Would Indian farmers benefit from liberalization of world cotton and sugar markets?

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Abstract

Rich-country support programs for cotton and sugar producers are frequently claimed to be detrimental for developing-country farmers. This study investigates whether a reduction in protectionist policies for Organization for Economic Cooperation and Development cotton and sugar producers would have a measurable effect on the welfare of Indian farmers. The fact that these sectors are intensively regulated within India might suggest that any such effect will be small. However, this study shows econometrically that prices in Indian rural markets closely follow world prices, and that Indian farmers are flexible in the medium to long run in changing production according to price signals from these markets. Depending on the crop and the nature of liberalization, producer surplus increases from 4.2\% to 22.3\% in the long run.

\textit{Keywords:} Trade liberalization; Cotton; Sugar; India; OECD

One country for which rich-country sugar and cotton supports have particular relevance is India. India is the world’s second largest sugar producer and third largest cotton producer (FAO, 2006). Production is carried out by millions of small farmers, many of whom carry out a marginal existence.\textsuperscript{1} Support policies in Organization for Economic Cooperation and Development (OECD) countries are often identified as a reason for the farmers’ hardships (Oxfam, 2002; World Bank, 2004). The idea is that OECD support programs artificially reduce world prices below the cost of production and inhibit the ability of Indian farmers to compete.

On the other side of the coin, India has interventionist policies of its own making. For example, the government maintains a system of Minimum Support Prices (MSPs) that shield cotton and sugar cane farmers from adverse price swings (Elobeid and Beghin, 2005; Landes et al., 2005). Cotton production is taxed by export controls with the goal of providing low-cost cotton to domestic textile mills (Mohanty et al., 2003). Distribution costs potentially add another layer between world prices and rural market prices. Thus it is not obvious that OECD liberalization

\textsuperscript{1} Sugar production in India is in the form of sugar cane, but usually in the form of sugar beets in countries with colder temperatures and a shorter growing season. The sugar produced from cane and beets are perfect substitutes in international markets.
of cotton and sugar markets would have much effect on prices within India.

In turn, even if cotton and sugar prices would rise, it is unclear that this would have much effect on farmers’ production decisions. Farmers’ ability to respond to price changes is often inhibited by lack of access to inputs such as credit. Policies on nonprice incentives may contradict those of the MSPs. Again, it is far from clear that liberalization of world cotton and sugar markets would have a noticeable effect on Indian farmers. This provides a line of defense for those who would seek to justify OECD policies; since every cotton- and sugar-producing country has distortionary policies in these sectors, OECD policies should not be blamed for the problems of farmers elsewhere (Roney, 2004).

The purpose of this article is to investigate whether OECD liberalization of cotton and sugar markets would have a discernible effect on Indian farmers. We first estimate the magnitude by which Indian cotton and sugar prices adjust to those of the world market. We then estimate the supply response of Indian farmers to changes in price versus all the other factors that play a role. We develop a simple spatial equilibrium model that predicts world price changes associated with complete removal of all production and export subsidies for OECD cotton and sugar producers. The results from this model, as well as results from the literature concerning other forms of liberalization, are fed into a producer surplus welfare model to simulate how Indian farmers would fare under such changes.

This study contributes to the literature in a number of ways. In contrast to general equilibrium studies of global trade distortions such as Anderson and Valenzuela (2007) and Hertel and Winters (2006), we take a partial equilibrium approach and carry out econometric analysis of key elasticities. A general equilibrium approach would enable analysis of liberalization’s effects on poverty and the overall economy, but we are interested in the welfare of farmers in particular, since farmer well-being has been central to the Doha round of trade negotiations. Similar to our study, Elobeid and Beghin (2005) and Sumner (2005a) simulate the worldwide effects of sugar and cotton subsidy elimination, respectively. However, while those studies provide greater detail on the production and trade structure of individual countries, we focus specifically on price transmission and supply response within India, estimating many of the key parameters involved. This study is the first of its kind to quantify the impact that liberalization of world cotton and sugar markets would have on Indian farmers.

To anticipate our main results, Indian rural market prices are found to closely follow world reference prices in the case of both cotton and sugar. This occurs despite extensive public regulation for these two commodities within India. A 10% rise in world prices is followed in the near term by a 7.28% and 8.66% rise in cotton and sugar prices, respectively. In turn, farmers are found to be surprisingly responsive to price changes, at least in the long run. In the short run there is a good deal of sluggishness, with price elasticities of supply approximately 0.2 for both commodities. In the long run, however, a 10% rise in producer price is followed by a 9.14% and 6.66% increase in area planted for cotton and sugar, respectively. The evidence suggests that Indian farmers are more closely tied to international markets than might otherwise be anticipated.

Farmer welfare is evaluated for each of the three liberalization scenarios: one involving OECD subsidy cuts, another involving Doha-round tariff cuts by all countries, and a third involving elimination of all subsidies and tariffs by all countries. In the case of cotton, the welfare of Indian farmers varies little across the three liberalization scenarios. On average, producer surplus increases 5.2% in the short run and 8.7% in the long run. In the case of sugar, the welfare of Indian farmers depends much more closely on the precise form of liberalization. The Doha-round tariff cuts offer the smallest benefits in both the short and long run (3.1% and 4.2% increases in producer surplus, respectively), while complete liberalization by all countries offers the largest benefits in the short and long run (16.2% and 22.3% increases in producer surplus, respectively). This does not imply, of course, that rich-country policies constitute the most important supply constraint for Indian cotton and sugar producers. However, they are clearly an important factor.

The first section below provides a brief overview of OECD cotton and sugar policies. The following section introduces the conceptual frameworks used to model price transmission, supply response, the trading equilibrium, and producer welfare. The subsequent section presents our empirical procedures and numerical results. The following section concludes. Data and econometric issues are discussed in a data appendix at the end of the article.

