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ABSTRACT

Although computable general equilibrium (CGE) models have been used extensively to evaluate the potential impact of economic reforms, few efforts have been made to assess the predictive power of the models. This paper attempts to test the performance of one such model, viz., Chadha, Pohit, Deardorff and Stern's study of India's unilateral trade/domestic policy reforms in the 1990s. Our model does not incorporate many of the rigidities/features of the Indian economy. Nevertheless, our model can perform quite well at simulating, if not forecasting, actual changes in sectoral output and exports

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1. INTRODUCTION

The product of many CGE model-building exercise is often seen as simply another economic model to add to a collection rather the birth of an important tool capable of answering economic questions. There are many reasons for the current level of skepticism surrounding CGE modeling effort. In implementing a CGE model, one is required to make many assumptions regarding data base, behavioral equations, and parameters. While CGE modelers may find that most of these assumptions are necessary and defensible, this provides little assurance to consumers of results. Of more interest to the modeler's clients is whether a model is capable of producing a proven set of results deemed accurate and reliable. Thus, an exercise aimed at evaluating a model based on its predictive performance seems well placed. Of late, few attempts have been made in validating results of CGE models of developed countries.[1] In this spirit, this paper makes an attempt to test the forecast changes due to Indian trade liberalization in the nineties as modeled by Chadha, Pohit, Deardorff and Stern (1998a, 1998b) in their 34-sector India CGE model.

This India Model is a single-country, multi-sectoral CGE model.[2] India is modeled to produce, consume and trade 33 tradable goods. In addition, there is one non-traded sector, rail transport. The sectors of the model, their market structure along with key sectoral economic indicators of the Indian economy in the base year of our model, viz. 1989-90, is shown in Table 1.

The market structure in 29 of the 34 sectors is modeled as either perfectly competitive or monopolistically competitive, depending on the degree of scale economies in production. All the tradable sectors are assumed to be characterized by some degree of product differentiation..

There are two factors of production namely, labor and capital in the non-agricultural sectors of model. However, land is also considered as an additional factor of production in the four agricultural sectors. All factors of production are assumed to be perfectly mobile across sectors, except that all capital is assumed to be immobile into and out of the state monopoly sectors. Returns to land, capital (in sectors across which it is mobile), and labor are determined to equate factor demand to an exogenous supply of each factor. The aggregate supplies of labor, capital, and agricultural land are assumed to remain fixed so as to abstract from macroeconomic considerations involving, for example, determination of investment, since our focus is on the intersectoral allocation of resources.

India's merchandise imports/exports are subject to tariffs and non-tariff barriers (NTBs). NTBs are incorporated by endogenously solving for the ad valorem tariff-equivalent rate that would hold imports/exports within each product category covered by NTBs at a pre-determined level. Tariff rates are aggregated according to the sectors specified in Table 1.

In our model we assume that aggregate expenditure varies endogenously to hold aggregate

[1]Fox (1999) has looked at the predictive power of the Michigan model of Brown and Stern (1989). Similarly, Kehoe, Polo and Sancho (1994) have cross-checked their model results with the actual outcomes.

employment constant. In addition to above closing rule, we need to specify several variables to be exogenous for obtaining the model solution. Typically, these are the policy inputs to the model.

3. THE SCENARIOS AND DATA

The paper by Chadha et al (1998a) reported different scenarios on changes in tariffs/NTBs relating to exports/imports/output under following alternative assumptions: (1) the economy retains certain product market imperfections (state monopolies and administered prices) as these existed in 1989-90; (2) the economy is free from such distortions. In that paper, we reported two sets of policy shocks depending on our assumption regarding the path of reforms that were likely to take place between 1989-90 to 1995-96 and between 1989-90 to 1998-99.[3]

