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**India's Grain Security Policy in the Era of High Food Prices:
A Computable General Equilibrium Analysis**

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This study evaluates the fiscal and welfare costs of India's food policy during the 2007-08 global food crisis. India's domestic grain price stabilization through consumer and producer subsidies and export restrictions is shown to have caused huge fiscal costs and equally large welfare costs, an outcome that is almost always the worst as compared to alternative policy mixes examined. While the most efficient and cost-effective alternatives may not be feasible due to political economy considerations, we argue that there exist some feasible and superior "middle-ground" policy mixes featuring partial relaxations of domestic subsidizations and/or less restrictive border policies.

Keywords: India, food security policy, trade policy, agriculture subsidy, computable general equilibrium



1. Introduction

Following recent world food price spikes, particularly the 2007-8 world food price crisis, food security has once again been recognized as a major challenge facing the world. In addressing the global food security issue, many experts and policy analysts focus on India as an ideal case study, because it is home to one third of the world's poor and nearly one quarter of the world's undernourished population; it has a long history with problems in feeding its huge population and food insecurity has still been identified as one of its biggest challenges; and it maintains one of the most expensive and extensive food and related subsidy programs. India's post-independence food policy has evolved on the basis of painful experiences of recurrent food shortages and famines during the colonial period (Shreedhar *et al.*, 2012). And it has been further shaped in recent years by the emergence of the "right to food" concept, which has gained momentum in India since the late 1990s. As pointed out by Pritchard *et al.* (2014, p.4), "*these rights-based perspectives on food are complemented by conceptualizing food security through the notions of freedoms and capabilities*". The right-based approach to food has been further strengthened by the passage of the National Food Security Act (NFSA) in September 2013. Because of these reasons, food grain production and consumption in India have been heavily influenced by government interventions with the overriding objectives being securing food grain self-sufficiency and providing/distributing subsidized food grains to its large population. India managed to achieve overall food self-sufficiency after launching an agricultural strategy, commonly known as the Green Revolution in the 1960s, which helped transform the supply/demand food grain balance sheet and placed India into a much better position to feed its people (Pritchard *et al.*, 2014).¹ This achievement has also been aided by extensive policy interventions in supporting domestic production. The Government of India (GOI) has also been active in using food subsidies to combat widespread hunger, malnutrition and food insecurity among its large poor population.

¹ Currently India ranks second in the world in both rice and wheat production by contributing around 21 and 11 percent respectively to world rice and wheat production. About 64 percent of gross cropped area in India has been allocated for grain production (Shreedhar *et al.*, 2012). Some even predict that India will face a growing surplus in rice and wheat by 2025 (Ganesh-Kumar *et al.*, 2012).

To maintain high level of domestic grain supply, the GOI has implemented food policy to insulate its domestic market from the international market through higher border protections such as high import barriers and/or support for exports (or export restrictions when world market prices are high) over four decades (see Pursell *et al.*, 2009). Domestically, minimum support prices (MSPs) and central issue prices (CIPs) for key agricultural commodities have been used to fix prices at farm gate and consumer levels. In order to sustain the targeted MSPs, key agricultural inputs such as fertilizers and electricity are heavily subsidized. Public stockholding and state trading also play important role in regulating domestic demand and supply balance to achieve the goals of building a targeted level of public stock and of dispersing food grains through its public distribution system (PDS) which evolved as the targeted public distribution system (TPDS) in 1997. The PDS was restructured as TPDS in order to target poor households and use the food subsidy program to reduce poverty. The TPDS is the largest food distribution system in the world and the largest food subsidy program in India.² This has become a major component of India's social safety net and poverty reduction program. On the consumption side, in recent years the TPDS has provided subsidized wheat and rice to poor consumers at the CIPs, which have been kept artificially low and stable.

While helping realize its food security goals, India's food policy certainly places heavy fiscal burdens on the GOI and its welfare effects have also been debated (see e.g. Jha *et al.* 2013, Sharma 2012, Shreedhar *et al.*, 2012, and Svedberg, 2012). As shown in Figure 1, food and fertilizer subsidies amounted to US\$9 billion in 2004-05. The high fiscal costs of these interventions have further increased during the recent world food price crisis (see Figure 2), as higher world market prices necessitated more stringent export restrictions and higher fiscal expenditures in maintaining stable domestic prices. For example, food and fertilizer subsidies in India jumped to US\$ 27 billion in 2008-09 (Figure 1) and total fiscal costs of India's policy in maintaining stable domestic food grain prices is estimated to be about 19 percent of the India's fiscal revenue in 2008 (Jones and Kwiecinski, 2010). This is because to curb the transmission of higher world

² The PDS has a very long history dating back to the colonial era. There is a large body of recent literature on the PDS and TPDS. For details, see Tarozzi (2005), Ganesh-Kumar *et al.* (2007), Khera (2011a, 2011b and 2011c), Sharma (2012), Svedberg (2012), Jha *et al.* (2013), Bandara (2013) and Prichard *et al.* (2014).

market prices to domestic markets, export restrictions were put in place. At the same time, in order to compensate for the rising input costs, the MSPs were also increased together with increased spending on input subsidies to partially offset rising input costs. On the consumption side, higher procurement prices for the TPDS under stable CIPs implied much higher spending on providing subsidized grains to poor consumers. As such, India's fiscal spending was ballooned as a result of its policy responses to higher world food prices. With the NFSA aiming at expanding coverage of food subsidies, some predict that the cost of its implementation will be even higher (Gulati *et al.*, 2012, and Sinha, 2013).

Although India's policy responses to the recent world food price crisis have been documented at the international level, the welfare costs of these policy responses have not been evaluated and discussed extensively in domestic policy debates in India, probably due to the considerable political support for such actions.³ In fact, recent debates in India seem to be narrowly focused on how to adjust elements contained in the NFSA without addressing the insulating and price stabilizing nature of India's overall food policy. For instance, much of the domestic debate is about whether the current TPDS system should be completely or partially replaced by cash transfers (CTs)⁴, rather than whether a more market-oriented approach should be adopted. Against this background, in this study we choose to focus on the international linkages of India's food policy interventions for purposes of estimating their true welfare and fiscal costs. This is because these linkages are not sufficiently explored in the current literature and also because in the absence of these linkages the true welfare/fiscal costs cannot be accurately measured. In particular, the "endogeneity" of the fiscal costs of the various

³ See Anderson and Nelgen 2012, Bouet and Laborde Debucquet 2012, Ivanic *et al.* 2011, and Martin and Anderson 2012 for recent evaluations on insulating domestic and trade policy responses to the world food price crisis at the global level. For recent political economy discussions of distortions to agricultural markets, see Anderson, Rausser and Swinnen 2013.

⁴ Contentious issues in these debates are whether the proposed CTs would ensure better targeting, such as better inclusion of actual poor people identifiable by multiple criteria and exclusion of un-intended recipients; whether the CTs would increase actual access to food grains of the poor people; whether the CTs would fare better in eliminating/reducing leakages, wastes and corruptions which have plagued the TPDS, thereby improving the transfer efficiency; and whether the CTs would operate within a reasonable fiscal framework (see e.g. Gulati *et al.* 2012, Kapur 2011, and Svedberg 2012).

subsidy programs on world market price movements are explicitly investigated in this study. In pursuing this focus, we use India's experience during the world food price crisis in 2007-8 as an example. We also illustrate the development and interactions of the various policy instruments used by India during the recent world food price crisis, and explore the comparative desirability of India's policy choice, as compared to alternative policy options. The lessons learned from the global food crisis of 2007-08 may provide useful inputs to policy advisers and policy makers in making future food security policy in India.

In order to achieve the above objectives, we rely on numerical simulations based on a computable general equilibrium modeling framework to explore – in the presence of world market price spikes and international trade linkages – the individual and joint effects of observed policy interventions on the domestic market outcomes. Based on the quantified effects, the fiscal costs and welfare implications of these policy interventions aiming at maintaining food security will be computed and illustrated. With these quantified estimates, we hope to shed some light on the real economic costs/benefits of India's food security policy as well as on illuminating potentially conflicting effects of individual policy instruments when these instruments are used in conjunctions with others. Since such broad perspectives have been largely missing in the current debate on the NFSA and CTs in India, it is hoped that this analysis will contribute to a better positioning of the debate of India's food security policy.

