Agricultural trade liberalization: growth, welfare and large country effects

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Accepted 20 May 1997

Abstract

The impacts of trade liberalization for India have been examined with an applied general equilibrium model with nine agricultural sectors, one non-tradeable nonagriculture sector and one tradeable nonagriculture sector and with five rural and five urban expenditure classes. Different scenarios are generated using the model. Since comparison of GDP in two alternative scenarios can be misleading, the policy alternatives are assessed on the basis of their impact on welfare in terms of equivalent incomes of different expenditure classes. A policy is assessed preferable only when the distribution of welfare is found to be preferable in a well defined way. It demonstrates the importance of accounting for large country effects in rice trade and estimates the welfare optimal tariff/quota for rice exports for India—which is shown to be just half a million tons of net export of rice. The results also show that nonagricultural trade liberalization is even more important for agriculture than even agricultural trade liberalization, both of which help accelerate growth.

1. Introduction: background and issues

The primary objective of economic reforms initiated in June 1991 in India is to put the economy on a high growth path. High growth is considered essential even to deal with poverty and to attain sooner the various social objectives. It is commonly accepted that the Indian economy has not grown rapidly because of inefficient use of industrial investment, obstructions created by bureaucratic regime in the path of entrepreneurs and lack of incentives for efficiency. Industries faced neither domestic nor international competition and rent-seeking was much more profitable than improvement in resource use efficiency.

Unlike industries, agriculture in India functions in a relatively competitive environment. Inefficiencies in resource use in agriculture arise mainly from inappropriate pricing of inputs and outputs. There is very little production control through direct means and deregulation does not have the same kind of a role to play as in industries except in some agro-processing activities. It is possibly for this reason that agriculture has not been touched by the economic reform process.

Furthermore, agricultural outputs are produced by millions of small farmers. There are no monopolists who need to be disciplined by the competition that liberal trade can provide. The gains from trade liberalization would be mainly due to improvement in allocative efficiency. How large could such gains be?

Even when every farmer operates efficiently, there could be significant inefficiencies in the system if the macro-policy environment affect incentives adversely. If inputs such as water or electricity are priced too low, the inputs would be wastefully used. If product markets are fragmented, movements regulated or trade restricted farmers may not get appropriate prices and that may distort supply. Bhagwati and Srinivasan (1993), Parikh (1993), Hannan (1993), Purcell and Gulati (1993), Gulati et al. (1993), etc., have discussed the various distortions in Indian agriculture and their consequences.

Thus, agricultural liberalization and deregulation would lead to change in relative prices, better allocative efficiency and improved incentives. It would be worthwhile to examine the extent of such gains. Apart from such gains, changes in relative prices of agricultural commodities are important for two other considerations. First, industrial liberalization changes relative prices of various industrial goods. The terms of trade between agriculture and nonagriculture gets altered unless agricultural prices adjust. Second, as the industrialized countries liberalize their agricultural trade, new opportunities will open up for India's agricultural exports.

Agricultural liberalization thus seems an option worth considering. In so doing, however, we need to account for the macroeconomic incidence of policy changes and the general equilibrium consequences for growth, distribution and welfare. This is necessary as agriculture provides nearly 30% of the gross domestic product (GDP), engages bulk of the population and for most people, agricultural products provide a large part of consumption and have a weight of 57% in the consumer price index. Any policy that affects agriculture, thus, affects virtually everyone in the society. For the more than 200 M poor in the country, many of whom are small and marginal farmers and landless labourers, changes in food prices can have profound welfare consequences. Thus assessment of agricultural policy demands an analytical framework that can account for such feedbacks and consequences. A general equilibrium framework is the appropriate framework as is reflected in the large number of studies which has used such a framework. Shoven and Whalley (1984) and Srinivasan and Whalley (1986) report on many studies of trade policy analysis using such a framework, whereas agricultural trade liberalization have also been analyzed by Anderson and Tyers (1990), Brandao et al. (1991), Burniaux et al. (1990), Goldin and Knudsen (1990), Linneman et al. (1979). In addition, the large number of applied general equilibrium models developed as a part of the Basic Linked System (BLS) at the International Institute for Applied Systems Analysis (IIASA) for several country/regions which include USA, Canada, EC, Sweden, Finland, Japan, Hungary and India, have also been used for examining impacts of agricultural trade liberalization; see Fischer et al. (1988), Parikh et al. (1987).

The impacts for India have been analyzed by Narayana et al. (1990) using the model of India, Agriculture, Growth and Redistribution of Incomes Model (AGRIM), developed as a part of the BLS. Subramanian (1992) has also examined agricultural trade liberalization in a general equilibrium framework. The present study uses a further developed version of AGRIM and differs in an important way from the earlier two studies, namely it recognizes the importance of large country effect of India's rice trade and explores the issue of optimum tariff/quota on rice exports. In addition we also examine the relative impact of agricultural and nonagricultural trade liberalization. We have addressed the following specific questions.

(1) Should agricultural trade be liberalized? If yes, should we liberalize all commodities or only selected ones? In particular, should we liberalize rice as its global market is thin?

(2) What would be the impact of liberalization on variables like GDP, sectoral outputs, trade, and prices?

(3) How would agricultural trade liberalization affect welfare of different expenditure classes in both rural and urban areas?

While we may adopt the normal small country assumption for most of the Indian agricultural produce, the case of rice appears to be different. India is a major producer of rice. The buffer stock of rice with the government is itself almost equal to the world trade volume of this commodity. Given such market power we study the large country effects while considering trade liberalization of rice. In particular we look into the question of adopting optimal tariffs/export quota policy.

Different scenarios are generated using the model.

Since comparison of GDP in two alternative scenarios can be misleading, the policy alternatives are assessed on the basis of their impact on welfare in terms of equivalent incomes of different expenditure classes. A policy is assessed preferable only when the distribution of welfare is found to be preferable in a well defined way.

In Section 2 we describe briefly the computable general equilibrium model to be used in our analysis. In Section 3, we describe our approach to analysis and describe the reference scenario and policy scenarios. The results of simulations are presented in Section 4. Finally, we conclude in Section 5.

2. The AGRIM model and its basic structure

In a mixed economy such as India's in which market transactions are dominant, the welfare of an individual depends on the quantities and prices of the goods and factor services she sells (or buys) in the market as well as on any income transfers she receives from others including the government. In particular, government fiscal policies (other than income transfer policies) affect the welfare of all individuals including the poor through their direct effects on the prices they face and the incomes they earn. Of course, income transfer policies also affect prices indirectly through their effects on demand.

The AGRIM model (Narayana et al., 1990), substantially modified to be used in this study, is of the sequential applied general equilibrium (AGE) genre in which an equilibrium price vector is computed for each year in succession. Unlike other such models, a number of behavioural equations relating to demand and supply have been econometrically estimated with data mostly from the period 1950–1951 to 1973–1975. For validating the model, for the period up to 1980, imports and exports were set equal to their actual values, and the actually observed prices were generated as equilibrium prices by ensuring market clearance at these prices through stock accumulation or decumulation. Indeed, the fact that such a procedure did not lead to implausible values of changes in stocks was viewed as a validation of the model. Great simplification was achieved by imposing a one-year lag between production and market sale. Thus, in effect the economy became an exchange economy for the purpose of computing equilibrium prices. The model, like all Walrasian general equilibrium models, generates only relative prices and is homogeneous of degree zero in prices.

