Impact of Trade Reforms on Markups: Analysis of Indian Manufacturing Plants

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Abstract

This paper analyses the impact of trade reforms on plant level markups using a panel data for the period 1998-99 to 2007-08. Accounting for plant level heterogeneity in terms of productivity levels and pricing behaviour, this paper finds evidence of fall in markups due reduction in input and output tariffs. Rise in imported input variety and export variety are found to have exerted a positive impact on markups.

1. Introduction

Over the past two decades, India has gradually rationalized its trade policy across several sectors with a large emphasis on the manufacturing sector. Certain strands of endogenous growth models and 'new' new trade theory suggest that trade liberalization can generate productivity gains to the domestic industries.

While productivity gains are enjoyed by producers, trade liberalization can also lead to welfare gains for consumers due to the disciplining effect of a competitive market. Intensified competition may force the domestic firms, which might have reaped oligopoly profits in a protected market, to reduce their price to marginal cost markups (Lehvinshon, 1993). Reduction in trade barriers increases the elasticity of demand faced by the domestic firms and hence lower markups. Tybout (2003) notes that the change in demand elasticity due to trade can work through various channels. Under the "Armington assumption" where foreign and domestic goods are imperfect substitutes, trade reforms lead to a fall in relative price of foreign goods leading to a rise in the demand elasticity for domestic goods.

In new trade models, with varying elasticity of substitution between varieties, free trade leads to an increase in the number of varieties available to consumers. Larger number of varieties increase the elasticity of demand, which in turn forces domestic firms to reduce markup.[1] The previous decade witnessed a large shift in the theoretical trade literature with an increased emphasis on micro level heterogeneity. The models of 'new' new trade theory assume firm heterogeneity in various forms such as, productivity levels, export participation, pricing behaviour etc. Heterogeneity in productivity levels and pricing behaviour can have direct implications for firm level markups or price-cost margins.

In the Melitz (2003) model, the assumptions of CES utility function and fixed price elasticity results in constant markups. However, a recent model by Meltiz and Ottaviano (2008) introduces endogenous markups into the Melitz (2003) framework that respond to the toughness of competition in the market. In Meltiz and Ottaviano model (henceforth M-O model) trade liberalization has two conflicting effects on average markups. First, tougher competition leads to a fall in average markups and a rise in aggregate productivity. Second, in contradiction to the previous effect, the exit of least productive firms with the lowest markups can result in a rise in average markups. In the M-O model, the first effect dominates and the model predicts that the pro-competitive effect induced by import competition leads to a fall in average markups and thus generates welfare gains.

On the contrary, the model formulated by Bernard et al (2003) predicts that the composition effect towards more efficient firms (with higher markup) would dominate the pro-competitive effect in the market and would hence result in a rise in average markups. Models by Nocke and Yeaple (2006), Eckel and Neary (2009), Bernard et al (2011) discuss that trade liberalization may force the firm to undertake a process of product rationalization where they drop their least attractive product lines and concentrate in the areas of their core competency. Greater specialization might

[1] However, in models with constant elasticity of substitution, the markup remains constant as elasticity of demand does not change.

help the firm enjoy a higher degree of market power with respect to its chosen product lines which in turn could result in an increase in the markups charged by the firm.

Overall, the theoretical literature provides a mixed view pertaining to the relationship between trade liberalization and markups. Thus, understanding the implications of trade liberalization on markups remains largely an empirical exercise. In this paper, we examine the impact of trade liberalization on markups across manufacturing plants in India. We use plant level panel data of the ASI for the period 1998-99 to 2007-08 for the analysis. Our methodology for estimating markups closely follows De Loecker and Warzynski (2012). Our analysis shows a fall in markups across all industries in the Indian manufacturing sector. We also analyse the impact of other trade related variables, such as growth of export and import variety, and certain plant level characteristics. We find strong evidence that tariff reductions led to a fall in markups across manufacturing plants in India. We also find that growth in export and import variety exerted a positive effect on plant level markups.

The rest of this paper is organized as follows. Section two provides a brief review of empirical studies in the Indian context. Section three discusses the technique for markup estimation. Section four provides a descriptive analysis of markups in Indian manufacturing sector. Section five lays the theoretical background and hypotheses. Section six discusses the econometric specification. Section seven discusses the regression results. Finally, section eight provides the concluding remarks.

2. Review of related empirical literature for India[2]

In the Indian context, studies by Krishna and Mitra (1998), Srivastava et al (2001), Kambhampati and Parikh (2001), Goldar and Aggarwal (2004), Balakrishnan et al (2006), De Loecker et al (2012) and Pal (2015) have analysed the impact of trade liberalization on markups. These studies either use the price-cost margin (PCM), defined as a ratio of sales net of variable costs over sales (Kambhampati and Parikh, 2001; Goldar and Aggarwal, 2004; Pal, 2015) or rely on insights from Hall's (1986, 1988, 1990) production function based output growth decomposition technique (Krishna and Mitra, 1998; Srivastava et al, 2001; Balakrishnan et al, 2006; De

[2] In this review we cover only studies pertaining to India. There exists a huge literature in the context of other countries (See Tybout, 2000; Yalcin, 2000; Marchetti 2002; Morrison, 1992).

Loecker et al, 2012) to estimate firm level/industry markups. In what follows, we now briefly discuss the approach and findings of these studies.

Analysing firm level data for the period immediately following 1991 reforms, a study by Krishna and Mitra (1998) examines the impact of trade liberalization on market competition and productivity. Using an econometric methodology following Harrison (1994) which extends the Hall (1988) estimation approach by eliminating the assumption of constant returns to scale, this study analyses four industries (electronics, electrical machinery, non-electrical machinery) for the period 1986–1993. The study finds a significant decline in markups in three out of the four industries suggesting strong evidence of increase in competition in the Indian manufacturing sector. They point out that the decline in markups is so large that it falls to less than one in the post-liberalization period. According to the authors, a plausible explanation for this is that, in the presence of adjustment and sunk costs, a firm may incur loses as it adapts to a new environment following liberalization.

Srivastava et al (2001), using firm level data and Hall's approach but for a longer time period from 1980 to 1997, however, find that trade liberalisation did not contribute to markups reduction for most of the industries. In contrast, he noticed a rise in markups for some industries (publishing and printing, leather products, food products, rubber, motor vehicles and electrical machinery) in the post-reform period. A decline in markups was registered only for metals and non-metallic mineral products while no changes were observed for textiles, machinery and fabricated metal products industry groups.

Kambhampati and Parikh (2003) use a regression model to analyse the determinants of firm-level price cost margins (PCM) in the Indian manufacturing sector for the period 1980–1998. The study uses a dummy variable to separate the post and pre-liberalization periods. The dummy is found to be positive and only marginally significant indicating that the impact of reforms on markups was neither large nor systematic. The study, however, finds that increase in exports led to a fall in PCM while the impact of imports on PCM is found to be ambiguous. Pal (2015), using firm level data and PCM to analyse the change in market power of firms finds that the post-liberalization dummies (one for the period 1990-2000 and another for 2001-

2010) are negative and significant indicating a fall in markups due to trade reforms. Pal (2015) also finds that export intensity of firms had no impact on markups while rise in import dependency (of supplies for operation) had a negative significant impact on firms' markups.

Goldar and Aggarwal (2004) analyse a panel of three-digit industries for the period 1980-81 to 1997-98 using both PCM as well Hall's methodology to estimate markups. The study finds that removal of tariffs and quantitative restrictions led to a significant fall in industry markups. Despite this, the authors find a rise in average PCM in most of the industries. The authors attribute this to substantial fall in wage rate in the post-reform period which led to reduction in marginal costs in the industry. Hence, the overall effect of fall in wage rate on marginal costs is found to be greater than the pro-competitive effect of reforms on PCMs thereby leading to an aggregate rise in industry PCMs.

A common limitation of studies by Krishna and Mitra (1998), Srivastava et al (2001), Kambhampati and Parikh (2001) is that all these studies use a post-reform dummy variable to analyse the impact of reforms on markups. None of the studies use data on tariff or other trade policy to capture the inter-temporal and across-industry variation in trade protection. Goldar and Aggarwal (2004) use the data on tariff rates and non-tariff barriers to explain price-cost margin. However they rely on aggregate industry level data for the purpose of analysis and hence do not account for firm level heterogeneity in markups within an industry. Kambhampati and Parikh (2001) and Goldar and Aggarwal (2004) rely on the assumption of constant returns to scale for markup estimation while Krishna and Mitra (1998) avoid this assumption. However, the latter provides an average estimate of markup for selected industries and ignores firm level heterogeneity of markups within industries.

Further, Hall's approach makes use of the notion that, under imperfect competition, input growth is associated with disproportional output growth as measured by the relevant markup. That is, estimating markups using the Hall's technique is about measuring disproportional output growth with respect to input growth. An estimated value of markup higher than one would indicate market imperfection. However, it must be noted that unobserved factors which can impact output and input growth have not been taken into account in the previous studies that have used Hall's approach. In particular, not controlling for unobserved productivity shocks might bias the estimate of the markups as productivity is potentially correlated with input growth (De Loecker and Warzynski, 2012). Further, the change in markups due to a change in the operating environment (such as trade liberalization), is not identified without controlling for the impact of policy changes on productivity. Given that trade liberalisation had exerted a positive impact on productivity in India, as established in previous papers, estimating the impact of trade reforms on markups, without accounting for productivity changes, would result in incorrect estimates.

