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Trade liberalization, market discipline and productivity growth: new evidence from India

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Abstract

This paper investigates the effects on competition and productivity of the dramatic 1991 trade liberalization in India. Using firm-level data from a variety of industries, we find strong evidence of an increase in competition (as reflected in the reductions in price-marginal cost markups) and some evidence of an increase in the growth rate of productivity. The methodological framework differs from earlier studies in that we 'allow' for returns to scale to change after the liberalization, a relaxation of estimation restrictions that improves our estimates allowing more accurate (partial equilibrium) computation of welfare changes. Welfare analysis using the estimated parameters mostly suggests an increase in welfare, albeit quite small, in the sectors analyzed. © 1998 Elsevier Science B.V. All rights reserved.

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1. Introduction

The welfare effects of free trade have been extensively debated. While the traditional argument for free trade, based on allocative efficiency, was made under

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the assumption of perfect competition, it has been further argued that in imperfectly competitive markets, trade liberalization will bring additional welfare gains by reducing the dead weight losses created by domestic monopolies and oligopolies by increasing competition and reducing price-marginal cost markups. [2,3]

In addition, trade has also been argued to have dynamic effects. However, in contrast to the theoretical predictions on the effect of trade on competition and markups, the theoretical literature on the dynamic effects of trade is quite ambiguous: In models of trade and endogenous growth, trade can potentially generate growth-accelerating as well as growth-decelerating forces. Trade can spur innovation by enhancing industrial learning since it facilitates international exchange of technical information, can improve the efficiency of global research since it eliminates the duplication of research effort in different countries, can adversely affect research by diverting resources away from R&D or can improve growth by bringing resources into R&D, depending upon the abundance of skilled labor or the efficiency in R&D of any country relative to the rest of the world. Also, trade via market size effects, can reduce the incentives faced by domestic producers to innovate. [4] Since the theory appears to suggest that virtually anything may happen to productivity growth after opening up to trade, the question has largely become an empirical one.

However, until recently, these hypotheses linking trade to competition and to productivity growth received relatively little empirical attention. The problems with conducting studies to investigate the putative link between trade, productivity and competition are obvious enough: to examine this question directly, one must obtain detailed firm-level data both before and after a trade liberalization and sufficiently detailed data has only rarely been available. As a consequence, most studies that examined this question at the micro level employed calibrated industry level simulation models rather than providing econometric estimates. [5]

This paper investigates the effects of the dramatic 1991 trade liberalization in India. The extensive changes in the trade regime of India (significant reductions of tariffs on a wide range of imports, rationalization of the tariff schedule and expansion of quota limits) coming unexpectedly as they did, after several decades of restrictive external policies, provided an excellent controlled experiment in

[2] This argument was first made in context of domestic monopolies in the classic paper by Bhagwati (1965) and was subsequently extended to oligopolies by the more recent work of Helpman and Krugman (1989), inter alia.

[3] See Helpman and Krugman (1989) for a detailed discussion.

[4] Many of these arguments are developed in Grossman and Helpman (1990). See also Rodrik (1992).

[5] The recent papers by Levinsohn (1993), Tybout et al. (1991) and Harrison (1994) are important exceptions. Each of these papers employed detailed plant level data to study the effects of specific trade liberalizations (Turkey, Cote D'Ivoire and Chile, respectively). Industry studies include the well known Krueger and Tuncer (1982) study of Turkish firms. Examples of simulated industry studies include the works of Dixit (1988), Rodrik (1988) and Baldwin and Krugman (1988).

which the effects of restrictive trade policies could be measured. The data set used in this paper contains detailed firm level data on a large sample of firms in a variety of industries, thereby facilitating analysis at a high level of disaggregation. Our main results are that we find evidence of significant reductions in price-marginal cost markups in the post 1991 period and some weaker evidence of an increase in the growth rate of productivity. Finally, partial equilibrium welfare analysis using the estimated parameters mostly suggests an increase in welfare, albeit quite small, in the sectors analyzed. [6,7]

The remainder of this paper is organized as follows. Section 2 briefly discusses the trade reforms in India. Section 3 outlines the estimation methodology, discusses some econometric issues and describes the data. Section 4 presents the estimation results. Section 5 presents some welfare calculations. Section 6 concludes.