The economy is characterized by eleven sectors, nine of which are agricultural and the other two are nonagricultural sectors. These are wheat, rice, coarse grains, bovine and ovine meat, dairy, other animal products, protein feed, other foods, non-food agriculture, non-tradeable nonagriculture and tradeable nonagriculture, (Table 1). Since the analytical focus, especially with regard to nonagriculture, is at a

Table 1
Macro impacts of trade liberalization, year 2000 [a]

Macro indicators		% change over REF			Welfare indicators		% change over REF		
	REF	ATL	NTL	TL		REF	ATL	NTL	TL
GDP70	1 740 126	0.87	4.37	4.49	CAL/CAP	2721	7.97	3.99	0.18
GDPA70	510 565	0.90	3.15	4.08	AVR.EQY	878	1.46	−2.60	−5.62
GDPN70	1 229 561	0.85	4.87	4.66	PARITY	0.443	0.40	13.63	16.26
TR.DEF70	23 981	0.77	3.72	3.69	RURL.INC	20 199	0.87	−9.59	10.25
INVEST70	419 256	0.79	13.86	12.07	URBN.INC	45 551	0.47	−20.43	−22.80
TAXRATE	0.141	−7.11	6.35	22.39	AG.WGERT	6280	1.37	3.01	4.78
PA/PNA	1.025	1.74	27.88	32.82	DIST-FGR	26 165	0.00	0.00	0.00
PNA	17.78	−0.45	−24.83	−27.03	TOTL.POP	1 046 625	0.00	0.00	0.00
RER	1.00	2.09	9.34	18.63	URBN.POP	285 606	−0.04	−0.89	−0.99
G.I.AREA	80 619	0.53	7.38	7.70					
FRTLZR	14 364	3.47	7.50	7.50					

[a] Variable description and measurement units are given in Appendix A.

macro level rather than at specific commodity levels, such broad treatment of nonagriculture into just tradeables and non-tradeables is considered to be adequate for comparing various liberalization policies. In agriculture too except for rice and wheat the other sectors are aggregates of several commodities. However, since rice and wheat occupy a very important place, both for public distribution as well as trade purposes, in Indian economy these two were treated as two separate sectors.

There are three sets of agents: producers, consumers and government. Consumers are classified by their residence as rural or urban. Rural as well as urban consumers are divided into five expenditure classes each according to their monthly per capita household consumption expenditure. Means of production (capital), natural resources (land), human resources (labour) and livestock (draft and milch animals, poultry, etc.) generate income through production activities that is distributed to consumers. Thus, behaviour of producers (i.e., their production activities) determines commodity supplies and incomes. Consumer behaviour generates commodity demands (and implicitly resource supplies). The government sets policies (e.g., investment targets, taxes, tariffs, quotas, rations, price supports and ceilings, etc.). Finally, equilibrium is achieved through exchange in which domestic demands, together with export demand by the rest of the world for each sector's output, is equated to the sum of domestic supply (emerging from previous year's production net of changes in stocks) and import supply.

Total nominal investment is assumed to follow a desired aggregate relationship between total investment and total nominal GDP. For each sector the composition of investment originating from non-tradeable and tradeable nonagriculture remain fixed in real terms assuming a Leontieff technology. This however, neither means that investment itself is constant in nominal terms nor the composition of investment is identical across sectors. The volume of total investment and its allocation across various sectors in both nominal and real terms change over time due to changes in GDP, prices of investment goods and terms of trade between agricultural and nonagricultural sectors. Resources for investment come from household savings, government savings and foreign capital inflow, if any. Tax rates on nonagriculture, tariffs, etc., forming sources for government revenue, are endogenous. Tax rates adjust so as to generate enough public savings (after meeting the government's expenditure) which, together with household savings and exogenously specified foreign capital inflow, will equal aggregate desired investment. No distinction is maintained between public and private components of investment. Household savings are estimated as the difference between their aggregate disposable income and consumption expenditure.

Agricultural investment influences the total gross cropped area as well as the irrigated portion of it. A detailed model of allocation of area among crops, choice of varieties to be cultivated (high yielding or traditional), fertilizer intensity based on a version of Nerlovian adaptive expectations framework determine the vector of crop outputs. Assuming a labour surplus economy, capital is the only scarce factor used in the production of the nonagricultural good.

Output of the tradeable and non-tradeable nonagriculture sectors is determined in two stages as follows. First, nonagricultural capital stock, determined by past capital accumulation, determines potential total nonagricultural production given uncertain demand and a cost function, quadratic around the capacity level of output. However, actual production also takes into account the demand which in turn depends on GDP, investment, public consumption and demand for intermediate products by agriculture. That means actual production is the minimum of the potential and the anticipated demand for it. Next; the change in the ratio of tradeables to non-tradeables components in this total nonagricultural production with respect to base year is determined as a function of the ratio of the expected relative prices of these two components in the current year to the same in the base year with an elasticity of 0.25. Since the expectation is based on the past realized prices in the model, the split of nonagriculture into these two components is thus endogenized.

Finally, income generated in producing outputs of agriculture and nonagriculture together net of taxes and transfers determine the income available to consumers.

Complete algebraic description of these sub-modules of the model and the associated estimations are available in Narayana et al. (1987, 1990).

3. Approach to policy analysis, reference run and policy scenarios

3.1. The reference scenario

The base run is a business-as-usual scenario in which past policy regimes continue. This scenario is called reference run since the results of a policy scenario representing a policy change are evaluated with reference to the results of the reference run. A change in policy may be introduced by changing values of some parameters and/or by altering the specification of some functions. Comparison of the outcomes of the reference run and the policy scenario for the indicators reflecting the various objectives of the society show the impact of the policy change.

In the reference run (denoted as REF), it is assumed that the trade policies would correspond to those prevalent in the recent past. In particular the following assumptions are made:

(1) The total population of India is projected to grow at the rate of 2.26% per annum.

(2) Trade deficit is 1.5% of the GDP.

(3) Trade quotas on different agricultural commodities range from 5% to 15% of domestic supplies; i.e., production plus initial stocks. For rice, a quota of half a million tons of net exports is imposed to reflect the thinness of the world market.

(4) Domestic price policy sets target prices in a way that provides the estimated degree of protection to that particular commodity. It should be noted, however, that when trade quotas are binding these target prices may not be realized (see below).

(5) Future world prices are based on the World Bank projections of various commodity prices.

The nominal protection factor for the agricultural sectors of our model for the year 1993, shown in Table 3, are based on the estimates by Gulati et al. (1993). For tradeable nonagriculture, it was observed that production weighted average tariff rates had fallen down from 102% in 1987–1988. The tariff rates have been brought down significantly since the reforms were initiated in 1991. By 1993–1994, the maximum tariff rate was only 60% and except for few banned/import restricted consumer goods, imports do not require licenses. Since many state controlled imported goods do not carry tariffs but have administered prices, based on rough calculations and using our judgement on the likely effective protection of import restricted consumer goods, the nominal protection factor for tradeable nonagriculture was fixed at 0.35. [1] These estimates of protection rates assume that the world price is not affected by India's trade. Obviously, such an assumption may be valid for a small economy but in commodities where India's trade can be a sizeable part of the global trade, this need not be the case. We will return to this later.

The reference scenario was simulated with the model for the period 1970–2000. The historical period for the model was 1970–1985 during which the model was constrained to reproduce the actually observed course of the economy with respect to most of the major endogenous variables as equilibrium values. Any policy changes relative to the reference scenario have been introduced beginning 1993 (see below for more details) and their impacts studied over the period 1993–2000.

3.2. The policy scenarios

Trade liberalization in our analysis involves: (i) setting up target prices to be world prices, and (ii) removal of trade quotas. An exception is rice. Since world market for rice is thin, even when rice price is liberalized, an export quota is imposed on rice to reflect the limitation of the world market to absorb it.

Two sets of policy scenarios have been developed to analyze impact of trade liberalization:

Set 1: The first set of scenarios study the impact of trade liberalization in agriculture and nonagriculture. In these scenarios an export quota on rice is specified to reflect the thinness of world trade in rice.

Set 2: The second set of scenarios examine the question of optimal export quotas/tariff for rice.

[1] One may note that our analysis and conclusions depend on changes in relative protection rate. So, even if this estimate of protection rate is inaccurate, the results can simply be re-interpreted as outcomes of partial trade liberalization.

4. Results

Before we discuss the results concerning trade liberalization, it may be useful to consider what can agricultural trade liberalization be expected to do. This is shown schematically in Fig. 1. When positive and negative protection is removed from agricultural commodities, the prices of agricultural commodities will change. Since the (dis)protection rates differ from commodity to commodity, these prices change relative to each other as also relative to nonagriculture. This will lead to different cropping patterns and input use intensities and production pattern. In turn, income level and income distribution change. With that, nominal household savings change. With different incomes and different prices consumer demand will be different. This will affect trade pattern and government tariff revenues. With our assumption that government adjusts tax rates to ensure that total (public + private) investment follow a specified investment–GDP relationship, this leads to change in tax rate. It should be emphasized that though in Fig. 1 this is shown as a sequential process, in the model tax rate, consumption levels, trade levels and prices are determined simultaneously. The same nominal investment may lead to a different real investment if the price of investment goods has changed. This changes growth rate and growth pattern. The impact on consumption levels of different expenditure groups of all these changes will be different and hence the welfare impact would differ from class to class. With this schematic process in mind, we now discuss the results.