None of the above studies, with an exception of De Loecker et al (2012) address these limitations while estimating markups. Accounting for unobserved productivity shocks, De Loecker et al (2012) obtain firm level estimates of markup for Indian firms covered in the Prowess database[3]. They examine the impact of trade liberalization on prices, markups and marginal costs of single and multi-product firms for the period 1989-2003. The estimation technique closely follows De Loceker and Warzynski (2012) that accounts for unobserved productivity shock in the production function using the control function approach of Olley and Pakes (1996) for estimating the output elasticity of a variable input. The estimation of markup relies on the insight that the cost share of factors of production, that is labour and intermediate inputs, are only equal to their revenue share if output markets are perfectly competitive. However, under any form of imperfect competition the markup drives a wedge between revenue and cost shares.

De Loecker et al (2012) finds that reduction in input tariffs led to a substantial fall in marginal costs for producers outweighing the pro-competitive effect of output tariffs on markups.[4] The study finds that trade liberalization led to a steep decline (by 40.3 percent on average) in marginal costs as it enabled producers to procure cheaper imported intermediate inputs. As to the impact on prices, the study finds that the fall in factory gate prices was relatively modest (16.8 percent on average). This gap between the large gains in marginal costs and relatively smaller decline in factory gate

[3] Prowess is a database of the financial performance of Indian companies. The principal source of this database is the Annual Reports of individual companies.

[4] De Loecker et al (2012) find the output tariff to have a significant positive impact on markups only when once they control for marginal costs in the regression equation.

prices explains the increase in relative markups which grew by an average of 23.4 percent over the period.

The present study differs from that of De Loecker et al (2012) in two ways. Firstly, De Loecker et al (2012) use firm level data from the Prowess database to estimate markups in the Indian manufacturing sector. By using plant level data, we avoid the problem of dealing with multiproduct firms while estimating markups. Secondly, the analysis by De Loecker et al largely covers the initial phase of liberalization (1989-2003), while we focus on the second decade of reforms. While the decade of the 1990s witnessed certain extent of trariff reduction in capital and intermediate goods industries, the consumer goods industries were subjected to high trade barriers (Banga and Das, 2012). Further, despite the tariff reduction during the 1990s, there would have been considerable 'water in tariff' and hence tariff reduction might not have stimulated a great deal of competition from imports. By focussing on the second decade of reforms, which witnessed considerable trade liberalisation in a wide range of industries, we hope our data will capture the impact of trade reforms on markups more accurately.

3. Estimation of Plant Level Markups

Theoretical literature defines market power as the wedge between the price and marginal cost which is measured using the Lerner Index. The Lerner index, which varies between zero and one for a firm, rises with an increase in its monopoly power. The empirical estimation of Lerner's Index, however, poses a challenging task of estimating the marginal cost of production. The most initial estimation techniques to address this issue and to estimate markups at the industry level were suggested in a series of publications by Hall (1986, 1988, 1990).

Hall's technique of estimation used insights from the Solow's (1957) seminal paper on productivity measurement. In the Solow model, under the assumptions of perfect competition in product and factor markets (and constant returns to scale), total factor productivity, or the so called 'Solow residual' is obtained from the data as the difference between the growth rate of output and the share-weighted average of the growth rates of factor inputs. Hall's approach introduces imperfect competition into the product market such that the Solow residual is no longer equal to the rate of technical change, but also includes a component involving markup of price over marginal cost.

Under the assumption of constant returns to scale and perfectly competitive market, such that the shares of capital and labour in output valued at marginal costs measures the elasticity of output with respect to inputs, Hall's Solow residual (SR) is defined as follows:

$$SR = \Delta q - \alpha\, \Delta l - (1- \alpha)\, \Delta k = (\mu - 1)\, \alpha\, (\Delta l - \Delta k) + \theta \qquad (1)$$

Where, q is the output, l is the labour, k is the capital, α is the share of labour in total expenditure, θ is the technical change parameter and μ is the markup which is defined as price over marginal cost. Hence, in case of perfect competition, where μ=1, the Solow residual would not be affected by the growth rate of capital to labour ratio and would be equal to the rate of technical change, that is θ.

Hall's approach makes use of the notion that, under imperfect competition, input growth is associated with disproportional output growth, as measured by the relevant markup. An estimated markup higher than one would indicate market imperfection. However, output growth can be affected by other unobserved factors, one of which being productivity. Not controlling for unobserved productivity shocks bias the estimates of markup since under imperfect competition the choice of inputs is correlated with the productivity term which can render the OLS estimates inconsistent.

De Loecker and Wazynski (2010) derive an estimation technique which addresses this issue by using production function framework and micro level data.[5] Furthermore, this approach yields estimates of markup at the plant /firm level. Our estimation of markups in this paper closely follows the econometric approach proposed by De Loecker and Wazynski (2010).

As in Hall (1986), the methodology of De Loecker and Wazynski (2010) crucially relies on the insight that in a perfectly competitive output market the cost share of the

[5] Previous studies have tried to address this issue by using instrument variable approach, price-based Solow residual (Roger, 1995) and GMM estimation technique. These methods do not use production function approach and yield an average markup estimate for a given industry. These methods do not yield plant level estimates of markup.

variable inputs of production (such as, labour, intermediate inputs that are free of adjustment costs) are only equal to their revenue shares. De Loecker and Wazynski (2010) begin with a standard cost minimization conditions for variable input, labour. Drawing insights from Olley and Pakes (1996) and Lehvinshon and Petrin (2003), the production function estimation uses the control function approach to proxy for unobserved productivity. The estimation procedure closely follows Ackerberg, et al (2006). This approach uses the insight of Levinshon and Petrin (2003) method to control for endogeneity between TFP and input choices while closely following the production function estimation technique proposed by Ackerberg et al (2006); ACF henceforth. In this approach we include all the state variables such as industry's trade policy, trade orientation, state level factors etc. in the control function of input choices. Using ACF technique provides the flexibility for adding additional state variables in the production function without having to revisit the underlying dynamic model when considering modification to the original OP/LP setup (De Loecker and Warzynski, 2012).

Like the LP technique, we use intermediate input 'electricity used' as a proxy for unobserved productivity. Here, the proxy variable 'electricity used' is defined as a function of productivity, state variable *k* (whose current value is assumed to be uncorrelated with current productivity), labour *l* and all additional variables potentially affecting the optimal input demand choice.[6]

$$\mathrm{m_{it}} = \mathrm{m_{it}}(\,\omega_{\mathrm{it}}, \mathrm{l_{it}}, \mathrm{k_{it}}, \mathbf{Z}_{\mathrm{it}}) \tag{2}$$

Z is the vector of all additional variables that are expected to influence plant level material demand decision, which in this study imply the trade orientation (tariff rates, knowledge spillover index, rent spillover index, import variety index, export variety index) of the industry and state level institutional factors (electricity availability, credit availability and labour market conditions) in which the plant is located. Assuming that a plant's material demand function is a monotonically increasing function in productivity, *ω*, we get an inverse demand function

$$\omega_{\mathrm{it}} = \mathrm{h_t}(\,\mathrm{m_{it}}, \mathrm{l_{it}}, \mathrm{k_{it}}, \mathbf{Z}_{\mathrm{it}}) \tag{3}$$

[6] For ease of estimation, we use information on production workers only in this technique.

This inverse function is plugged into the production function and the parameters are estimated using a semi-parametric approach discussed in the following section. We estimate a Translog production function to check for the robustness of our results. Assuming a Translog production function and pooling plants across all industries and years, the empirical specification of our model is defined as[7]:

$$y_{it} = \beta_l l_{it} + \beta_{ll} {l_{it}}^2 + \beta_k k_{it} + \beta_{kk} {k_{it}}^2 + \beta_{lk} l_{it} k_{it} + \beta_\tau T_{it-1} + \beta_S S_{it} + \lambda_t + I^j + \omega_{it} + \epsilon_{it} \qquad (4)$$

Here *y* is the log real value added, *l* is the number of production workers employed, *k* is real capital employed , *T* is vector of all trade related variables (namely tariff rates, spillover indices and variety indices), *S* is the vector of all state level variables (electricity generated per capita in the state, credit availability to industry per thousand capita and mandays lost in strikes and workouts per thousand industrial workers in the state,), λ is year dummy, *I* is NIC-2 digit industry dummy, ω is the productivity and ε is the unpredictable and unobserved (by plant) zero mean shock for each firm *i* at time *t*. To avoid problem of endogeneity of trade policy, lagged values of trade variables have been used as regressors.