2. The trade reforms in India

In June 1991, following the general elections, a new government came to power, inheriting, consequently, one of the world's most complex trade regimes characterized by severe quantitative restrictions on imports and exports and extraordinarily high tariffs on imports. [8] A weak external payments position, exacerbated by the oil price hike caused by the Gulf war, forced the government to approach the IMF, whose loans came attached with the strong conditionality that, by popular account, eventually led the government to undertake major economic reforms. [9] Thus, in July 1991, the government announced its primary trade reforms which included the removal of most licensing and other non-tariff barriers on all imports of intermediate and capital goods and significant reductions in tariffs on imports. Table 1 shows the reduction in average tariffs in several industrial sectors along with the nominal and real exchange rates before and after the liberalization. [10]

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[6] We do not analyze the impact of the reforms on one crucial sector in the Indian economy—Agriculture. See the works of Bardhan (1979), Bardhan (1985) and Bardhan and Srinivasan (1988) for classic theoretical and empirical discussions of this sector.

[7] For an investigation of the impact of these reforms on factor markets, in particular, labor markets, see Kambhampati et al. (1997), whose empirical findings of negative correlations between markups and labor demand in various industries suggest 'pro-competitive' effects of these reforms as well.

[8] For a classic and highly readable account of India's economic policies in this earlier period, see Bhagwati and Desai (1970). See also Krueger (1993) for a comprehensive discussion of the political economy of policy determination and policy reform in developing countries.

[9] See Krishna and Mitra (1996) for a more detailed description of the economic and political factors that led to the undertaking of the reforms by the Indian government.

[10] An extensive description of the economic reforms and economic forecasts is provided in the World Bank's 'India: Recent Economic Developments' 1994 report and *Trade Policy Review Mechanism for India*, published by the GATT in 1993.

Table 1
GDP, inflation, the real exchange rate and tariffs

	1990–1991	1991–1992	% Change
Growth rate: real GDP	5.1	1	−80.3
Inflation rate (wholesale prices)	10	14	40
Real exchange rate (CPI based)	16.8	18.24	7.89
Tariffs			
Diversified	127.7	94.3	35.41
Electrical machinery	127.6	95.6	33.47
Non-electrical machinery	143.1	107.5	33.11
Electronics	99.6	76	31.05
Transport equipment	120.6	93	29.67

There were also changes in the exchange rate. The Indian Rupee was devalued 20% against the US Dollar in July 1991 and further devalued in February 1992 when an explicit dual exchange market was introduced. Despite the devaluation, which by itself would have been expected to have an import reducing effect, [11] imports were expected to grow substantially and create competitive pressures within the Indian market, due to the even larger reduction in tariffs and quantitative restrictions.

3. Estimation methodology

One technique of productivity measurement that has been widely employed is the Solow (1957) method of estimating multifactor productivity (TFP) changes. However, Solow's methodology makes two crucial assumptions: constant returns to scale and perfect competition, that render it unsuitable for direct application to the problem at hand. Since a liberal shift in trade policy could be expected to alter the competitive environment as well, especially in highly protected markets, productivity changes measured using the assumptions implicit in the Solow framework are likely to be biased. The econometric methodology employed in this paper borrows from Harrison (1994) who extended the methodology of Hall

[11] It should also be pointed out that due to an immediate pass-through to domestic inflation, the real depreciation of the Indian Rupee was less than 7% (annually) in the years following the reforms, inducing a less restrictive effect on imports than the magnitude of the nominal depreciation may indicate.

(1988) and Domowitz et al. (1988) to provide a simple approach to productivity measurement that corrects estimated TFP growth for these biases.