The rest of the paper is organized as follows. In section 2, we briefly review India's food security situation and its policy actions during the 2007-8 period. In section 3, we set out our numerical modeling and simulation methods, as well describe essential data and calibration efforts, before turning into the policy scenarios to be simulated and analyzed. Section 4 is devoted to the analysis of the numerical results. The last section concludes.

2. India's grain trade and grain security policy during 2007-8

As noted in the introduction, India has been able to maintain a high level of self-sufficiency in food grains. Rice and wheat are the two most important food grains

consumed and produced in India. On the world market, India has been an occasional importing or exporting country of wheat, depending on the domestic market situations rather than the world market situations. As can be seen from Figure 3 (plotted using UN COMTRADE data; same for Figures 3 and 4), during the period of 1988-2012, India had noticeable wheat exports for only 10 years, with five of those years with exports around or lower than 1 million tons. In another mostly different 10 years in the period India imported wheat, with the highest imports of over 5 million tons reached in 2007. As suggested by a number of studies, wheat imports in India were either motivated by the need to supplement domestic supply or to restore depleted domestic stockholding. Therefore, these wheat trade flows were not direct responses to world market situations.⁵

Rice, on the other hand, has been consistently exported by India in the same 25 years period, with the highest exports exceeding 10 million tons in 2012, making India an important player on the world rice market for that year (see Figure 4). During the recent period of high world rice prices, however, India was not supplying as much to the world market. For instance, India only supplied 3.5 million tons in 2008 and 2.1 million tons in 2009, as compared to 6.2 million tons in 2007, even though the world rice price in 2008 was almost doubling that in 2007. On the import side, India basically did not import rice at a noticeable scale. In fact, from 2003 to 2010, the UN COMTRADE data shows no imports by India.

Unlike rice and wheat, India has not been able to be as nearly self-sufficient on fertilizers, the key input vital to India's rice and wheat production. According to Figure 5, India has increasingly relied on imported fertilizers since 2005, with peak import values reaching a historical high of US\$12.3 billion in 2008. During the period of 2009-2012, fertilizer imports remained in the range of US\$ 6 to 9 billion. Since India does not export fertilizers, this recent import record places India as one of the more important importers on the world fertilizer market.

⁵ See Acharya et al. 2012 for evidence on the lack of integration between India's domestic grain market and the world market.

India's food security policy, as briefly described in the introductory section of this paper, has generally followed an upward trend in terms of its implied fiscal spending in recent years. This trend can be illustrated in Figure 1, where three important subsidies underpinning India's grain security policy are listed for the period of 2004-2012. They include: food subsidy related to public procurement and public distribution of grains; fertilizer subsidy used for reducing users' (farmers') production costs; and electricity subsidy to agricultural consumers which is mainly used for reducing irrigation costs. Food subsidy rose from about US\$5 billion in 2004-5 to about 10 billion in 2008-9, and then 14 billion during 2009-11, and eventually reached 15.4 billion in 2011-2. Fertilizer subsidy was US\$3.5 billion in 2004-5, reached the peak level of nearly 17 billion in 2008-9, and remained at or above 12 billion thereafter. Similarly, electricity subsidies also followed this upward trend. These rising subsidy costs have been noted in recent discussions at the international level (see e.g. Wiggins 2010, and Jones and Kwiecinski 2010). Continued increase of these subsidies even after the global food crisis in 2007-08 has also become a major concern among policy makers and policy analysts in India, as for example observed by Rashid *et al.* (2013, p.714):

“ . . . A disturbing feature of agricultural policy in our country is the large and growing amount of input subsidies. The subsidies are progressively losing their relevance and becoming an unbearable fiscal burden. Their role in contribution to productivity enhancement is fast disappearing. As a vehicle for increasing income of the producers, they have proved to be an inefficient and inequitable instrument. Three areas where actions need to be taken with urgency are subsidies on fertilizer, power, and surface irrigation.”

This rising trend of subsidies, coincides with the rising trend of world market prices for rice, wheat and fertilizer, as can be seen in Figure 5, where the price indices of these products sourced from the World Bank Pink Sheets are superimposed to the plot of the subsidy data. For instance, the price index for fertilizer on the world market increased by 168% in 2008 as compared to 2007, whereas India's fertilizer subsidies rose from less than US\$7 billion to nearly US\$17 during the same period. The apparent correlation between world market prices and India's expenditures on the subsidies is hardly a coincidence. Taking food subsidy as an example, when facing the rising grain prices and

fertilizer prices on the world market, the GOI had to adjust the MSPs to defray rising production costs on the one hand and had to maintain the CIPs for the poor consumers on the other hand. This implies that the subsidies given to both producers and consumers amount to a large sum, as indicated by the food subsidy spending in Figure 4 and 5. The same can also be said for the fertilizer subsidy, because rising world market prices of fertilizers implies that the GOI had to provide more subsidies to management users' price for fertilizers.

In addition to providing larger amount of domestic subsidies to manage the pressure of rising world market prices (and domestic situations), the GOI also imposed various export restrictions. During the 2006-2009 period, a number of import and particularly export policies were put into place, with the aim of securing domestic supply by restricting export supply.⁶ The major trade policy measures adopted by GOI in the period included reductions of import tariffs on wheat and wheat flour, rice, maize, pulses, and vegetable oils, for purposes of increasing domestic supply and moderating the upward pressure on domestic prices; increased export taxes and minimum export prices on basmati and non-basmati rice; as well as export bans and quotas on wheat and wheat products, and pulses and milk powder. Given India's position as a consistent exporter of rice, the most restrictive aspect of these trade policy changes seems to be on rice exports, especially considering the sharp rise of world rice price, which in 2008 increased by nearly 100 percent.

3. Methodology, Data and Scenarios of Numerical Experiments

3.1 Model and Numerical Methodology

The objectives of this study require detailed economic modeling of many policy instruments influencing the production, public procurement, international trade and consumptions of food grains, as well as the production and uses of key grain inputs such

⁶ See Jones and Kwiecinski (2010) for a detailed review of India's trade policy during the 2007-8 period, and OECD (2009) for a more general perspective on India's agricultural trade policy. Gopinath (2008) provides a detailed assessment on measuring India's agricultural domestic support within the WTO classifications, whereas Narayanan (2013) offers a more updated assessment on whether India's agricultural trade policy can be accommodated with its WTO commitment. Also see Shreedhar (2012).

as fertilizers. In other words, both domestic and international markets of grains and key inputs have to be modeled. Moreover, consistent economic welfare analysis has to be conducted to evaluate the economic consequences of different and alternative policy instruments. As such, a general equilibrium modeling approach featuring inter-sectoral and international trade linkages would be a preferred analytical vehicle for this study. For these purposes, we adopt and modify the global CGE modeling framework and database nicknamed GTAP, developed in Hertel (1997), to carry out modeling and numerical analysis. Observed world market price shocks and actual and alternative government policy changes can be modeled as exogenous shocks in alternative experiments to generate numerical results, which can then be analyzed in regards to the proposed research objectives of this study.

The GTAP model is a widely used multi-sector and multi-region computable general equilibrium model of the world economy. The standard GTAP model assumes perfectly competitive markets and constant returns to scale technology. Nested constant elasticity of substitution production functions are defined over intermediate inputs and primary production factors such as land, capital, skilled and unskilled labors, and natural resources. On the demand side, private demand of a representative private household follows a constant difference in elasticity demand function, which in turn enters into the aggregated demand function together with government and saving demands. Countries and regions in the model are linked through international trade linkages specified in the Armington structure and a global bank sector that intermediates global savings and consumptions (for details see Chapter 2 of Hertel, 1997).

To illustrate the welfare and fiscal costs of India's food security policy under high world market prices for grains, economic effects of individual policy instruments and their combinations as pursued by the GOI are examined through a series of counterfactual simulations with our modified version of the GTAP model. We base these simulation exercises on the GTAP version 8 database, which has 2007 as its base year and covers 112 countries/groups of countries and 57 sectors.⁷ For the purposes of this study, we aggregate the original database and model to a world of two regions: Indian and the Rest of World (ROW) and 44 sectors (including all 19 agriculture and food sectors originally listed in the disaggregated GTAP database). The compact aggregation of two regions allows us to maintain the important international trade linkage vital to this analysis, while at the same time affords us the

⁷ Detailed documentation for the GTAP 8 database are available in Badri, Aguiar and McDougall (2012).

flexibility to generate the needed world market price shocks which are considered “exogenous” to India. In addition, this choice permits more focused analysis of India’s food policy.

