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The Impacts of India's Food Security Policies on South Asian Wheat and Rice Markets

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Abstract

We quantify the extent to which India's success in stabilizing its wheat and rice markets affects other countries in South Asia. We deal with the variability of Indian trade and price policies by analyzing market outcomes during periods of low and high world prices; we also conduct stochastic simulations where Indian policies endogenously adjust to fluctuations in domestic and world supplies. South Asian wheat and rice markets operate near autarky, and therefore, intra-regional price transmission is limited. However, we find that when India's policies result in implicit export subsidies, consumers in countries that import from India benefit; meanwhile implicit producer taxation harms consumers elsewhere. Pakistan—the only country in the region that competes with India in foreign markets—would see gains in market shares when India reduces its export subsidies. We also find that the low intra-regional trade shields India's neighbors from the excess volatility caused by Indian policies.

JEL classification: F14, F15, N55, Q17, Q18

India has succeeded in stabilizing its domestic wheat and rice prices relative to international prices (Srinivasan and Jha 2001; Pursell, Gulati, and Gupta 2009). Such success is due to a system of policies that seeks to both increase production and reduce price volatility (Shreedhar et al. 2012; Hoda and Gulati 2013). However, agricultural policies do not operate in a vacuum. Domestic price stabilization policies may result in lower prices, which can discourage competition from abroad (Houck 1986). Moreover, international trade operates as a risk-sharing agreement, and when one country obstructs trade to reduce its own price volatility, it may further exacerbate volatility in foreign markets (Anderson and Nelgen 2012).

This paper examines the extent to which India's wheat and rice price management policies influence production, consumption, and prices in Bangladesh, Nepal, Pakistan, Sri Lanka, and an aggregate region comprising Afghanistan, Bhutan, and the Maldives. We focus on India because it is an important producer that actively operates elaborate policies to influence domestic food markets. India produces 70% of all the rice in South Asia and around a fifth of all global production. India is also the dominant wheat producer in South Asia and is the second largest producer in the world (USDA 2014). A considerable

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amount of these grains (up to 35% in 2011–12) are acquired by India's government in an effort to stabilize its domestic markets (Acharya et al. 2012). Moreover, India is committed to maintaining and expanding its food security programs (Krishnamurthy et al. 2014), which will likely require increasing public procurement of cereals (Sharma 2012).

The market interventions used by the Government of India, particularly Minimum Support Prices (MSP), open-ended procurement, and variable trade policies, are of public policy interest because of their domestic costs (Sharma 2012) as well as because of their effects on other countries. For instance, disagreement about agricultural safeguards between India and the United States were a chief reason behind the failure of the Doha round of trade negotiations. And more recently, ensuring the right to stockpile was a chief reason behind the breakdown (and posterior renewal) of negotiations on the Bali agreement on trade facilitation (Melendez-Ortiz, Bellmann, and Hepburn 2014, 9). Closer to home in the South Asia region, there are concerns that price insulating policies further restrict regional markets, as illustrated by the export bans on rice during 2007–09 (Dorosh 2009).

Capturing the effects of India's policies is difficult because of the multiple policy instruments in place at any given time (for a systematic effort on separating stockholding from other policies, see Gouel, Gautam, and Martin (2014)). We circumvent this difficulty by measuring the wedge between the domestic market prices distorted by India's food security policies and the prices that would prevail in the absence of such distortions. This task is greatly facilitated by the comprehensive assessment of agricultural price distortions in India undertaken by Pursell, Gulati, and Gupta et al. (2009) as part of the World Bank "Distortions to Agricultural Incentives" (DAI) (Anderson et al. 2008).

In addition, India's price policies rely on variable trade policies that buffer the variability of domestic and foreign supply shocks. We deal with this variability through a three-pronged strategy that includes analyzing the effects of the policy during periods of low and high world prices and then conducting stochastic simulations where the policy instruments are endogenous to fluctuations in domestic and world supplies. As discussed below, we also consider the targeted consumption subsidies under the Targeted Public Distribution System (TPDS).

The effects of India's policies on other countries depend on the degree of market integration. Regional wheat and rice markets operate near autarchy, and therefore, price transmission is limited. However, we find that when India's policies result in implicit export subsidies, consumers in countries that import from India—Bangladesh, in the case of wheat, and Bangladesh, Nepal, and Sri Lanka, in the case of rice—benefit. However, when India's policies result in implicit taxation, Indian export prices are higher than they would be in the absence of the policy distortions, and so consumers are harmed. Opposite effects operate on the producer's side. The only country in the region that competes with India in foreign markets is Pakistan, which would see gains in market shares when India reduces its export subsidies. We also find that India's policies effectively push price instability out of its domestic markets. However, the low trade levels in rice and wheat among South Asian nations tend to shield India's neighbors from the excess volatility caused by Indian policies.

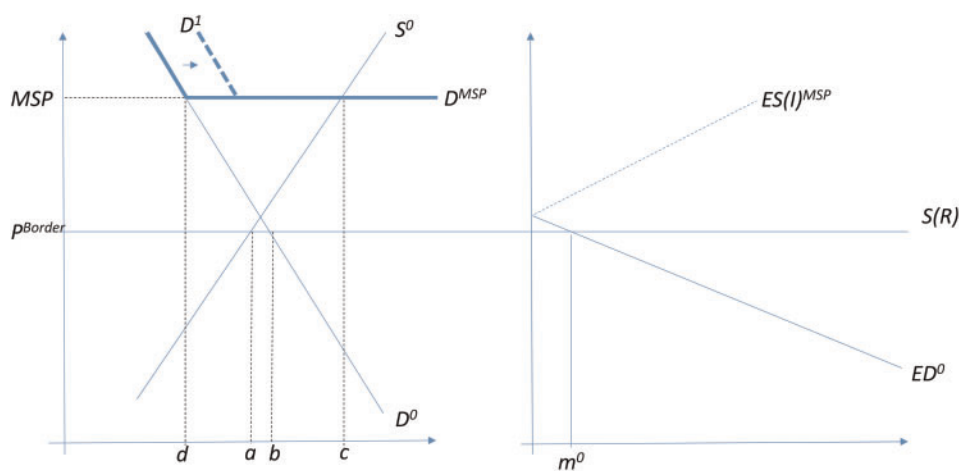
Our work contributes to several strands of the literature. In particular, it extends and complements the work of Srinivasan and Jha (2001), who found that Indian policies destabilized world wheat and rice prices. These authors used a dynamic model driven by stochastic simulations. They examined the effects of India's policy on the domestic market and world prices but not the regional effects on its South Asian neighbors. Our work helps to understand the effects of India's policies on its South Asian neighbors and also, more broadly, the opportunities and challenges posed by greater regional integration to achieve food security (Bouet and Corong 2009). Lastly, we contribute to the literature looking at how variable trade policies in a given country influence price stability in other regions (Anderson, Martin, and van der Mensbrugghe 2013).