We begin with a production function for firm i in industry j at time t:

$$Y_{ijt} = A_{jt} f_{it} G(L_{ijt}, K_{ijt}, M_{ijt}) \tag{1}$$

Output Y_{ijt}, is produced by firm i with inputs, labor, L, capital, K, and materials, M. A_{jt} is an industry specific index of technical progress, while f_{it} is a firm specific parameter which allows for firm specific differences in technology. Assuming Cournot behavior on the part of firms, assuming that the markup only varies across sectors, and using the first order conditions from each firm's profit maximization problem yields, just as in Harrison (1994):

$$\frac{\mathrm{d}Y}{Y_{ijt}} = \mu_j \left[\alpha_l \frac{\mathrm{d}L}{L} + \alpha_m \frac{\mathrm{d}M}{M} \right]_{ijt} + \mu_j \alpha_k \frac{\mathrm{d}K}{K_{ijt}} + \frac{\mathrm{d}A}{A_{jt}} + \frac{\mathrm{d}f_{it}}{f_{it}}, \tag{2}$$

where μ_j is the markup and where α_l, α_m and α_k are factor shares in output. Note that the share of capital in output—α_k is unobservable. Noting that the sum of factor shares can be expressed as β/μ, where β may be greater or less than one (and where $\beta = 1$ is the constant returns case), using an interactive slope dummy to account for changes in competitive behavior after the trade reforms in India, an intercept dummy to allow for changes in productivity growth by firms in the post 1991 period and an interactive dummy to allow the returns to scale to change with the trade reforms and finally using lower case y, l and m to denote $\ln(Y/K)$, $\ln(L/K)$ and $\ln(M/K)$, we finally have: [12]

$$\mathrm{d}y_{ijt} = \beta_{1j}[\mathrm{d}x]_{ijt} + \beta_{2j}[D\mathrm{d}x]_{ijt} + \beta_{3j}D + \beta_{4j}\mathrm{d}k_{ijt} + \beta_{5j}[D\mathrm{d}k_{ijt}] + \frac{\mathrm{d}A}{A_{jt}} + \frac{\mathrm{d}f_{it}}{f_{it}},$$

where:

$$\beta_{1j} = \mu_j, \beta_{4j} = (\beta - 1), \mathrm{d}x = [\alpha_1 \mathrm{d}l + \alpha_m \mathrm{d}m] \text{ and } \mathrm{d}k = \frac{\mathrm{d}K}{K} \tag{3A}$$

[12] Fixing the returns to scale instead, as done, for instance, in Harrison (1994), could be quite restrictive particularly in light of the results obtained by Tybout (1992) who argues that there was a significant change in returns to scale after the Chilean trade liberalization. In particular, if returns to scale decrease after the trade liberalization, the assumption of fixed returns to scale biases upward the estimate of the growth rate of productivity prior to liberalization and biases downward the post liberalization estimates thereby biasing downward the estimates of the change in the growth rate of productivity after by the liberalization.

Eq. (3A) is the final estimating equation. [13] In order to adjust for capital according to capacity utilization (which changes over the business cycle), we model the true utilization of capital, following Harrison (1994) as $K * E$ where E is the plant's energy use and reflects changes in the utilization of capacity.

Firm data were obtained from the Center for Monitoring Indian Economy (CMIE) database. Although the CMIE collects annual data on all industrial firms listed on Bombay Stock exchange, our sample only includes firms in four randomly chosen industries: Electronics, Electrical machinery, Non-electrical machinery, Transport equipment. Firms for which missing values were present in the sample period (1986–1993) were excluded. [14]

To estimate Eqs. (3A) and (3B) using our panel of firms, data on real output, labor, raw materials and energy, their shares in real output, and capital stock were required. Real outputs were obtained by deflating nominal outputs by sectoral price level deflators. Real labor was obtained by deflating the wage bill by the public sector employee wage rates. [15] Material input price deflators were constructed using the figures in the Input–Output table for India along with the sectoral price level deflators. [16] Real capital stock was computed by deflating net fixed assets by sector level investment deflators. [17]