We perform a two-step estimation of (4). In the first stage, we regress

$$y_{it} = \phi_{it}(m_{it}, l_{it}, k_{it}, \mathbf{Z}_{it}) + \epsilon_{it} \qquad (5)$$

Where, $\phi_{it} = \beta_l l_{it} + \beta_{ll} {l_{it}}^2 + \beta_k k_{it} + \beta_{kk} {k_{it}}^2 + \beta_{lk} l_{it} k_{it} + \beta_\tau T_{it-1} + \beta_S S_{it} + \lambda_t + I^j + h_t(m_{it}, l_{it}, k_{it}, \mathbf{Z}_{it})$

… …(6)

and Z = (T_{it-1}, S_{it})

We estimate (6) by OLS using a third order polynomial in *l, k, m* and *Z* and obtain the estimate of expected output ϕhat and the random error *ε.* Hence, the first stage eliminates the random error ε from the output and provides an estimate of expected output ϕhat. To estimate the parameters of regressors in (4a.7), in the second stage, we assume that productivity follows a first –order markov process

[7] Pooling plants across all industries is done to data problems, with small set of plant-year observations in individual industries, the estimation techniques leaves zero degrees of freedom thereby making it impossible for matrix inversion, discussed in detail later in the paper.

$$\omega_{it} = g_t(\omega_{it-1}) + \xi(\beta)_{it} \quad (7)$$

This implies that conditional on lagged productivity, current productivity should be a surprise. [8]

We now run an OLS on equation 4 and get candidate values of *β,* which are used to get an estimate of productivity using

$$\omega_{it} = \phi hat_{it} - \beta_l l_{it} - \beta_{ll} l_{it}^2 - \beta_k k_{it} - \beta_{kk} k_{it}^2 - \beta_{lk} l_{it} k_{it} - \beta_\tau T_{it-1} - \beta_S S_{it} \quad (8)$$

Similar as above, we obtain ω_{it-1} and regressing ω_{it} on ω_{it-1} we recover the innovation term in productivity $\xi_{it}(\beta)$.The β vector is then estimated using GMM with the following moment conditions:

$E(\xi_{it} l_{it-1}) = 0$, $E(\xi_{it} l_{it-1}{}^2) = 0$, $E(\xi_{it} k_{it}) = 0$, $E(\xi_{it} k_{it}{}^2) = 0$, $E(\xi_{it} k_{it} l_{it-1}) = 0$, $E(\xi_{it} T_{it-1}) = 0$, $E(\xi_{it} S_{it}) = 0$.

The GMM procedure, estimates the β vector by setting the above moment conditions as close as possible to zero. The standard errors have been estimated using block bootstrapping. This involves sampling with replacement, where firm's id is randomly drawn and the entire time series of observations for that firm is placed in the bootstrapped sample.

For the above Translog production function the output elasticity of labour (as obtained by differentiating equation 4 with respect to *l*) is obtained as follows:

$$\theta_{it}^l = \beta_l + 2\beta_{ll} l_{it} + \beta_{lk} k_{it} \quad (10)$$

Notice that the above labour elasticity varies for each plant-year observation as it utilizes data on total labour (l_{it}) and capital employed (k_{it}) per plant per year and allows us to estimate plant level and year specific markup estimates. This is an advantage of using a Translog production function as opposed to a Cob-Douglas production function where the output elasticity of labour is constant across plants and over the years.

[8] Apart from lagged productivity, current productivity term can also be expressed as a function of additional decision variables such as trade orientation, innovation etc faced by the firm. However, for simplicity we restrict to first order Markov assumption which has commonly been used in existing studies like Fernandes (2007), Parmeswaran (2009), DeLoecker and Warzynski (2012).

Following De Loecker and Wazynski (2010), we retrieve the plant level markups using the following equation:

$$\mu_{it} = \theta_{it}^{l}(\alpha_{it}^{l})^{-1} \quad (11)$$

Where, μ_{it} denotes the markup, θ_{it}^{l} is the output elasticity of labour *l* as estimated using the Translog production function, and α_{it}^{l} is the share of expenditure of labour in total revenue of plant *i* at time *t*.[9]

3. Data

The data for estimating productivity in this study corresponds to plant-level panel data obtained from the Annual Survey of Industries (ASI) covering the period from 1998-99 to 2007-08. The ASI is the principal source of industrial statistics in India. It covers all factories registered under Sections 2m(i) and 2m(ii) of the Factories Act, 1948 i.e. those factories employing 10 or more workers using power; and those employing 20 or more workers without using power. The primary unit of enumeration in the survey is a plant/factory in the case of manufacturing industries. The ASI frame classifies industries into two sectors namely the 'Census' sector and the 'Sample' sector.

In the census sector, the data from all the factories employing 100 or more workers is collected on a complete enumeration basis. The remaining factories fall under the sample sector for which data is collected by drawing a representative sample using sampling techniques.[10] This study covers only those plants that fall under the census sector of ASI since continuous data is only available for this set which can be successfully analyzed in a panel form. The data are an unbalanced panel and contains detailed information on production related factors like output, fixed assets, inventories, working capital, inputs, employment, labor costs, raw materials, electricity, power and fuel consumption, state location, ownership, year of incorporation etc. ASI classifies each plant in this data into industry categories according to the National Industrial Classification (NIC) upto the 4-digit level of

[9] The total revenue used here is the first stage estimates of revenue (Φ) obtained after eliminating the random error component in equation 6.

[10] For further details pertaining to the ASI data, see Ministry of Statistics and Programme Implementation (MOSPI, Government of India) website- http://mospi.nic.in

disaggregation. In this study, only those plants which operate in the manufacturing sector, that is, which belong to the NIC15 to NIC36 two-digit industry groups have been included in the analysis. The data has also been cleaned to eliminate plants with missing, duplicate or junk information.

For estimating the plant level real value added (*y*), data has been obtained as the difference of real output and real intermediate input. Relevant industry level WPI has been used to deflate nominal output. Intermediate input deflators have been created for each industry using Input-Output tables of the CSO and industry specific WPIs. Plant level data on total number of production workers employed has been used to measure unskilled labour (*l*). Skilled workers (*h*) consist of supervisory and managerial staff. Capital stock (*k*) is estimated using the perpetual inventory method.

4 Descriptive Statistics

4.1 Aggregate Manufacturing Sector

We estimate markups for 57,513 plant year observations spread across the time period 1999-2000 to 2007-2008. Since our production function estimation technique (that is, the Direct method) uses lagged plant productivity levels, we are unable to estimate the markups for the first year of the data that is 1998-1999. Table 1 presents estimates of aggregate markups, average plant level markups and standard deviations for manufacturing sector as a whole.[11] The estimates show that the markups for aggregate manufacturing sector declined from 2.12 in 2000 to 1.73 in 2003 and then remained broadly constant. Overall we find a decline in aggregate markups at the rate of 2.12 percent per annum.

Note that markup is the ratio of output elasticity of labour (θ_{it}^{l}) to the share of expenditure of labour in total revenue of the plant (α_{it}^{l}). Figure 1 shows the trends in the average values of θ^{l}, α^{l}, and μ. We find that the average labour elasticity with respect to output declined steadily over the period at an average rate of 0.78 percent per year. The average wage share rose until 2003 and then showed a declining trend at the rate of 0.97 percent per year.

[11] Aggregate markup is estimated as an output weighted sum of plant level markups

The decline in markups between 2000 and 2003 was driven by the fall in labour elasticity, θ_{it}^{l} and a simultaneous rise in average wage share, α_{it}^{l}. Though, labour elasticity continued to decline during the post 2003 period, it did not translate into a fall in markups due to an offsetting decline in wage share.

An analysis of the kernel density plot of plant-level markups in Figure 2 displays a leftward shift in the distribution indicating a fall in average plant markups over the period. The plot is also seen to have a narrower distribution indicating a decline in the dispersion of plant level markups. The standard deviation of plant level markup distribution has declined from 1.17 to 1 over the period (Table 1). A decline in dispersion results in a higher peaked kernel density plot for the year 2008 indicating a disciplining effect with a larger number of plants moving to markups level closer to the mean of the distribution. Fall in dispersion is also evident for the confidence interval plot of plant level markups over the period as displayed in Figure 3. We find that the 99% confidence interval plot of plant level markups has steadily become narrower over the period.

4.2 Industry level markups

Table 2 displays industry-wise mean markup estimates for the period 2000-2008. We find that mean markups are the highest in capital and technology intensive sectors such as Office, Accounting and Computer Machinery (NIC 30), Radio, TV & Communication Equipment (NIC 32), Electrical Machinery (NIC 31), Medical, Precision & Optical Instruments (NIC 33), Chemical (NIC 24) and Machinery & Equipment (NIC 29). The relatively labour and natural resource intensive sectors such as Wood (NIC 20), Leather (NIC 19), Textiles (NIC 17) registered lowest mean level markups in the manufacturing sector. Figure 4 displays the mean and confidence interval of plant level markups across industries. We find that the within-industry dispersion of markups is the highest in Accounting & Computer Machinery (NIC 30), Electrical Machinery (NIC 31), Medical, Precision & Optical Instruments (NIC 33) and Chemical (NIC 24).

Table 3 displays the trends in aggregate level (output-weighted) markups for various industry groups over the period 2000-2008. We find a fall in aggregate industry markup level across all the sectors except for Wood (NIC 20), Printing and Publishing

(NIC 22) and Radio, television and communication equipment industry (NIC 32). The industries that registered steepest declines in markups were Coke, refined petroleum (NIC 23), Chemicals (NIC 24), Rubber (NIC 25), Food products (NIC 15), Non Metallic Minerals (NIC 26) and Furniture (NIC 36). The trends in industry markups, labour elasticity and wage shares have been displayed in the Appendix Figure A.1 and Figure A.2 respectively.