I. The Economics of India's Food Security Policies

The Government of India (GOI) operates a large consumer subsidy and food distribution program that is supplied almost exclusively through domestic production. The explicit objectives of the program are to ensure "remunerative prices" to producers, provide the poor with subsidized grains, and build buffer stocks (Food Corporation of India 2014). The GOI is committed to open-ended procurement of about 24 crops at pre-announced, season-fixed, Minimum Support Prices (MSP). Rice and wheat are the most important crops in the program. MSPs are announced each year, just before the Rabi (for wheat) and Kharif (for rice) harvest seasons.

The Food Corporation of India (FCI) and various other state agencies are committed to buying all of the supply that producers are willing to sell to them at the MSP. Nevertheless, producers are free to sell in the open market. The levels of MSP are recommended by the Commission of Agricultural Costs and Prices (CACP), which "along with other factors, takes into consideration the cost of various agricultural inputs and the reasonable margin for the farmers for their produce" (Food Corporation of India 2014). The main effects of combining a minimum support price with open-ended procurement are displayed in figure 1. In this simplified representation, India faces a perfectly elastic foreign supply curve, $S(R)$, with resulting prices P^{Border}. Figure 1 assumes that India has a propensity to import—a situation that characterized the decade of the 80s when India was a net importer of both rice and wheat (Hoda and Gulati 2013). At this initial, undistorted, equilibrium, imports m^0 are the difference between consumption (b) and production (a).

Figure 1. The Simple Economics of India's Food Security Policies



Source: Authors' own elaboration.

The figure then introduces the minimum support price, labeled *MSP*. As depicted, the MSP is greater than the undistorted market price P^{Border}; however, this need not be the case—and indeed it has not been the case for prolonged periods over the last 50 years, a point that we will revisit in the next section. At *MSP* prices, demand by nongovernment agents (i.e., households and firms that consume cereals or use them as an intermediate input) is reduced to d. Meanwhile, the *MSP* signals producers to supply at point c, which, in this simplified illustration, creates an excess supply relative to the undistorted market equilibrium, $ES(I)^{MSP}$, and eliminates the need for imports.

Under the open-ended procurement system, the excess supplies are absorbed entirely by the GOI, which pays producers the fixed *MSP*. This action introduces a kink in the demand curve for cereals, rendering the government demand for cereals at the *MSP* perfectly elastic. As a consequence, market prices are forced to converge to the *MSP* because at this price, producers are indifferent between selling to the open market or to the government. In other words, the *MSP* becomes a lower bound or price floor which will prevail as long as the available supply surpasses the amount given by point *d*. The new demand curve is composed of the downward sloping portion of D^0 until *MSP* and by D^{MSP} at *MSP*.

Although there are important differences in the implementation of the MSP across Indian states (Deshpande 2008)—which can lead to actual market prices in some locations to diverge from the government fixed MSP—Deshpande (2008) and Acharya et al. (2012) show that both wholesale and retail prices in main Indian markets follow closely the MSPs. Moreover, Pursell, Gulati, and Gupta (2009) use the MSP as the representative domestic prices to calculate the levels of protection conferred by both domestic and border policies (see next section for further discussion.)

In order to defend the price targets implied by the MSP, the GOI must actively fend off the price changes coming from both domestic and foreign shocks to supply and demand. For instance, an outward shift of the supply curve would increase grain surpluses forcing the GOI to either increase stockpiling or exports. As drawn, with an excess demand of ED^0, international prices are too low relative to the *MSP* for India to be able to sell its excess supplies in the international market; therefore, getting rid of the excess supply would require subsidizing exports. Conversely, if there is a negative supply shock in India, the GOI is likely to import from international markets to satisfy its need for additional output (e.g., Acharya et al. 2012).

Turning abroad, if international prices increased above the domestic price floor implied by the *MSP*, at any level of supply, producers would be tempted to sell their output abroad, which explains the imposition of export bans in years of high prices. Active trade policy is also a way of increasing domestic cereal availability.

The stylized predictions of figure 1 are verified in practice. For instance, a number of studies document the government interventions to stabilize the grain markets by selling back to either the domestic or the international markets under the Open Market Scheme (Pursell, Gulati, and Gupta 2009; Acharya et al. 2012; Hoda and Gulati 2013). Moreover, Pursell, Gulati, and Gupta (2009) and Shikha, Srinivasan, and Landes (2007) offer detailed chronologies of the way in which the GOI adjusts its trade policies often in order to counteract world price fluctuations and to achieve long-term price stability and food security goals. Procurement of wheat and rice under the MSP as a percentage of production has fluctuated over the years, from around 12% in 1996–97 to about 35% in 2011–12. Some of the procured grains, between 36 and 50 million tons from 2002–03 to 2010–11 (Acharya et al. 2012, 8) are sold at deeply discounted prices—known as Centrally Issued Prices (CIP)—to the poor through the Targeted Public Distribution System (TPDS). Additionally, a portion of the grains are distributed through welfare schemes, which include a supplementary nutrition program, midday meals for school children, food for work or employment linked programs, and other welfare programs (Acharya et al. 2012). The CIP has been kept constant since the early 2000s, while the MSP is adjusted every season (see Sharma 2012 for a detailed historical account).

The subsidy, provided by way of rations sold in designated ration shops at CIP prices, can be typified as an inframarginal subsidy (Besley and Kanbur 1988). Inframarginal subsidies are equivalent to direct cash transfers that, unlike marginal subsidies, do not change the relative price of the subsidized good (Besley and Kanbur 1988; Sicular 1988).This is confirmed by Balasubramanian (2015) who uses a panel of Indian household data for 1999–2010 to conclude that Indian poor households “treat additional TPDS subsidies wholly as a source of cash—exactly as a cash transfer,” and that the subsidies have failed to increase consumption.

II. India’s Food Security Policies and Price Distortions

Measuring the effects of Indian food price policies requires capturing the combined effect of the MSPs, open-ended procurement, and variable trade policies. For this we rely on the comprehensive assessment of agricultural price distortions in India undertaken by (Pursell, Gulati, and Gupta 2009) as part of the World Bank's "Distortions to Agricultural Incentives" (DAI) (Anderson 2009; Anderson and Nelgen 2012).