[13] Alternately, Eq. (2) can estimated under the assumption of constant elasticity of output with respect to capital, i.e., that $\mu_j \alpha_k$ is constant as would be the case, for instance, with a Cobb–Douglas production function. This gives us the following estimating equation:

$$\frac{\mathrm{d}Y}{Y_{ijt}} = \beta_{1j}[\mathrm{d}X]_{ijt} + \beta_{2j}[D\mathrm{d}X]_{ijt} + \beta_{3j}D + \beta_{4j}\mathrm{d}k_{ijt} + \frac{\mathrm{d}A}{A_{jt}} + \frac{\mathrm{d}f_{it}}{f_{it}} \tag{3B}$$

where:

$$\beta_{1j} = \mu_j, \beta_{4j} = \mu_j \alpha_K, \mathrm{d}X = \left[\alpha_1 \frac{\mathrm{d}L}{L} + \alpha_m \frac{\mathrm{d}M}{M} \right] \text{ and } \mathrm{d}k = \frac{\mathrm{d}K}{K}$$

If trade liberalization leads to an increase in competition, we would expect the coefficient β_2 to be negative, reflecting a reduction in mark-ups. If the reforms lead to overall increase in productivity growth, we would expect β_3 to be positive.

[14] Complete data was available on a total of 90 firms in Electronics, 90 firms in Electrical machinery, 72 firms in non-electrical machinery and 111 firms in the Transport equipment sector. Eqs. (3A) and (3B) were also estimated for a fifth sector: Firms producing diversified products. However, since the assumption of an identical production function would be particularly suspect when the products are, by definition, diverse, we do not present these results here. We should note, however, that the estimates for this sector (see Krishna and Mitra, 1996) indicated an increase in the growth rate of productivity and a reduction in markup—just as in the other sectors we examined and report on here.

[15] The sectoral price deflators and the public sector employee wage rates were obtained from the 'Economic Survey' which is published annually by the Indian Ministry of Finance. The public sector employee wage rate is a particularly good indicator of the overall manufacturing wage rate, itself not available for recent years due to reporting lags, since the ratio of the public sector wage rate to the overall manufacturing wage rate was almost constant in the last 20 years.

[16] The 72-sector Input–Output table for India was obtained from the World Bank's India Country Division.

[17] The sector level investment deflators were obtained from the World Bank's 'India: Recent Economic Developments' report, published March 1994.

4. Estimation results

In order to capture the effect of heterogeneous behavior across firms, Eq. (3A) can be estimated by allowing for varying intercept terms across firms. One might either model these different intercept terms as (following the standard terminology) being ‘fixed’ or ‘random’. [18] In our case, while individual estimates differ, the conclusions we arrive at overall are generally invariant to specification and do not vary much even with the alternate specification—Eq. (3B). [19] However, in most cases, the Hausman test statistic suggested that the random effects model was more appropriate and therefore our presentation and discussion of the regression results focuses on the random effects model.

4.1. Returns to scale

Estimation results for Eq. (3A) under the assumption of changing returns to scale are presented in Table 2. It is evident that in all industries except Electrical machinery, there were reductions in returns to scale after 1991 (negative coefficients β_5). [20] The reductions in returns to scale could also have been seen simply by noting that the sum of the factor shares (of labor, material and fuel) in our sample hardly changed after the liberalization and markups dropped significantly in nearly all industries (as discussed in the next paragraph). [21] As discussed by Devarajan and Rodrik (1991), this reduction in the returns to scale (mirroring the Chilean experience investigated by Tybout et al., 1991) may be understood to have resulted from an increased exploitation of returns to scale by firms which may have been operating at too small a scale prior to the reforms. [22] However, the magnitude of this change in our data is quite large and is perhaps indicative of the presence of relatively inflexible capacity constraints in these industries.

[18] The relative merits of each approach have been extensively been debated in the literature. For instance, as Mundlak (1978) pointed out, modelling the firm specific effect as random would lead to biased estimates of the slope coefficients if these effects were correlated with the explanatory variables. On the other hand, modelling the firm specific effect as ‘fixed,’ if the true model was random would cause an efficiency loss. See Hsiao (1990) for an extensive discussion.

[19] The estimates for Eq. (3B) are presented in Krishna and Mitra (1996).