After seven years of economic reforms, it is now evident that the most of the domestic reforms are yet to be undertaken. Consequently, if we are to validate our predictions against actual, it seems to be more appropriate to compare our model results keeping status quo as far as domestic reforms are considered. This is more so since the data availability constraint us to compare our predictions against actual outcomes for the period 1989-89 to 1994-95.[4]

In the original run of the model, we have applied the following shocks for the simulation pertaining to the period 1989-90 to 1995-96.

a. Reduction in Import/Export tariffs: We have reduced the import tariff as per the recommendation of Chelliah Committee.[5] Since export taxes were already negligible in 1989-90, they were not shocked.

b. Reduction in NTBs on Imports/Export: The existing NTBs (1989-90) on imports/exports were assumed to be partially relaxed so as to permit a specified per cent increase in the imports/exports that had been constrained. This was implemented in the model by increasing the level of imports (or exports) that were under some kind of quantitative restriction for the sectors subject to import NTBs (or export NTBs). The estimated increases in imports from relaxation of NTBs for agricultural, consumer and other goods including services are respectively 10% 25% and 75%. On the other hand, we have assumed increases in exports from relaxation of NTBs on exports for agricultural sectors as 25% and for the remaining sectors as 50%. While these estimates are not based on any actual declared numbers, we have tried to incorporate the implicit intentions in various policy announcements whereby the imports of agricultural and consumer goods are likely to remain more restricted than the other sectors of the economy.[6]

c. Rationalization of Indirect Taxes: In the original runs of the model, we had reduced the subsidies

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[2] The technical details and equations of the model are available in Chadha, Pohit, Deardorff, and Stern (1998b).

[3] It should be mentioned that the breakup of the time period was a bit arbitrary.

[4] The data problem is discussed later.

[5] See Table 8.2 of Interim Report, Chelliah Committee (1991). The actual reduction in rates is shown in Chadha et al (1998a).

(net indirect taxes) in the following sectors--- 4 agricultural sectors; fertilizer; and electricity, gas, and water supply sectors --- by 5% and had decreased excise duties in the remaining sectors by 5%.

In retrospect, we find from the latest available data/publication that our assumption regarding deepening of trade liberalization by the year 1994-95 was completely off marks in certain sectors. For example, there was no relaxation on NTBs in service sectors during the period 1989-90 to 1994-95. The same holds true for the four agricultural sectors.[7] On the other hand, actual import tariff rates in 1995/96 were by and large in line with Chelliah committee recommendations (used for the model run).[8]

In the light of these observations, it seems appropriate to modify the shocks for the validation exercise. Accordingly, the following modifications to the shocks were made:

(a) we assume status quo to be maintained in the NTBs in the agricultural and the service sectors,

(b) other indirect tax rates are modified on the basis of actual changes between the years 1989-90 and 1994-95.[9]

The original model requires estimates of various types of elasticity measures, viz. demand elasticities of exports and imports and elasticites of substitution between factors of production and between varieties of goods. We have used the same values of the parameters for this exercise.[10]

Given the fact that revised shocks are given only to 23 manufacturing sectors, our validation exercise is carried out only for three major variables, namely, output, exports and imports, of these sectors for which we could generate sectoral data sets for the years 1989-90 and 1994-95.

4. EVALUATION OF INDIA MODEL RESULTS

In order to measure the goodness of fit of the predicted changes in selected variables, we have considered for our analysis following two measures of goodness of fit----

1. *weighted correlation (r)*, between the predicted and observed vectors of changes:

$$r = \frac{\sum_i w_i^2 y_i \hat{y}_i}{\sqrt{\sum_i w_i^2 y_i^2 \sum_i w_i^2 \hat{y}_i^2}}$$, where w_i , the weight for sector i, is derived from the base year (1989-90) values of the variable. This measure rewards predictions that have the right signs and relative magnitudes, but it does not take into account the absolute magnitude of the changes.

2. adjusted R^2 resulting from the *weighted regressions* of the predictions against actual outcomes:

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[6] See Panagariya (1999), *Export/Import Policy* document of Government of India.