Price distortions in the DAI database are expressed as commodity-level Nominal Rates of Assistance (NRA) to producers. We focus on border NRAs, which are the percentage by which domestic producer prices exceed a counterfactual undistorted market price of an equal product at the same point of the supply chain, for example, a port of entry. Algebraically, and using the notation in figure 1, let *MSP* denote domestic producer prices and P^{Border} denote the prevailing price at the market of reference; the NRA is given by:

$$NRA_{bms} = 100 \times \frac{MSP - P^{Border}}{P^{Border}} = s. \tag{1}$$

The term s is the *ad-valorem* expression of the price wedge introduced by a border measure such as an export or import subsidy (positive NRA) or tax (negative NRA). Without loss of generality, this later case corresponds to the situation depicted in figure 1, where *MSP* is the domestic producer price and P^{Border} is the counterfactual market price that would prevail in the absence of open-ended procurement at MSP and variable trade policies.

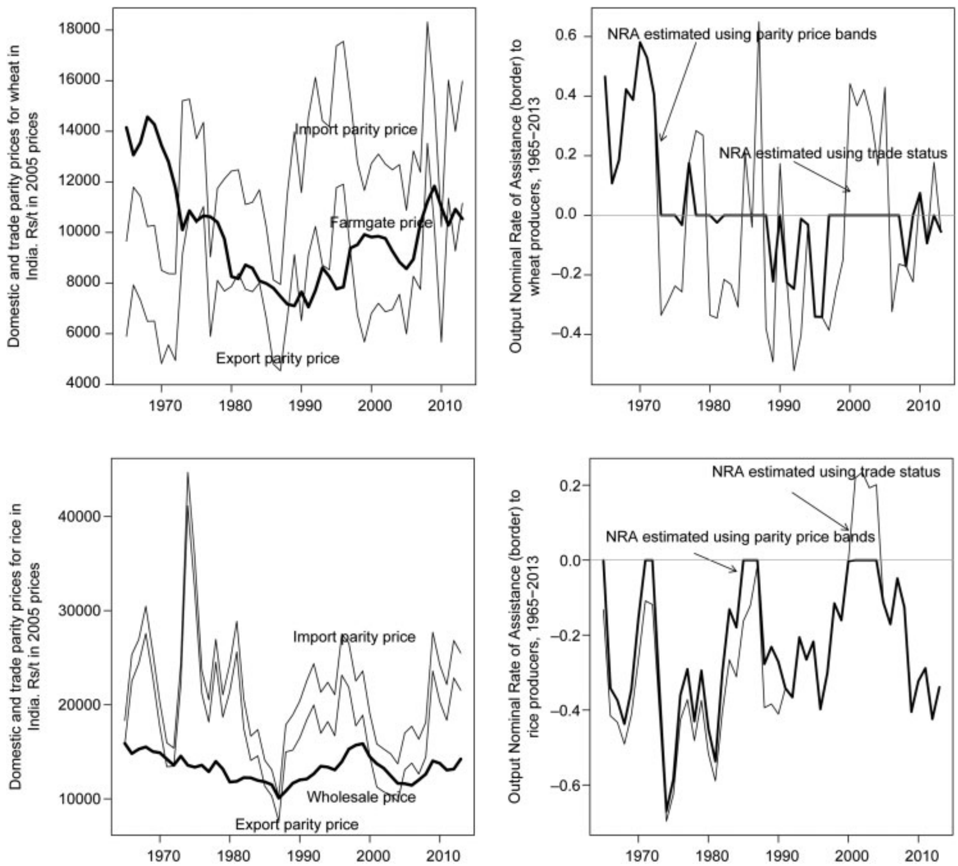
Figure 2 displays Pursell, Gulati, and Gupta's (2009) time series of real prices and NRAs (see the supplemental appendix section S.1 available at https://academic.oup.com/wber for data sources, definitions, and procedures to extend the data from 2004 to 2013). The left panel of the figure displays two types of NRAs calculated using the prices in the right panel. The first, labeled "NRA estimated using parity price bands," follows the DAI methodology (Anderson et al. 2008). These NRAs require first classifying a product as exportable, importable, or nontradable. For importable products, the NRAs are positive when government policies protect domestic producers by boosting domestic prices above the price of competing imports. In the case of exportables, a negative NRA arises from government policies that force domestic prices to go below export parity prices, thus reducing the ability of producers to take advantage of higher export prices. When the domestic price of an importable product is below the import parity price or when the price of an exportable is above the export parity price, the NRA equals zero (nontradables also have zero NRAs).

While this is the most appropriate way of calculating protection, particularly when the trade price parity bands are wide and when countries frequently switch their trading status (Byerlee and Morris 1993), the truncation of the NRA at zero may underestimate the degree of fluctuation of the relationship between domestic and external prices. For example, in the year 2004, wheat MSPs were below the import parity price, and therefore, the border NRA in the DAI database equals zero. However, that same year, India subsidized wheat exports to dispose of domestic surpluses (Pursell, Gulati, and Gupta 2009), thus indirectly protecting producers. Therefore, we present an alternative measure, labeled "NRA estimated using trade status," in which the NRA is calculated against the import parity price when the country was a net importer and against the export parity price when the country was a net exporter. When we apply this decision rule to Indian wheat in 2004, we obtain an alternative NRA of 17%, which effectively captures the fact that Indian exports were subsidized.

As evidenced by figure 2, the alternative rice NRAs closely resemble the DAI NRAs, except during the period 2000–2004 when domestic prices were above export parity prices. For wheat, the differences are more noticeable because the domestic price was within the trade parity price bands during 1998–2008, for which the DAI figures show a border NRA of zero, while our estimates show protection or taxation, depending on each year's trade status.

A direct comparison of domestic prices against parity prices and resulting NRAs exhibits two features that illuminate our empirical strategy for measuring the effects of Indian policies on the stability of food prices in the rest of South Asia. First, through flexible policies, India has achieved long-run domestic prices that are more stable than those of its international counterparts. Specifically, the standard deviation of the year-to-year percentage change in real domestic rice prices over 1965–2013 is 6%, while the

Figure 2. Real Domestic Producer and Trade Parity Prices and Nominal Rates of Assistance for Wheat and Rice in India, 1965–2013



Note: All the prices are in constant 2005 rupees per metric ton using the wholesale price index.
Source: Data for 1965–2004 is from Pursell et al. (2009); thereafter, estimates are made as explained in section S.1 of the supplemental appendix.

standard deviation of international prices is 25%. For wheat, the figures are 7% for domestic producer prices and 28% for reference prices. This implies that the policy objectives of government interventions could reasonably be summarized as stabilization of domestic prices.

Second, NRAs are remarkably stable over time, and their variance is virtually invariant to the period used as support of the calculations. For instance, the average NRA for wheat over 1965–2013 was zero, with a standard deviation of 33%. If we focus only on the decade 2003–2013, the average NRA was 1%, with a standard deviation of 24%. In the case of rice, the average NRA over 1965–2013 was −27% (std. dev. of 21%) while, during the more recent period 20013–2013, the average was −17%, with a standard deviation of 22%. (See tables S.5 and S.6 in the suplemental appendix and Anderson and Martin (2009) for a discussion of the recent evolution of protection in India.) The model validation strategy for the stochastic simulations relies on matching the moments of model-generated and observed border NRAs. The extent to which these moments are time-invariant gives us clear fixed targets for comparison.