1. OECD cotton and sugar policies

This section briefly describes some of the OECD support programs that are identified as harmful for farmers in developing countries like India (Economist, 2007; Goldberg, 2006; OECD, 2005; Oxfam, 2002). Essentially, all countries intervene in their agricultural sectors in some way, for example, through price supports or input subsidies. OECD countries are especially generous, however; in recent years more than 30% of farmers’ receipts came from a combination of government interventions in markets and budgetary payments (OECD, 2005). Two thirds of this support directly raises domestic commodity prices, the most trade-distorting form of support. This has fallen since the Uruguay Round was launched in the 1980s (at which time it was 37%), yet little has changed since the conclusion of the round (OECD, 2005).

OECD cotton and sugar farmers are among the largest recipients of this largesse. As part of the Agreement on Agriculture, WTO members agreed to reduce their overall agricultural subsidies as defined by an Aggregate Measure of Support (AMS) covering all commodities. This approach is not commodity specific, however, and has allowed governments to maintain or increase support for politically sensitive commodities such as cotton and sugar.

Support programs for U.S. cotton producers and EU sugar producers are of particular notoriety since WTO dispute panels
have concluded they are in conflict with prior commitments. Brazil was a complainant in both cases. The first case concerned assistance to U.S. cotton producers in the form of marketing loans, export credits, commodity certificates, direct payments, and counter-cyclical payments. Brazil contended that the United States exceeded the $19.1 billion cap on these subsidies that it had agreed to under the Agriculture Agreement of the Uruguay Round. The WTO Cotton Panel found similarly, and that these subsidies caused serious prejudice to Brazil’s cotton growers (Powell and Schmitz, 2005; Sumner, 2005b).

The second WTO case concerned EU sugar policy. The EU sugar regime establishes quotas regarding the maximum amounts of sugar that may be sold within the EU in a given year. These quotas are divided among EU sugar producers according to their previous production levels. The EU also provides direct subsidies for export of certain categories of sugar. The WTO Sugar Panel found that the EU exceeded both the amount of exports and the level of subsidies stipulated in its prior sugar agreements (Powell and Schmitz, 2005).

Other OECD support programs may avoid conflict with WTO agreements, yet still encourage inefficient production and distort trade. For example, U.S. sugar policies are unlikely to be challenged within the WTO since U.S. sugar is not exported and production is not directly subsidized. However, U.S. sugar production is aided by high tariffs on imported sugar that cause U.S. prices to be three times as high as world prices (Powell and Schmitz, 2005; Sumner, 2005b). Another example is found in EU cotton production. The only sizable production occurs in Greece and Spain, which together account for 2.5% of world production and 5% of world exports. Nonetheless, these two countries receive about 18% of world cotton subsidies, and production costs are nearly three times those of the world’s least-cost producing regions (Goreux, 2004).

2. Conceptual models

2.1. Price transmission

In this section we outline our approach for measuring price transmission between international markets and Indian rural markets. The literature on price transmission indicates that it is influenced by at least six groups of factors: transport and transaction costs, border and domestic policies, exchange rates, product differentiation, scale economies, and the degree of concentration (Conforti, 2004). Most equilibrium models of trade focus on only one or two of these aspects. For example, a spatial equilibrium model might allow for transportation costs, while the Armington model allows for product differentiation by country. Since we take a statistical approach and have data as our starting point, none of the above potential imperfections are necessarily excluded from our estimates. We identify the degree of price transmission that an equilibrium model might ideally replicate.

Our approach draws upon techniques used within the literature on market integration and spatial price transmission. While much of this literature is concerned with tests of the law of one price and other forms of integration, our focus is on measuring the extent that a given rise in world cotton and sugar prices will be transmitted to local Indian markets.

Existing studies estimate that tariff reduction in rich countries would raise the world prices of cotton and sugar by 4–7% and 3–16%, respectively (Burfisher, 2001; Winters, 2005). However, prices in rural Indian markets are unlikely to change by this much. Extensive government intervention and fixed distribution costs imply that an x\% change in the world price translates into a smaller change at the producer level.

The most obvious example of government intervention is the system of MSPs, which is perceived by Indian farmers as a guaranteed price for their produce when they harvest it. The MSPs are adjusted annually according to the recommendations of the Commission on Agricultural Costs and Prices, which monitors trends in domestic and world prices and costs (Landes et al., 2005). The lags in these adjustments and other institutional rigidities impede the price transmission process. Abbott (1979) proposes that minimum price support schemes of this nature cause domestic prices to adjust to world market prices in the manner of a partial-adjustment model. Since domestic prices are constrained from directly following world prices, full adjustments never occur within a given period. This motivates the following autoregressive specification proposed by Bredahl et al. (1979):

\[
\ln PD_t = \beta_0 + \beta_1 \ln PD_{t-1} + \beta_2 \ln PW_t + \varepsilon_t, \tag{1}
\]

where \(PD_t\) is the domestic price at time \(t\), \(PW_t\) is the world reference price, the \(\beta\)'s are parameters to be estimated, and \(\varepsilon_t\) is an error term with classical properties, except as described below. \(\beta_2\) is the parameter of greatest interest as it is a price transmission elasticity. It indicates the percentage by which the domestic price changes in the near term as the world price increases by 1\%. Since a lagged value of the dependent variable is on the right-hand side (\(PD_{t-1}\)), it cannot be independent of the disturbance vector, and ordinary least squares estimation may give rise to biased estimates in small samples. This consideration is offset, however, by the fact that (1) is a partial-adjustment model for which the parameters can be consistently and efficiently estimated by ordinary least squares (Greene, 2004, p. 568). Additional econometric issues are described in the results section and the data appendix.