We find substantial inter-temporal variation in plant markups. For example, on an average only about 16% variation in markups is explained by two-digit industry dummies. About 22% of the variation in plant level markup is explained by three-digit industry dummies. Table A.1 reports the adjusted R-square values of the regressions with plant and year dummies for each 2-digit industry groups. The average adjusted R-square over all the industry groups is found to be 69%, which increases slightly to 0.71% when year dummies are also included in the regressions. This implies that time varying plant and industry specific factors are important for explaining the variation in plant markups. The inter-temporal variation in markups could be influenced by time variant factors such as degree of trade liberalization, trade orientation and other plant level factors. This provides the motivation for analyzing the role of changing trade regime and other time variant factors on markups dispersion across industries, plants and years. In what follows, we analyze the impact of trade reforms and other factors on plant level markups.

5 Trade reforms and Plant level Markup

5.1. Theoretical background

The model formulated by Melitz and Ottaviano (2008) (M-O henceforth), analyses the link between trade liberalization and markups. This model, taking into account firm level heterogeneity, shows that market size and trade openness affect the toughness of competition, influencing the selection of producers and exporters in the market. Aggregate productivity and average markups depend on both the size of the market and the extent of trade openness. In what follows, we briefly discuss the salient features of the M-O model.

As in Melitz (2003) model, the M-O model resort to the assumption of a monopolistically competitive market where firms are heterogeneous in terms of productivity levels and are faced with initial uncertainty concerning their future productivity level while making the costly and irreversible investment decision of entry. However, unlike the Melitz model that assumes constant elasticity of substitution (CES), the M-O model assumes a linear demand function with horizontal product differentiation[12]. In this framework, the price elasticity of a product depends not only on the level of product differentiation but also on average prices and number of competing varieties in the market. This assumption makes it possible to incorporate endogenous markups in the model.

Increased factor market competition plays no role in the M-O model as supply of labour is assumed to be perfectly elastic. Entry in the differentiated product sector is assumed to be costly as each firm incurs product development and production start-up costs. Since the entry cost is sunk, firms that can cover their cuttoff marginal cost survive while others exit the market (selection effect). Least productive firms with lowest markups exit leading to a rise in average productivity and average markups.

As the economy opens up to trade, there is a resultant increase in market size and a fall in threshold price, the price above which the consumers choose not to buy. Larger markets induce tougher competition, with more product variety and more productive firms. The firms in the market respond to tougher competition by setting a lower price and hence lower markups. Least productive firms exit as tougher competition shifts up the residual demand price elasticities for all firms at any given demand level. The M-O model predicts that this pro-competitive effect of a fall in markups due to liberalization outweighs the selection effect leading to an overall fall in markups.

The paper by Bernard et al (2003) is another model (BEJK model henceforth) which incorporates endogenous markups in a set-up with heterogenous firms. The BEJK model assumes Ricardian differences in technological efficiency across firms. Unlike Melitz (2003), this model assumes that product variety/set of goods is exogenously fixed such that each firm competes worldwide to be the sole supplier of a given variety. The model introduces Bertrand type of competition amongst firms such that

[12] The assumption is based on Ottaviano et al (2002)

the firm with the lowest marginal cost becomes the sole supplier of a given variety. The assumption of differences in technological efficiency across firms allows the firm with the least cost to charge a markup which in equilibrium equals the marginal cost of the second best firm in the market.

The BEJK model predicts that the more efficient firms, which have the lowest marginal costs, have higher markups. Thus, the model associates higher productivity with higher markups. Trade liberalization in this model is seen as a channel of entry for more competitive firms such that some foreign firms with lower marginal costs replace the lowest cost domestic producers. Exit of inefficient producers generates productivity gains in the economy. However, unlike the M-O model, the BEJK model predicts that trade liberalization would result in higher average markups as compared to autarky. The surviving firm, which is more efficient compared to its potential competitors, is the sole supplier of a given good and hence enjoys some monopoly power with respect to the variety it produces.

These models provide the theoretical background for the analysis in this paper as we analyse the impact of trade reforms on markups.

5.2. Hypotheses

Based on the above theoretical background, we empirically test the impact of greater trade openness on plant level markups in the Indian manufacturing sector. We also analyse if other trade related channels, namely growth in import and export variety, had any impact on plant level markups. The various hypotheses subjected to empirical testing and the definition of different variables used are discussed below.

(i) Import Liberalization: Theoretical literature suggests two alternate responses of producers in the wake of increased competition. First, removal of trade restrictions leads to entry of foreign products into the domestic market resulting in tougher competition and a fall in market power of domestic producers (M-O model). On the other hand, greater competition can lead to exit of low productivity plants with lowest markups, which in turn raises the average industry level markups (BEJK model). Surviving plants are the most productive and show higher markups.

Further, theoretical models dealing with multiproduct firms suggest that in response to trade liberalization firms are forced to focus on their 'core competencies' by dropping the product lines that are inconsistent with their comparative advantages (Bernard et al, 2011). An implication of this is that the firms may enjoy some market power with respect to their chosen product line and hence may charge a higher markups.

To analyze the impact of increased competition due to trade reforms on markups, we use the average tariff rate applicable on Indian imports of final goods in a given industry i in year t ($Outtariff_{it}$). Since theoretical predictions provide mixed view pertaining to the impact of trade openness on markups, we do not have strong priors regarding the expected sign of this variable.

As to the impact of tariff reduction for intermediate inputs, the domestic producers can gain access to more and cheaper intermediate inputs which can generate substantial reductions in marginal costs. Lower marginal costs may induce increased entry into the market thereby exerting negative impact on markups. We use the variable $Inptariff_{it}$ to capture the impact of input tariffs which is defined as

$$Inptariff_{it} = \sum_j \alpha_{ij} \; Outtariff_{jt} \qquad (12)$$

Here *i* is the industry and *t* is the time, α_{ij} is the share of input *i* in the total input cost of industry i. We expect this variable to exert a positive effect on markup such that a fall in input tariff is expected to reduce markups.

As an alternative to using output and input tariffs separately to measure the impact of import liberalization, we use Effective Rate of Protection index (ERP) which accounts for protection faced by an industry in final as well as intermediate goods. One limitation of using nominal tariff rates on final goods as a measure of protection is that it does not take into account the fact that the degree of protection conferred on an industry depends not only on tariffs levied on the final product itself but also on the intermediate goods used in production. This shortcoming is addressed using ERP that measures the percentage excess of domestic value added that is made possible by the tariff structure relative to the situation in the absence of tariffs on final and intermediate goods. Following Cordon (1966) we use the variable ERP_{it} which is defined as follows.

$$ERP_{it} = \frac{Outtariff_{it} - Inptariff_{it}}{1 - \sum_j \alpha_{ij}} \quad (13)$$

As in the case of output tariff, the sign of ERP variable is expected to be positive if the pro-competitive effect as in M-O model dominates over the effect highlighted in BEJK model. Otherwise, the sign is expected to be negative.

(ii) Intermediate Input Import variety: Theoretical literature links growth in input variety to greater product differentiation (See, Goldberg et al, 2012). Higher product differentiation can imply higher markups as producers enjoy a certain degree of monopoly power with respect to their differentiated product. However, greater product variety can also imply a rise in demand elasticity of products which can lead to a negative impact on plant level markups.

Hence, the impact of a rise in input variety growth on plant level markup would depend on which impact outweighs the other, that is, the market power of plants due to differentiated product (which can increase the markups) as opposed to rise in demand elasticity of products (which can reduce the markups). We use the variable IV_{jt}, which captures the growth of import variety in a given industry *j* in year *t*. This variable is constructed following Feenstra (1994). The import variety index for industry *j* is defined as a weighted measure of import variety indices of all intermediate inputs (*i*) used in production in industry *j*. The index measures the rise in the variety of intermediate inputs available to an industry *j* for its production process. The index is constructed as follows.

First, the import variety growth index for each input *i* is given as.

$$Var\_In_{i,t,t-1} = \frac{\sum_{i \subset I_t} p_{it} x_{it} \,/\, \sum_{i \subset I} p_{it} x_{it}}{\sum_{i \subset I_{t-1}} p_{it-1} x_{it-1} \,/ \sum_{i \subset I} p_{it-1} x_{it-1}} \quad (14)$$

Where I denotes the set of varieties available in both the periods *t* and *t-1* (i.e., $I \subset (I_t \cap I_{t-1})$, *p* denotes the price of product *i*, *x* denotes the quantity imported, *t* denotes the time. An index value greater than one depicts variety growth over the two periods.[13]

[13] This index can be interpreted in the following manner. The denominator depicts ratio of value of imports in t-1 to the value of imports in the common set in time t-1. This index can be greater than or equal to one depending on the common set, If the common set of varieties is the same as the whole set

Having obtained a measure of variety growth for each input (*i*), the variety index for each industry (*j*) that uses one or more of (*i*) is obtained using weights from Input-Output (I-O) tables and is defined as:

$$IV_{jt} = \sum_i Var\_In_{i,t,t-1} * \left(\frac{m_{ij}}{\sum_i m_{ij}}\right) \quad (15)$$

where m_{ij} is the imported intermediate input *i* used in industry *j*

(iii) Export variety: A rise in export variety growth may indicate an increase in the degree of product differentiation within an industry. With higher product differentiation, we expect plant level markups to rise as firms enjoy some monopoly power with respect to its chosen variety. In contrast, greater number of variety in the market can induce a rise in demand elasticity of the product leading to a fall in markups. Thus, we do not have strong priors regarding the expected sign of this coefficient. To analyse the impact of export variety on plant level markups, we define the variable EV_{it}, which captures the export variety growth in a given industry *i* in year *t.* The export variety index, denoted as EV_{it}, is constructed analogous to $Var\_In_{i,t,t-1}$ with x_{it} in equation 14 now stands for exports instead of imports.