3.2 Modification to the GTAP model and database

The original GTAP model and database has been modified in several respects. Due to the short-run nature of India’s policy, especially its trade policy responses to changes in world market prices in 2007-8, we make several modifications to the model such that it resembles a short-run model. This involves changes to some of the modeling structures, especially the production specification. For instance, fertilizer subsidy is an important consideration of GOI, since India does not have enough capacity to mobilize capital to build new fertilizer plants in responding to rising fertilizer prices. Therefore, we restrict capital mobility in the model to prevent unreasonable inter-sectoral capital movement in the short run.

Another noteworthy change is the creation of an additional fertilizer sector in the model and database. Fertilizer is not a separated GTAP sector, as it is included in the “chemical, rubber and petroleum” (CRP) category. In order to capture the effects of the aforementioned domestic policies on fertilizer (which differ significantly from trade policies applied to CRP in general), we use a GTAP database program named SplitCom (Horridge, 2008) to create a new fertilizer sector in our aggregated GTAP database. In carrying out the split, we target both fertilizer trade flows as well as total domestic fertilizer production in India. Without further information on the cost structure of the newly created fertilizer sector, we allow it to mirror that of the original CRP sector. However, shares of fertilizer uses in India’s agricultural sectors are reasonably represented with the new fertilizer sector, given the fact that both fertilizer production value and agricultural production values are explicitly targeted in the calibrated database. Moreover, since most of the CRP outputs used in agricultural production in India are in fact fertilizers, this split greatly reduce the intensity of CRP use in agriculture. The resulted new database otherwise maintains all other information in the original GTAP database. After the SplitCom procedure, the specific trade policies for fertilizer are imposed in the new database to establish the base case of this study.

Other changes to the model and data are related to the need to either create new policy instruments or to generate auxiliary variables to account for or facilitate the design of alternative policy scenarios.

3.3 Policy instruments and database calibration

Data on India’s policy measures are gathered from various recent policy reports and publications from the GOI, other public agencies and international organizations, as well

as academic sources. Central to the purposes of this paper are India's domestic support policy on grains, mainly on wheat and rice. The Global Agriculture Information Network (GAIN, various issues) reports on India provided by the Foreign Agriculture Service of the US Department of Agriculture (USDA-FAS) offer annual accounts of India's grain production, consumption, trade, and stock situations as well as government support price for grain procurement and central issue prices for grain distribution under the TPDS. We rely on these reports and the GOI's annual financial reports as primary source of India's domestic policy on grains. Trade policy practices by the India government in recent years have been surveyed in a number of studies by several international organizations, such as an FAO report on policy responses to the world food price crisis (Demeke *et al.*, 2008), and an OECD working paper on policy responses in emerging economies to commodity price surges (Jones and Kwiecinski 2010) which contains details on India's domestic and trade policy changes in 2007-8. Another OECD publication (OECD, 2009) also provides discussions on other aspects of India's agriculture domestic support policy, such as various input subsidies on fertilizers and electricity. We use information from these sources and data gathered from various other sources, such as the World Bank's agricultural distortion data base on India (Pursell, Gulati and Gupta 2009), the IFRPI's shadow WTO agricultural domestic support notifications on India (Gopinath, 2008), and several recent journal articles, to develop a complete picture of India's input subsidy programs.

The gathered policy data for the year 2007 – as summarized in Figures 4 and 5 – are then integrated into the modified model and the actual “size” of the instruments (i.e. government spending) are calibrated into the accompanying GTAP version 8 database, which has a base year of 2007.⁸ More specifically,

- a. *Food subsidy* on grains which is implemented through the MSP on production side, the CIPs on the consumption side, is calibrated and modeled as a single

⁸ The calibration of the GTAP version 8 database to the following policy details are achieved through numerical simulations with the ALTERNATE routine of the GTAP modeling suite (Malcolm, 1998)

output/consumption subsidy attached to rice and wheat. To simplify matters, a homogenous subsidy rate is used across rice and wheat.⁹

- b. *Fertilizer subsidy* is calibrated as an intermediate input subsidy to the use of fertilizers in agricultural crops, with a homogenous subsidy rate across fertilizer-using crops. The subsidy rate, however, differs across imported and domestically produced fertilizers, as per the reported split between subsidies allocated to the two categories according to the GOI financial reports.
- c. *Electricity subsidy* for agricultural consumers is calibrated and modeled as an intermediate input subsidy to the use of electricity in agricultural crops, with a homogenous subsidy rate across crops.
- d. *Reported government expenditures* on the above subsidies, as obtained from the GOI financial reports and the Planning Commission's report, are individually targeted during the calibration process. This is achieved in the calibration process by fixing the GOI's subsidies expenditure while allowing the corresponding subsidy rates to adjust.
- e. *Observed trade policy changes in 2007* include reductions of ad valorem import tariffs, introduction and changes of export taxes, and imposition of export bans. Export bans are modeled and calibrated as prohibitive export taxes by observing average historical domestic and world market prices.

This calibrated database reasonably reflect India's food security policy for the year 2007, as well as the agricultural production, demand and trade situation for that year. Therefore, it forms a good basis against which the effects of India's policy changes and world market price changes in 2008 can be simulated.

3.4 Experiment design

Against the calibrated 2007 database, we first simulate the actual annualized changes of the world market prices for the two most important food grains in rice and wheat, as well as that for fertilizers, using the price data sourced from the *World Bank Pink Sheets*. These price shocks are 13.8% for wheat, 99.2% for rice, and 168% for fertilizers. Unlike

⁹ In the actual model, food subsidy on rice is specified as a subsidy on paddy rice, rather than on processed rice for ease of model implementation.

single country CGE models or partial equilibrium models, all prices except for the price of the numeraire good in the GTAP model are typically endogenously determined. Therefore, we need to shock a set of exogenous variables in the model to replicate the observed changes in world market prices. To avoid overly complicated mechanisms to achieve these changes in world market prices, we choose to introduce endogenous supply side shocks so as to lock in the observed actual changes in world market prices. More specifically, this is achieved through “swapping” the total factor productivities (which are normally exogenous in the model) in the ROW for the world market prices of the above-mentioned three products, such that the former is endogenously determined whereas the latter becomes exogenous and can be shocked to the desirable levels.

With the actual changes of world market prices for rice, wheat and fertilizer being guaranteed to be part of the equilibrium solution of the model, we then introduce actual policy actions in India in 2008, including:

- domestic market stabilization of rice and wheat prices;
- domestic market stabilization of fertilizer prices;
- changes in export tax and bans on the relevant products.

Domestic price stabilization for rice, wheat and fertilizer is realized in the model by endogenizing food and fertilizer subsidies and exogenizing the corresponding market prices, whereas the export bans are modeled through fixed export quantities and endogenous export taxes. These shocks to the model, including the shocks to the world market prices, comprise the first experiment of this study (termed “*EXP1*”), with the aim being illustrating the endogenous nature of India’s fiscal burden in choosing the observed these stabilization policies as responses to rising world market prices of food grains and fertilizers in 2008.

Policy scenarios as alternatives to the observed policy actions contained in experiment *EXP1* are explored in various additional experiments, with the aim of revealing the fiscal and welfare costs of the actual policy measures adopted by India, especially with respect to the possibly conflicting nature of actual used policy instruments which exerted

opposite influences on important policy objectives.¹⁰ Simulating these alternative scenarios also helps to provide analytical inputs on better policy options in the future.

These alternative scenarios are summarized in Table 1, with the policy choices and model implementations being listed under the headings of food subsidy, fertilizer subsidy, and export policy. The relationship between these alternative scenarios and *EXP1* is also outlined in respect to implementations in the GTAP model. These alternative scenarios are briefly described below:

- *EXP2* is a scenario in which domestic market stabilization measures on rice, wheat and fertilizers as contained in *EXP1* are retained, but increases in export tax or imposition of export bans in 2008 are assumed to be absent, such that export quantities are endogenously determined.
- *EXP3* differs from scenario *EXP1* in allowing consumer prices of rice and wheat to be endogenously determined while fixing the food subsidy spending to the 2007 level. This scenario allows for transmission of world rice and wheat prices to the Indian market, while restricting exports to the world market.
- *EXP4* allows endogenous food and fertilizer prices, and endogenous export quantities, with fixed spending on food and fertilizer subsidies and unchanged export policies. This scenario implies unchanged spending on food and fertilizer subsidies and unchanged export policies, thereby offers a completely “opposite” policy mix as compared to the actual policies modeled in *EXP1*. Therefore it can be considered as the most market-oriented responses to the world food price crisis.
- *EXP5* only allows domestic market stabilization for grains by fixing rice and wheat prices while endogenizing food subsidy spending. Unlike *EXP1*, fertilizer subsidy spending is fixed and export policy is unchanged from 2007.