The results are discussed for three years: 1995,

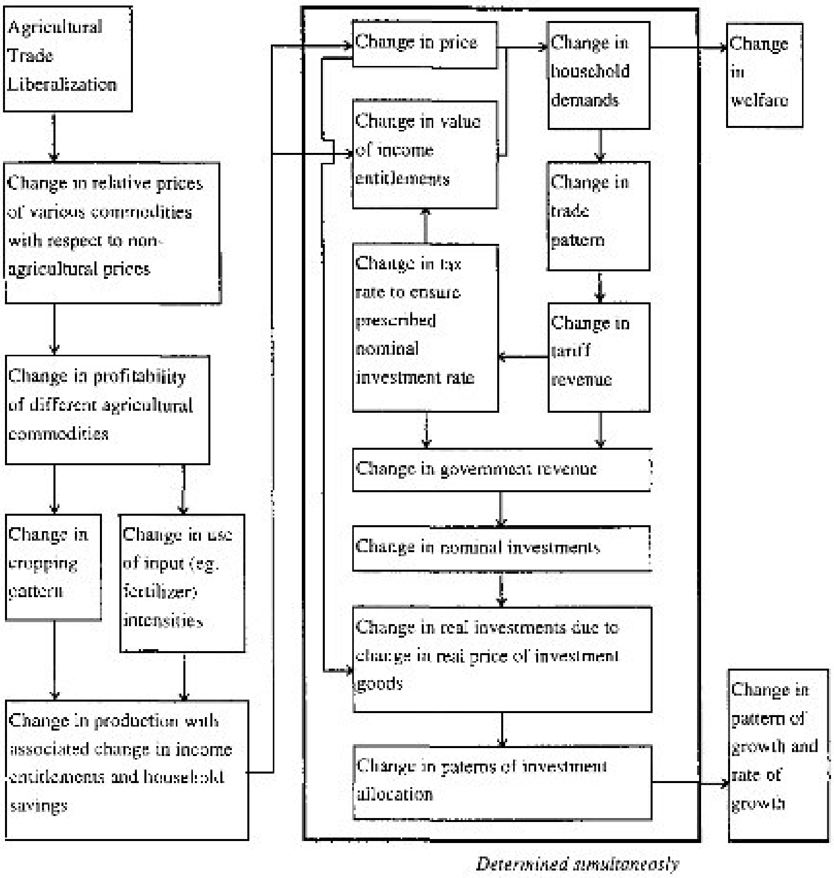

Fig. 1. Impact of trade liberalization—a schematic explanation.

1998 and 2000. Since the trade reform process basically derives its logic from long run effects, we focus our discussion mostly on the year 2000, i.e., seven years after the liberalization process starts and return to 1995/1998 results to examine short/medium run special features only. [2]

4.1. Set 1 scenarios: trade liberalization

This set consists of the following three different policy scenarios: ATL: All agricultural sectors (S1–S9) are in free trade since 1993. However rice exports are limited to 3 million tons (m.t.). No change in world market price for rice assumed. Nonagriculture is not in free trade; NTL: Only tradeable nonagriculture (S11) is in free trade starting from 1993. Agricultural sectors (S1–S9) are not in free trade; TL: All sectors (S1–S9 and S11) are in free trade starting from 1993. The 3 m.t. export quota in rice is maintained with no change in rice world market price.

The results of this set of scenarios for year 2000 are documented in Tables 1–3 and 5.

4.1.1. Does trade liberalization help growth?

That trade liberalization improves long run GDP growth is unambiguously revealed by our results. When both agricultural and nonagricultural sectors are liberalized (scenario TL, Table 1), economic growth as measured by real GDP rises by about 4.5% over the reference run in the year 2000, i.e., in seven years after liberalization. This implies an increase of the average annual GDP growth rate by 0.65 percentage point during 1994 to 2000. Agricultural income rises by 4.1% and nonagricultural income by 4.7%.

While both ATL and NTL help long term growth of the economy, one striking result is that it is NTL that has more growth inducing effects than ATL. Thus. GDP increase due to ATL is only about 0.9% in year 2000, while it is 4.4% due to NTL. In order to appreciate this result, we reiterate that the main driving forces in our AGE model are the relative prices and that we are essentially analyzing the price induced effects. The relative magnitude of the effects of ATL and NTL then depends on the price changes caused by ATL and NTL. Given the initial condition that the distortions in many of agricultural sectors are lower in magnitude than the distortions in the nonagricultural sectors (as revealed by the protection factors), the price changes due to ATL are smaller in magnitude than those due to NTL and hence the observed GDP effects of reforms in agricultural and nonagricultural sectors.

Apart from the allocative efficiency increase due to correction of price distortions there is yet another major factor contributing to favourable GDP effects of trade liberalization arising from price changes of investment goods and specially operative in the NTL measures. Investment goods become relatively cheaper with trade liberalization so that the same nominal investment–GDP relation as in reference run now generates more real investment. Nominal GDP falls by about 14% in NTL, but price of investment goods falls by 24.8%. The result is an increase in real investment by 13.9% due to NTL. Thus change in terms of trade away from investment goods positively contributes to economic growth. Real investment rises by 0.8% in ATL too. This is due to increase in nominal GDP and consequent nominal investment increase. Note that price of investment good does not change in ATL. [3]

Thus, a very important conclusion emerges. Nonagricultural trade liberalization is even more important for Indian agriculture than agricultural trade liberalization. This also means that the process of liberalization which has so far only reduced nonagricultural protection cannot be said to have bypassed agriculture.

[2] The detailed tables for the years 1995 and 1998 are available on request.

[3] It is ironic to note here that the 'heavy industry first' strategy followed by Indian planners which led to high protection and high cost for capital goods and universal intermediates was just the wrong strategy to follow. It is even more ironic to note that when P.C. Mahalanobis argued for the 'machines to build machines to build machines' strategy he had argued it on the basis of India having a comparative advantage in heavy industries. It is a sad fact of history that whatever comparative advantage India may have had in heavy industries was frittered away through the permit quota raj and Mahalanobis's argument was forgotten in the pursuit of the strategy which was questioned much too late

Table 2
Sectoral impacts of trade liberalization, year 2000

Sector	Raw prices (10^6 Rs. per sectoral unit)				Production (in sectoral units)				Net Exports (in sectoral units)			
		% change over REF				% change over REF						
	REF	ATL	NTL	TL	REF	ATL	NTL	TL	REF	ATL	NTL	TL
(1)Wheat	10.74	13.64	0.00	13.64	74 748	3.10	6.46	8.78	3746	9132	9601	14 908
(2)Rice	22.94	4.71	−16.58	−13.93	89 102	1.07	4.99	5.54	471	2854	494	2978
(3)Coarse grains	6.53	−9.09	0.00	−9.09	44 907	−4.56	1.82	0.10	−25	−4574	790	−2260
(4)Bovine and ovine meat	66.69	17.65	0.00	17.65	1156	5.31	8.84	15.29	−525	−297	−241	25
(5)Dairy	21.88	17.65	0.00	17.65	80 234	3.46	1.35	5.06	−5015	5223	3924	15 546
(6)Other animals	1440.27	17.65	0.00	17.65	610	0.98	0.05	1.03	−18	10	2	33
(7)Protein feed	22.57	42.86	0.00	42.86	6352	1.44	2.97	4.32	1905	1932	1961	1987
(8)Other food	67.10	−28.57	0.00	−28.57	41 248	−0.73	2.24	1.59	750	−12 003	7092	−797
(9)Non-food ag.	174.79	11.11	0.00	11.11	5327	1.90	2.87	4.77	190	749	1115	1821
(10)Non-tradeable nonag.	144.08	−1.26	−22.93	−29.10	53 948	0.87	5.62	6.02	0.00	0.00	0.00	0.00
(11)Tradeable nonag.	128.13	0.00	−25.93	−25.93	91 998	0.65	4.24	3.83	−5475	−6931	−17 528	−17 843

Sectoral Units: S1–S3: 000 tons; S4: 000 tons of beef and mutton; S5: 000 tons of fresh milk equivalent; S6 and S7: 000 tons of protein equivalent; S8–S11: US$ M 1970 prices.