(iv) Final goods import variety: Theoretical models suggest that a rise in the variety of imported final goods leads to greater competition in the domestic market thereby increasing the demand elasticity of domestic goods and exerting a negative impact on the markups charged by domestic producers. To analyse the impact of final good import variety on markups, we construct an index defined as fgv_{it}. This index is constructed analogous to $Var\_In_{i,t,t-1}$ defined in equation 14 where x_{it} stands for imports of final variety

(v) Other plant level controls: In addition to the above trade related variables we include a number of plant level variables such as number of workers, capital stock, plant age, and plant productivity. Number of workers and capital stock are included to

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of varieties in time period t-1, the value of the denominator $\sum_{i \subset I_{t-1}} p_{it-1}x_{it-1} \; / \sum_{i \subset I} p_{it-1}x_{it-1}$ equal one. In case if some varieties are only present in time t-1 and drop out in time period t, the ratio would be greater than one. Similarly the denominator will also be greater than or equal (if new varieties enter in time t) to 1 (if no new variety enters in time t). Overall, the index will be greater than 1 if number of varieties at time t are higher than that in time t-1.

capture the factor intensity of production. All these variables are included in addition to plant fixed effects, which controls for time invariant plant specific factors.

6 Regression Specification

We now build an econometric model to examine how the plant level markups responded to trade liberalization in India since 1998-99. The baseline specification of the model is defined as follows-

$$\mu_{ijt} = \beta_0 + \beta_i + \beta_{jt} + \beta_\tau T_{i,t-1} + X'y + \eta_{ijt} \quad (16)$$

μ_{ijt} is the estimated markup of plant *i* in industry *j* at time(year) *t*. β_0 is the common intercept, β_i is the plant fixed effect and β_{jt} is the industry and year interacted fixed effect. *T* is defined as the vector of one year lagged variables related to trade. *X* is the vector of all the plant level characteristics such as age, number of workers, capital stock and productivity and lastly, η_{ijt} is the random error component.

5.7 Econometric Analysis

Our data for econometric analysis consists of 57,456 observations representing 13,042 manufacturing plants covering the period 1999-00 to 2007-08.[14] The results of the regression analysis are displayed in Tables 5-8. Most of the specifications include plant level fixed effects to control for time invariant plant specific factors. We also include industry-year interacted dummies to control for all the unobserved industry-specific macroeconomic shocks.

In Table 5, column 1, we regress one year lagged output tariffs, input tariffs, export variety and imported input variety in addition to current year plant level controls (plant age, number of workers employed, and capital stock) on plant level markups. We find the coefficient of output tariff to be negative and significant at 1% level indicating that a fall in tariff on final goods leads to a rise in plant level markups. This effect could be indicative of increase in market power of the surviving plants that enjoy lower marginal costs (due to higher productivity) and some monopoly power.

[14] While plant level markups have been estimated for a total of 57,513 plant year observations, data on plant age was not available for a few plants. Excluding those observations we are left with 57,456 number of plant year observations in the regression analysis.

The coefficient of input tariff is found to be positive and significant at 1% level indicating that greater access to intermediate inputs leads to lower marginal costs and increases competition due to higher entry. This rise in competition results in lower markups in the market. The coefficient for export and imported input variety growth are found to be positive and highly significant indicating that there has been a rise in monopoly power of plants with respect to their differentiated products leading to a rise in markups. We find that the point estimate of export variety is much higher than the imported input variety variable.

The coefficient of plant age is found to be negative and highly significant indicating that older plants have lower markups in the Indian manufacturing sector. The coefficient of plant's capital stock is found to be positive and significant, indicating that higher capital intensity raises markups. In contrast, the variable representing number of workers yields statistically significant negative coefficient indicating that plants operating in labour intensive industries have lower markups.

In column 2, we include final goods import variety index in the regression specification instead of export and intermediate input variety indices. The coefficient of this index is found to be negative and highly significant indicating the disciplining effect of competition on domestic markups. A rise in this index leads to fall in markups.[15] The output tariff index continues to be negative and significant as in Column 1 and the point estimates stand slightly higher. The results with respect to other variables broadly remain the same.

In column 3, we analyse the interactive effect of output tariffs with plant level capital stock variable. While the signs and significance levels of other variables are unchanged, the output tariff coefficient changes sign from negative to positive. The interaction term (outtariff * k) is found to be negative and highly significant indicating that plants operating in capital-intensive industries are the ones which had experienced a rise in markups with tariff reduction. This result is plausible as the process of product rationalization would have been more intense in capital intensive industries, which are usually import competing in labour abundant countries such as

[15] Including the final goods variety index in column 1 yields a coefficient that is negative in sign but insignificant.

India and were subjected to greater protection in the pre-reform period.[16] The negative coefficient for output tariffs is found to have been entirely driven by plants operating in capital intensive industries. Once this effect is controlled for, we find that reduction of output tariffs stimulates a disciplining effect leading to a fall in markups.

In column 4, in addition to the interactive effect of output tariffs with plant level capital stock, we include the interactive effect of output tariffs with number of workers employed (labour intensity). The interactive term with labour intensity is found to be positive and highly significant indicating that plants operating in labour intensive industries have experienced a fall in markups with tariff reduction. The coefficient of output tariff remains positive and now turns out to be significant at 10% level indicating that a fall in output tariff leads to a fall in markup as predicted by the M-O model. Coefficients of the remaining variables are generally unaffected when the interaction terms are included. In column 5 and 6, we include the interactive effect of output tariff with plant age. The coefficient is found to be positive suggesting that the pro-competitive effect of output tariff reduction is greater for older plants.

Although the results of Hausman test support a fixed effect model, for comparison, we also furnish the corresponding result of the random effects model in Table 6, columns 1-6.[17] We find that most of the variables have similar coefficients and significance levels except for output tariffs which is found to be positive and highly significant in columns 3 through 6. Overall, the random effect model reinforces the results discussed above.

In Table 7, we analyse the overall impact of import liberalization on plant level markups using the measure of ERP. As expected, in column 1, we find the coefficient of ERP to be positive and significant at 10% level, confirming the pro-competitive effect of tariff reduction. The coefficients of variables representing export and imported input variety remain positive and highly significant as well. In Columns 3-6,

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[16] Thus, capital intensive industries would have faced greatest competitive pressure from imports subsequent to tariff reduction. The heighted competitive pressure, in turn, would have forced the firms operating in these industries to rationalize the choice of product lines on the basis of their core competencies leading to higher markups.

[17] The Hausman test yielded a Chi-Square Value of 1027.74 (p value =0.000) for the specification in Column 1 (Table 5.4). Other specifications (Columns 2-6) also yield Chi-Square values that rejects the null hypothesis of random effects model.

we interact the ERP variable with plant capital, size and age. The interative terms show similar results as in Table 5 while the own effect of ERP remains positive and improves its significance to 1% level. In Columns 2 and 6, we introduce final goods variety index and find the coefficient to be negative and significant as expected.

In Table 8, in addition to the previous variables, we include plant level total factor productivity (ω) in the regression specification. The coefficient of this variable always turns out to be positive and statistically significant indicating that plant level productivity is poisitvely related to markups. This result is consistent with the BEJK model. In Columns 6 and 7 we analyse the interactive effect of output tariff with plant level productivity. In these specifications, the coefficient of output tariff (own effect) is found to be positive and highly significant at 1%. The interactive term is found to have a significant and positive coefficient indicating that tariffs reduction induces more productive plants to reduce markups by a greater extent.[18]

8 Conclusion

In this paper, we examine the impact of trade on consumer level gains measured by the level of markups over marginal costs as charged by manufacturing plants in India. The period of anaysis is from 1999-00 to 2007-08. We find some decline in the average level of markups charged by the manufacturing plants. We further examine the impact of trade reforms on plant level markups. Our regression analysis suggests that a reduction in tariff rate on final goods led to a rise in plant level markups as plants would have rationalized their product lines which generated some monopoly power. The process of product rationalization would have been more intense in capital intensive industries which were subjected to greater protection in the prereform period. In order to examine this, we analyse the interactive effect of plant's capital stock and output tariffs. We find that once we have controlled for this interactive effect, there is evidence of a pro-competitive effect that led to a fall in plant level markups as output tariffs were reduced. As to the impact of input tariffs, we find that a reduction in tariffs led to fall in markups. Rise in imported input variety and export variety is found to have resulted in higher markups reflecting the positive effect of product differentiation on firm's market power.

[18] Results of the corresponding random effect model are displayed in Appendix Table 5.A.2.

Our findings are robust to various model specifications and the results are similar when we use the measure ERP instead of tariff rates. The results also remain qualitatively similar in fixed and random effect models. To conclude, this paperprovides empricial evidence of consumer level gains arising from lower markups due to the pro-competiitve effect of trade.