[20] The assumption of fixed returns to scale would have been quite restrictive in our case and would have led to biased and relatively insignificant estimates of the change in productivity with biases in the directions that were discussed in Section 3.

[21] These figures as well as the estimates obtained when Eq. (3A) was estimated under the assumption that returns to scale did not change are not presented here, but are available from the authors upon request.

[22] Using the same India data, output changes (increases) in each industry are reported by Srivastava (1997).

Table 2
Regression results[a]

Industry	Random effects estimates						
	β_3	β_1	β_2	β_4	β_5	R^2	Hausman test statistic
Electrical machinery	0.03 (0.01)	0.59 (0.05)	0.18 (0.09)	−0.53 (0.04)	0.1 (0.06)	0.98	0.71
Non-electrical	0.05 (0.02)	1.94 (0.04)	−1.43 (0.06)	0.40 (0.03)	−0.95 (0.05)	0.99	3.33
Electronics	0.06 (0.04)	1.64 (0.06)	−0.96 (0.06)	0.14 (0.04)	−0.62 (0.04)	0.94	11.1
Transport equipment	−0.00 (0.02)	1.00 (0.09)	−0.71 (0.40)	0.08 (0.08)	−0.96 (0.13)	0.38	7.4

[a] The figures in parentheses are standard errors. The estimated equation is Eq. (3A). At the 5% level, the critical value for the Hausman statistic, testing for the orthogonality of the random effects and the regressors, is 11.07.

4.2. Price-marginal cost markups

The estimated reductions in markups under the assumption of flexible returns to scale are presented in Table 2. Recalling from Eqs. (2) and (3A) that β_1 denotes the level of the markup before the reforms and that β_2 denotes the change in the markup, we can see that in three of the four industries, Non electrical machinery, Transport equipment and Electronics, there is evidence of significant reductions in markups in the years following the reform, while for Electrical machinery, we see a slight increase in the markup. [23]

In the three industries with reduced markups, markups drop to less than one after the liberalization. As Levinsohn (1993) suggests, this is not inconsistent with the notion that in the presence of adjustment and sunk costs, a firm may lose money while it adapts to a new trading environment. [24]

In the fourth industry, Electrical machinery, markups are below one before the reforms. As such, if this was a description of one period behavior, this would not be too surprising since firms may decide to endure a loss if they believe this loss to be temporary. However, the fact that pre-reform estimates stretch over the period 1986–1990 implying a longer run description rather than that of one-period behavior, thus casting doubt on the markup estimates for this industry.

[23] We computed the correlation between tariffs and markups and tariffs and returns to scale using our estimated markups and returns to scale and tariff data for the year before the trade liberalization and the year after the trade liberalization. Markups are found to be positively correlated with the tariff level (correlation coefficient of 0.49) as are returns to scale (correlation coefficient of 0.53).

[24] Of course, this interpretation lies outside the framework of the simple Cournot oligopoly model that generated the estimating equation.

4.3. Growth rate of productivity

Recalling from Eqs. (2) and (3A) that β_3 captures the change in the growth rate of productivity, our estimates presented in Table 2, suggest increases in the growth rate of productivity in three industries: Electronics, Non-electrical machinery and Electrical machinery. The magnitudes of the change in the growth rate of productivity (3–6%) are large but not implausibly so. [25] Several growth accelerating factors related to trade have been discussed in the introduction. In addition, the traditional *X*-efficiency argument may be invoked to explain these increases in the growth rate of productivity. The present framework does not allow us to separate between these several possible explanations.

The reader should be alerted here to two specific problems with the estimation-traditional in the present formulation. [26] The first problem has to do with endogeneity: since each firm's inputs and outputs are simultaneously chosen, the inputs will be correlated with any shocks, say demand or productivity shocks (that would be captured in the error term) and the coefficient estimates will be biased. Thus, in Eq. (3A), we should expect the dk term to certainly be correlated with, say, productivity shocks even if the term dx on the right hand side which measures the change in labor to capital and material to capital *ratios* is not. In general, as Levinsohn (1993) and Harrison (1994) point out, we should expect to see markups overestimated with such correlation. To correct for these biases one would ideally want instrumental variable estimates. As instruments, we would need variables that are correlated with capital and with labor and materials per unit of capital but independent of any demand or productivity shocks that would affect the firm. Since Eq. (3A) was estimated in differences rather than in levels, lagged changes in the input terms did not serve well as instruments. Due to the lack of other appropriate instruments in our data base, our instrumental variable estimates were not meaningful and these results are not presented in the paper.