2.2. Supply response model

In this section we consider how price and nonprice factors help determine producer supply response in the case of cotton and sugar cane. We focus on the price elasticity of supply since price is the main link between world and Indian markets. Supply response is also determined by nonprice factors such as power, credit, rainfall, and transportation infrastructure. In addition, producer choices are conditioned by harder-to-measure considerations that we may have less success in modeling. To the extent that nonprice factors influence production decisions,
liberalization of world markets would have limited impact on Indian producers.

Supply response can be studied for area, yield, or output. It is probably most common in the literature to study area response (Sadoulet and de Janvry, 1995). Actual output response may be larger than area response due to increased use of other inputs such as water, fertilizers, pesticides, and better seeds. This may be offset, however, if the expansion is onto poor-quality land with lower yields. Instead of trying to model these extra aspects, we concluded that area allocation is the most important aspect of supply response that producers have direct control over, especially since yield is heavily influenced by weather conditions. The area planted for cotton and sugar has varied considerably in recent years (Landes et al., 2005; Mohanty et al., 2003). Using 1991–2003 data from FAO (2006), we find that area harvested for both cotton and sugar cane has a coefficient of variation of 9%, with the volatility increasing over time.

In thinking about how to model supply response, we note that producers cannot instantaneously adjust area planted in accordance to evolving prices. Since the quantities that we observe in the data may differ from what producers actually desired, these adjustment lags must be taken into account. In turn, lags between production decisions and the realization of output imply that producers have expectations (as opposed to a clear indication) of the profitability of alternative choices. To incorporate these elements into the analysis, we follow the reduced-form partial-adjustment approach of Nerlove (1958).

A crop is realizable within the first year of planting for both cotton and sugar cane. Sugar cane adds a complication, however, in that once planted, a stand of cane can be harvested several times over the course of several years. Nevertheless, producers generally have multiple plots, and make planting decisions on an annual basis according to the minimum support price announced for that period. With this consideration we model price expectations as a naïve, one-period lag process.

Since the cross-price elasticity of supply for cotton and sugar is zero (Gulati and Kelly, 1999), the supply response models for cotton and sugar are estimated independently of one another. However, if area planted for cotton or sugar cane increases, this must come at the expense of some other activity. As in the Nerlovian approach we include the returns to the principal competing uses of the land as explanatory variables. In the case of sugar cane this is rice and wheat; the minimum support prices set for wheat and rice directly affect area allocated to cotton (Landes et al., 2005). In the case of cotton the principal competing activity is coarse grains (sorghum, pearl millet, and maize).

We include last period’s rainfall as a regressor, which may have a positive effect on area allocation. This is probably not necessary for sugar cane, since it is grown mainly as an irrigated crop, but we include it for both crops in line with the existing supply response literature. We construct a rainfall index for each state by averaging monthly rainfall data across the regions of each state, and use this as an explanatory variable. Rural transportation infrastructure may also be an important determinant of supply response. We get at this by including an index of road density as an explanatory variable. This is expected to have a positive relationship with area planted. It is worth noting that we might have also wanted to include the density of sugar mills/cotton gins/mills, but this information was unavailable to us and is anyway unlikely to vary by much on a year-to-year basis. Finally, we also include lagged yield as an explanatory variable since high yields in a previous season, caused by exogenous events such as weather, may encourage a farmer to increase the area planted to a crop in the current season (Landes et al., 2005).

Based on the above considerations we estimate the following logarithmic model of supply response for each commodity:

\[
\ln A_t = \alpha_0 + \alpha_1 \ln A_{t-1} + \alpha_2 \ln P_{t-1} + \alpha_3 \ln P_{C_{t-1}}^C + \sum_i \alpha_i \ln Z_{t-1} + \sum_j \alpha_j S_j + \epsilon_t, \tag{2}
\]

where the \(\alpha\)’s are parameters to be estimated, \(A_t\) is actual area under cultivation at time \(t\), \(P_{t-1}\) is the lagged farm harvest price, \(P_{C_{t-1}}^C\) is the lagged harvest price of competitive crop \(C\), and \(Z_{t-1}\) and \(S_j\) are variables, indexed by \(i\), corresponding to own yield, fertilizer price, local wage, rainfall, and road density. We also include state dummy variables, indexed by \(j\), as explanatory variables (\(S_j\)). The parameter \(\alpha_2\) is the short-run elasticity of supply response to last period’s price change (Sadoulet and de Janvry, 1995). The long-run elasticity of supply response is calculated as \(\alpha_2/(1 - \alpha_1)\). The parameter \(\alpha_3\) is a short-run elasticity of supply response to last period’s price change in the competitive crop \(C\). Properties of the error term \(\epsilon_t\) and other econometric considerations are discussed in the results section and in the data appendix.

2.3. Changes in world prices

Although estimation of the above two specifications will tell us much about the Indian situation, we wish to place the results in context by way of a model that relates changes in world prices back to the welfare of Indian producers. In particular, we want to see how price transmission and supply response interact to dampen the potential welfare gains from rich-country liberalization of cotton and sugar markets.

Reading the popular press, it is not a foregone conclusion that reduction of OECD agricultural support programs will raise world prices. For example, Ray (2002) states that “a change in the level of subsidies has a miniscule effect on the level of major-crop production in the U.S. and therefore an almost imperceptible impact on commodity prices.” However, published studies employing computable general equilibrium (CGE) models suggest that the changes would be nontrivial. For example,
Winters (2005) estimates how adoption of Doha-round policy proposals, involving a lowering of average tariffs for a large number of commodities, would affect world prices. He finds that world cotton and sugar prices would increase by 6.9% and 3.2%, respectively. Burfisher (2001) reports that if all (measurable) forms of protectionism are eliminated by all countries, world cotton and sugar prices would increase by 5.6% and 16.4%, respectively.