4.1.2. *How does liberalization affect price behaviour?*

Domestic prices, when both ATL and NTL measures are undertaken, would equal world prices as stipulated by the scenario. Hence, sectoral prices turn out to be equal to reference prices deflated by the protection factor $(1+t_i)$. Obviously, prices in sectors which have positive protection rates in reference run (e.g., tradeable nonagriculture) are reduced with liberalization and prices in sectors which have negative protection or disprotection (e.g., wheat) are increased. The only exception to this general rule is the case of rice where prices decline even after removal of nominal disprotection in NTL. This apparent strange happening could be explained by the presence of export quota for rice in this experiment. We shall return to this case later for some interesting observations.

Table 3
Sectoral nominal protection rates (NPR) and share in total output

Sector	NPR	Share in total output (%)—year 2000			
	Year 1993	REF	ATL	NTL	TL
(1)Wheat	−0.12	2.75	3.19	3.38	3.95
(2)Rice	−0.34	7.43	7.77	7.51	7.85
(3)Coarse grains	0.10	1.02	0.88	1.20	1.08
(4)Bovine and ovine meat	−0.15	0.25	0.31	0.31	0.39
(5)Dairy	−0.15	6.61	7.95	7.74	9.50
(6)Other animals	−0.15	2.84	3.33	3.28	3.93
(7)Protein feed	−0.30	0.46	0.66	0.55	0.80
(8)Other food	0.40	9.25	6.48	10.92	7.80
(9)Non-food ag.	−0.10	6.02	6.74	7.15	8.15
(10)Non-tradeable nonag.	–	25.21	24.79	23.94	22.45
(11)Tradeable nonag.	0.35	38.13	37.91	34.00	34.09

Table 2 shows that trade liberalization would cause substantial changes in relative prices in the Indian economy with an upward pressure on prices of several agricultural products and downward pressure on prices of nonagricultural products and some agricultural products. For wheat, meat, dairy products, other animal products and non-food agriculture, the price rise ranges between 11% to 18% over the reference run. The sector protein feed (cake residuals, etc.) has large disprotection at present and liberalization is likely to exert maximum upward price effect on this sector. On the other hand, tradeable nonagriculture as well as other food prices would decline by 26% to 29% because of high initial protection levels. Note that liberalization would lead to decline in coarse grains prices too as it is being protected at present.

What is the overall effect on the terms of trade between agriculture and nonagriculture? Terms of trade shifts in favour of agriculture in all the scenarios. The impact of ATL is rather modest and relative price of agriculture to nonagriculture, PA/PNA in Table 1, increases by 2% to 4% in different years. However, under NTL there is a dramatic increase in PA/PNA of about 28% and under TL it is about 33% in year 2000. The terms of trade effects dominates the scenario outcomes.

4.1.3. Price of non-tradeables and real exchange rate

We had introduced a non-tradeable sector to capture the impact of real exchange rate (RER) effects of the trade liberalization policies. Changes in the prices of tradeables relative to nontradeables is considered as a measure of the real exchange rate effect. In our context, there are 10 tradeable and only one non-tradeable commodity in the model. The composite price index of all tradeables in a scenario is computed as a weighted average of the individual commodity price indices. The price indices for both tradeables and non-tradeables are defined as the ratio of the price of the commodity in a scenario to that in the reference scenario and the weights are based on production in the reference scenario. RER is then the ratio of the composite price index of tradeables to that of the non-tradeables price index. The RER so computed is reported in Table 1.

It is seen that liberalization increases the RER for all the scenarios. The increase is lowest at about 2% when only agriculture is liberalized and is highest at about 18.6% when the entire economy is liberalized. Such significant changes in the RER, obviously, results in reallocation of resources across sectors. Which sectors would benefit from such reallocation of resources? In a text book two-sector model of tradeables and non-tradeables, the implication is simple in the sense that resources would move in favour of the tradeables following an increase in RER. However, in a model with many tradeable sectors, some of which were protected and others were disprotected initially, the implications of an increase in RER are not straightforward. The sectors which were initially disprotected are likely to experience larger benefits from such resource reallocation. On the other hand, the flow of resources into sectors that were initially protected is likely to depend on the degree of tariff reduction witnessed in such sectors and on the extent of increase in the RER. The final outcome of the RER effects can be observed as changes in the sectoral growth pattern, to which we turn below.

4.1.4. What would be the sectoral growth pattern?

We have noted earlier that one of the major benefits of liberalization would be higher GDP level primarily due to cheaper investment goods. This along with the large relative price changes obviously would have substantial income and price effects on consumer demand. On the supply side, the farmers would reallocate resources among various sectors taking into account the new price factors. What are the general equilibrium effects of the changes in supply and demand factors?

Table 2 shows that liberalization of both agriculture and nonagriculture together has favourable effect on output of all sectors in the year 2000. Bovine and ovine meat sector experiences the maximum growth effect with its output being 15.3% larger than the reference case for 2000 followed by wheat and rice output growth of 8.8% and 5.5%, respectively. The tradeable and nontradeable nonagricultural outputs grow by 3.8% and 6%, respectively. Dairy products, protein feed and non-food agriculture grow by 4% to 5% over reference run. When agriculture alone is liberalized direction wise broadly similar movements follow; but two sectors, coarse grains and other food, experience negative output growth. The decline in output of coarse grains by about 4.6% (in ATL) is because of shift in demand within food grains towards wheat and rice.

The sectoral shares in total output in the economy across scenarios are given in Table 3, which also gives the sectoral NPRs. This table clearly shows that trade liberalization (TL) changes the structure of output in favour of those sectors that were disprotected initially. Most of the agricultural sectors fall in this category. On the other hand, the sectors that were initially protected, particularly nonagriculture and other foods, witness a fall in their contribution to the total output in the economy. The resource reallocation behind these changes in the sectoral shares are broadly consistent with the increase in the RER observed earlier.

4.1.5. Do short run effects differ?

Sectoral output behaviour in the short run turn out to be different from long run behaviour, specially under ATL. The overall agricultural and nonagricultural growth results for years 1995, 1998 and 2000 are summarized in Table 4.

This table reveals that ATL disrupts agricultural production in the short run. GDP from agriculture falls by 1.7% largely due to fall in output of other food sector (which includes sugar, oil, etc.) by 8.3%. As noted earlier, price of other food sector falls by 28.6% even when terms of trade moves in favour of agriculture. This sector does not pick up even in 2000 though the extent of negative effect gets reduced. But, if NTL alone is undertaken, agricultural GDP picks up immediately by 4.1% over reference run in 1995. Note that the other food sector becomes a major beneficiary of investment expansion in NTL, particularly in the short run.

The effect of NTL on nonagricultural GDP is felt more strongly over time. The short run growth effect in nonagriculture is only about 0.5%, but it rises to nearly 5% by 2000. Output of nonagriculture is constrained by capacity in the short run and so immediate effect of demand expansion is a big jump in nonagricultural import level. As capacity is created with a time lag, imports stabilize in medium and long run.

4.1.6. Overall, does trade liberalization alter production structure?

Liberalization of nonagriculture alone leads to higher growth of nonagriculture compared to agriculture in the long run, though short run effect is other way as discussed above. If agriculture alone is liberalized, long run effects on overall agriculture and nonagriculture are of similar order. Trade liberalization in all sectors, however, helps both agricultural and nonagricultural GDP to grow by 4.1% and 4.7%, respectively (see Table 1). There is a shift in production structure within agriculture towards meat products, wheat, rice, dairy products and non-food agriculture.

4.1.7. Will liberalization help agricultural exports?

Trade liberalization would normally help exports of all agricultural goods except coarse grains and other food products. Particularly, amongst food items, net exports of wheat, rice and dairy products would increase considerably over reference scenario (see Table 2); i.e., by 11, 2.5 and 20.5 m.t., respectively.

Table 4
Short run vs. long run effects of trade liberalization

	% change over REF					
	ATL			NTL		
	1995	1998	2000	1995	1998	2000
GDP	−0.54	0.38	0.87	1.68	2.38	4.37
GDP agriculture	−1.70	0.68	0.90	4.12	2.47	3.15
GDP nonagriculture	0.04	0.25	0.85	0.45	2.34	4.87
Investment	0.58	0.82	0.79	13.12	12.51	13.86
Output—other food sector	−8.34	−0.83	−0.73	9.08	1.96	2.24
Imports—tradeable nonag. (10^6 US$, 1970)	6909	7353	6931	16648	17020	17528

Exports of non-food agriculture would also grow substantially by about US$1.6 B (at 1970 prices). Nonagricultural imports would, of course rise because of availability of larger foreign exchange.