Our primary interest in this exercise, however, is to estimate the *change* in markups and productivity growth due to the trade reforms. Even with correlation between the inputs and the error term, what the direction of bias will be for the change in markups, for instance, is not so clear. Indeed, in general, should the correlation between dk and ϵ and between dk and dx not change after the reforms, we should expect estimates of the *change* in markups, productivity

[25] Productivity is generally procyclical. In India, output growth actually decreased (figures presented in Table 1) in the years following the reform, due to IMF induced macroeconomic restraint. One may therefore casually argue that the increases in productivity caused by the trade reforms would have been even greater if the reforms had taken place in a less austere macroeconomic context.

[26] For a superb survey and discussion of these and other potential problems in studies of this nature, see Tybout (1992).

Table 3
Monte Carlo simulation results[a]

Corr (dK, e)	β_3	β_1	β_2	β_4	β_5	R^2
0.2	0.07 (0.09)	1.65 (0.12)	0.18 (0.13)	0.72 (0.12)	0.12 (0.14)	0.6
0.4	0.00 (0.07)	1.80 (0.08)	0.12 (0.09)	1.26 (0.09)	0.19 (0.08)	0.8
0.6	0.07 (0.06)	2.26 (0.07)	0.05 (0.08)	1.72 (0.08)	−0.05 (0.08)	0.9
0.8	0.00 (0.00)	2.60 (0.00)	0.00 (0.00)	2.07 (0.08)	0.00 (0.00)	0.99

[a]The figures in parentheses are standard errors.

growth and returns to scale to be unbiased. Table 3 (discussed in Appendix A) presents some results from Monte Carlo simulations undertaken with varying assumptions regarding the correlation between the right hand side variables and the error term. Using input data generated to match sample correlations between the right hand side variables in Eq. (3A), we estimated the bias that simply a correlation between the inputs and the error term would generate. As discussed in Appendix A, with the Monte Carlo simulations, in most cases, we could not reject the null that the bias in measuring the changes in markup, growth rate of productivity was zero.

A second issue involves measurement error of the right hand side variables. As is well known, measurement error in even a single right hand side variable will deliver biased estimates of all of the coefficients. Measurement of capital is particularly problematic and would likely be the greatest source of problems here, [27] given varying utilization rates inter alia. We correct for this by using capital adjusted for capacity utilization by using $K*E$ instead, where E is the plant's energy use and reflects change in utilization of capacity. While this does not eliminate the problem entirely, we expect that it should be considerably mitigated.

5. Welfare calculations

While the theory of international trade in the presence of perfectly competitive markets generally predicts welfare improvements with unilateral reductions in trade barriers, it is well known that the effects of trade liberalization on welfare in

[27] On this problem of errors in measurement of capital, in the present context, see Tybout et al. (1991).

the presence of imperfect competition and increasing returns to scale in particular, are more ambiguous. [28]

In terms of obtaining actual numerical estimates, the approach taken in the literature, thus far, has been to carry out numerical simulations under specific assumptions and then to ascertain the sensitivity of the outcomes by altering key parameters. This is essentially the strategy adopted in the simulation studies referred to earlier: Dixit (1988), Baldwin and Krugman (1988) and Rodrik (1988). The calculations that follow in this paper are somewhat similar in spirit. The crucial difference, however, is that we obtain several key variables from our data set and via our estimations (in particular, from Eq. (3A)) in contrast to earlier studies where specific values for these variables were simply assumed.