The results of counterfactuals such as this can be used in our welfare analysis, but we are also interested in what would happen if subsidies for cotton and sugar farmers in OECD countries were to be eliminated. Since no known study in the literature considers this counterfactual, we develop an approach to measuring how world prices would be affected. We use a simple multimarlet spatial-equilibrium approach of the sort used in Goreux (2004) and described at length within Sadoul et and de Janvry (1995). We forego a detailed algebraic treatment since this is provided in those sources. In the case of both cotton and sugar, we assume linear supply and demand curves and a single homogeneous good. Prices of other commodities, income, population, technology, and preferences are held constant. Transport costs, handling costs, exchange rates, and government programs are ignored.

The first step of the procedure involves determining the amount by which prices in individual subsidizing countries would fall if that country’s subsidies are eliminated. In doing this it is assumed that this country by itself is small enough that world excess demand for this country’s product is perfectly elastic. We assume that the reduction of output is equal to area removed times the national yield, which itself does not vary with the simulation. The resulting fall in quantity supplied by each country is aggregated, and an OECD joint excess supply curve shifts in a manner consistent with the reduction in quantity. The rest-of-world excess demand curve is assumed to be downward sloping in this context, and the world free trade price rises as excess supply is taken off the market. The percentage change in quantity supplied by each country is aggregated, and an OECD joint excess supply curve shifts in a manner consistent with the reduction in quantity. The rest-of-world excess demand curve is assumed to be downward sloping in this context, and the world free trade price rises as excess supply is taken off the market. The percentage change in India’s border price is assumed to equal the percentage change in world price.

The results from this counterfactual depend most heavily on the supply and demand elasticities of individual countries. A number of estimates are available in the literature for the two commodities. We compile three domestic supply elasticities and three domestic demand elasticities for each commodity, and assume these pertain uniformly across the relevant OECD countries, that is, those involved in the production and trade of cotton and sugar. If each possible combination of these estimates is used, there are nine distinct scenarios that can be considered for cotton as well as sugar. The use of multiple elasticities will provide a range of world price changes, from low to high, and thus a form of sensitivity analysis for the exercise.

2.4. Changes in producer welfare

An evaluation of welfare change for India as a whole would take into account the harm caused by increased prices of cotton and sugar, such as to the textile industry and food processors. However, our focus is on Indian farmer welfare, and our measure of welfare is producer surplus. This is a partial equilibrium (and thus imperfect) measure of welfare, but a major advantage is empirical simplicity and the fact that the first-round effects it measures are generally a reasonable approximation of the total effects (Sadoul and de Janvry, 1995). We note that use of a farm household model is unnecessary in this context since cotton and sugar are cash crops in India.

To calculate the welfare effects of the proposed changes on producers in India, the assumptions of the above section are maintained. Instead of a world market, however, we focus on the supply and demand curves of India alone. In turn, we use our own, estimated price transmission and supply response elasticities instead of relying on estimates from the literature.

We now sketch our measure of producer surplus, showing where our price transmission and supply response estimates fit into the analysis. The percentage change in the world price is denoted \( \hat{p}_{\text{world}} \) (the hat signifies percentage change). We consider three counterfactual scenarios differing in the form of liberalization, and thus three versions of \( \hat{p}_{\text{world}} \). Scenario 1 corresponds to subsidy cuts by OECD countries and uses the version of \( \hat{p}_{\text{world}} \) generated in the above section. Scenario 2 corresponds to the global, Doha-round tariff cuts examined in Winters (2005). Scenario 3 examines complete, global liberalization of all forms of trade barriers, as examined in Burfisher (2001). The price change experienced within India is the product of \( \hat{p}_{\text{world}} \) and \( \beta_2 \) from the price transmission regression, where \( \beta_2 \) is the percentage increase in domestic price for a 1% increase in \( \hat{p}_{\text{world}} \). The actual price change in India is denoted \( \hat{p}_{\text{producer}} \) and calculated as: \( \hat{p}_{\text{producer}} = \beta_2 \hat{p}_{\text{world}} \).

The change in production based upon \( \hat{p}_{\text{producer}} \) can be calculated using short- and long-run elasticities of supply response. The short-run elasticity is denoted \( \alpha_2 \) (from the supply response regression) and gives the percentage increase in production for a 1% increase in domestic price. Denoting the change in production by \( \hat{q} \), the change in production is then: \( \hat{q} = \alpha_2 \hat{p}_{\text{producer}} \).

Using these changes in conjunction with information on base production and price levels, we can derive the producer surplus and change in producer surplus.

3. Results

3.1. Price transmission results

A detailed description of the data and econometric considerations is provided in the data appendix. In brief, world cotton lint prices correspond to the U. K. Liverpool index while the world sugar prices correspond to the Caribbean free market. Domestic wholesale cotton lint prices correspond to the market at Abokar in Punjab, while wholesale sugar prices correspond to the market at Hapur in Uttar Pradesh. Each of these markets is in one of the larger producing areas of India.
These results suggest that there is a considerable degree of linkage with the world reference price. This is somewhat surprising given that the overall agricultural policy attitude of India is often perceived to be interventionist (Conforti, 2004; Elobeid and Beghin, 2005; Landes et al., 2005). In addition to MSPs, direct farm procurement by public agencies occurs in some states, and nonproduct-specific support is provided in the form of either free or subsidized fertilizers, seeds, water, power, and credit (Chandrashekhar, 2006). Whatever the effects of these interventions, local prices appear to follow movements in world prices with reasonable closeness in the time period of this study. This may be in part due to the fact that MSPs are adjusted annually by the Commission on Agricultural Costs and Prices, based on trends in world and domestic prices and costs.

The most recent study of price transmission for India to which we can compare our results is Conforti (2004). He restricts his analysis to commodities with at least 30 annual observations and does not consider sugar or cotton. For the eight commodities that he does study, however, India has a considerable degree of linkage with world reference prices, based upon the unit root, cointegration, and related tests that he performs. Conforti (2004) finds evidence of long-run equilibrium between domestic and the world reference prices of wheat, maize, cassava, milk powder, and rice, although not for meats.