4.1.8. What is the welfare impact of trade liberalization? Do the poor gain by trade reforms?

The welfare indicators considered in this paper are average calorie intake, average equivalent income and rural–urban income parity, where the averages are computed over the entire population. Equivalent income of a person is defined as the minimum expenditure needed at 1970 prices to achieve the same utility that he enjoys currently. It may be noted that higher current income need not necessarily mean higher equivalent incomes. All these welfare indicators (Table 1) show improvement under ATL. This is true for 1995, 1998 and 2000.

The impact of NTL policies, however, is adverse on average caloric intake and average equivalent incomes for 1995, 1998 and 2000 in the scenario NTL. When both ATL and NTL policies are pursued as in TL, the NTL effects dominate and the average calorie intake marginally falls. While average equivalent income improves under ATL, it deteriorates under NTL by 4.3% in 1995 and by 2.6% in 2000. It falls by even higher magnitude ranging between 4.1% to 5.6% when NTL is accompanied by ATL in scenario TL. This fall is largely due to fall in the equivalent income of the richest class in rural and all classes in urban areas due to an increase in tax rate on nonagricultural incomes (note that the richest rural class gets a substantial share of nonagricultural income also from rural nonagricultural activities in our model). This raises the question, what is the distributional impact of trade liberalization?

In fact, distributional impacts pose the real political economy problem. Under ATL urban income distribution improves. There are fewer poor persons and all classes show higher equivalent incomes. This is true for 1995, 1998 and 2000. This is a consequence of the reduction of tax rate. Recall that taxes are levied only on nonagricultural production. In later years the higher growth of nonagricultural GDP reinforces this effect. The poorest three rural classes (see Table 5) also gain in ATL as they show fewer persons and higher equivalent incomes.

Willig and Bailey (1981) comparisons which permit us to compare alternative distributions, under assumptions of pareto principles, anonymity and aversion to regressive transfers are shown in Fig. 2. These compare the average per capita equivalent incomes of bottom X percent of the population for all X from 0 to 100. When one curve dominates the other, i.e., it shows a higher equivalent income for all values of X, we can say that it represents a superior situation.

In terms of Willig–Bailey comparison, the bottom

Table 5
Distributional impacts, rural and urban, of trade liberalization, year 2000

Expenditure class [a]	Classwise population proportions				Classwise per capita equivalent incomes [b]			
					Rs.	% change over REF		
	REF	ATL	NTL	TL	REF	ATL	NTL	TL
Rural < 216	0.198	0.196	0.198	0.194	150	5.41	13.39	21.14
Rural < 336	0.126	0.126	0.126	0.126	295	4.72	13.50	20.17
Rural < 516	0.137	0.137	0.135	0.136	416	2.05	12.04	15.38
Rural < 900	0.196	0.195	0.190	0.191	604	−1.18	6.22	4.67
Rural > 900	0.344	0.347	0.351	0.353	1361	−1.29	0.15	−4.64
Urban < 216	0.002	0.002	0.002	0.002	181	6.34	−18.63	16.79
Urban < 336	0.012	0.012	0.010	0.010	266	5.65	−16.74	−15.69
Urban < 516	0.048	0.047	0.042	0.042	375	4.23	−16.37	−16.96
Urban < 900	0.178	0.176	0.166	0.166	581	4.47	−16.53	−17.62
Urban > 900	0.759	0.763	0.780	0.780	1580	3.26	−12.95	−17.45

[a] Class boundaries are based on per capita annual consumption expenditure at 1970 prices.
[b] Equivalent income is the income required at base (1970) year prices to provide the same utility from current consumption.

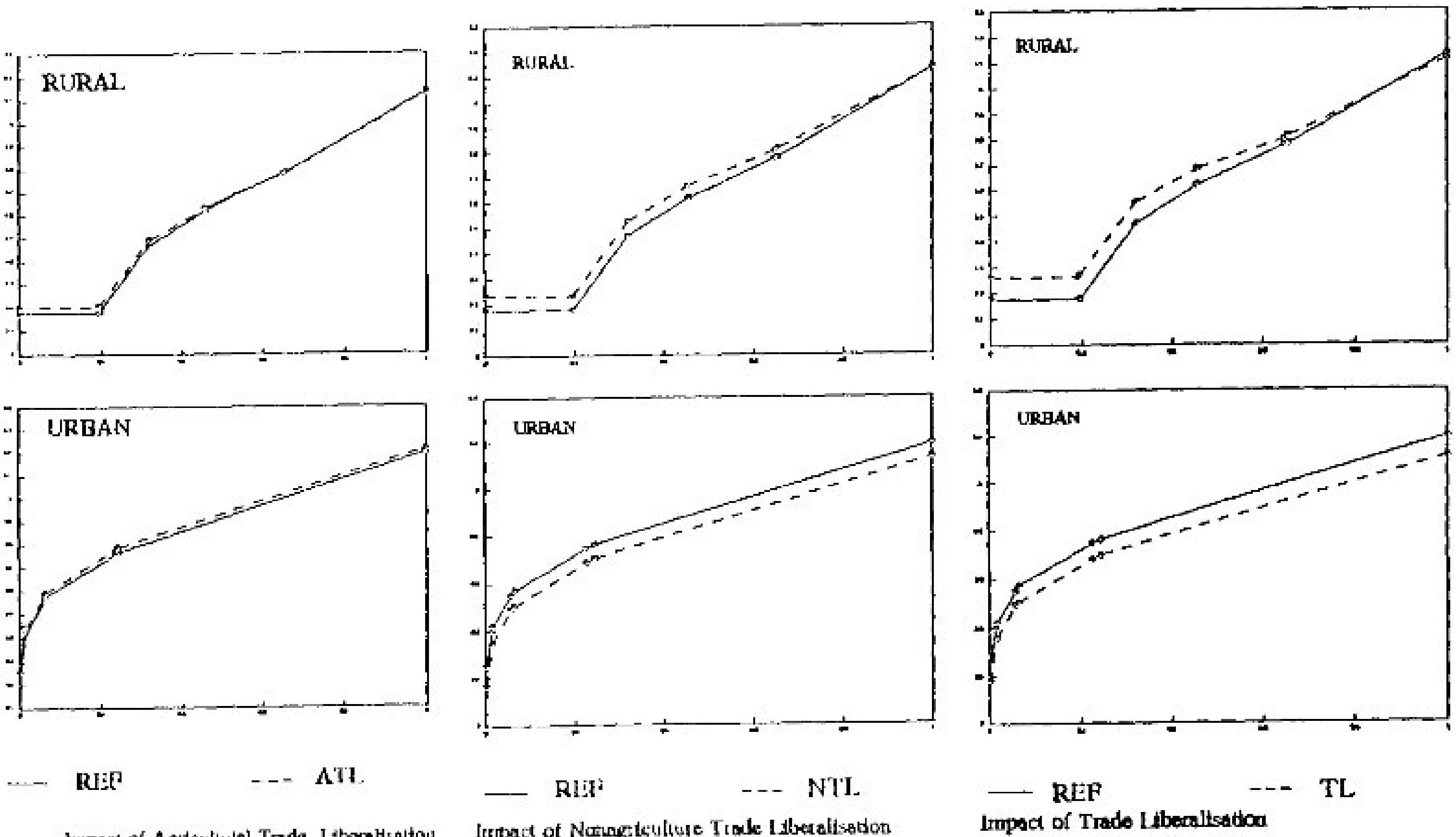

Fig. 2. Willig–Bailey welfare comparisons—year 2000. X-axis: Population proportion; Y-axis: Logarithm of average equivalent income at 1970 prices Rs./cap of all persons below the indicated population proportion.