III. Empirical Framework

We use a simulation model of the wheat and rice world markets focused on South Asia based on the standard version of the Global Trade Analysis Project model (Hertel 1997). As discussed above, India's food security policies adjust each season in order to neutralize price volatility originating either domestically or abroad. As a consequence, the opportunities for farmers in India and elsewhere to adapt to India's policy changes in a given year are limited (in agriculture, most planting decisions, such as the amount of land to cultivate and type of crops to plant, are irreversible, and opportunities for intraseasonal adjustment are very limited.) We capture these rigidities by fixing labor, land, and capital in the production of paddy rice and wheat in order to match short-term supply responses. We also restrict intraseasonal substitution between production factors and inputs.

In addition, we introduce an across the board, endogenous, consumption subsidy that keeps the real wages received by Indian unskilled laborers fixed. This subsidy is equivalent to a shift in the budget constraint and is consistent with an inframarginal subsidy as its first-order effects operate through income, without changing the relative price of the goods (Besley and Kanbur 1988; Balasubramanian 2015).

We calibrate the model to the GTAP Database Version 8.1 (Narayanan, Aguiar, and McDougall 2012), which has country-level data for Bangladesh, India, Nepal, Pakistan, and Sri Lanka and has aggregated data for Afghanistan, Bhutan and the Maldives into a single region (Rest of South Asia). We also include three aggregated regions that capture non–South Asia regions, namely, NAFTA, the European Union, and the rest of the world.

The overall strategy to measure the effects of India's price distortions on other countries consists of three experiments. In the first experiment, we explore the effects of eliminating India's policies under the conditions that characterized the first half of the 2000s when world prices were low and stable. For this experiment, we calibrate our model to the reference year 2004 of the GTAP Database Version 8.1 (Narayanan, Aguiar, and McDougall 2012). In this year, the combination of stable domestic prices in the presence of low international prices gave rise to implicit wheat and rice export subsidies of 17% and 20%, respectively. These subsidies are close to the maximum levels of protection observed during the last 50 years. Therefore, they provide the upper bound of the effects of India's food price management policies on South Asian countries.

In the second experiment, we explore the effects of India's policies in the second half of the 2000s, a period characterized by price spikes and increased price volatility. For this analysis, we calibrate our model to the reference year 2007 of the GTAP Database 8.1. As shown in figure 2 the combination of stable domestic prices in the presence of rising international prices in 2007 gave rise to an implicit rice export tax of 5% and an import subsidy on wheat of 16%.

In both experiments, the border subsidies and taxes are *exogenous* shifters of the existing wedge between *endogenously* determined domestic and external prices. The elimination of the exogenous border distortion as captured by the NRAs is therefore equivalent to eliminating the gamut of food price management policies used by India such that domestic prices are forced toward the counterfactual market price that would prevail in the absence of distortions. In terms of our previous discussion, this entails setting PMS equal to P^{Border} in figure 1.

The results of the two experiments provide useful information on the effects of aligning domestic and world prices within India, c*onditional* on the particular configuration of supply and demand conditions in India and elsewhere in the considered reference years. However, both experiments miss the fact that supply shocks to agriculture are inherently random. As such, any single crop year is a unique configuration of worldwide supply and demand conditions that may not be representative of any other year in a given period of time.

The response of India to an ever-changing set of supply conditions is a constantly changing set of policies that counteract the effects of supply shocks both within the country and in the rest of the world (e.g., Pursell, Gulati, and Gupta 2009; Gouel, Gautam, and Martin 2014). This is important for other countries in South Asia and the rest of the world because variable trade policies tend to push instability out of domestic markets, potentially exacerbating price instability elsewhere (Anderson and

Nelgen 2012). Therefore, in order to achieve a more complete assessment of the effects of Indian food price management policies on other South Asian countries, we conduct a third experiment to explore the degree to which India's success in stabilizing its domestic prices have resulted in more variable prices elsewhere.

For this experiment, we create an alternative model in which border taxes in India are *endogenous* in the sense that they adjust in response to domestic and foreign supply shocks in order to keep domestic producer prices constant. In this alternative model, the nominal rate of assistance conferred by border measures adjusts in order to keep Indian producer prices unchanged in the face of internal and external supply volatility.

Capturing such volatility involves a four-step procedure. In the first step, we estimate the joint distribution of nonsystematic supply shocks (e.g., excluding technological change trends) in the wheat and rice sectors of all the regions in the world using data for 1962–2013. Second, from these joint distributions, we draw a number of vectors of supply shocks (one shock for each region and crop) large enough to obtain accurate measures of model outcomes. Third, we solve the new equilibrium in the standard and alternative models (i.e., with border taxes exogenous and endogenous) implied by each vector of supply shock drawn in the previous step. In the fourth step, we calculate the means and standard deviations of the changes in prices and quantities. The comparison between the models with full price transmission (exogenous border taxes) and incomplete price transmission (endogenous border taxes) across countries and crops is a useful metric of India's price effects in the rest of South Asia.

The results that we discuss in the next section depend on the assumptions embedded in the chosen modeling framework. Two aspects are particularly important. First, the results depend on the structure of international trade among countries in South Asia, as well as on the ease with which South Asian countries change their trade patterns in response to changes in India's policies. Such ease is captured by the assumed price elasticity of export demand. It is well known that changes in trade flows in CGE models are highly sensitive to these parameters (Hertel et al. 2007). The set of trade elasticities we use have been econometrically estimated by Hertel et al. (2007) using a gravity model of international trade in which explicit data on transportation costs and tariffs allows identifying the elasticity of substitution among export sources—in this sense, these elasticities are consistent with both the underlying trade theory of the GTAP model as well as with observed facts.

Moreover, in the supplemental appendix (section S.2), we report the results of comparing model-generated and observed annual changes in trade flows. For the model-generated results, we follow Valenzuela et al. (2007) and assume that, in the short run, most of the variation in trade flows is explained by supply shocks. This assumption is also consistent with the stochastics simulations in experiment III. The overall results are that the model correctly predicts the direction of change, although it tends to underestimate the magnitude of actual changes. We surmise that these discrepancies may be explained, at least in part, by the exclusion of many other factors that influence commodity prices at a given point in time.

The second aspect of model validity is whether the model adequately captures the main institutional aspects of the India's food security policies. As discussed in experiment III below, the moments of the distribution of NRAs obtained by subjecting our simplified representation of endogenous border protection in India to shocks covering the historical distribution of worldwide yield volatility accurately matches the mean and the variance of the observed NRAs calculated by Pursell, Gulati, and Gupta (2009).