¹⁰ This point is made in Yu and Jensen (2014).

- *EXP6* differs slightly from *EXP5* by fixing fertilizer spending rather than food subsidy spending so that domestic rice and wheat prices are fixed while users' fertilizer prices are allowed to adjust. Again, export policy is assumed to be unchanged from 2007.

Among the various hypothetical alternative scenarios, *EXP4* is considered to be the antithesis of *EXP1* which contains the observed policy responses of India in 2008. All the other alternative scenarios (i.e. *EXP2*, *EXP3*, *EXP5*, and *EXP6*) are somewhere “in between” *EXP1* and *EXP4* and represent a set of possible “mid-ground” policy mixes. In what follows, we first present results from *EXP1* and then proceed to the alternative scenarios. In analyzing the results from the alternative scenarios, we pay particular attention on the welfare and fiscal costs of the “middle-ground” policy mixes.

4. Results

4.1 *Market effects of India's actual policy responses in 2008 (exp1)*

We first present the results regarding the effects of India's policy responses in 2008, as simulated in our benchmark experiment *EXP1*. According to the formulation of this experiment, domestic market prices for rice, wheat and domestic user prices for fertilizers are all assumed to be kept constant whereas the expenditures on these subsidies are allowed to adjust. In responding to higher world market price for fertilizers (168% increase), domestic costs for imported fertilizers also rise. But with our short-run modeling structure featuring limited capital mobility, capacities of domestic fertilizer production cannot be expanded very much. Therefore, large increase of domestic subsidies on fertilizers is triggered for maintaining unchanged user prices. When world market prices for rice and wheat rise but their domestic market prices are held constant, there would be reallocations of production factors from rice and wheat to other agricultural sectors, which in turn bids up input prices and hence higher producers prices for rice and wheat. With fixed domestic market prices, increased producer prices imply higher food subsidies. As shown in Figure 6, both food and fertilizer subsidies were increased from 2007 to 2008, from about US\$7 billion to more US\$10.2 billion for food subsidy and 16.9 billion for fertilizer subsidy, respectively. As a

validation of our modeling exercises, it can be seen that our estimated food and fertilizer subsidies (which are endogenous in the scenario *EXP1*) for 2008 come reasonably close to these actual numbers, with the food subsidies at nearly US\$7.96 billion and fertilizer subsidies at 17.92 billion.

More detailed results on the market and output effects from *EXP1* are summarized in Table 2. As per the assumption of the experiment, paddy rice and wheat prices are constant, whereas processed rice price only decreased slightly and fertilizer price also rises slightly. As also expected, producer prices of both paddy rice and wheat rise, by respectively 1.9 and 2.7 percent. Indeed, these gaps between producer and market prices are the sources of the increased food subsidies. Domestic market price and producer's price of fertilizers increase by the same proportion as we assume that fertilizer subsidies are mainly paid to imported fertilizers. On the output side, paddy rice and process rice supply actually decrease slightly, mainly due to the further export restrictions on rice exports, even though producer prices actually increase. Wheat outputs, however, increase noticeably (by 3.4%), due to reduced imports in the presence of high world market prices. Similarly, domestic fertilizer outputs also rise, in responding to slightly increased producer price.

The rest of Table 2 presents a decomposition of the individual effects of the various shocks contained in *EXP1*, which provides more details into how these different shocks jointly determine the observed market outcome in India. Starting with the decomposed effects on market prices in Table 1, it can be seen that changes in world market prices would have increased domestic wheat and processed rice price by more than 11% in the absence of India's policy responses in the form of export restriction and increased spending in food subsidies. Similarly, fertilizer prices would have increased by nearly 30% on the Indian market, if fertilizer subsidies had not been increased. Export restrictions on rice alone moderated about 7.8 and 4.7 percentage points of the potential paddy and processed rice price increases caused by the rise in world market prices. The remaining moderating effects are due to increased fertilizer and food subsidy spending, with the fertilizer subsidy contributing much more than food subsidy. Likewise, the positive producer price effects of increased world market prices are estimated to be

moderated by export restrictions and increased food and fertilizer subsidies, as illustrated in the middle panel in Table 2. From the point view of stabilizing domestic market prices for both food grains and key inputs, it can be readily seen that by using export restrictions and domestic subsidies, the GOI was able to achieve the intended domestic objectives. However, the realization of these objectives came at a rising fiscal cost.

While both export restriction and in particular domestic subsidies help rein in rises in domestic grain prices in India, these two types of policies offer quite opposite supply responses. As a rice exporting country, India's export restrictions certainly discourage Indian rice producers from taking advantage of rising world market price (which increased by over 99% in 2008) and serve the purposes of diverting export supply to domestic supply. Against rising input prices and constant domestic market prices and only slightly increased producer prices, these export restrictions alone would have resulted in reductions of paddy and processed rice supply by nearly 9 and more than 13 percent, respectively, which would have completely offset the potentially positive supply responses caused by rising world market prices alone (lower panel in Table 2). Rising fertilizer and food subsidies, however, counteract the negative supply side impact of export restrictions, by allowing imported fertilizers of lowered costs and slightly increased producer prices for rice and wheat. So, on balance, both wheat and fertilizer outputs are estimated to expand rather than contract, and rice output only decreases slightly.

In summary, this decomposition analysis clearly illustrates the different market price and output effects of export restrictions and domestic subsidies; i.e., while these policy instruments help moderate rising pressure of domestic market prices for grains and fertilizers, they generate opposite domestic supply responses. This is a point highlighted by Yu and Jensen (2014) in their analysis of China's responses to the world food price crisis.

4.2 Market effects of alternative scenarios (EXP2-6)

We now turn to summarized simulation results from alternative scenarios EXP2-6, which are reported in Table 3 and are discussed below.

Instead of increasing export restrictions in rice, *EXP2* assumes export policy in India remain unchanged in 2008; however, food and fertilizer subsidies are still endogenously determined to fix grain and fertilizer market prices. Simulation results show that processed rice market price would rise by 5.4% and fertilizer market price would rise by 7.2%. This is due to large increase in export demand in the presence of high world market prices. For producers, paddy rice and wheat prices would rise even more, by 42.7% and 8.9%, respectively, implying that spending on food subsidy would rise significantly. Also, with rising fertilizer price, there would also be even higher fertilizer subsidy. Both these developments suggest even higher government subsidy expenditure. However, when evaluating the welfare and fiscal costs of this scenario (as will be done in section 4.3), these rising subsidy expenditures should be evaluating against potentially rising export tax revenues due to relaxed export restrictions assumed, especially on rice.

EXP3 offers a set of policies that is the complete opposite of *EXP2*. Here it is assumed that there is no extra domestic market stabilization beyond what are included in the base case of 2007 against rice, wheat and fertilizer (i.e. expenditure on food and fertilizer subsidies are exogenous and fixed, whereas market prices are endogenous), but further export restrictions in *EXP1* are assumed. Under this scenario, while further export restrictions prevent transmission of rising grain prices (mainly rice price) to India's domestic market, rising input costs especially that of fertilizers will push up producer prices and hence market prices of grains. Since farmers do not receive extra subsidies to cover their rising costs according to the assumptions of this scenario, grain output actually would drop slightly. In this case, the GOI would not suffer further fiscal pressure because there would be no increased food and fertilizer subsidies. So, from a fiscal policy point of view, this set of policies is quite appealing; however, rising market prices would most likely make this alternative scenario political infeasible.

In *EXP4*, we continue to assume away domestic market stabilization, together with the additional assumption of no further export restrictions. Therefore this is a scenario that is the complete opposite of the actual situation in 2008 (i.e. *EXP1*). This scenario essentially assumes that the India government did not respond to the rising prices in

2008 and thus is purely hypothetical. In this hypothetical scenario, both market and producer's prices for rice, wheat and fertilizer would jump significantly. But at the same time, domestic outputs for rice and fertilizer would also rise substantially. In fact, as paddy rice outputs would rise by nearly 15% due to strong export demand, wheat output would shrink due to resource reallocations between the rice and wheat sectors. Significantly higher rice and wheat price would surely be met with massive resistance from consumers, even though producers would be assured of gains from both domestic and world markets. So even though the government would not commit any additional fiscal resources to subsidize food and fertilizer and would actually gain from increased export tax revenue from rice exports, implementing this mostly market-oriented policy option is highly unlikely.