3.2. Supply response results

The supply response models are estimated with annual observations on production in 9–10 Indian states over the period 1991–2003. Our data have a spatial as well as temporal dimension, and we employ a fixed-effects panel model that allows the intercepts to vary by state. To account for serially correlated errors we employ a Prais-Winston transformation with AR(1) errors. In turn, since large producing states have greater variation in acres planted than small states, we employ White’s heteroskedasticity consistent covariance estimator. In addition to this generalized least squares (GLS) approach, we also estimate equation (2) using two-stage least squares (2SLS). In this procedure an instrumental variable is constructed from the predicted values of the corresponding right-hand-side endogenous variable that has been regressed on all the exogenous variables of the system. Although this may not make a large difference in our results, 2SLS estimators have a number of desirable small-sample and large-sample properties, and this provides a robustness check on our estimates. Further description of the data and econometric issues is in the data appendix.

Table 2 reports the estimation results. There are four columns of results corresponding to the two commodities and two methods of estimation (GLS and 2SLS). Each model explains a great deal of the variation in area planted over time, with adjusted $R^2$ values greater than 0.95. The signs and magnitudes of nearly all of the estimated coefficients are consistent with prior expectations.

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Cotton lint rural market price in India (lnPDt)</th>
<th>Sugar cane rural market price in India (lnPDt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lagged domestic price</td>
<td>0.337</td>
<td>-0.275</td>
</tr>
<tr>
<td>World price (lnPWt)</td>
<td>0.728***</td>
<td>0.866**</td>
</tr>
<tr>
<td>Constant</td>
<td>(−1.44)</td>
<td>(−0.85)</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.71</td>
<td>0.18</td>
</tr>
</tbody>
</table>

Notes: Entries with one, two, and three asterisks are statistically different from zero in a two-sided test at the 0.10, 0.05, and 0.01 level, respectively. $t$-values are in parentheses. There are 12 observations. World cotton lint prices correspond to the Liverpool index and world sugar prices correspond to the Caribbean free market. Within India, wholesale cotton lint prices correspond to the market prices of Abohar, Punjab, and wholesale sugar cane prices correspond to the market prices of Hapur, Uttar Pradesh. See the data appendix for more information.

The domestic price series has considerable gaps if one goes back too many years, and our data are restricted to span the period 1991–2003. The shortness of this series limits our ability to run time-series and other statistical tests. However, under the reasonable assumption that world and domestic prices do indeed follow each other over time (Abbott, 1979; Conforti, 2004), these data allow us to gauge the degree of comovement.

Over this period, mean world and Indian cotton prices were $1,469 and $1,391 per million ton, respectively, with the world price an average 5.6% higher. World prices exhibit more variation, with a coefficient of variation of 23% versus 16% for domestic prices. In the case of sugar, mean world and Indian prices are $206 and $378 per million ton, respectively, with the Indian price 83.5% higher on average. Again, the world price is more volatile with a coefficient of variation of 24% versus 7% for Indian prices. While domestic prices vary considerably, they do so less than world prices due to the system of MSPs.

Table 1 reports the results of estimating the price transmission model using ordinary least squares. The cotton equation is reported in the first column. The results suggest that the domestic price adjusts fairly consistently in line with the world reference price. The price transmission elasticity ($\hat{\beta}_1$) is 0.728, which implies that a 1% increase in world price is associated with a 0.728% rise in domestic price. This coefficient is statistically nonzero at the 1% level of significance, and the model has an adjusted $R^2$ of 0.71.

The sugar equation is reported in the rightmost column of Table 1. As above, the results suggest that domestic prices vary closely with the world reference price. The price transmission elasticity ($\hat{\beta}_2$) is 0.866, which implies that a 1% increase in world price is associated with a 0.866% rise in domestic price. This coefficient is statistically nonzero at a 5% level of significance, and the adjusted $R^2$ is 0.18.
The coefficient of greatest interest, \( \alpha_2 \), is associated with the natural logarithm of lagged own price. In the case of cotton the GLS estimate (\( \hat{\alpha}_2 \)) is 0.203, which is statistically nonzero at the 5% significance level. This corresponds to short-run supply response, and implies that a 1% increase in last period’s price is associated with a 0.203% increase in area planted in the near future. The long-run elasticity of supply response is calculated as \( \alpha_2/(1 - \alpha_1) = 0.914 \). This suggests that a 1% increase in last period’s price gives rise to a 0.914% increase in area planted within a period of several years. Coefficients for the other variables are largely consistent with prior expectations. For example, an increase in the price of a substitute crop that the farmer can grow has a negative, statistically significant relationship with area planted. The results for the 2SLS model do not deviate in meaningful ways from the GLS approach, and are not described here.

The sugar cane regressions are reported in the rightmost columns of Table 2. Under the GLS regression, short-run supply response is \( \alpha_2 = 0.218 \). This means that a 1% increase in last period’s price is associated with a 0.218% increase in area planted in the near term. The long-run elasticity for sugar is \( \alpha_2/(1 - \alpha_1) = 0.666 \). Thus a 1% increase in last period’s price is associated with a 0.666% increase in future area planted. Again, the coefficients for the other variables are largely consistent with prior expectations. The results for the 2SLS model are also reasonably similar.

Consistent with economic theory, the long-run supply response exceeds the short-run supply response for both commodities. Our results also make sense in the context of the recent literature. For example, in the case of cotton, Gulati and Kelly (1999) report low, medium, and high supply elasticities of 0.20, 0.45, and 0.70, respectively. While our long-run elasticity for cotton (0.914) exceeds these values, our short-run elasticity (0.203) is clearly in line with them. In the case of sugar, Gulati and Kelly (1999) report low, medium, and high sugar supply elasticities of 0.19, 0.41, and 0.62, respectively. Both our short-run (0.218) and long-run (0.666) area response elasticities fit within this range. As noted above, actual supply response is likely greater than just the area response, because higher prices lead to greater use of other inputs such as water, better seeds, fertilizers, and pesticides. Direct use of our estimates, therefore, may be on the conservative side of what may actually happen.