IV. Experiment I: Response of South Asian Wheat and Rice Markets to the Elimination of India's Export Subsidies

The first experiment uses 2004 as the reference year. This was a period of low and stable commodity prices in which implicit wheat and rice export subsidies in India reached 17% and 20%, respectively.

Export subsidies introduce a wedge between the prices received by Indian producers and the prices paid by foreign consumers. The upper portion of table 1 (all the results discussed in this subsections are under the columns labeled "I") shows that eliminating this wedge in India forces the prices received by Indian wheat producers to fall by −9.2% (ps), while the prices of Indian wheat exports (FOB) increase by 6.3% (pfob). Such a fall in domestic wheat prices discourages domestic production, which falls by 1.6% (*qo*).

Table 1. Changes in Selected Variables after Eliminating Indian Wheat and Rice Implied Export Subsidies in 2004

		India		Bangladesh		Nepal		Pakistan		Sri Lanka		Rest SA	
		I	II	I	II	I	II	I	II	I	II	I	II
Wheat	Export FOB price (*pfob*)	6.3	32.1	5.9	11.0	5.9	10.3	5.9	11.0	5.9	10.3	5.9	10.3
	Import price (*pim*)	1.3	17.5	2.9	−1.3	3.8	2.4	1.3	−1.3	2.2	−1.3	1.8	−0.8
	Domestic supply price (*ps*)	−9.2	11.0	2.6	−1.2	0.4	−0.2	1.1	−1.6	1.8	−1.3	1.3	−0.9
	Production (*qo*)	−1.6	1.5	0.4	−0.2	0.0	−0.0	0.1	−0.2	−3.4	−0.1	0.1	−0.1
	Foreign demand (*qxs*:I /*qim*:r)	−1.7	−0.0	−0.9	0.2	−13.9	−10.5	−0.8	−1.5	−0.0	0.0	−1.5	−0.2
	Consumption (*qp*)	0.9	−1.1	−0.2	0.1	−0.0	0.0	−0.1	0.1	−0.3	0.2	−0.1	0.1
Rice	Export FOB price (*pfob*)	11.3	−3.1	8.6	−2.7	8.5	−2.7	8.6	−3.1	8.6	−2.7	8.6	−2.7
	Import price (*pim*)	1.6	−0.6	8.4	−2.7	8.5	−2.6	7.1	−0.8	6.3	−1.9	3.0	−1.2
	Domestic supply price (*ps*)	−7.3	2.0	2.5	−0.9	2.4	−1.7	2.4	−0.8	3.8	−0.6	2.2	−0.7
	Production (*qo*)	−1.1	0.5	0.3	−0.1	0.4	−0.4	0.3	−0.2	0.4	−0.1	0.3	−0.1
	Foreign demand (*qxs*:I/*qim*:r)	−1.7	0.6	−13.2	4.8	−13.5	2.1	−10.8	−0.0	−5.4	3.4	−1.8	1.3
	Consumption (*qp*)	0.7	−0.2	−0.2	0.1	−0.1	0.1	−0.2	0.1	−0.5	0.1	−0.2	0.1
Welfare	Allocative efficiency (USDM)	14.0	46.9	−5.3	0.1	0.1	0.1	2.5	−2.1	−2.0	0.4	0.2	0.1
	Terms-of-trade (USDM)	75.1	12.9	−18.0	15.7	0.1	1.1	19.7	−15.6	−10.8	3.5	−1.3	0.5
	Equivalent variation (USDM)	77.1	78.5	−19.8	13.9	0.4	0.9	26.9	−23.2	−14.0	4.6	−1.0	0.6

Note: Unless otherwise indicated, units are percentage changes relative to baseline.

Source: Author's own calculations. Simulation includes a subsidy in the consumption of all the goods that keeps real wages of unskilled laborers unchanged.

For wheat markets to clear, the contraction in supply must be matched by contractions in aggregate wheat demand, which are in turn determined by changes in demand for household consumption, as an intermediate good, and foreign demand. Demand for household consumption (*qp)* remains virtually constant. Demand for intermediate use (not shown in table 1) also remains unchanged. Therefore, the contraction in Indian wheat domestic supply is mostly explained by changes in foreign demand, which falls by 1.7% (*qxs*).

Such a small change in the aggregate demand for Indian wheat contrasts with the sharp declines in bilateral export demands, particularly from Bangladesh, which declined by 22.8% (see figure 3). This is due to the fact that only around 6% of the wheat produced in India is exported (see sources of demand for domestic production in table 2), and therefore, the changes in foreign demand for Indian wheat are of little consequence for India's domestic market. Moving out of India, table 1 shows that other countries in South Asia face Indian wheat prices (*pfob*) 5.9% higher after the elimination of the implicit subsidies.

In order to follow this price change as it makes its way into the decisions of wheat producers and consumers in Bangladesh (Indian wheat exports to Pakistan, Nepal, and the rest of South Asia are negligible; furthermore, Sri Lanka, Nepal, and the rest of South Asia are marginal producers and consumers of wheat), we need first to consider India's share of wheat imports in Bangladesh's total wheat import bill, which in 2004 was 39.8% (table 2). Such a modest share dilutes the transmission of the change in Indian FOB prices as they are transmitted into Bangladesh, so the price that Bangladeshi agents pay for wheat imports increases by just 2.9% (*pim*). As shown in figure 3, Bangladesh responds to this increment in prices by substituting extra regional imports for Indian imports.

Table 2. Importance of Foreign Trade in the Wheat and Rice Sectors of South Asian Countries in 2004 (All in %)

		Bangladesh	India	Nepal	Pakistan	Sri Lanka	Rest SA
Wheat		Imports from India					
	Share of all imports	39.8	—	60.1	0.0	24.6	13.8
		Import shares in the cost structure of firms and household consumption					
	Households	26	0	0	56	100	0
	Firms	37	0	0	12	100	23
		Sources of demand (in shares) for domestic production					
	Domestic	100	94	100	100	5	99
	Other S. Asia	—	1	—	—	—	—
	ROW	—	4	—	—	95	—
	Total	100	100	100	100	100	100
Rice		Share of imports from India					
	Share of all imports	97.7	—	99.1	80.4	69.9	19.5
		Import shares in the cost structure of firms and household consumption					
	Households	4	0	5	0	20	26
	Firms	3	0	2	1	0	12
		Sources of demand (in shares) for domestic production					
	Domestic	100	93	100	65	100	100
	Other S. Asia	—	2	—	3	—	—
	ROW	—	5	—	32	95	—
	Total	100	100	100	100	100	100