Tables and Figures

Table 1: Estimates of Markups for Aggregate Manufacturing Sector

Year	Aggregate Markup	Average Markup	Std. Dev.
2000	2.12	1.95	1.17
2001	1.93	1.83	1.11
2002	1.89	1.78	1.09
2003	1.73	1.66	1.03
2004	1.74	1.68	1.04
2005	1.73	1.68	1.01
2006	1.75	1.68	1.00
2007	1.75	1.70	1.01
2008	1.72	1.65	1.00
Growth (%)	**-2.12**	**-1.64**	**-1.82**

Note: Growth rates have been estimated using semi-logarithmic regression
Source: Author's estimation using ASI plant level data

Table 2: Estimates of Markups across Industry Groups

NIC Industry Group	Obs	Mean Markup
NIC 15: Food products & Beverages	9979	1.42
NIC 16: Tobacco	403	1.57
NIC 17: Textiles	8384	1.29
NIC 18: Wearing Apparel	1750	1.53
NIC 19: Leather	1042	1.29
NIC 20: Wood	478	1.25
NIC 21: Paper	1497	1.31
NIC 22: Publishing	1091	1.32
NIC 23: Coke, refined petroleum products	689	1.73
NIC 24: Chemicals	6342	2.14
NIC 25: Rubber	2104	1.86
NIC 26: Non Metallic Mineral Products	3402	1.67
NIC 27: Basic Metals	4028	1.56
NIC 28: Fabricated Metal Products	2116	1.98
NIC 29: Machinery & Equipment	4160	2.00
NIC 30: Office, Accounting & Computer My.	239	3.50
NIC 31: Electrical Machinery	2402	2.60
NIC 32: Radio, TV & Communication Equip.	936	3.29
NIC 33: Medical, Precision & Optical Inst	1156	2.35
NIC 34: Motor Vehicles	2384	1.54
NIC 35: Transport Equip	1497	1.61
NIC 36: Furniture	1436	1.52
All manufacturing	**57513**	**1.70**

Source: Author's estimation using ASI plant level data

Table 3: Industry-wise year-on year trend in aggregate markups

year	15	16	17	18	19	20	21	22	23	24	25
2000	1.88	1.82	1.45	1.57	1.64	0.90	1.49	1.34	3.60	2.93	2.49
2001	1.80	1.65	1.41	1.68	1.32	1.25	1.37	1.27	3.49	2.59	2.26
2002	1.59	1.87	1.36	1.53	1.51	1.20	1.49	1.54	2.39	2.57	2.12
2003	1.45	1.74	1.26	1.38	1.62	1.08	1.35	1.31	2.31	2.33	1.86
2004	1.20	1.35	1.30	1.43	1.28	1.13	1.22	1.06	1.84	2.19	1.86
2005	1.33	1.56	1.22	1.43	1.37	1.35	1.29	1.37	2.11	2.20	1.83
2006	1.32	1.49	1.38	1.62	1.20	1.42	1.25	1.27	1.82	2.07	1.84
2007	1.38	1.58	1.34	1.53	1.14	1.12	1.40	1.44	1.68	2.20	1.83
2008	1.32	1.66	1.23	1.61	1.75	1.48	1.29	1.46	1.63	2.17	1.63
Growth	**-4.38**	**-1.76**	**-1.30**	**-0.02**	**-1.37**	**3.77**	**-1.50**	**0.62**	**-9.55**	**-3.58**	**-4.28**

year	26	27	28	29	30	31	32	33	34	35	36
2000	2.27	1.83	2.57	2.51	5.50	3.16	4.96	2.87	1.60	1.73	1.86
2001	1.99	1.70	2.13	2.20	4.34	2.66	3.43	2.70	1.53	1.53	1.83
2002	1.99	1.61	2.00	2.07	4.86	2.90	3.50	2.47	1.66	1.94	1.78
2003	1.71	1.53	1.90	2.00	4.19	2.54	3.09	2.30	1.47	1.70	1.87
2004	1.79	1.84	2.27	1.96	4.40	2.92	3.43	2.47	1.76	1.65	1.56
2005	1.68	1.67	1.87	2.01	5.33	2.88	3.57	2.49	1.58	1.58	1.52
2006	1.74	1.62	2.05	2.01	4.45	2.81	4.06	2.86	1.51	1.64	1.61
2007	1.72	1.49	1.93	2.17	5.31	2.68	4.27	2.43	1.55	1.66	1.48
2008	1.52	1.55	1.99	2.02	4.47	2.72	4.27	2.40	1.42	1.46	1.22
Growth	**-3.81**	**-1.62**	**-2.14**	**-1.58**	**-0.25**	**-0.87**	**0.84**	**-1.09**	**-0.92**	**-1.39**	**-4.45**

Note: Growth rates have been estimated using semi-logarithmic regression. Source: Author's estimation using ASI plant level data

Table 4: Coeffcient Estimates ofTranslog Production Function

	Translog Production Function **(4)**
l	1.501 *** (0.002)
k	-0.733*** (0.003)
l^2	0.052*** (0.005)
k^2	0.045*** (.000)
l*k	-0.082*** (0.002)
Outtariff **(t-1)**	-0.179*** (0.003)
Inptariff **(t-1)**	
ERP **(t-1)**	
EV **(t-1)**	1.401*** (0 .003)
IV **(t-1)**	0.168*** (0.003)
SK **(t-1)**	0.047*** (0.007)
SR **(t-1)**	0.067*** (0.002)
Elec	0.248*** (0 .003)
Credit	0.020*** (0 .003)
Mandays	-0.040*** (0.003)

Note: (1) l=labour, k=capital, outtariff= lagged output tariff, Inptariff = lagged input tariff, ERP = lagged Effective rate of protection, EV= lagged export variety index, IV= lagged import variety index, SK= lagged knowledge spillover index, SR= lagged rent spillover index, Elec= electricity availability per capita in state, Credit= industrial credit availability per state domestic product, Madays= mandays lost in strikes and lockouts per 1000 industrial workers. (2) All values are in logarithms. (3)Bootstrapped Standard errors in parentheses,(4) *** p<0.01, ** p<0.05, * p<0.1.

Table 5: Trade liberalization and plant level markups (Plant Fixed Effect Models)

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
			Plant Level Fixed Effect Models			
Outtariff $_{(t-1)}$	-0.0428***	-0.0577***	0.0175	0.0586*	0.0391	0.0310
	(0.00781)	(0.00814)	(0.0294)	(0.0320)	(0.0358)	(0.0396)
Inptariff $_{(t-1)}$	0.0637***	0.0487***	0.0639***	0.0632***	0.0626***	0.0469***
	(0.00713)	(0.00750)	(0.00713)	(0.00713)	(0.00715)	(0.00753)
EV $_{(t-1)}$	2.876***		2.868***	2.871***	2.875***	
	(0.136)		(0.136)	(0.136)	(0.136)	
IV $_{(t-1)}$	0.881***		0.882***	0.880***	0.880***	
	(0.108)		(0.108)	(0.108)	(0.108)	
fgv $_{(t-1)}$		-0.0203***				-0.0203***
		(0.00321)				(0.00321)
age	-0.251***	-0.271***	-0.249***	-0.252***	-0.282***	-0.320***
	(0.00960)	(0.0105)	(0.00964)	(0.00970)	(0.0264)	(0.0293)
k	0.123***	0.123***	0.134***	0.151***	0.150***	0.159***
	(0.00396)	(0.00428)	(0.00657)	(0.00835)	(0.00836)	(0.00915)
l	-0.109***	-0.115***	-0.110***	-0.144***	-0.141***	-0.163***
	(0.00353)	(0.00386)	(0.00354)	(0.0108)	(0.0110)	(0.0119)
Outtariff * k			-0.00336**	-0.00838***	-0.00821***	-0.0105***
			(0.00158)	(0.00220)	(0.00221)	(0.00241)
Outtariff * l				0.0106***	0.00991***	0.0152***
				(0.00326)	(0.00331)	(0.00359)
Outtariff * age					0.00669	0.0102*
					(0.00553)	(0.00617)
Constant	-0.888***	-0.721***	-1.093***	-1.232***	-1.143***	-0.989***
	(0.0974)	(0.103)	(0.137)	(0.143)	(0.161)	(0.176)
Industry-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	57,456	57,456	57,456	57,456	57,456	57,456
R-squared	0.175	0.160	0.175	0.175	0.175	0.160
Number of plants	13,042	13,042	13,042	13,042	13,042	13,042

Note: (1) Dependent variable- Plant level markup. Outtariff= output tariff, Inptariff = input tariff, EV= export variety index, IV= import variety index, Page-plant age, k- plant capital stock, l- number of workers employed (2) All values are in logarithms. (3) Standard errors in parentheses *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 6: Trade liberalization and plant level markups (Random Effect Models)