[7] The shares of restricted imports to total imports for paddy, wheat, other cereals were 100% in 1994-95. There was only marginal relaxation in NTBs in the other agricultural sector (see Chadha and Pohit, 1998c, for details).

[8] See Pursell (1996), RIS (1998) for details.

[9] The rates are computed using our constructed inter-industry transaction tables, concorded to our sectors, for the years 1989-90 and 1994-95.

[10] Incidentally, our earlier study has shown that our model results are not particularly sensitive to the values of the major parameters used in the model (see Chadha et al, 1998a).

$$y_i = \beta_1 \hat{y}_i \sqrt{w_i} + \varepsilon_i \sqrt{w_i}$$

Before we begin our evaluation exercise, it will be worthwhile to see the sectoral growth rates of output, imports, and exports for manufacturing sectors of our economy (see Table 2a). As Table 2a shows, growth rates of sectoral output lie between –70% to 120%. The same is not true of imports and exports. As this table shows, several sectors, notably, furniture and fixtures, fertilizer, and non-metallic mineral products exhibit abnormally high/low growth rates of exports/ imports due to a low base factor. It is understandable that the predictions from no model can match such high sectoral growth. For this reason, we have dropped above 3 sectors for validating import/export's growth rates.

Table 2a displays actual and predicted direction of change of output, imports, and exports between the years 1989-90 and 1994-95. A '+' (or '-') under the heading actual/predicted for a sector in Table 2a implies that the corresponding sector registered positive (or negative) rate of growth during the period. According to Table 2a, the model correctly predicts the observed direction of change of output in 18 out of 23 sectors under study. That is, our prediction of output change is off the target in 22% of cases. With regard to export, our model could correctly infer the direction of change in 16 out of 20 sectors. As far as imports are concerned, our inference is less accurate: we could predict correctly in 8 out of 20 sectors.

The above discussion suggests that our model predicts moderately well the observed direction of change. How well are these predictions in terms of standard measures of goodness of fit? Table 2b summaries our findings. As this table shows, the weighted correlation between the predicted and observed changes of output is 0.56. On the other hand, the goodness of fit, as measured by adjusted R^2 of the regression of the predictions of the model against actual outcomes of output is 0.80. By these criteria, one can conclude that our simulation predicts reasonably well the observed changes in output.

The performance of the CGE simulation for exports is also equally good: the weighted correlation between the observed and predicted values is 0.75 whereas the adjusted R^2 of weighted regression measures 0.46. However, the model runs fare poor for imports, yielding a weighted 'r' of -0.51 and a adjusted R^2 of 0.06.

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Table 1. Sectoral Breakup of India CGE Model, Key Economic Indicators (Rs. million, 1989-90)