### 3.3. World price changes

This section describes our use of a spatial equilibrium model to estimate how world cotton and sugar prices would change given OECD elimination of subsidies for these two commodities. We calculate aggregate OECD domestic support based upon individual countries’ notifications to WTO by criteria of export subsidies, blue box subsidies, and the AMS. Other details of the approach are described in a prior section and in the data appendix.

Results are reported in Table 3 (boldface rows denote the scenarios used in welfare analysis). The first two columns (OECD Es and Ed) report the estimates of OECD supply and demand elasticities compiled from various studies. There are nine unique scenarios for both cotton and sugar. The change in world price associated with a given scenario is reported in the third column. Depending on the range of world demand and supply elasticities, the world cotton price change ranges from 6.55% to 20.85% (top half of column 3). The overall impact on sugar price is also potentially quite substantive, ranging from a 7.45% increase to a 26.42% increase under alternative supply and demand scenarios (bottom half of column 3). These simulations support the hypothesis that OECD subsidies do have a measurable impact on world markets, in contrast to what observers such as Ray (2002) and Roney (2004) have suggested.

The impact of world price changes on Indian rural markets is obtained by multiplying the percentage change in world prices

### Table 2
Estimated area response equations

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>GLS</th>
<th>2SLS</th>
<th>GLS</th>
<th>2SLS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton: ln area planted lag</td>
<td>0.778***</td>
<td>0.337</td>
<td>0.672***</td>
<td>0.630**</td>
</tr>
<tr>
<td>In own price lag</td>
<td>(15.73)</td>
<td>(0.46)</td>
<td>(10.85)</td>
<td>(2.44)</td>
</tr>
<tr>
<td>ln yield lag</td>
<td>0.203***</td>
<td>0.239*</td>
<td>0.218***</td>
<td>0.229**</td>
</tr>
<tr>
<td>In fertilizer price lag</td>
<td>(2.47)</td>
<td>(1.84)</td>
<td>(3.15)</td>
<td>(2.45)</td>
</tr>
<tr>
<td>In price substitute crop lag</td>
<td>-1.67**</td>
<td>-0.116</td>
<td>0.005</td>
<td>0.016</td>
</tr>
<tr>
<td>In price substitute crop log</td>
<td>(-2.40)</td>
<td>(-0.61)</td>
<td>(0.78)</td>
<td>(0.31)</td>
</tr>
<tr>
<td>ln area planted lag</td>
<td>-</td>
<td>-</td>
<td>-1.537**</td>
<td>-0.1400</td>
</tr>
<tr>
<td>AR(1)</td>
<td>(4.71)</td>
<td>(2.74)</td>
<td>(1.88)</td>
<td>(0.64)</td>
</tr>
<tr>
<td>Constant</td>
<td>0.037</td>
<td>0.033</td>
<td>0.080**</td>
<td>0.0892</td>
</tr>
<tr>
<td>In wage price lag</td>
<td>(0.42)</td>
<td>(0.21)</td>
<td>(1.84)</td>
<td>(1.29)</td>
</tr>
<tr>
<td>In rain lag</td>
<td>0.025</td>
<td>0.078</td>
<td>-0.052</td>
<td>-0.069</td>
</tr>
<tr>
<td>In road density</td>
<td>(0.66)</td>
<td>(0.68)</td>
<td>(-0.55)</td>
<td>(-0.86)</td>
</tr>
<tr>
<td>1.130***</td>
<td>3.933</td>
<td>-2.187***</td>
<td>-1.571***</td>
<td></td>
</tr>
</tbody>
</table>

Notes: Entries with one, two, and three asterisks are statistically different from zero in a two-sided test at the 0.10, 0.05, and 0.01 level, respectively. t-statistics are in parentheses. Coefficients on state dummy variables are not reported. In the case of cotton, the substitute crop is coarse cereals (an index of the prices of sorghum, pearl millet, and maize). In the case of sugar, the substitute crop is rice and wheat. The cotton price is the Farm Harvest Price (FHP), and the sugar cane price is the Statutory Minimum Price (SMP), as announced by the Indian sugar mills board. See data appendix for more information.
by the price transmission elasticity. For cotton, rural market prices increase from 4.77% to 15.18% (top half of column four). For sugar, rural market prices increase from 6.45% to 22.88% (bottom half of column four).

The rightmost two columns in Table 3 concern the change in Indian area planted resulting from the change in the rural market prices. Cotton production increases from 0.97% to 3.08% in the short run, and 4.36% to 13.87% in the long run. Sugar production increases from 1.41% to 5.00% in the short run, and 4.30% to 13.87% in the long run. These results rely on the assumption that the percentage change in rural market prices translates into an equivalent percentage change in producer prices. This assumption could imply that there will be an overstatement of the actual change in producer prices. However, the bias should be small since this margin is never more than 10–15% for the two crops considered here.

The two rows in Table 3 that are in boldface type signify the two scenarios that we use in the welfare analysis below. These scenarios are chosen because they are the most conservative.

### 3.4. Welfare gains through change in price and production

For both cotton and sugar, we consider the welfare effects of three different price change scenarios. The scenarios differ in terms of the nature of liberalization and also with respect to the model used to generate the results. The first scenario is discussed in the preceding section and corresponds to OECD subsidy elimination. The second scenario considers global tariff cuts for the two commodities proposed in the Doha round, and comes from Winters (2005). Relative to the other scenarios, this may be the most realistic since it corresponds to negotiations that have taken place (although not implemented). The third scenario comes from Burfisher (2001) and corresponds to global elimination of all tariffs, domestic subsidies, and export subsidies for these commodities. This is the least realistic scenario, but provides a benchmark against which to compare the others.