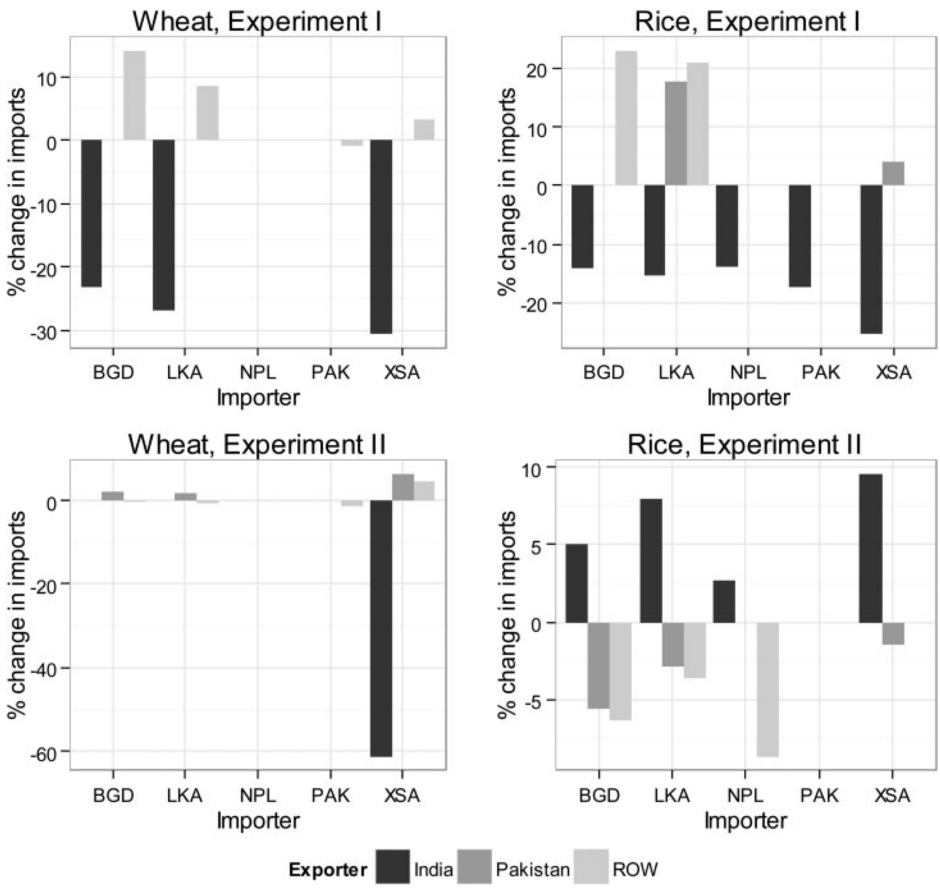
Source: GTAP V8.1, reference year 2004.

A second crucial share filtering the transmission of price changes originating in India and transmitted to other South Asian economies is the total of domestic consumption that comes from abroad. In table 2, we show that imported wheat makes up 37% and 27% of total firms and household wheat consumption in Bangladesh, respectively. These import shares are high enough to transmit some of the price increase in Indian wheat to Bangladesh's economy, and therefore, both wheat producers and consumers in Bangladesh face prices 2.6% higher (*ps* back in table 1). The more expensive imports cause wheat users in Bangladesh to substitute imports with domestically produced wheat, which is satisfied by a slight increase in total supply of 0.4% (*qs*). Finally, private consumption of wheat falls slightly ($qp = -0.2\%$) due to the higher consumption prices.

In the case of rice, eliminating the export subsidy in India forces domestic prices to converge to international prices, which implies a reduction of 7.3% (*ps*). The decrease in domestic prices is a disincentive that leads to a reduction in domestic rice supply by −1.1% (*qo*). As was the case in wheat, the contraction in domestic rice supply is fully explained by the contraction in foreign demand (*qxs*), which falls by 1.7%. Figure 3 indicates that exports from India fell across all the destinations—ranging from a contraction of about 12% to Bangladesh and Nepal, 22% in the rest of south Asia, and between 25% and 26% to the rest of the world. Although the contractions in foreign demand appear to be substantial, most of the rice produced in India (about 93%) is consumed domestically, and therefore domestic prices show little response to changes in foreign demand.

In contrast to the case of wheat, the transmission of Indian rice prices to South Asian neighbors is stronger because India is the main source of rice in South Asia (table S.4 in the supplemental appendix for figures in million US$). For example, as shown by the share of India in the import bill of each country (table 2), nearly 100% of rice imports to Bangladesh and Nepal originate in India. This translates to a one-to-one transmission of India's price changes such that change in Indian FOB prices and change in the price of the average rice composite (*pim*) are almost the same in magnitude (6.3% in Sri Lanka and 8.5% in Nepal). However, for both Bangladesh and Nepal, the share of imported rice in domestic

Figure 3. Changes in Wheat and Rice Trade Flows after Eliminating Indian Implicit Import and Export Subsidies in Experiments I and II



Source: Authors' own calculations.

consumption is small. For instance, the import shares in the cost structure of firms and household consumption in table 2 show that only 2% of total household rice consumption in Nepal originated abroad. Such a low level of imports for domestic use dilute the impacts of price increases in India. For instance, domestic prices (*ps*) in Bangladesh and Nepal increase only by around 2% with an almost negligible impact on supply (*qo* 0.3%–0.4%) and consumption ($qp = -0.2\%$ and -0.1%).

Unlike the case of wheat, Pakistan directly competes with India in regional rice markets. In 2004, Pakistan supplied 25% and 76% of Sri Lanka's and the Rest of South Asia's rice imports; moreover, Pakistan was home to around 10% of South Asian rice exports to the rest of the world (see table S.4 in the supplemental appendix. As India eliminates its exports subsidies, its rice exports become less competitive. As a consequence, Pakistan gains market share in each of the markets where it competes. For example, rice exports from Pakistan to Sri Lanka increased by 15% while imports from India decreased by 13% (figure 3). The increased export demand in Pakistan drives up producer prices ($ps = 2.4\%$), and consequently, rice production increases ($qo = 0.3\%$). Most of this increase in rice production will go to supply increased foreign demand, while Pakistan's domestic demand for rice actually shrinks due to increased domestic prices such that rice consumption in Pakistan decreases ($qp = -0.2\%$).

The results for Sri Lanka and the rest of South Asia further highlight the competition between India and Pakistan in the rice market. Around 70% of Sri Lanka's rice imports are sourced from India. The increase in Indian rice prices is transmitted to Sri Lanka, causing import prices (*pim*) to increase by 6.3%. The higher import prices translate to higher domestic supply prices, and production in Sri Lanka and the rest of South Asia go up. Sri Lanka and the rest of South Asia have relatively large shares of imports in domestic consumption (respectively, 20% and 26% of these countries' household consumption is sourced from abroad—see table 2), which explains the relatively higher transmission (relative to Bangladesh) of price changes in India to domestic consumer prices.