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
			Plant Level Random Effect Models			
Outtariff $_{(t-1)}$	-0.0283***	-0.0409***	0.112***	0.137***	0.196***	0.219***
	(0.00683)	(0.00711)	(0.0270)	(0.0296)	(0.0311)	(0.0339)
Inptariff $_{(t-1)}$	0.102***	0.0958***	0.100***	0.100***	0.0998***	0.0936***
	(0.00602)	(0.00631)	(0.00602)	(0.00602)	(0.00602)	(0.00631)
EV $_{(t-1)}$	2.944***		2.923***	2.927***	2.912***	
	(0.136)		(0.136)	(0.136)	(0.136)	
IV $_{(t-1)}$	0.883***		0.881***	0.880***	0.867***	
	(0.108)		(0.108)	(0.108)	(0.108)	
fgv $_{(t-1)}$		-0.0182***				-0.0180***
		(0.00319)				(0.00319)
PAge	-0.142***	-0.145***	-0.142***	-0.143***	-0.0706***	-0.0536***
	(0.00376)	(0.00409)	(0.00376)	(0.00376)	(0.0125)	(0.0138)
k	0.121***	0.122***	0.145***	0.155***	0.156***	0.162***
	(0.00210)	(0.00226)	(0.00503)	(0.00678)	(0.00678)	(0.00739)
l	-0.132***	-0.136***	-0.133***	-0.153***	-0.163***	-0.177***
	(0.00271)	(0.00294)	(0.00272)	(0.00973)	(0.00989)	(0.0107)
Outtariff * k			-0.00780***	-0.0108***	-0.0113***	-0.0131***
			(0.00145)	(0.00204)	(0.00204)	(0.00221)
Outtariff * l				0.00629**	0.00999***	0.0133***
				(0.00300)	(0.00306)	(0.00330)
Outtariff * PAge					-0.0223***	-0.0282***
					(0.00369)	(0.00404)
Constant	-1.052***	-0.973***	-1.485***	-1.567***	-1.750***	-1.786***
	(0.0452)	(0.0477)	(0.0924)	(0.100)	(0.105)	(0.114)
Industry-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	57,456	57,456	57,456	57,456	57,456	57,456
R-squared	-	-	-	-	-	-
Number of plants	13,042	13,042	13,042	13,042	13,042	13,042

Note: (1) Dependent variable- Plant level markup. Outtariff= output tariff, Inptariff = input tariff, EV= export variety index, IV= import variety index, PAge-plant age, k- plant capital stock, l- number of workers employed (2) All values are in logarithms. (3) Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 7: Trade liberalization and plant level markups (Plant Fixed Effect using ERP)

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
ERP $_{(t-1)}$	0.0133*	0.0110	0.0263***	0.0261***	0.0261***	0.0472*
	(0.00756)	(0.00818)	(0.00796)	(0.00796)	(0.00795)	(0.0307)
EV $_{(t-1)}$	2.867***		2.772***	2.775***	2.784***	
	(0.136)		(0.137)	(0.137)	(0.137)	
IV $_{(t-1)}$	0.839***		0.883***	0.882***	0.881***	
	(0.109)		(0.110)	(0.110)	(0.110)	
fgv $_{(t-1)}$		-0.0200***				-0.0203***
		(0.00325)				(0.00325)
PAge	-0.279***	-0.343***	-0.278***	-0.282***	-0.341***	-0.442***
	(0.0100)	(0.0110)	(0.0100)	(0.0101)	(0.0256)	(0.0238)
k	0.115***	0.107***	0.124***	0.134***	0.141***	0.138***
	(0.00424)	(0.00464)	(0.00456)	(0.00553)	(0.00625)	(0.00763)
l	-0.109***	-0.108***	-0.110***	-0.142***	-0.142***	-0.157***
	(0.00377)	(0.00419)	(0.00378)	(0.0110)	(0.0110)	(0.00934)
ERP * k			-0.00250***	-0.00531***	-0.00743***	-0.00938***
			(0.000478)	(0.00102)	(0.00132)	(0.00184)
ERP * l				0.0102***	0.0103***	0.0161***
				(0.00327)	(0.00327)	(0.00280)
ERP* PAge					0.0135**	0.0195***
					(0.00538)	(0.00451)
Constant	-0.808***	-0.347***	-0.846***	-0.850***	-0.812***	-0.406***
	(0.105)	(0.0937)	(0.105)	(0.105)	(0.106)	(0.142)
Industry-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	51,937	51,937	51,937	51,937	51,937	51,937
R-squared	0.177	0.143	0.178	0.178	0.178	0.144
Number of plants	12,741	11,742	12,741	12,741	12,741	11,742

Note: (1) Dependent variable- Plant level markup. ERP- effective rate of protection index, EV= export variety index, IV= import variety index fgv= final good variety, PAge-plant age, k- plant capital stock, l- number of workers employed (2) All values are in logarithms. (3) Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 8: Trade liberalization and plant level markups (Plant Fixed Effect with plant TFP)

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Outtariff $_{(t-1)}$	-0.156***	-0.172***	-0.036	0.0170	0.048	0.062**	0.091***
	(0.006)	(0.006)	(0.024)	(0.027)	(0.030)	(0.030)	(0.033)
Inptariff $_{(t-1)}$	0.0280***	0.0191***	0.0283***	0.0274***	0.0284***	0.0269***	0.0183***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
EV $_{(t-1)}$	1.767***		1.751***	1.755***	1.749***	1.722***	
	(0.115)		(0.115)	(0.115)	(0.115)	(0.115)	
IV $_{(t-1)}$	0.380***		0.382***	0.378***	0.378***	0.376***	
	(0.091)		(0.091)	(0.091)	(0.091)	(0.091)	
fgv $_{(t-1)}$		-0.003					-0.002
		(0.002)					(0.002)
PAge	-0.196***	-0.218***	-0.192***	-0.197***	-0.150***	-0.151***	-0.162***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.022)	(0.022)	(0.024)
k	0.195***	0.198***	0.218***	0.240***	0.240***	0.240***	0.252***
	(0.003)	(0.003)	(0.005)	(0.007)	(0.007)	(0.007)	(0.007)
l	-0.109***	-0.111***	-0.110***	-0.154***	-0.157***	-0.155***	-0.164***
	(0.002)	(0.003)	(0.002)	(0.009)	(0.009)	(0.009)	(0.01)
ω	0.862***	0.904***	0.862***	0.863***	0.863***	0.786***	0.814***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.021)	(0.022)
Outtariff * k			-0.006***	-0.013***	-0.013***	-0.0135**	-0.015***
			(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Outtariff * l				0.013***	0.015***	0.014***	0.016***
				(0.002)	(0.002)	(0.002)	(0.003)
Outtariff * PAge					-0.010**	-0.010**	-0.012**
					(0.004)	(0.004)	(0.005)
Outtariff * ω						0.023***	0.027***
						(0.006)	(0.006)
Constant	-1.339***	-1.207***	-1.745***	-1.926***	-2.067***	-2.116***	-2.148***
	(0.082)	(0.086)	(0.116)	(0.121)	(0.136)	(0.137)	(0.149)
Observations	57,456	57,456	57,456	57,456	57,456	57,456	57,456
R-squared	0.412	0.407	0.412	0.412	0.412	0.413	0.408
Number of plants	13,042	13,042	13,042	13,042	13,042	13,042	13,042

Note: (1) Dependent variable- Plant level markup. Outtariff= output tariff, Inptariff = input tariff , EV= export variety index, IV= import variety index, PAge-plant age, k- plant capital stock, l- number of workers employed, ω- plant level productivity (2) All values are in logarithms. (3) Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

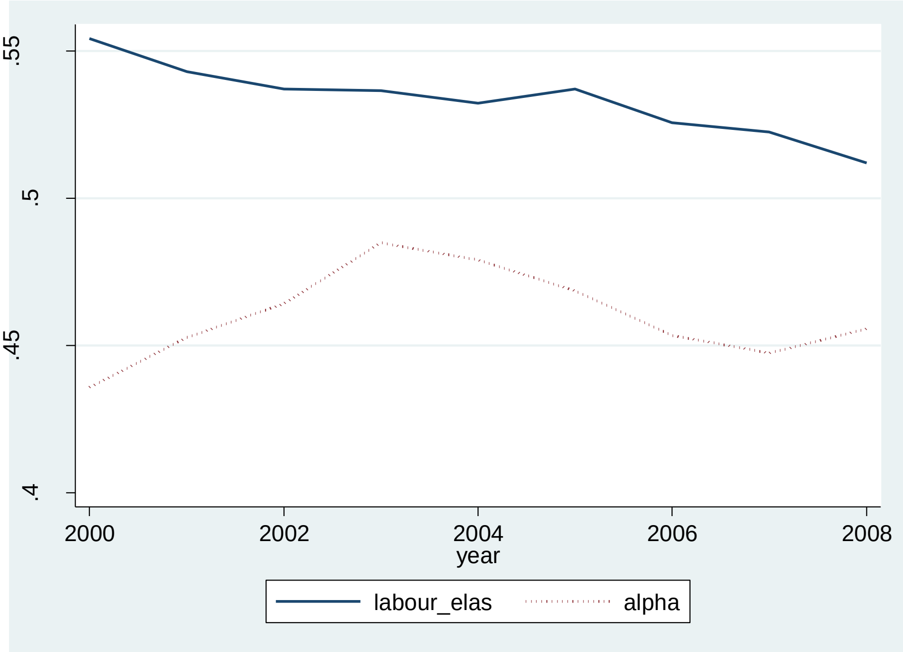

Figure 1: Labour elasticity (θ^l) and wage share (α^l)