Results are reported in Tables 4 and 5 for cotton and sugar, respectively. Looking at the first row of Table 4, the change in world price is seen to be quite similar across subsidy elimination (6.55%), the Doha reforms (6.90%), and full liberalization (5.60%). While this variation may reflect the nature of the liberalization being proposed, it also reflects the particular model used to generate the results. Looking next at the second row, the change in Indian rural market prices ranges from 4.08% to 5.02%.

The associated change in Indian cotton production is reported in the lower two sections of Table 4. The results depend on whether we consider a short-run supply elasticity (0.203) or long-run supply elasticity (0.914). In the short run the expected rise in production is only about 1% for all three scenarios (first row of middle section). In the long run, however, the rise is as much as 4.59% in the Doha reform scenario (top row of lowermost section). In both the short and long run there is a clear impact on producer surplus. It averages 5.2% in the short
These differences reflect primarily the nature of the liberalization being proposed, but also may stem from the model upon which a scenario was based.

Looking at the second row of Table 5, the change in Indian rural market prices ranges from 2.77% to 14.20%. The ultimate effect on India production varies according to whether we consider the short-run supply elasticity (0.218) or long-run supply elasticity (0.666). In the short run the predicted rise in production averages 1.7% across the three scenarios. The change in producer surplus increases from as little as 3.1% under the Doha scenario, to as much as 16.2% under the full liberalization scenario. In the long run, the increase in Indian production is as much as 9.46% in the Doha reform scenario, and as little

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Table 4
Cotton: Change in producer surplus due to liberalization

<table>
<thead>
<tr>
<th>Scenario 1 OECD subsidy elimination (this study: $Es = 0.25; $Ed = -1.27)</th>
<th>Scenario 2 Global Doha tariff cuts (Winters)</th>
<th>Scenario 3 Global liberalization (Burfisher)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in world price (%)</td>
<td>6.55</td>
<td>6.90</td>
</tr>
<tr>
<td>Change in India price (%)</td>
<td>4.77</td>
<td>5.02</td>
</tr>
<tr>
<td>Base India price ($/mt)</td>
<td>1,241.40</td>
<td>1,241.40</td>
</tr>
<tr>
<td>New India price ($/mt)</td>
<td>1,300.50</td>
<td>1,303.70</td>
</tr>
</tbody>
</table>

**Short-run results**

| Change in India production (%) | 0.97 | 1.02 | 0.83 |
| Base India production (million mt) | 2.66 | 2.66 | 2.66 |
| New India production (million mt) | 2.69 | 2.69 | 2.68 |
| Base producer surplus ($ million) | 2,967.00 | 2,967.00 | 2,967.00 |
| Change in producer surplus ($ million) | 158.20 | 166.70 | 135.20 |
| Change in producer surplus (%) | 5.30 | 5.60 | 4.60 |

**Long-run results**

| Change in India production (%) | 4.36 | 4.59 | 3.73 |
| Base India production (million mt) | 2.66 | 2.66 | 2.66 |
| New India production (million mt) | 2.78 | 2.78 | 2.76 |
| Base producer surplus ($ million) | 1,793.00 | 1,793.00 | 1,793.00 |
| Change in producer surplus ($ million) | 160.90 | 169.70 | 137.10 |
| Change in producer surplus (%) | 9.00 | 9.50 | 7.60 |

Notes: The price transmission elasticity underlying the price change results is 0.728. The area response price elasticity underlying the short-run results is 0.203. The area response price elasticity underlying the long-run results is 0.914.

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Table 5
Sugar: Change in producer surplus due to liberalization

<table>
<thead>
<tr>
<th>Scenario 1 OECD subsidy elimination (this study: $Es = 0.11; $Ed = -0.4)</th>
<th>Scenario 2 Global Doha tariff cuts (Winters)</th>
<th>Scenario 3 Global liberalization (Burfisher)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in world price (%)</td>
<td>7.45</td>
<td>3.20</td>
</tr>
<tr>
<td>Change in India price (%)</td>
<td>6.45</td>
<td>2.77</td>
</tr>
<tr>
<td>Base India price ($/mt)</td>
<td>386.31</td>
<td>386.31</td>
</tr>
<tr>
<td>New India price ($/mt)</td>
<td>411.20</td>
<td>397.00</td>
</tr>
</tbody>
</table>

**Short-run results**

| Change in India production (%) | 1.41 | 0.61 | 3.10 |
| Base India production (million mt) | 21.03 | 21.03 | 21.03 |
| New India production (million mt) | 21.33 | 21.16 | 21.68 |
| Base producer surplus ($ million) | 7,237.00 | 7,237.00 | 7,237.00 |
| Change in producer surplus ($ million) | 527.80 | 225.80 | 1,171.70 |
| Change in producer surplus (%) | 7.30 | 3.10 | 16.20 |

**Long-run results**

| Change in India production (%) | 4.30 | 1.85 | 9.46 |
| Base India production (million mt) | 21.03 | 21.03 | 21.03 |
| New India production (million mt) | 21.93 | 21.42 | 23.02 |
| Base producer surplus ($ million) | 5,419.00 | 5,419.00 | 5,419.00 |
| Change in producer surplus ($ million) | 535.40 | 227.20 | 1,208.40 |
| Change in producer surplus (%) | 9.90 | 4.20 | 22.30 |

Notes: The price transmission elasticity underlying the price change results is 0.866. The area response price elasticity underlying the short-run results is 0.218. The area response price elasticity underlying the long-run results is 0.666.
4. Conclusions

This article investigates whether a reduction in protectionist policies for OECD cotton and sugar producers would have a discernable effect on Indian farmers. We evaluate the contention that OECD policies are not responsible for the problems of cotton and sugar farmers elsewhere since every country intervenes heavily in these sectors (Roney, 2004).

