both of which produce tradable goods, and services \((S)\), which produces a nontradable. Output \(Y_i\) in each sector \(i = A, M, S\) is produced with a specific (i.e., immobile) type of capital \(K_i\) and with labor \(L_i\). In the case of agriculture, \(K_A\) is just land. Labor is perfectly mobile across sectors but its supply is fixed at \(L = L_A + L_M + L_S\) within each district.\(^3\)

To deal with multiple crop outputs \(Y_1, ..., Y_c\), let \(Y_A = G(Y_1, ..., Y_c)\), where the product transformation function \(G\) is assumed to be homogeneous of degree one. A price index \(P_A\) thus exists such that \(P_A Y_A = \sum_{j=1}^{c} P_j Y_j\), which upon differentiation yields

\[
\hat{P}_A = \sum_j s_j \hat{P}_j
\]

where “hats” denote proportional changes and \(s_j\) is the value share of crop \(j\).

Now let \(W\) be the nominal wage for manual labor and \(P_M\) and \(P_S\) be the prices of manufactures and services, treating the former output price as fixed so that manufactures is the numeraire. Finally, let \(\Pi_j\) be the average return on capital in sector \(j\); that is, for production function \(F_j\), total return or profit is \(\Pi_j K_j = P_j F_j(L_j, K_j) - WL_j\).

Assuming Cobb-Douglas production functions with equal input cost shares across sectors and constant returns to scale, we obtain the following system of four equations

\[
\begin{align*}
\alpha \hat{W} + (1 - \alpha) \hat{\Pi}_A &= \hat{P}_A \\
\alpha \hat{W} + (1 - \alpha) \hat{\Pi}_M &= 0 \\
\alpha \hat{W} + (1 - \alpha) \hat{\Pi}_S &= \hat{P}_S \\
\beta_A \hat{\Pi}_A + \beta_M \hat{\Pi}_M + \beta_S \hat{\Pi}_S &= \hat{W}
\end{align*}
\]

for \(\hat{W}\) and the \(\hat{\Pi}_i\) (recall, \(\hat{P}_M = 0\) by assumption). The first three equations are the sectoral price-equals-unit-cost conditions, with \(\alpha\) denoting the input cost share of labor, whereas the last equation is derived from the labor constraint (which implies \(\sum_i \beta_i \hat{L}_i = 0\)) and the fact that \(\hat{L}_i = \hat{\Pi}_i - \hat{W}\) in the Cobb-Douglas case.

The solution for the wage-price elasticity is

\[
\hat{W}/\hat{P}_A \equiv \epsilon = \beta_A + \beta_S \delta, \quad (A.2)
\]

\(^3\)Jacoby (2013) and Kovak (2011) consider slightly more general models along these same lines.
where $\delta$ is the (endogenous) elasticity of $P_S$ with respect to $P_A$. Solving out $\delta$ involves equating changes in service sector supply $\hat{Y}_S$ and demand $\hat{X}_S$. Suppose that the Marshallian demand function for services takes the form $X_S = M/P_S$, where income is $M = \sum_i P_iY_i$, the total value of product from all three sectors. Given the Cobb-Douglas assumption, sectoral income shares are equivalent to sectoral labor shares (i.e., $\beta_j = P_jY_j/M$). Therefore, differentiating demand and using the envelope theorem, we obtain

$$\hat{X}_S = \beta_S \hat{P}_S + \beta_A \hat{P}_A - \hat{P}_S. \quad (A.3)$$

On the supply-side, from the production function and the fixity of land, we have

$$\hat{Y}_S = \alpha \hat{L}_S. \quad (A.4)$$

Meanwhile, the condition that input prices equal respective marginal value products delivers $\hat{W} = \hat{P}_S + \hat{F}_{LS} = \hat{P}_S - \hat{L}_S + \hat{Y}_S$, where the second equality follows from the total differentiation of the marginal product functions $F_{LS}$. Rearranging yields

$$\hat{Y}_S = \frac{\alpha}{1 - \alpha}(\hat{P}_S - \hat{W}). \quad (A.5)$$

To summarise, equation (A.3) implies that $\hat{X}_S/\hat{P}_A = (\beta_S - 1)\delta + \beta_A$ and equation (A.5) implies that $\hat{Y}_S/\hat{P}_A = \frac{\alpha}{1 - \alpha}(\delta - \epsilon)$. Equating $\hat{Y}_S/\hat{P}_A$ to $\hat{X}_S/\hat{P}_A$ and rearranging gives

$$\delta = \frac{\alpha \epsilon + (1 - \alpha)\beta_A}{1 - (1 - \alpha)\beta_S} \quad (A.6)$$

which, when combined with equation (A.2), yields $\epsilon = \beta_A/(1 - \beta_S)$. Finally, substituting this expression for $\epsilon$ into equation (A.6) delivers $\delta = \beta_A/(1 - \beta_S) = \epsilon$. In other words, the proportional responses of wages and of nontraded goods prices to a price shock are identical.