Table 6
Classwise per capita expenditures (Rs.) and consumer price indices (CPI), year 2000

Expenditure class			% change over REF					
	REF		ATL		NTL		TL	
	Exp.	CPI	Exp.	CPI	Exp.	CPI	Exp.	CPI
Rural < 216	2396.6	1526.6	8.37	1.17	2.64	−8.19	3.85	14.57
Rural < 336	4891.6	1591.3	8.04	0.12	2.91	−8.35	3.53	−14.88
Rural < 516	7429.0	1720.4	7.41	2.78	1.82	−9.10	2.18	−14.31
Rural < 900	11654.0	1859.3	5.70	5.03	−3.79	−10.00	−4.47	−12.54
Rural > 900	26393.5	1898.2	4.00	3.41	12.16	−13.04	−14.87	−14.53
Urban < 216	2892.2	1521.3	−0.03	−4.46	−25.04	−6.75	−28.02	−13.99
Urban < 336	4542.8	1656.5	0.07	−3.66	−25.27	−9.73	−28.59	−17.00
Urban < 516	6806.8	1766.1	0.26	−2.46	−25.32	−10.86	−28.90	−17.30
Urban < 900	10946.6	1836.5	0.52	−3.64	−25.38	−11.21	−29.32	−18.06
Urban > 900	30567.9	1903.6	2.14	−3.51	−24.22	−14.11	−29.59	−19.39

three rural classes are better off under ATL (see Fig. 2). However, the richest two rural classes, representing more than 50% of the rural population lose. This is because agricultural GDP falls due to liberalization as output of other food sector falls by 8.3% in 1995 due to a 28% fall in its price. Over time this output loss is nearly regained and by 1998 GDP agriculture already exceeds the reference run value. Nevertheless, the fall in other food price translates into a fall even in 2000 in the equivalent income of the top two rural classes. Therein lies the dilemma of agricultural trade liberalization. The rich farmers would oppose it even though the rural poor and urban population gain from it.

Table 6 shows the per capita expenditures in current prices and classwise consumer price indices (CPI) for the year 2000 for three scenarios. It is seen that the CPI move more favourably for the poorer classes compared to the richer classes in ATL. The poorest classes gain in terms of equivalent incomes more due to fall in CPI than due to rise in current expenditure. Thus, the commodity structure of prices matters for welfare. The fall in prices of coarse grains and other food more than compensates the poor for increases in other agricultural prices.

The distributional impact of NTL is as expected. The rural population gains and the urban population loses (Fig. 2). A fall in nonagricultural price due to NTL increases relative price of agriculture by 27.9% in 2000. This, along with an increase in tax rate, results in a loss in the equivalent income of the urban population in spite of an increase of 4.9% in the real nonagricultural GDP. [4]

When trade is liberalized in all sectors, the urban population still loses as the NTL effects dominate the ATL effects. For the rural classes, now bottom four classes gain and only the richest rural class loses. This class is still sizeable, constituting about 35% of the rural population.

We would like to emphasize here that in our model, there is no rent seeking. Both before and after liberalization, production is assumed to be on the production possibility frontier. Thus liberalization in the model, does not provide any gain from removal of rent seeking distortions. This is not much of a limitation when dealing with agriculture where rent seeking distortions are minimal. But the model would underestimate gains from NTL. Further, tradeable nonagriculture is a one aggregate sector. Thus, even efficiency gains due to resource reallocation within nonagriculture are not captured. If these gains were to be captured in the nonagricultural sector, the welfare impact on urban populations could have been very different. It is conceivable that even the urban populations would have gained due to greater efficiency and a more rapid growth.

[4] Note that current expenditure falls for rural top two classes too. While the fall in CPI cannot compensate for fall in current consumption expenditure in urban areas, it does compensate for the rural top two classes. The rural poor, on the other hand, gain due to both price fall and nominal expenditure increase.

In conclusion, we note that the distributional impacts of trade liberalization are complex and raise issues of political economy. In any case it does indicate the need for a safety net for the poor.

4.1.9. Why does the price of rice, which is disprotected, fall under liberalization? Why do we impose a quota on rice exports?

Though the nominal protection rate for rice was estimated to be −34%, liberalized rice price actually falls by only 13.9% in scenario TL for year 2000. This apparently anomalous behaviour is due to the various supply and demand elasticities and quota on rice exports. First, let us look at the reasons for imposing a quota on rice exports and its consequence.

A qouta of roughly 0.5 m.t. (0.5% of production) is imposed on rice exports in the reference scenario. (For 1993, the reference scenario gives a consistent set of domestic price, world market price and estimated nominal protection rate of −34% with an export level of 0.45 m.t.). When we liberalize trade we relax, but still retain, the rice export quota to roughly 3.0 m.t., i.e., equal to 3.0% of production. The purpose of retaining the quota on rice export is that the world market cannot absorb all that India might want to export under substantially higher rice prices. The export quota is imposed to reflect the thinness of the world market (currently the total world trade in rice is around 15 m.t.) and the non-linearity of world price with respect to India's rice trade.

Estimates of protection rates made by Gulati et al. (1993) and used above are based on small country assumption; i.e., assuming that world market price is not affected by the country's trade. If the small country assumption is relaxed, as it should be for the case of rice exports for India, the 'true' protection rate should be calculated by comparing domestic rice price with the world market price that would prevail if India were to export rice freely. This would be quite different. This is shown in Fig. 3.

The top part of the figure shows domestic demand curve. Given a fixed supply (the argument is valid even if supply is made to respond to price) the export level will vary with domestic price. Thus at price P_1^d, the export will be SE_1 and at P_2^d it will be SE_2. In the bottom part of the figure is shown the

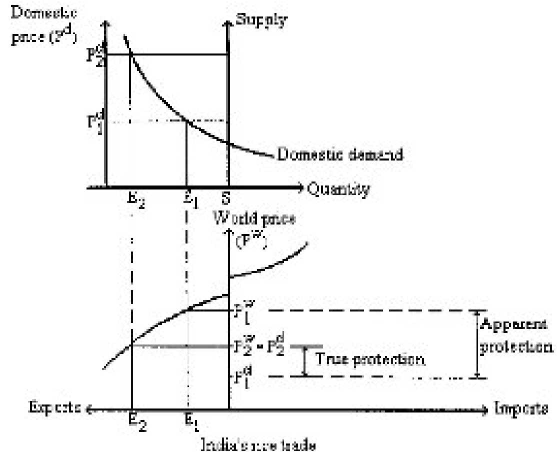

Fig. 3. India's rice trade, World price and protection level.

world market price's response to India's rice trade. At an export level of SE_1 world price would be P_1^w and at a level of SE_2 it would be P_2^w.

In a situation where a domestic price of P_1^d prevails an apparent estimate of nominal protection rate would be $(P_1^w - P_1^d)/P_1^w$. Now suppose under no export restriction the domestic price is P_2^d, exports SE_2 and world market price $P_2^w = P_2^d$. The 'true' nominal protection rate is now estimated to be $(P_2^w - P_1^d)/P_2^w$.

The estimate of rice protection of −34% is an apparent estimate under small country assumption. It is because we think that this is an unrealistic estimate that we impose a quota on rice exports. When trade of all agricultural commodities is liberalized, rice export quota is raised to 3.0 m.t. (3.0% of production).

To find out the level of rice export needed to set domestic price of rice at the level of world price, we made a run without any quota on rice export (detailed results not presented here). Indeed the domestic price is now, as expected, substantially higher (by $55\% = 100 \cdot (1.0/(1.0 - 0.34))$) compared to the reference scenario, but this requires an export of rice of 13 m.t. by 2000. The world market simply cannot absorb so much rice unless rice price collapses.

4.1.10. Does the fall in rice price make sense?

Even when one accepts our argument about the estimates of (dis)protection rate of rice, one may still wonder why under TL with quota of rice exports, rice output increases and price falls. Due to liberalization, investment goes up and irrigation capacity increases. This raises rice production which is highly elastic with respect to irrigation and relatively inelastic with respect to its price. Even though the quota on rice export is raised under liberalization, it still restricts it and domestic availability goes up. To absorb it domestically rice price has to fall.

As noted earlier, under TL, which involves agricultural and nonagricultural trade liberalization, the GDP growth is higher. The larger real investment increases gross irrigated area by 7.7% (6 M ha). Irrigated area under rice is not sensitive to rice price. The increase in rice output of 5.5% (4.9 m.t.) is a consequence of higher irrigation availability and still lower price of coarse grains. The main competing crops for rice are ragi and jute.