In the last two alternative scenarios (i.e. EXP5 and EXP6), we explore the likely market outcomes of stabilizing either food price (EXP5) or fertilizer price (EXP6), while maintaining the 2007 export policy (i.e. no further export restrictions). Under EXP5, domestic fertilizer price would follow the rise on the world market, thereby pushing up production costs of rice and wheat and their producer prices. With fixed market prices for rice and wheat, rising producer prices imply a massive increase in food subsidy. However, as further export restrictions are assumed absent, there would be large amount of exported rice from India, thereby pushing up domestic production, as well as export tariff revenue. Under the alternative scenario EXP6, fertilizer subsidy would rise due to increased rice and wheat production and rising producer and market prices of these products.

In summary, domestic market outcomes can be very different under alternative policy scenarios, depending on whether the government objective is to maintain disciplined fiscal policy or to ensure market price stabilization at any cost. Clearly, the size of the subsidies and the degree and magnitude of supply responses depend critically on the assumed export restrictions on the main exportable good of rice. In the next section, we offer some further evidence regarding the relative desirability of these alternative scenarios from fiscal spending and welfare effect perspectives.

4.3 Fiscal implications and welfare effects of alternative policy scenarios

Despite the GOI's obvious choice to ensure market stabilization and self-sufficiency of rice and wheat supply, this choice is still very much debatable when considering the costs to reach this objective through the actual policy pursued. Table 4 presents both the fiscal costs and welfare effects associated with the actual policy choices (as in EXP1) and with the alternative scenarios (EXP2-6).

Judging from the total welfare effect, the actual policy choices as contained in EXP1 would actually result in the largest welfare loss at around US\$10 billion, as compared to the completely opposite policy choice as contained in EXP4, which is estimated to generate the second highest welfare gains amongst all the alternative scenarios considered. The net difference of estimated economic welfare between these two scenarios amounts to a massive US\$18.4 billion! The reason that the actual policy choices in EXP1 led to large welfare losses can be understood by the decomposition of this result as also provided in Table 4: a US\$8 billion loss of terms of trade and an additional loss of US\$1.2 billion in allocation efficiency. The large terms of trade loss is almost completely avoidable if further export restrictions and bans were not in place and if no further subsidies on grains and fertilizers were given, as in scenario EXP4. However, the highest economic welfare can be obtained from scenario EXP5, where no further export restrictions are assumed and fertilizer prices are allowed to adjust against fixed spending on fertilizer subsidies. In that case, larger adjustments in supply responses in the grain and fertilizer sectors are needed for realizing the large efficiency gains. Even though alternatives such as EXP4 (and EXP3 and EXP6) are politically infeasible, there seem to be some "middle-ground" policy choices consisting of less restricted export policy, such as the scenario EXP2, which would generate welfare gains rather than losses by allowing some supply to the export market when world market prices are high.

If one assumes that a systematic welfare economic analysis was absent when GOI policy makers were dealing with the situation in 2008, surely the fiscal implications of the chosen policy option must have been considered by these policy makers. Interestingly although not surprisingly, it is clear from the simulation results that the actual policy choices by the GOI would rank near the bottom when compared to the alternative

scenarios. Results from our simulation exercises of EXP1 show an increase of about US\$9.4 billion of government spending on food and fertilizer subsidies, net of the increased export tax revenue. This amount is a stark contrast to the estimated net saving of US\$10.9 billion in government spending from the scenario EXP4, which is comprised entirely of increased export tax revenues (recall that food and fertilizer subsidies are kept constant in EXP4). The largest estimated increase in fiscal spending is found in EXP2 at US\$11.4 billion, because of larger increase in food and fertilizer subsidies due to increased producer prices caused by assumed more relaxed export policies in that scenario.

5. Conclusions and Policy Implications

Consistent with its food security policy objectives, the GOI actively pursued domestic price stabilization for its major food grains and key agricultural inputs such as fertilizer when facing rising world market prices during the recent world food price crisis of 2007-8. The GOI also supplemented domestic interventions with more restrictive export policies. While able to insulate its domestic markets, such policy actions had the undesirable side-effects of incurring extremely large fiscal and welfare costs. Through a series of modeling exercises within a computable general equilibrium modeling framework where actual rising world market prices are simulated, we are able to explore the effects of both the actual and alternative policy options in this study.

Simulation results from this study suggest that full domestic market stabilization or insulation in the presence of rising world market prices for both grain commodities and key inputs is feasible only if both the international linkages in the agricultural commodities market and key input markets are restricted. Failing to do (as in the case of India where reliance on imported fertilizer is high) would result in very large fiscal costs. Moreover, when the interests of agricultural producer, poor consumer, as well as input producers all have to be considered, multiple policy instruments would have to be installed, further exasperating the government's fiscal burden. Indeed, as shown by the simulation results, actual policy mix pursued by the GOI resulted in almost the highest fiscal burden, as compared to a wide range of alternatives that are available. Part of the

reason is that when multiple instruments are used, offsetting effects amongst the policy instruments are inevitable which would necessitate higher government spending. In addition, the actually adopted policy mix is also shown to be the worst in terms of economic welfare effects, due to the very damaging export bans and high export taxes used in conjunctions with domestic subsidies.

These negative welfare and fiscal consequences of recent policy choices during episodes of high world market prices do not bond well with the recent policy development in India. By adopting the NFSA, the GOI is essentially committed to expanding many of the elements of the food security policy reviewed in this study, thereby exposing itself to further fiscal uncertainties, in addition to the economic inefficiency as suggested by this study and many other authors (see for example Gulati *et al.* 2012, GOI 2013, and Jha *et al.* 2013). Given the nature of food subsidies as an instrument of political patronage and its highly visible gesture to rural voters in the world's largest democracy, if outright free trade and more liberalized domestic policies are infeasible, at least some "middle-ground" policy mix that is located somewhere between purely market-oriented policy and those actually pursued during the 2007-8 period should be considered. For instance, as shown by simulation results in this study, incomplete domestic market stabilization and partial relaxations of stringent export restrictions would almost always generate much better outcomes both in terms of fiscal costs to the GOI and the welfare cost to the whole India economy. Overall, the results of our study suggest that the Indian government should carefully evaluate its food policy during and after the global food crisis and formulate future policy to minimize fiscal burden and welfare losses. In addition, the debate on changes to elements contained in the new NFSA should be separated from how India's food policy is formulated vis-à-vis India's linkage with the world market.

References

- Acharya, S.S., Chand, R. Kumar, B.S. and Negi, D.S. 2012. Market Integration And Price Transmission In India: A Case Of Rice And Wheat With Special Reference To The World Food Crisis of 2007/08. FAO, Rome.
- Anderson, K. and S. Nelgen. 2012. Trade Barrier Volatility and Agricultural Price Stabilization. *World Development*. Vol. 40, No. 1, pp. 36–48.
- Anderson, K., G. Rausser, and J. Swinnen. 2013. Political Economy of Public Policies: Insights from Distortions to Agricultural and Food Markets. *Journal of Economic Literature*, vol. 51(2), pages 423-77.
- Bandara, J.S. 2013. What is driving India's food inflation? A survey of evidence, *South Asia Economic Journal*, 14, 1, 127-156.
- Bouët, A. and D. Laborde Debucquet. 2012. Food crisis and export taxation: the cost of non-cooperative trade policies. *Review of World Economics*, Vol. 148, no. 1, 209-233.
- Demeke, M., G. Pangrazio, and M. Maetz. 2008. Country responses to the food security crisis: Nature and preliminary implications of the policies pursued. Rome, Agricultural Policy Support Service, FAO.
- GAIN-IN2026. 2012. India, Grain and Feed Annual, USDA FAS, 23 February.
- GAIN-IN1117. 2011. India, Grain and Feed Annual, USDA FAS, 23 February.
- GAIN-IN101. 2010. India, Grain and Feed Annual, USDA FAS, 17 February.
- GAIN-IN9025. 2009. India, Grain and Feed Annual, USDA FAS, 20 February.
- GAIN-IN8015. 2008. India, Grain and Feed Annual, USDA FAS, 20 February.
- Ganesh-Kumar, A., Gulati, A. and Cummings, A.R. 2007. 'Food grains policy and management in India: responding to today's challenges and opportunities', Mumbai and Washington D.C.: Indira Gandhi Institute of Development Research and IFPRI.
- Ganesh-Kumar, A., Mehta, R., Pullabhotla, H., Prasad, S., Ganguly, K., and Gulati, A. 2012. Demand and Supply of Cereals in India 2010-2025. IFPRI Discussion Paper 01158. New Delhi: International Food Policy Research Institute.
- Gopinath, M. 2008. India: Shadow WTO Agricultural Domestic Support Notifications. IFPRI

Discussion Paper 00792 September 2008. Market, Trade and Institutions Division, International Food Policy Research Institute.