The lower panel of table 1 shows economy-wide effects on welfare. The model results indicate that the elimination of the export subsidies would achieve modest welfare gains in India of about $77.1 USDM. Most of these welfare gains come from improvement in India's terms of trade as the price of its wheat and rice exports increases faster than its import prices. There are also gains in allocative efficiency via the dismantling of the export subsidies. These welfare gains may understate total potential gains as we do not consider additional savings associated with costs of procurement and reduced costs of storage.

Bangladesh has net, albeit moderate, welfare losses due fundamentally to a deterioration of its terms of trade due to the increased price of rice and wheat imports from India. The rest of the welfare losses, captured by changes in allocative efficiency, come from the increase in the production of subsidized wheat following higher supply prices. A similar case is observed in Sri Lanka, which has a total negative change on equivalent variation, most of which is explained by the deterioration of the terms of trade due to higher price imports. The pattern repeats in the rest of South Asia, although the magnitudes are much more modest. Finally, welfare effects in Nepal are negligible due to the very low weight of rice and wheat imports in the Nepal consumption profile. In contrast to Bangladesh and Sri Lanka, Pakistan gains from India's policy changes. The overwhelming majority of these gains come from improvements in the terms of trade, as the price of Pakistani rice exports causes an improvement of its aggregated export prices relative to import prices.

V. Experiment II: Response of South Asian Wheat and Rice Markets to the Elimination of Indian Export Taxes on Rice and Import Subsidies on Wheat

This second experiment represents a year of high world prices for both wheat and rice. In contrast to the previous experiment, rice exports are taxed (by 5%) while wheat imports are subsidized (by 16%). The results of eliminating these import subsidies and export taxes are also summarized in table 1, under the columns labeled "II". Because of the very tenuous links among the wheat markets in the region, there are virtually no effects on the wheat production or consumption of other countries in the region. However, within India, eliminating the subsidy on wheat imports increases the price of the composite wheat import (*pim*) by 17.5%. This translates to a large increase in the supply price ($ps = 11.0\%$), which in turn stimulates production ($qo = 1.5\%$). Such an increase in production is explained by an increase in household demand for domestic wheat, which in turn acts as counterbalance for the contraction in demand from private households and the industrial sector. Demand for imports contracts sharply (*by* -21.9%, not displayed in table 1), mostly explained by the reduction in wheat imports from NAFTA, which was India's main supplier of wheat in 2007.

In the case of rice, eliminating India's export tax reduces the FOB prices at which India exports to other countries (by $pfob = 3.1\%$), along with an increase in domestic prices ($ps = 2.0\%$). Intuitively, the removal of export taxes makes Indian rice exports more competitive abroad. Higher supply prices are in turn associated with an increase in supply ($qo = 0.5\%$), which in turn is entirely driven by an increase in foreign demand (*qxs*) as shown in the bottom-left panel of figure 3. Outside India, all the countries see reduced import prices (*pim* ranging from -1.2% in the rest of SA to -2.7% in Bangladesh), and, except for the case of Pakistan, the reduction in Indian import prices is larger than the reduction in domestic prices (*ps*). Therefore, and in contrast to the discussion in experiment I, households and firms in these countries substitute away from domestic production toward India's imports, with a consequent reduction in domestic supply *qo*. The lower prices are associated with slightly larger consumption (*qp* around 0.1%). Pakistan, on the other hand, loses market share to Indian exports, which can be verified by the reduction in the demand from abroad (figure 3) and consequent supply reduction (*qo*) of −0.2%.

In terms of welfare, the joint elimination of the border taxes (export taxes in rice and import subsidies in wheat) improves India's welfare through changes in allocative efficiency (in general, reducing distortions will improve the allocation of resources) but also as a result of the improvements in its terms of trade. Except for Pakistan, the rest of the countries in South Asia have aggregated welfare gains stemming from India's elimination of its taxes on rice. The main source of these gains are improvements in the terms of trade as India's rice prices are reduced due to the elimination of the rice export tax. However, more competitive Indian exports harm Pakistan's terms of trade, for a net welfare loss.

VI. Experiment III: India's Food Price Management Policies and Price Stability in South Asia

As described above, the first step in this experiment is to characterize the distribution of the random wheat and rice yield shocks that drive supply variability in India and elsewhere. For this, we follow Valenzuela et al. (2007) and fit Autoregressive Moving Average (ARIMA) time-series models to FAO data on annual wheat and rice yields for each region. This specification is appealing because it allows controlling for trends (e.g., technological change) as well as for other time-persistent factors by explicitly controlling for past values of yield (Greene 2008). In addition, ARIMA models rely on past prediction errors to arrive at a current forecast (Kennedy 2003). Therefore, the residuals of the ARIMA models are in essence current prediction errors, which we assume arise largely from weather shocks to production.

Following the approach of Arndt (1996) and Pearson and Arndt (2000), we use a symmetric triangular distribution to approximate the distribution of residuals from the single-region ARIMA regressions. The endpoints of the symmetric triangular distribution are recovered using the mean and variance of the ARIMA residuals according to the formula, $c = \mu \pm \sqrt{6V}$, where c is an endpoint of the distribution, μ is the average yield, and V is the variance of residuals. (See tables S.7 and S.8 in the supplemental appendix for the approximate triangular distributions of yields for each region.) The second step is to sample an adequate number of vectors from these distributions and solve both versions of the model (with and without India's policy) for each one of these vectors. The samples are obtained via a Gaussian quadrature procedure developed by DeVuyst and Preckel (1997), which Arndt (1996) shows is a reasonable approximation to the Monte Carlo methods, at a fraction of the computing cost.

We then calculate the means and standard deviations for the outcome of each model. A reasonable question to formulate at this point is how well do the stylized assumptions in our model capture observed policy outcomes in India. For this, we compare the standard deviation of the simulated percentage changes in the endogenous border with the actual average and standard deviation changes in the historical NRAs (summarized for several periods in tables S.5 and S.6 in the supplemental appendix). For wheat, the standard deviation of the simulated changes in border taxes is 37%, while the standard deviation of historical NRA is 33%. For rice, the standard deviation of the changes in simulated border taxes using the 2004 reference year is 27%, which matches the standard deviation of the historical NRAs. These results suggest that the model aptly captures the essence of India's inherently changing food price management and trade policies.