While rice price falls by 13.9%, the coarse grains price also falls by 9.1%. Since in this scenario, tradeable nonagriculture is also liberalized and its price falls by 26%, fertilizer price falls correspondingly. As a consequence, the rice price relative to fertilizer price actually increases which raises rice yield by 0.9%.

Rice supply thus, increases by 4.9 m.t. The rice export quota, on the other hand, is raised to 3.0 m.t. from 0.5 m.t. Thus, about 2.5 m.t. more rice has to be domestically absorbed which would cause the fall in rice price. In order to check whether the fall in rice price is consistent with the increased availability of rice, we turn to a rough estimate of demand level. Household demand in the model is represented by linear expenditure systems estimated separately for five rural and five urban expenditure groups. Rice demand, therefore, depends on all prices, but to get a rough idea we look at the expenditure and own price elasticities for these classes and use these to estimate the change in household demand.

Total household consumption of rice was 87.179 m.t. in the reference scenario in the year 2000. Taking REF scenario price and expenditure levels as base values, we calculate percent changes in price and expenditure levels and use elasticities to roughly estimate the demand for TL. This is a rough estimate for providing basic intuition behind the results as we do not account for cross price effects that the model solution accounts for. Surprisingly, this roughly estimated demand turned out to be 89.494 m.t. which is nearly the same as the model estimate of 89.479 m.t. suggesting that the net cross price effects on rice demand is negligible. One may emphasize that the parameters of the demand systems are by and large econometrically estimated.

These arguments find further support when we look at rice price changes in the scenario ATL. Here rice price increases by 4.7% over the reference run price. This is much less than what the removal of disprotection of 34% would imply. The supply of rice does not increase here as much as in TL as the increase in irrigation is modest and fall in relative price of fertilizer is very small.

4.2. Set 2 scenarios: welfare optimal export quota / tariff for rice

We now turn to another question: what would be the welfare optimal export quota/tariff for rice to maximize welfare? The next set of scenarios are designed to answer this question.

As already mentioned, India is a major producer of rice. Compared to the global trade in rice of about 15 m.t., in January 1995, Indian government had a stock of about 18 m.t. Thus if India were to freely export rice the global rice price can be expected to fall unless there is a policy shift in some major rice trading/consuming countries. In fact, for strategic policy analysis which is the purpose of this paper, we have assumed neither such policy shifts nor any weather shocks. Of course, short run opportunities to export rice that open up due to such shifts and shocks should be exploited.

Ideally, world price of rice should not be fixed but an export demand function for rice should be used so that the world price of rice is consistent with India's exports. In the current version of the model this is not possible. However, we can get around the problem of consistency by specifying world prices and rice quotas and verifying later if in the solution exports and the world price are consistent. For e.g., if with a 3 m.t. of exports of rice by India world price is expected to be lower by 3%, then we specify an export quota of 3 m.t. and world price that is 3% lower than in the reference run. If in the solution, the quota is binding, then the world price and rice export are consistent.

To do this we first need to estimate the impact of

Table 7
World market price of rice (US$, 1970) from BLS—corresponding to different rice export by India

Year		% change over BASE						
	0.5 m.t. (BASE)	1.0 m.t.	2.0 m.t.	2.5 m.t.	3.0 m.t.	4.0 m.t.	5.0 m.t.	7.5 m.t.
1994	0.1331	−1.20	−5.18	−7.36	−9.47	−13.30	−17.36	−24.42
1995	0.1284	−0.62	−3.27	−4.75	−6.07	−8.64	−11.60	−17.13
1996	0.1252	−0.40	−2.00	−2.80	−3.59	−5.27	−6.87	−10.54
1997	0.1233	−0.41	−1.38	−2.11	−2.76	−3.97	−4.87	−7.38
1998	0.1222	−0.57	−1.47	−2.13	−2.78	−3.85	−4.75	−7.12
1999	0.1218	−0.74	−1.72	−2.46	−3.20	−4.35	−5.34	−8.13
2000	0.1220	0.90	−2.21	2.95	−3.69	−5.08	−6.31	−9.51

India's exports on world market price of rice. This is a major task in itself! It has been suggested to us by the World Bank, for whom this study was originally carried out, that we might use in our calculations a rest of the world (ROW) supply elasticity between 0.7 and 1.0, a ROW demand elasticity of −0.35 and an income elasticity of 0.2. We find the suggested world supply and demand elasticity to be too high compared to other available figures in the literature. For example, let us look at the estimates obtained from the simulations carried out in an IIASA (International Institute for Applied Systems Analysis, Laxenburg) study by Parikh et al. (1987) using the Basic Linked System (BLS) of National Models. The BLS has 34 empirically estimated national (or for groups of nations) models linked through trade and aid in a general equilibrium framework. The estimated elasticities of the various models range as follows (see Fischer et al., 1988).

The estimated supply elasticity of rice with re-

Table 8
Impact of rice export quotas, year 2000 [a]

		% change over REF	% change over ATLRQ0.5						
	REF	ATLRQ0.5	ATLRQ1.0	ATLRQ2.0	ATLRQ2.5	ATLRQ3.0	ATLRQ4.0	ATLRQ5.0	ATLRQ7.5
GDP70	1 740 126.00	0.72	0.03	0.08	0.11	0.16	0.23	0.30	0.51
GDPA70	510 565.50	0.84	0.01	0.04	0.05	0.07	0.09	0.11	0.17
GDPN70	1 229 561.00	0.66	0.04	0.10	0.14	0.21	0.29	0.39	0.66
INVEST70	419 256.80	0.15	0.16	0.40	0.52	0.73	1.00	1.30	1.99
TAX RATE	0.141	−5.23	−0.54	−1.25	−1.58	−2.11	−2.59	−3.04	−3.57
PA/PNA	1.025	0.28	0.39	0.97	1.33	1.79	2.58	3.45	5.67
PNA	17.78	−0.56	0.03	0.07	0.07	0.10	0.09	0.07	−0.04
CAL/CAP	2721.26	8.37	−0.11	−0.27	−0.37	−0.48	−0.69	−0.91	−1.45
AVR.EQY	878.21	1.55	−0.03	−0.09	−0.14	−0.17	−0.30	−0.44	−0.83
Rice price	22.94	−2.77	2.05	5.10	6.83	9.32	13.09	17.30	27.48
Wheat output	74 747.99	2.86	0.06	0.15	0.19	0.27	0.39	0.52	0.84
Rice output	89 101.58	0.57	0.13	0.33	0.44	0.60	0.84	1.09	1.69
Coarse grains output	44 906.72	−4.49	−0.02	−0.04	−0.06	−0.07	−0.10	−0.14	−0.19

[a] See Appendix A for description of variables and their measurement units: ATLRQ0.5: agricultural trade liberalization, rice export quota 0.5 m.t.: ATLRQ1.0: agricultural trade liberalization, rice export quota 1.0 m.t.: ATLRQ2.0: agricultural trade liberalization, rice export quota 2.0 m.t.; ATLRQ2.5: agricultural trade liberalization, rice export quota 2.5 m.t.; ATLRQ3.0: agricultural trade liberalization, rice export quota 3.0 m.t.; ATLRQ4.0: agricultural trade liberalization, rice export quota 4.0 m.t.; ATLRQ5.0: agricultural trade liberalization, rice export quota 5.0 m.t.; ATLRQ7.5: agricultural trade liberalization, rice export quota 7.5 m.t.

spect to its world price mostly varies within 0.0 and 0.45 with Kenya being the only outlier at 0.81. A simple average for 15 countries (including Kenya) listed in the study gives an elasticity of only 0.16. The average demand elasticity is less than 0.1 (in fact 0.03!). The BLS scenarios also showed that short run and long run price elasticities were very different. If India were to try to push more rice on the world market, other countries would also adjust their behaviour. Ideally, if we could have updated all the other models of the BLS as we have updated the model of India, we could have run the linked system of models without any quota on rice trade when it is liberalized. The world price would be consistent with India's rice exports. This was not feasible. In order to capture these impacts of policy responses of other countries we used the existing BLS model system and ran alternative scenarios in which India exported a fixed quantity of rice every year from 1994 onwards. The world rice price compared to reference scenario are given in Table 7. We used these factors to prescribe world rice price corresponding to different levels of rice export quota.

Different rice trade liberalization scenarios were run in which rice exports were restricted to different levels shown above with the world market price of rice correspondingly set. The difference between realized domestic price and export price would indicate the tariff/subsidy on rice exports. These different runs can be compared now in order to arrive at a level of tariffs that is optimal from the welfare point of view.