	Sector	Market Structure	Output	Exports	Imports	Labor Share
1.	Paddy	PC, AP	305273	3836	2829	0.1717
2.	Wheat	PC, AP	153795	19	214	0.1272
3.	Other cereals	PC	75988	19	235	0.1717
4.	Other agriculture	PC	1274741	25118	12999	0.1654
5.	Food, Beverages & Tobacco	MC	347930	10914	5061	0.0253
6.	Textiles	MC	519963	23770	3557	0.0223
7.	Clothing	MC	88864	43206	659	0.0016
8.	Leather products	MC	17917	10021	237	0.0008
9.	Footwear	MC	18285	5297	77	0.0007
10.	Food products	MC	24281	138	351	0.0011
11.	Furniture and fixtures	MC	3471	3	0	0.0001
12.	Paper and paper products	MC, AP	49211	158	9678	0.0021
13.	Printing and publishing	MC	36711	90	975	0.0022
14.	Fertilizer	MC, AP	62294	15	12279	0.0015
15.	Other chemicals	MC	253450	16029	43932	0.0067
16.	Petroleum & related products	MC, SM	173382	5303	15323	0.0009
17.	Rubber products	MC	45742	6765	629	0.0017
18.	Non-metallic mineral products	MC	58917	29076	178	0.0060
19.	Glass and glass products	MC	49087	23298	1534	0.0001
20.	Iron and steel	SM	177158	2258	30619	0.0065
21.	Non-ferrous metals	MC	37334	906	14059	0.0027
22.	Metal products	MC	66688	1093	12766	0.0035
23.	Non-electrical machinery	MC	135705	13033	90594	0.0073
24.	Electrical machinery	MC	168684	10060	33494	0.0057
25.	Transport equipment	MC	161818	7213	21404	0.0093
26.	Misc. manufactures	MC	120160	5338	14019	0.0032
27.	Mining and quarrying	SM	130772	4988	95098	0.0080
28.	Electricity, gas & water sup.	SM	215171	67	0	0.0038
29.	Construction	PC	561964	8449	4119	0.0403
30.	Wholesale & retail trade	PC	614688	56046	9393	0.0747
31.	Rail transport	SM	100802	0	0	0.0061
32.	Other transp. Storage & commn.	PC	365920	42615	48712	0.0220
33.	Financial services	PC	405957	7042	3799	0.0084
34.	Personal services	PC	761316	5877	207	0.0886

Notes:

- PC: Perfect Competition; MC: Monopolistic Competition; AP: Administered Price;
- SM: State Monopoly. Sectors under SM have administered prices.

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Source: Chadha, Rajesh, Sanjib Pohit, Alan V. Deardorff, and Robert M. Stern (1998a)

Table 2a. Sectoral Growth Rates (1994/95 over 1989/90), Actual and Predicted Direction Of Change

Sectors	Output			Exports			Imports		
	Growth rate	Actual	Pred.	Growth rate	Actual	Pred.	Growth rate	Actual	Pred.
Food, Beverages & Tobacco	129.1	+	+	134.9	+	+	269.2	+	-
Textiles	37.6	+	+	199.6	+	+	12.2	+	-
Clothing	111.7	+	+	79.6	+	+	-95.9	-	-
Leather products	60.4	+	+	40.3	+	+	134.1	+	
Footwear	24.8	+	+	55.4	+	+	112.1	+	-
Wood products	-70.8	-	+	-39.2	-	+	-30.3	-	-
Furniture & fixtures	-74.8	-	+	1713.8			100.0		
Paper & paper products	90.9	+	+	-6.3	-	+	30.9	+	+
Printing & publishing	13.0	+	+	5.2	+	+	-56.4	-	-
Fertilizer	100.7	+	+	8856.4			20.6		
Other chemicals	50.3	+	+	51.4	+	+	33.4	+	-
Petroleum & related products	79.0	+	+	4.9	+	+	101.6	+	+
Rubber products	-9.5	+	+	-99.8	+	+	-100.0	+	-
Non-metallic mineral products	131.6	+	+	2210.1			173.5		
Glass & glass products	-63.5	-	+	-94.9	-	+	-14.9	-	-
Iron & steel	103.7	+	+	217.8	+	+	-25.8	-	+
Non-ferrous metals	55.6	+	+	79.5	+	+	130.5	+	+
Metal products	-42.7	-	+	235.8	+	+	112.3	+	-
Non-electrical machinery	29.1	+	+	34.2	+	+	30.9	+	-
Electrical machinery	60.9	+	+	-17.4	-	+	7.5	+	-
Transport equipment	44.5	+	+	219.0	+	+	249.7	+	-
Misc. manufactures	-10.4	-	+	196.6	+	+	94.3	+	-
Mining & quarrying	34.6	+	+	116.0	+	+	23.1	-	-

Table 2b. Summary of Major Findings

Variables	*r*	adjusted R^2	Coefficients	T- Statistic
Output	0.56	0.80	0.39	4.08
Exports	0.75	0.46	0.90	3.05
Imports	-0.51	0.06	-0.25	-2.60