Consider any one industry. Following Rodrik (1988), we assume that customers can be parametrized by assuming a demand function with a constant elasticity, $\epsilon = 1/\tau$. The inverse demand function is then given by

$$P = \alpha(D+N)^{-\tau} \tag{4}$$

where α is simply a scaling factor, D denotes domestic output and N denotes the level of net imports. Aggregate welfare change is simply the sum of changes in consumer surplus, domestic firm profits and tariff revenues. The relevant welfare change expression can correspondingly be written as

$$\Delta W = \Delta\left[(1/(\epsilon-1))(nX+N)P\right] + \left[nX(1-\gamma/\mu)P + (T*I)\right] \tag{5}$$

where n denotes the number of firms, γ denotes the returns to scale, I denotes imports, X denotes the output of a single domestic firm, μ denotes the markup and T denotes the tariff rate. Further allowing for the fact that the firms in our sample may only be producing a fraction 's' of total domestic output, we arrive at the final expression for welfare change:

$$\Delta W = \Delta\left[(1/(\epsilon-1))((nX/s)+N)P\right] + \left[(nX/s)P(1-\gamma/\mu) + (T*I)\right] \tag{6}$$

where 's' denotes share of domestic output of the firms in our sample.

To ascertain the change in welfare due to the trade reforms, we evaluate the right-hand side of Eq. (6) using data for the years 1990 and 1991. In order to evaluate the right hand side of (Eq. (6)), we need data on the firms' outputs, the share 's', the returns to scale and markups and, tariff rates and tariff equivalents of the quotas, imports and the elasticity of demand.

[28] As Rodrik (1988) points out, in the presence of imperfect competition and increasing returns to scale, trade liberalization is in general compatible with both a magnification of the welfare gains and with welfare losses. On the one hand, industry rationalization due to the entry and exit caused by the change in the trade regime may reduce the number of firms and force the remaining ones down their average cost curves bringing benefits that can easily amount to several times the usual Harberger triangles. On the other hand, trade may contract sectors with supernormal profits and unexploited economies of scale and may consequently lead to welfare reductions instead.

Table 4
Welfare changes with trade liberalization[a]

Industry	Market share '*s*'	Welfare changes					
		Price elasticity of demand					
		0.5	0.75	1.25	1.5	1.75	2.0
Electronics	100%	−0.01	−0.03	0.52	0.29	0.21	0.18
Electrical machinery		0.01	0.01	0.14	0.13	0.13	0.13
Transport equipment		0.02	0.02	0.24	0.26	0.27	0.28
Non electrical machinery		−0.01	−0.02	0.22	0.13	0.10	0.09
Electronics	75%	−0.01	−0.02	0.42	0.23	0.17	0.14
Electrical machinery		0.01	0.01	0.15	0.14	0.14	0.14
Transport equipment		0.02	0.02	0.23	0.26	0.27	0.28
Non electrical machinery		0.00	−0.01	0.20	0.12	0.10	0.08
Electronics	50%	0.00	−0.01	0.19	0.10	0.07	0.05
Electrical machinery		0.01	0.01	0.29	0.29	0.30	0.30
Transport equipment		0.02	0.03	0.42	0.51	0.54	0.56
Non electrical machinery		0.00	−0.01	0.27	0.18	0.15	0.14
Electronics	25%	0.00	0.00	0.11	0.06	0.04	0.03
Electrical machinery		0.00	0.00	0.15	0.15	0.16	0.16
Transport equipment		0.01	0.01	0.21	0.26	0.28	0.28
Non electrical machinery		0.00	0.00	0.14	0.10	0.08	0.07

[a]Welfare change figures presented as a fraction of base year consumption.

The data on firm output was directly obtained from our data set. Returns to scale and markup were obtained from Table 2, which presents the regression results for Eq. (3A). Imports were obtained from the UN's International Trade Statistics yearbooks. Tariff rates were obtained from data sets provided by the World Bank's India division. [29] Two other variables that we do not have information on are the price elasticity of demand and the share '*s*'. Therefore we measure changes in welfare under varying assumptions for the share '*s*' and the price elasticity of demand.