GOI (Government of India). 2013. Economic Outlook 2012/2013. Economic Advisory Council to the Prime Minister, New Delhi. Accessed 11 April 2014, available at: http://eac.gov.in/reports/eco_report1708.pdf

Gulati, A., Gujral, J. Nandakumar, N. 2012. National Food Security Bill: challenges and options. Discussion Paper No.2, Commission for Agricultural Costs and Prices, Ministry of Agriculture, India, December.

Jha, R., Gaiha, R. Pandey, M. K., and Kaicker, N. 2013. Food subsidy, income transfer and the poor: A comparative analysis of the public distribution system in India's States. *Journal of Policy Modelling*, 35, 887-908.

Hertel T.W. 1997. *Global Trade Analysis: Modeling and Applications*, Cambridge University Press: Cambridge.

Horridge, M. 2008. SplitCom: Programs to disaggregate a GTAP sector. Centre for Policy Studies, Monash University, Melbourne, Australia.

Ivanic, Maros, Will Martin and Aaditya Mattoo. 2011. Welfare and Price Impacts of Price-Insulating Policies. Paper presented at the 14th Annual Conference on Global Economic Analysis, Venice, Italy, June 2011.

Jones, D. and A. Kwiecinski. 2010. Policy Responses in Emerging Economies to International Agricultural Commodity Price Surges. *OECD Food, Agriculture and Fisheries Working Papers*, No. 34, OECD Publishing.

Khera, R. 2011a. Trends in diversion of PDS grain. *Economic and Political Weekly*, 46(21), 106-14.

Khera, R. 2011b. India's public distribution system utilization and impact. *Journal of Development Studies*, 47, 4, 1038-60.

Khera, R. 2011c. Revival of the public distribution system: evidence and explanations, *Economic and Political Weekly*, 46(44), 36-50.

Kapur, D. 2011. The shift to cash transfers: running better but on the wrong road, *Economic and Political Weekly*, 46(21), 80-85.

Malcolm, Gerard. 1998. Adjusting Tax Rates in the GTAP Data Base. *GTAP Technical Papers* 15. Center for Global Trade Analysis, Purdue University. <http://docs.lib.purdue.edu/gtapt/15>

Martin, W. and K. Anderson (2012). Export Restrictions and Price Insulation During Commodity Price Booms. *American Journal of Agricultural Economics*, Vol. 94: 422-427.

Mishra, P. 2013. Financial and distributional implications of the food security law. *Economic and Political Weekly*, XLVII (39), 28-30.

Narayanan, S. 2013. IN THE BALANCE The National Food Security Act vis-à-vis the WTO Agreement on Agriculture. Working paper WP-2013-026, Indira Gandhi Institute of Development Research, Mumbai.

OECD. 2009. Agricultural Policies in Emerging Economies 2009 - Monitoring and Evaluation. (http://www.keepeek.com/Digital-Asset-Management/oecd/agriculture-and-food/agricultural-policies-in-emerging-economies-2009_agr_emerging-2009-en)

Pritchard, B., Rammohan, A., Sekher, M., Parasuraman, S. and Choithani, C. 2014. *Feeding India – Livelihoods, Entitlements and Capabilities*, Eathscane Routledge: London.

Pursell, G., A. Gulati, and K. Gupta. 2009. India. in *Distortions to Agricultural Incentives in Asia*, edited by K. Anderson and W. Martin, Washington, DC: World Bank, pp.339-378.

Rashid, S. P.A. Dorosh, M. Malek, and Lemma, S. 2013. Modern Input Promotion in Sub-Saharan Africa: Insights from Asian green revolution. *Agricultural Economics*, 44, 705-721.

Sharma, V.P. 2012. Food Subsidy in India: Trends, Causes and Policy Reform Options. Working Paper No. 2012-08-02, Indian Institute of Management, Ahmedabad.

Shreedhar, G., Neelmani G., Pullabhotla, H. Ganesh-Kumar, A. Gulati, A. 2012. A Review of Input and Output Policies for Cereals Production in India, Environment and Production Technology Division, International Food Policy Research Institute.

Sinha, D. 2013. Cost of implementing the National Food Security Act, *Economic and Political Weekly*, XLVII, 39, 31-34.

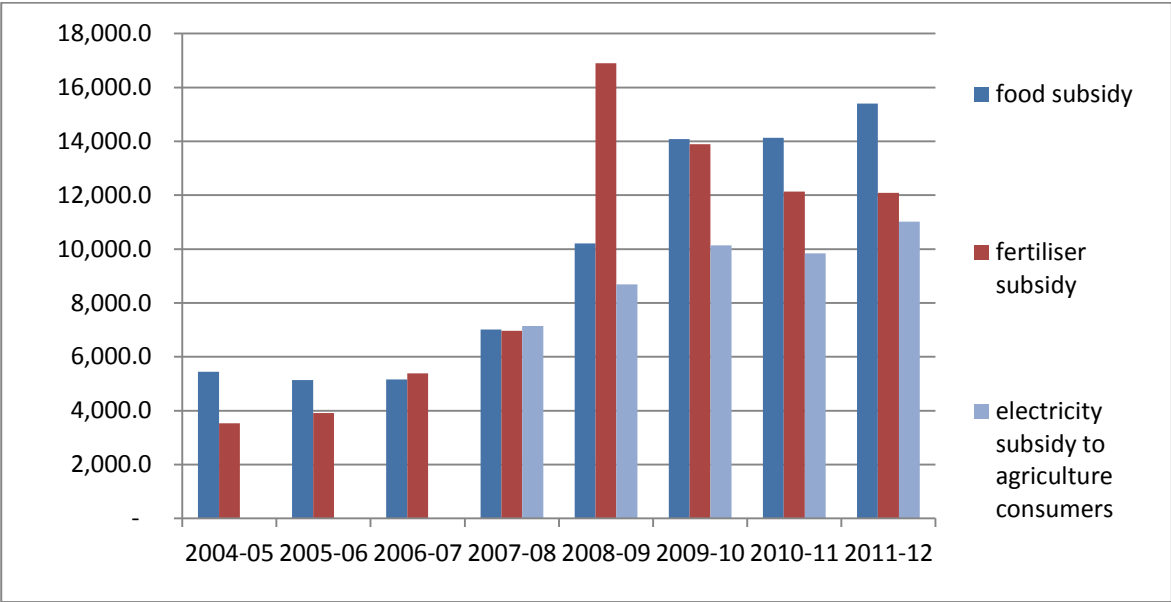
Svedberg, P. 2012. Reforming or Replacing the Public Distribution System with Cash Transfers? *Economic & Political Weekly*, 47(7), 53-62.

Tarozzi, A. 2005. The Indian Public Distribution System as a Provider of Food Security: Evidence from Child Nutrition in Andhra Pradesh, *European Economic Review*, 49, 1305-1330.

Wiggins, S. 2010. The Use of Input Subsidies in Developing Countries, A paper presented to the working party on Agricultural Policy and Markets, 15-17 November, 2010, TAD/CA/APM/WP(2010)45. OECD: Paris.