We would also like to emphasize that the BLS simulations, based on which we calculate the impact on world price of India's rice exports, accounts for the reactions of other countries to India's exports of rice.

Results of different export quota runs are shown in Tables 8 and 9. The scenario ATLRQ0.5 is a scenario of agricultural free trade but with a rice quota of 0.5 m.t. as in the reference scenario. It thus incorporates effects of trade liberalization in all agricultural sectors except rice. The other scenarios refer to different rice quota levels (ATLRQ1.0—1 m.t.; ATLRQ2.0—2 m.t.; and so on up to ATLRQ7.5—7.5 m.t.) and corresponding world market price with free trade in other agricultural sectors. Thus, in order to examine effects of imposition of rice quota, say, of 2 m.t., we need to compare the run ATLRQ2.0 with ATLRQ0.5.

The results show that as rice export expands, rice production rises but by a lesser extent than exports (see Table 8). For example, when rice exports is increased by 1.5 m.t. (from 0.5 m.t. in ATLRQ0.5 to 2 m.t. in ATLRQ2.0), output expands. Rice output has increased by 0.33% which is less than 0.3 m.t. This puts pressure on domestic price of rice, which rises by 5.1% even as world market price of rice falls. The rice price increase shifts demand in favour of wheat, whose output also rises marginally. On the

Table 9
Willig–Bailey welfare comparison of alternative rice export quota, year 2000

Cumulative population proportion	REF	ATLRQ0.5	ATLRQ1.0	ATLRQ2.0	ATLRQ2.5	ATLRQ3.0	ATLRQ4.0	ATLRQ5.0	ATLRQ7.5
Rural									
0.195	150.368	160.545	159.972	159.159	158.726	158.118	157.273	156.386	154.543
0.321	292.038	312.475	311.616	310.415	308.589	307.704	306.511	305.272	301.632
0.458	413.128	427.714	426.746	425.386	423.822	422.802	421.401	419.913	416.855
0.654	601.140	599.458	598.732	597.838	597.096	596.297	595.072	593.711	592.800
1.000	1360.558	1343.059	1342.945	1342.741	1342.409	1342.278	1341.300	1340.095	1336.594
Urban									
0.002	181.420	195.371	194.700	193.695	193.109	192.330	191.051	189.665	186.320
0.014	265.547	284.634	283.520	281.858	280.892	279.597	277.494	275.216	269.741
0.061	373.012	395.642	394.429	392.582	391.482	390.016	387.538	384.811	379.248
0.238	578.577	611.025	609.914	608.151	607.027	606.934	604.241	601.218	595.942
1.000	1580.159	1631.797	1630.766	1629.891	1629.042	1628.140	1627.301	1626.485	1625.220

other hand, output of some sectors like dairy products marginally decline. The net result of sectoral output changes is that GDP increases as rice export level increases to 2 m.t. Thus rice exports of 2 m.t. increases GDP by about 0.1%. Note that this rise takes place in spite of fall in world market price. This behaviour of GDP, rice output, wheat output and domestic rice price continues up to rice export quota of 7.5 m.t. However, domestic rice price increases steeply with rice exports.

The simulation results also provide a better estimate of the disprotection rate on rice. Note that the apparent protection rate on rice in Table 3 was −34%. With a rice export quota of 7.5 m.t. in the year 2000, the world price as shown in Table 7 falls by 9.5% and domestic price increases by 27.5% which add up to 37%, slightly more than the nominal disprotection rate. Thus, the 'true' disprotection rate on rice is 27.5%. It also shows that *without any export quota on rice and without any concern for social welfare under ATL, rice exports would have been around 7.5 m.t. in 2000.*

However, if we need to decide on optimal export tariff or quota level, the decision could not be based solely on consideration of GDP effects. We need to compare equivalent incomes for different classes. The results on equivalent incomes corresponding to different quota levels are presented in the form of Willig–Bailey comparisons in Table 9 where the average equivalent incomes at different cumulative population proportions are tabulated separately for rural and urban areas. The results clearly indicate that, amongst the scenarios with quota on rice exports and rest of agriculture being liberalized, the equivalent income remains dominantly the highest in the case of an export level of 0.5 m.t. of rice compared to any other export level considered. Thus, *the socially optimal tariff* on rice exports for India corresponds to an export quota of 0.5 m.t. We once again reiterate that this is optimal from welfare point of view and not from the point of view of maximizing GDP.

5. Conclusions

We have attempted in this paper to analyze quantitative implications of agricultural trade liberalization for India using an Applied General Equilibrium model. The following main results are worth reiterating in conclusion.

(1) Trade liberalization helps to accelerate economic growth in the medium run by (a) increasing allocative efficiency within agricultural sectors and between agriculture and nonagriculture and (b) increasing real investment due to terms of trade effects. In fact, in seven years after liberalization in 2000, the GDP is larger by 4.5% compared to the reference scenario.

(2) The impact of increase in investment is much stronger than that of increases in allocative efficiency. This implies that investment goods liberalization has a greater impact on growth, even agricultural growth, than agricultural liberalization.

(3) Agricultural liberalization by itself leads to a decrease in poverty. The marginal increase in terms of trade of agriculture and the decline in prices of coarse grain and other food together result in different impact on consumer prices for different expenditure classes. The adverse income effect associated with it is more than compensated by the gains to the poor as consumers due to fall in rice and coarse grain price. The rural rich are, however, worse off due to liberalization in terms of average equivalent income. As government loses tariff revenue due to liberalization, it has to raise other taxes, which are stipulated to be only on nonagricultural income as there is at present no agricultural income tax in India due to constitutional reasons.

This provides an important policy guideline. If the nonagricultural sector is more distorted than agriculture, liberalizing nonagricultural distortions is more beneficial to agriculture than removing only agricultural distortions. In many countries agriculture sector is usually competitive and provides far fewer rent seeking opportunities compared to nonagricultural sectors. This will further strengthen our conclusion as in our model, as in most general equilibrium models, gains of liberalization through the elimination of such opportunities are not accounted for.

The various scenarios of rice trade liberalization have shown the following.

(1) The 'true' disprotection rate, i.e., one that accounts for impact on world price of India's export, on rice in India is more likely 27.5% compared to the nominal rate of 34%.

(2) A social welfare oriented rice trade policy would put an export quota of 0.5 m.t. of *net exports*. Another policy insight emerges from this. Liberalization of a commodity that constitutes a main staple diet of a large part of the population of a poor country can have serious consequences on the welfare of the poor. The decision to liberalize should not be taken without due consideration of these consequences and instituting, if required, a safety net.

Appendix A. Variables used in output tables (in order of appearance)

Variable	Description and measurement units
GDP70	Gross Domestic Product, at 1970-1971 prices, 10^6 Rs.
GDPA70	Gross Domestic Product Agriculture, at 1970–1971 prices, 10^6 Rs.
GDPN70	Gross Domestic Product Nonagriculture, at 1970–1971 prices, 10^6 Rs.
TR.DEF70	Trade deficit, at 1970–1971 prices, 10^6 Rs.
INVEST70	Gross investment, at 1970–1971 prices, 10^6 Rs.
TAX RATE	Tax rate
PA/PNA	Terms of trade between agriculture and nonagriculture (ratio of agriculture price deflator to nonagriculture price deflator)
PNA	Nonagriculture price deflator
RER	Real exchange rate—defined as the ratio of production weighted average price of all tradeable commodities to the price of the single non-tradeable commodity
G.I.AREA	Gross irrigated area, '000 ha
FRTLZR	Total fertilizer (N + P + K) consumption over all crops, '000 tons
CAL/CAP	Food energy caloric intake per capita, kilo calories per person per day
AVR.EQY	Average equivalent income (income needed at 1970–1971 prices to provide same utility as provided by current consumption at current prices), Rs.
PARITY	Rural–urban incomes parity
RURL.INC	Rural income at current prices, Rs.
URBN.INC	Urban income at current prices, Rs.
AG.WGERT	Agricultural wage rate
DIST-FGR	Foodgrains distribution quantity, '000 tons
TOTL.POP	Total population, '000 persons
URBN.POP	Urban population, '000 persons
RAW PRICES	Producer prices (not inclusive of processing margins)

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