[29] Reliable industry level estimates of quota rents are impossible to find. We therefore do not consider changes in quota rents in making our welfare calculations. However, it should be noted that this exclusion, while common in studies of this type and always inappropriate, is probably particularly so in the Indian case—given the importance of non tariff barriers in the Indian trade regime prior to the reforms. Rent seeking activities may mitigate this somewhat in the Indian case since loss in quota rents were probably matched to some extent by a reduction in resources expended in seeking these rents as well. See Bhagwati (1982) and Krueger (1974) for theoretical discussion of rent seeking activities and some quantitative estimates for India.

The estimated welfare changes (as a fraction of base consumption) are presented in Table 4. [30] It can be seen readily, in almost all cases that welfare increased after the trade reforms, the only exceptions being Electronics and Non-electrical machinery which show welfare reductions at low elasticities combined with high market share of the firms in the sample. Interestingly, *all* of the estimated welfare changes are quite small. This is consistent with earlier results generated by many *competitive* computable general equilibrium models but stands in contrast to some larger estimates which were generated in an imperfectly competitive CGE context instead. [31] It is worth remembering that the lack of information on demand elasticities, the exclusion of quota rent changes in the calculations and the fact that standard errors around the welfare changes could not be computed imply that the numbers presented in Table 4 are only suggestive. These numbers should be understood and used keeping these weaknesses in mind.

6. Conclusions

In this paper, we use data on a panel of firms to investigate the effects of the dramatic 1991 trade liberalization in India. In particular, we test the relationship between trade liberalization, market discipline and productivity growth. Our methodology differs somewhat from other studies in that we 'allow' for the returns to scale to change after the liberalization, a relaxation of estimation restrictions that significantly improves our regression estimates. Our results strongly suggest that there was an increase in competition, as reflected in the drops in markups. We also find evidence of a reduction in returns to scale and some weaker evidence of an increase in the rate of growth of productivity in the years following the reforms. Finally, partial equilibrium welfare analysis using the estimated parameters also suggests that there was an increase in welfare, albeit quite small, in each of the sectors analyzed.

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[30] The reader is reminded, however, that the welfare change figures presented in Table 3, are only estimates, since, indeed, there are standard errors around the inputs to this calculation. However, due to the non linearity of the final welfare expression, the standard error associated with the final welfare changes could not be computed *directly*.

[31] See Whalley (1985) and also Norman (1990) for these comparisons and a comprehensive discussion.

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Appendix A

Table 3 presents results from Monte Carlo simulations which were performed to obtain a sense of the bias in our estimates due to the problem of correlation between factor inputs and the error term in Eq. (3A). Using the sample correlation (average across industries) between dx, dk and under the assumptions that dk term was positively correlated with the error term and that the dx term was uncorrelated with the error term,[32] ϵ, we generate values of dx, dk and ϵ. Under the assumption that the markup was 1.5 and the returns to scale were 1.5 as well (both before *and* after the reforms),[33] the dependent variable was generated (as in Eq. (3A), but excluding the dummies). These generated dy's were regressed against the right hand side variables, again as in Eq. (3A), but now including the reform dummies. Five thousand trials were performed for each level of correlation assumed. The results indicate, as expected, that markups and the returns to scale are overestimated. In every case, we could not reject the null that the *change* in markup was zero. The returns to scale themselves were also overestimated. In every case, however, changes in returns to scale were estimated to either be positive or did not differ significantly from zero. Since we report markup and returns to scale reductions with the trade reforms, taking these correlations into account do not weaken the results reported in Table 2 regarding the drop in markups and returns to scale. Further, in our simulations, the null that there is no change in productivity growth after the liberalization cannot be rejected, suggesting then that our productivity growth change estimates reported in Table 2 are likely unbiased as well.

[32] This simply assumes that while all input factors are positively correlated with any productivity shocks, the labor to capital and materials to capital ratios are not. Note that our measure of capital in estimating Eq. (3A) is adjusted for capacity utilization—and thus is not relatively fixed even in the short run.

[33] Identical simulations were run under different assumptions regarding initial markups and returns to scale—with essentially the same results. These can be obtained from the authors upon request.

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