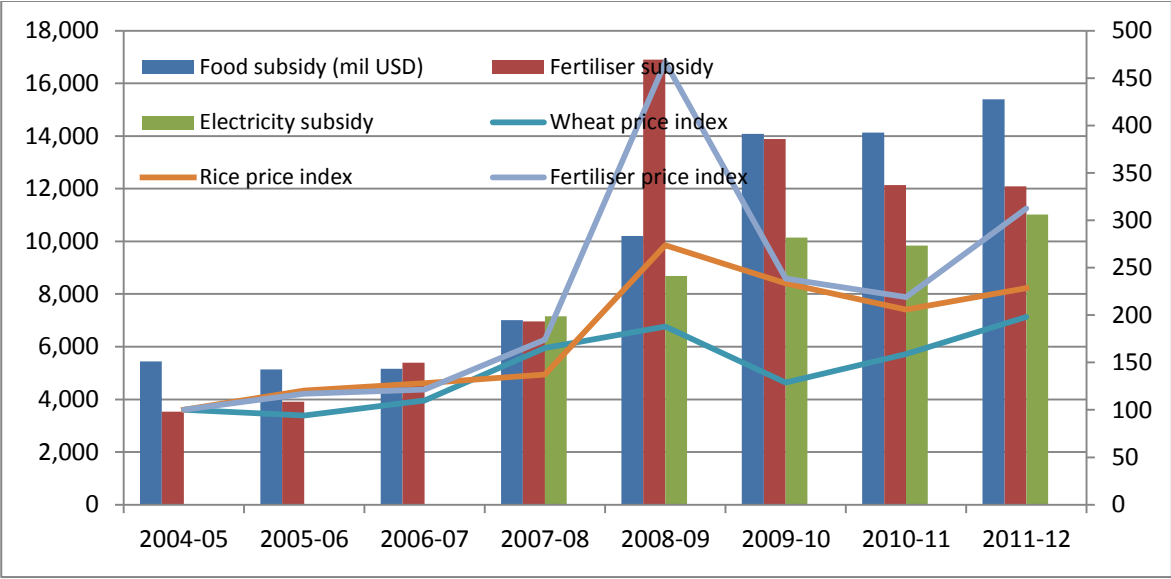
Yu, W and Jensen. H.G. 2014. Trade policy responses to food price crisis and implications for existing domestic support measures: the case of China in 2008. *World Trade Review*, 13, 651-683.

Figure 1. Government spending on food, fertilizer and electricity subsidies (Million USD)



Source: own compilation based on Financial Report of Government of India, various issues.

Figure 2. Government spending on food, fertilizer and electricity subsidies (left scale, million USD) and world market price indices for rice, wheat and fertilizer (right scale, % with 2004-5 base year)



Source: subsidy expenditures are own compilation based on Financial Report of Government of India, various issues. Price indices are from World Bank Pink Sheets.

Figure 3. India's wheat trade flows (1,000 tons; UNCOMTRADE)

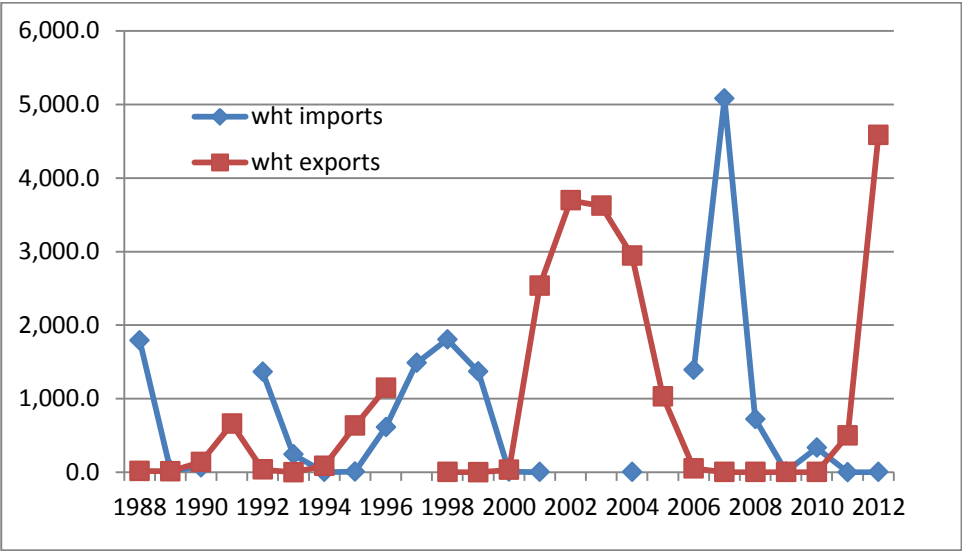


Figure 4. India's rice trade flows (1,000 tons; UNCOMTRADE)

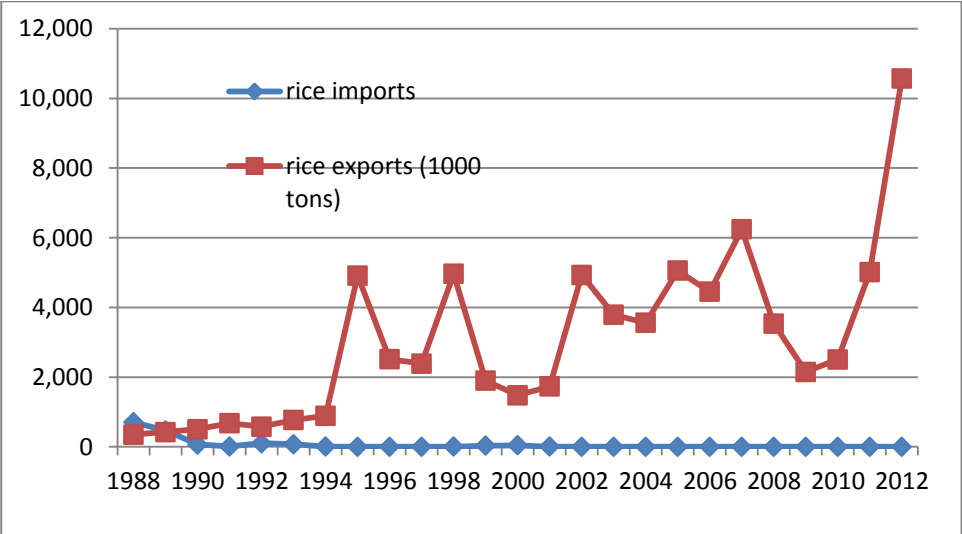


Figure 5. India's fertilizer trade flows (million USD; UNCOMTRADE)

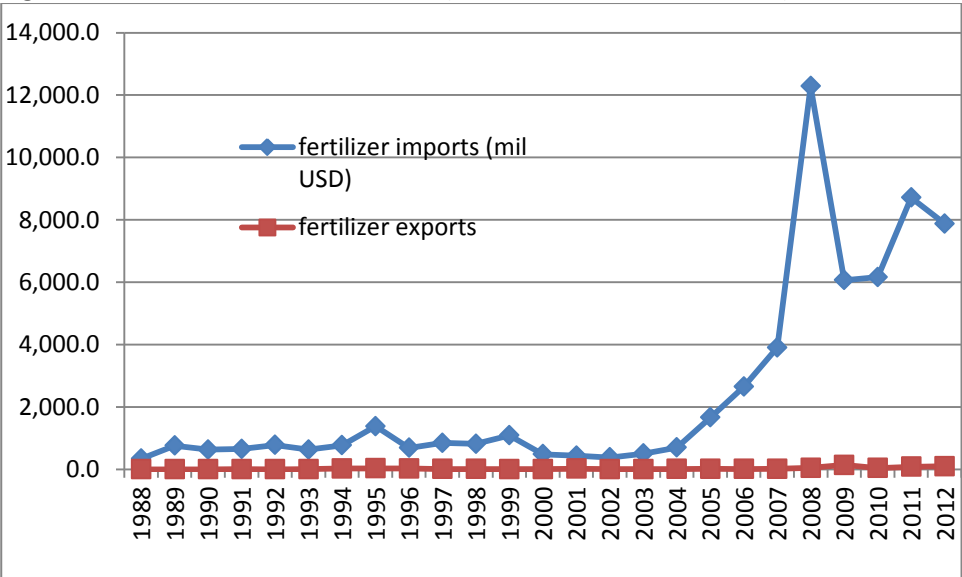
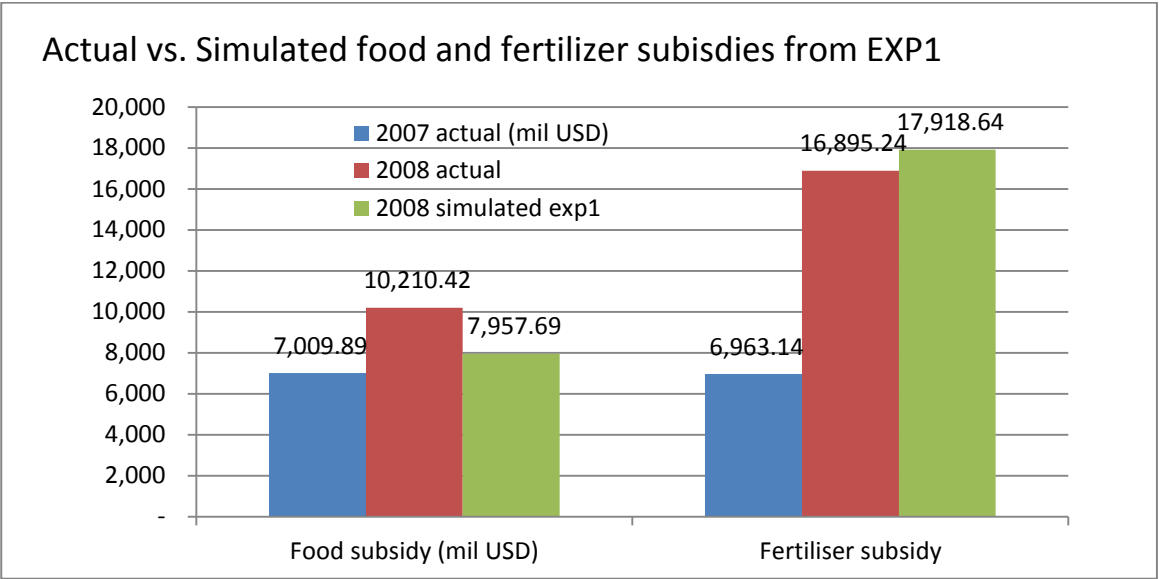