Our analysis shows that there is a considerable degree of price transmission from international markets to rural markets within India, despite the existence of extensive regulation and distribution costs. A 10% rise in world prices is associated with a 7.28% and 8.66% near-term rise in cotton and sugar prices, respectively. We further show that Indian producers are fairly responsive to price signals despite the supply constraints by which they are encumbered. Short-run price elasticities of supply are small, at approximately 0.2 for both commodities. However, long-term elasticities of supply are relatively substantial. For example, a 10% price rise is associated with a 9.14% and 6.66% long-run increase in area planted for cotton and sugar, respectively.

Using a simple spatial equilibrium model, we find that full elimination of OECD cotton subsidies would increase the rural market price of cotton by 4.77% to as much as 15.18%. In the case of sugar, a similar counterfactual suggests that Indian rural market prices would increase by 6.45% to as much as 22.88%. The variation in results for each crop is due to different assumptions about supply and demand elasticities within the OECD.

Using the above subsidy elimination scenarios, as well as alternative tariff reduction scenarios taken from the literature, we estimate how Indian cotton and sugar producers would fare in the wake of such liberalizations. In the case of cotton, the results are fairly similar across the three scenarios, with the average increase in producer surplus being 5.2% in the short run and 8.7% in the long run. In the sugar scenario, the results depend more closely on the nature of the liberalization that occurs. In the short run, producer surplus increases from 3.1% under Doha tariff cuts to 16.2% under global elimination of all tariffs and subsidies. In the long run these estimates grow to 4.2% and 22.3%, respectively. While Doha-round tariff cuts would offer the smallest benefits, full global elimination of all tariffs and subsidies offer the largest benefits.

The numerical results of the study are illustrative and do not suggest that OECD policies are the foremost supply constraint facing Indian cotton and sugar farmers. It is conceivable that improvements in infrastructure and reforms in input markets, for example, could benefit Indian farmers more than farm subsidy cuts by OECD nations. Chandrashekar (2006), for example, argues that there are limits to India benefiting from a global price rally given infrastructure, quality, and other limitations that would constrict export volumes. Nonetheless, the study shows that the fate of Indian farmers is indeed tied to policies made in other capitals, and that OECD reforms have the potential to improve the prospects of Indian farmers.

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Appendix: Notes on construction of the data set

The objective of the price transmission analysis is to gauge the magnitude of price adjustment between world and Indian prices in the recent past. The price series of interest has considerable gaps prior to 1991, and our analysis is restricted to annual observations during 1991–2003. It would be desirable to explore the dynamic properties of the price series with unit
root and cointegration tests, followed by the possible adoption of an error correction model, to avoid potentially misleading significance tests. Unfortunately, we do not have the degrees of freedom to engage in such tests. We feel that this is less important in our context since there is little question that world and domestic prices do indeed follow each other over time (Abbott, 1979; Conforti, 2004). In turn, we note that 1991–2003 is a relatively short period, which makes nonstationarity less likely. This period is also recent enough that the results are of relevance to the near future.

For the price transmission analysis, world prices are from the International Financial Statistics service of the International Monetary Fund (IMF). The cotton lint series corresponds to the Liverpool index and the sugar series is for the Caribbean free market. Indian wholesale cotton lint prices correspond to market prices of Abohar, Punjab. Indian wholesale sugar cane price corresponds to market prices of Hapur, Uttar Pradesh. Each of these markets is in a major producing area of India. We use annual data since (a) they are available for India on a consistent basis, (b) they are consistent with the fact that MSPs are revised annually, and (c) they limit issues with seasonality that might arise with data of greater frequency. Nominal price series are used since there is no appropriate deflator for world prices, and since in any case there is no consistent inflation that might give rise to spurious results. Plots of world and domestic prices show that they follow each other closely, without either having secular trends.

Regarding the supply response analysis, state-specific data on area, yield, production, input usage, prices, and irrigation are collected from published reports of the Government of India (2005). The data are annual in nature and span 1980–2000. For cotton we pool cross-section time-series data for nine states comprising 99% of area under cultivation and 99% of total production. For sugar cane we pool cross-section time-series data for 10 Indian states comprising 96.7% of area under cultivation and 97.1% of total production. The seed cotton (raw cotton) price used in the supply response equation is the Farm Harvest Price (FHP), and the sugar cane price is the Statutory Minimum Price (SMP), as announced by the Indian sugar mills board. These are 10–15% less than the rural market prices used in the price transmission analysis. The variables concerning rainfall were obtained from various reports published by Meteorological Department of India. An index was constructed for each state by averaging the monthly rainfall data across regions of each state.

With regard to the subsidy elimination and welfare analyses, data on OECD and India production are compiled from OECD databases and WTO statistical websites (OECD, 2006; WTO, 2006). As above, the relevant world price data are obtained from the International Financial Statistics service of the IMF. Indian supply elasticities, new prices, and new quantity information are estimated within this study itself. Supply elasticities for other countries are taken from the literature.

The analysis of domestic cotton and sugar supports concerns the total level of notifications made by OECD countries to the WTO during 1995–2003. Subsidy levels for a given commodity are determined by aggregating individual countries’ notifications across the standardized categories of support, including export subsidies, blue box subsidies, and the AMS. Non-product-specific AMS are weighted by share of the commodity in the total value of production, then added to the product-specific AMS to create a total AMS for cotton and wheat. A similar weighting is done for the blue box subsidies to recover the product-specific subsidy component.

References

World Bank, 2004. Agricultural export commodities of developing countries most affected by high levels of support and protection in OECD countries. World Bank, Washington, DC.