Table 3 shows the difference in the percentage changes of mean and standard deviations between the model with full price transmission and the model in which India actively stabilizes domestic prices by using variable border taxes. Our results indicate that without active policy, wheat supply prices in India would be on average 12.3% higher. These results are consistent with the depressing effect of India's

Table 3. Differences in Percentage Changes of Mean and Standard Deviations in Wheat and Rice Prices, Production, and Consumption between Models with Active (A) and Inactive (I) Indian Price Management Policies

		Wheat				Rice			
Country	Variable	Border price	Market price	Production	Consumption	Border price	Market price	Production	Consumption
India	Mean	−6.2	12.3	0.4	−0.0	−14.2	0.7	0.2	0.0
	St. dev.	−17.2	32.1	0.6	−0.0	−27.5	4.2	−3.8	0.0
Bangladesh	Mean	−3.1	−2.9	0.5	0.1	−10.1	−0.8	−0.3	0.1
	St. dev.	−7.6	−6.3	−1.2	−0.3	−20.0	−0.7	−0.2	−0.1
Nepal	Mean	−4.1	0.5	0.0	−0.0	−10.5	−0.7	−0.4	0.0
	St. dev.	−10.0	0.6	−0.1	0.1	−20.5	−0.9	0.0	−0.1
Pakistan	Mean	−1.9	−1.4	−0.0	0.1	−6.3	−0.3	−0.3	0.0
	St. dev.	−4.2	−2.9	−0.1	−0.2	−14.8	−1.1	−0.9	−0.1
Sri Lanka	Mean	−2.5	−1.9	−1.5	0.1	−4.7	−1.4	−0.6	0.2
	St. dev.	−6.2	−5.1	3.9	−0.5	−12.4	−1.7	−0.9	−0.3
Rest SA	Mean	−2.3	−1.5	−0.1	0.0	−0.7	−0.2	−0.2	0.0
	St. dev.	−5.4	−2.5	−0.1	−0.1	−3.6	0.1	−0.4	0.0
NAFTA	Mean	−2.1	−2.1	−0.0	0.0	−0.3	−0.1	−0.3	0.0
	St. dev.	−4.5	−4.7	0.1	−0.0	−2.0	−0.7	−1.9	−0.0
EU25	Mean	−1.9	−2.0	0.0	0.0	−0.2	−0.2	−0.0	0.0
	St. dev.	−4.2	−4.3	0.0	−0.1	−1.5	−0.9	−1.1	−0.0
ROW	Mean	−2.0	−2.0	−0.1	0.1	−0.3	−0.1	−0.1	0.0
	St. dev.	−4.4	−4.4	−0.0	−0.3	−2.0	−0.6	−0.3	−0.1

Note: Border prices are average FOB export prices for India and average import prices elsewhere.

Source: Authors' own calculations. Simulation includes a subsidy in the consumption of all the goods that keeps real wages of unskilled laborers unchanged.

stabilization policies on farmer prices as documented by Pursell, Gulati, and Gupta (2009). The increase in rice prices is much more modest, just 0.7%, suggesting that the price stabilization policies tend to have only moderate effects on price levels, coinciding with the findings of Anderson and Martin (2009) and Pursell, Gulati, and Gupta (2009). In contrast, eliminating India's implicit export subsidies would reduce wheat and rice FOB prices by around 6 and 14 percentage points, confirming the evidence from the historical NRAs, which suggests that stabilization policy in India often results in implicit export taxes (Anderson and Martin 2009).

Turning to volatility, the switch from stabilizing to unobstructed price transmission policies increases the standard deviation of Indian domestic prices of both wheat (32.1%) and rice (by 4.2%), reflecting the effectiveness of variable trade policies in dealing with the natural variability of prices in relation to random supply shocks.

As we move into the other economies in the region, it is helpful to write the relationship between market and export prices as:

$$\frac{TXS_{i,r,s}}{PFOB_{i,r,s}} = PM_{i,r}, \tag{2}$$

where $PM_{i,r}$ is the domestic price of either wheat or milled rice in India, which in the model with endogenous NRAs we keep relatively constant by fixing real producer prices; $TXS_{i,r,s}$, on the other hand, is the export tax (or subsidy) that changes in order to stabilize $PM_{i,r}$. It is clear from this expression that the export price FOB will vary in inverse proportion to the export tax, which in turn absorbs the price volatility that would otherwise be shared by India and the other regions according to their trade shares and demand and supply elasticities. A main implication of this is that by seeking to stabilize the domestic market, India pushes the instability out onto its trading partners.

Table 3 verifies that, indeed, once India refrains from using stabilizing policies, the standard deviation of the FOB prices of Indian commodities decreases, by 17.2 percentage points in the case of wheat and by 27.5 percentage points in the case of rice. As a consequence, the standard deviation of import wheat and rice prices originating in India falls across the board for both wheat and rice (column labeled "Border price" in table 3). However, although import prices become less volatile, wheat and rice markets in South Asia operate near autarchy, which shields the other countries in the region from India's policy-induced volatility, as evidenced by the very low change in the standard deviation of domestic prices, production, and consumption.

VII. Conclusions

We examined the extent to which India's price management policies have affected the rice and wheat markets in neighboring South Asia countries. A first conclusion is that consumers in countries that import from India (Bangladesh imports wheat, and Bangladesh, Nepal, and Sri Lanka import rice) benefit from the implicit export subsidies that India's policies confer on their products while producers are harmed. In contrast, when the policies result in taxation, Indian export prices are higher than they would be in the absence of distortions, and consumers in the importing countries face higher prices, which in turn benefit producers. For Pakistan, which competes with India in both the wheat and rice markets, new market opportunities open up when India reduces export subsidies. These benefits are even larger when the policies result in implicit export taxation that keeps Indian rice (or wheat) out of the regional markets.

The magnitudes involved are moderate. For example, in 2004 when export subsidies were among the highest in recent history, the price increases accruing to Bangladesh wheat producers after eliminating the subsidies were around 2%. A caveat is that we do not investigate the consequences of these increases for poor consumer. In countries where income protection / farm stabilization projects seek to protect the poor, this is an important consideration. Another caveat is that we have focused on the effects of Indian border policies on regional price stability given the current structure of regional trade flows. An important question, which we do not address here, is to what extent the limited openness of South Asian countries to each other in itself is a response to Indian policies (or to the stabilizing policies of other countries in the region). If it is the case that price protection policies lead themselves to low intraregional trade volumes, dismantling such measures could deepen trade ties.

Historical nominal rates of assistance show that India's policies flexibly adjust to insulate the domestic cereal markets from domestic and external shocks. We found that although India is a large producer of wheat, it is a marginal player in the global wheat market, and therefore its stabilization policies are of little consequence for both the region and the world. In the case of rice, our results show that by stabilizing its domestic market, India destabilizes prices in the region. However, due to the near-autarchy under which rice markets operate in South Asia, changes in India's price volatility do not have discernible effects in other South Asian regions.

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