Figure 6. Results: actual vs. simulated food and fertilizer subsidies from *EXP1*



Source: GOI data and own simulation results.

Table 1. Experiment Design: policy options and modeling implementations.

| | food subsidy | | fertilizer subsidy | | export tax/ban | | |
|------|----------------------------------|-----------------------|------------------------------|-----------------------------|--|---|--|
| | consumer's price for rice, wheat | food subsidy spending | users' prices of fertilizers | fertilizer subsidy spending | export tax on rice, wheat & fertilizer | export quantities of rice, wheat and fertilizer | relation to EXP1 in terms of model variables |
| exp1 | fixed | endogenous | fixed | endogenous | endogenous | fixed | actual |
| exp2 | fixed | endogenous | fixed | endogenous | fixed | endogenous | relax qxs |
| exp3 | endogenous | fixed | endogenous | fixed | endogenous | fixed | relax pm |
| exp4 | endogenous | fixed | endogenous | fixed | fixed | endogenous | relax pm and qxs |
| exp5 | fixed | endogenous | endogenous | fixed | fixed | endogenous | relax pm for fert, relax qxs |
| exp6 | endogenous | fixed | fixed | endogenous | fixed | endogenous | relax pm for food, and qxs |

Table 2. Domestic market effects of world market price changes, export restriction and food and fertilizer subsidies: EXP1

| total effect | | world market price effect | | | export restriction | | | | fertilizer subsidy | food subsidy |
|--|------|---------------------------|-------|------------|--------------------|-------|-------|------------|--------------------|--------------|
| | | rice | wheat | fertilizer | paddy rice | wheat | rice | fertilizer | | |
| (1) | | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
| % changes in domestic market price in India | | | | | | | | | | |
| Paddy rice | 0 | 10.2 | 0.3 | 15.7 | -1.7 | 0 | -7.8 | 0 | -15 | -1.6 |
| Wheat | 0 | 2.2 | 1.7 | 7.9 | -0.2 | 0 | -1.6 | 0 | -7.8 | -2.3 |
| Rice | -0.1 | 5.5 | 0.1 | 5.7 | -0.6 | 0 | -4.7 | 0 | -5.7 | -0.5 |
| Fertilizer | 0.2 | 2 | 0.2 | 27.7 | -0.3 | 0 | -1.6 | 0 | -28 | 0.1 |
| % changes in domestic producer produces in India | | | | | | | | | | |
| Paddy rice | 1,9 | 10,3 | 0,3 | 15,8 | -1,7 | 0 | -7,9 | 0 | -15,1 | 0,3 |
| Wheat | 2,7 | 2,2 | 1,8 | 8 | -0,2 | 0 | -1,6 | 0 | -7,9 | 0,4 |
| Rice | -0,1 | 5,5 | 0,1 | 5,7 | -0,6 | 0 | -4,7 | 0 | -5,7 | -0,5 |
| Fertilizer | 0,2 | 2 | 0,2 | 27,7 | -0,3 | 0 | -1,6 | 0 | -28 | 0,1 |
| %changes in domestic production in India | | | | | | | | | | |
| Paddy rice | -0.4 | 10.8 | -0.1 | -2.5 | -2.2 | 0 | -8.9 | 0 | 2.2 | 0.3 |
| Wheat | 3.4 | -0.6 | 2.9 | -3.4 | 0.1 | 0 | 0.5 | 0 | 3 | 0.8 |
| Rice | -0.4 | 13.3 | -0.1 | -2.1 | 0.2 | 0 | -13.4 | 0 | 1.4 | 0.2 |
| Fertilizer | 1.1 | 2.4 | 0.5 | 82.9 | -0.6 | 0 | -1.9 | 0 | -82.5 | 0.2 |

Note: simulation results.

Table 3. Simulation results on India's domestic market prices, production, and exports under alternative scenarios

| | Exp1 | Exp2 | Exp3 | Exp4 | Exp5 | Exp6 |
|---------------------------------------|------|------|------|------|------|------|
| % domestic market price | | | | | | |
| Paddy rice | 0 | 0 | 25.9 | 48.8 | 0 | 28.8 |
| Wheat | 0 | 0 | 15.1 | 22 | 0 | 9.8 |
| Rice | -0.1 | 5.4 | 8.8 | 19.8 | 6.4 | 13.3 |
| Fertilizer | 0.2 | 7.2 | 16 | 20 | 24.3 | 4.6 |
| % changes in domestic producer prices | | | | | | |
| | exp1 | exp2 | exp3 | exp4 | exp5 | Exp6 |
| Paddy rice | 1,9 | 42,7 | 22,2 | 40,5 | 69,1 | 23 |
| Wheat | 2,7 | 8,9 | 11,7 | 15,2 | 23,3 | 4,9 |
| Rice | -0,1 | 5,4 | 8,8 | 19,8 | 6,4 | 13,3 |
| Fertilizer | 0,2 | 7,2 | 16 | 20 | 24,3 | 4,6 |
| % changes in domestic production | | | | | | |
| | exp1 | exp2 | exp3 | exp4 | exp5 | Exp6 |
| Paddy rice | -0.4 | 32.3 | -1.3 | 14.9 | 31.9 | 20 |
| Wheat | 3.4 | 3 | -1.8 | -4.4 | 2.9 | 0 |
| Rice | -0.4 | 35.7 | -1.1 | 22.1 | 34.9 | 27.5 |
| Fertilizer | 1.1 | 13.6 | 51 | 58.1 | 68.3 | 8.3 |

Note: simulation results.

Table 4. Subsidy spending, export tax revenue, and welfare effects for India (million USD)

| | exp1 | exp2 | exp3 | exp4 | exp5 | exp6 |
|------------------------------------|----------|----------|----------|-----------|----------|----------|
| Food subsidy | 947.8 | 12,653.7 | 0 | 0 | 21,431.5 | 0 |
| Fertilizer subsidy | 10,955.5 | 14,226 | 0 | 0 | 0 | 12,854.8 |
| Export tax revenue on rice & wheat | 2,510.3 | 15,430.1 | 2,389.2 | 10,870.1 | 15,200.4 | 12,529.1 |
| Sum of fiscal burden | 9,393 | 11,449.6 | -2,389.2 | -10,870.1 | 6,231.1 | 325.7 |
| | | | | | | |
| Welfare changes (EV) | -9,905.2 | 5,446.1 | -3,583.1 | 8,419.1 | 11,407.2 | 3,741.9 |
| of which: | | | | | | |
| Allocation efficiency | -1,221 | 11,156 | -1,485 | 8,046 | 10,025.5 | 9,708 |
| Terms of trade | -8,085 | -6,178 | -1,978 | -185 | 296.9 | -6,140 |

Note: simulation results.