Source: Author's estimation using ASI plant level data

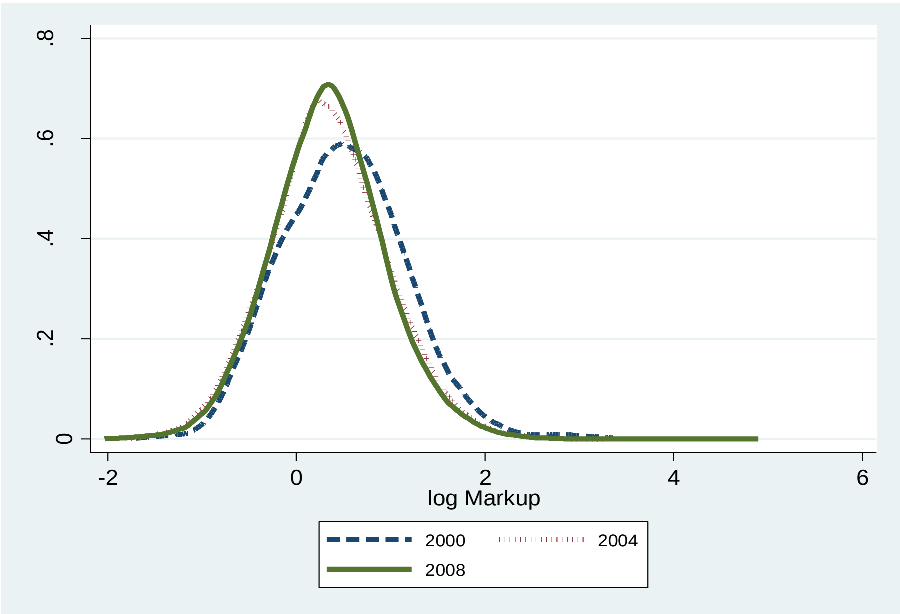

Figure 2: Kernel density estimate of markups

Source: Author's estimation using ASI plant level data

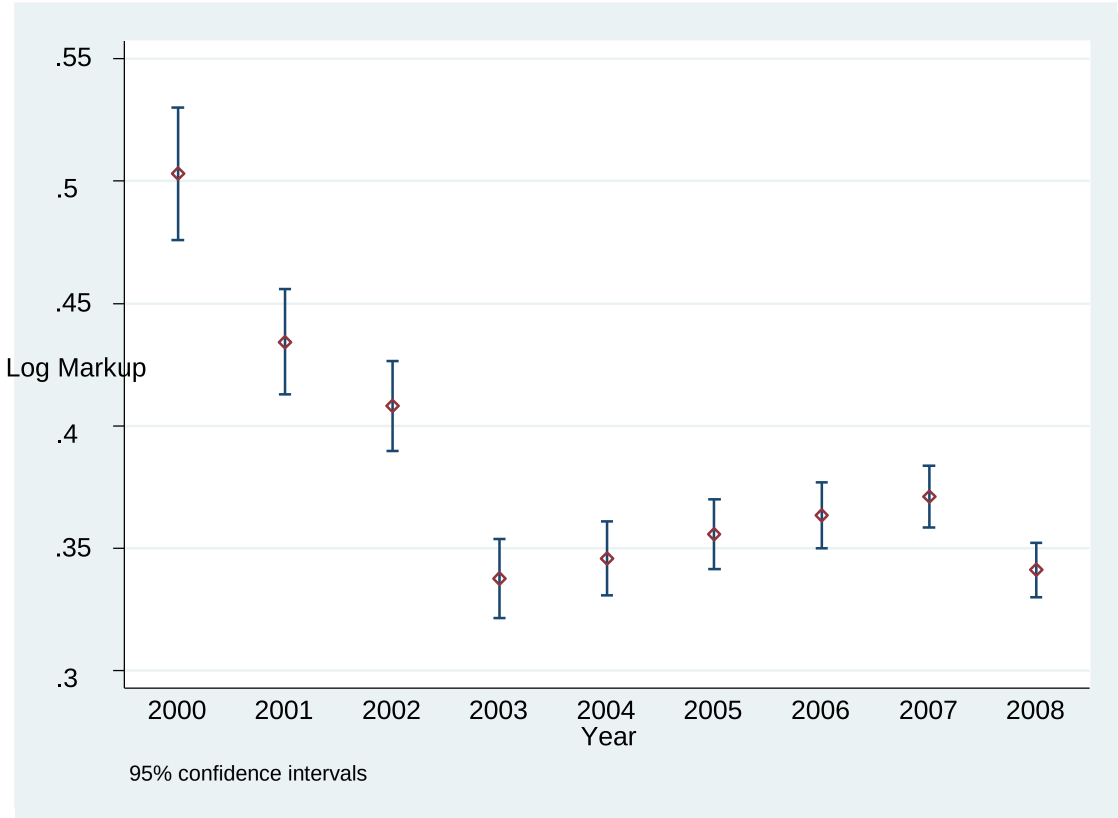

Figure 3: Year wise mean and confidence interval plot of markups

Source: Author's estimation using ASI plant level data

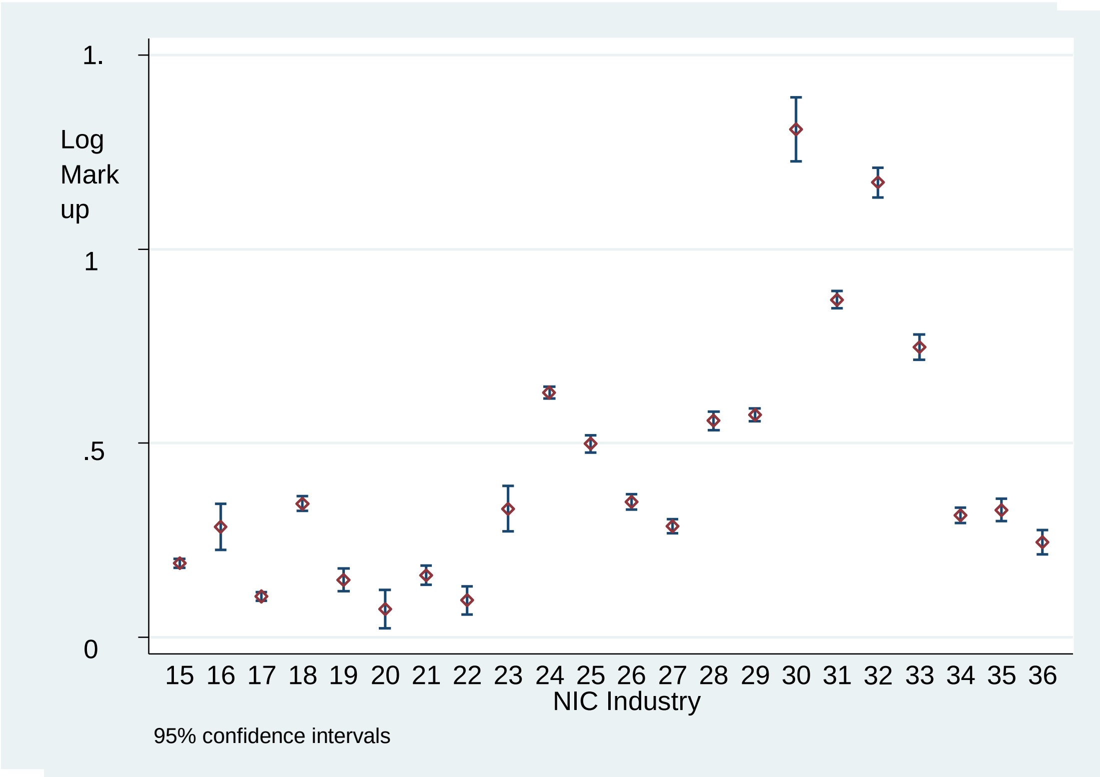

Figure 4: Industry-wise mean and confidence interval plot of markups

Note: The above graph displays confidence interval for industry mark-ups based on two digit industry classification where NIC 15: Food products & Beverages, NIC 16: Tobacco, NIC 17: Textiles, NIC 18: Wearing Apparel, NIC 19: Leather, NIC 20: Wood, NIC 21: Paper, NIC 22: Publishing, NIC 23: Coke, refined petroleum products, NIC 24: Chemicals, NIC 25: Rubber, NIC 26: Non Metallic Mineral Products, NIC 27: Basic Metals, NIC 28: Fabricated Metal Products, NIC 29: Machinery & Equipment, NIC 30: Office, Accounting & Computer My, NIC 31: Electrical Machinery, NIC 32: Radio, TV & Communication Equip., NIC 33: Medical, Precision & Optical Inst, NIC 34: Motor Vehicles, NIC 35: Transport Equip, NIC 36: Furniture.

Source: Author's estimation using ASI plant level data

Appendix

Table A.1: Adjusted R-square values obtained from regressing plant level markups on plant and year dummies

	Adj R-squares with plant dummies	Adj R-squares with plant and year dummies
NIC 15: Food products & Beverages	0.66	0.67
NIC 16: Tobacco	0.74	0.80
NIC 17: Textiles	0.65	0.66
NIC 18: Wearing Apparel	0.56	0.59
NIC 19: Leather	0.47	0.53
NIC 20: Wood	0.63	0.66
NIC 21: Paper	0.74	0.76
NIC 22: Publishing	0.68	0.70
NIC 23: Coke, refined petroleum products	0.68	0.71
NIC 24: Chemicals	0.56	0.60
NIC 25: Rubber	0.71	0.78
NIC 26: Non Metallic Mineral Products	0.75	0.78
NIC 27: Basic Metals	0.47	0.49
NIC 28: Fabricated Metal Products	0.72	0.73
NIC 29: Machinery & Equipment	0.71	0.73
NIC 30: Office, Accounting & Computer My.	0.72	0.71
NIC 31: Electrical Machinery	0.75	0.76
NIC 32: Radio, TV & Communication Equip.	0.75	0.78
NIC 33: Medical, Precision & Optical Inst	0.71	0.72
NIC 34: Motor Vehicles	0.65	0.67
NIC 35: Transport Equip	0.66	0.68
NIC 36: Furniture	0.78	0.80
Mean	**0.69**	**0.71**

Note: Dependent variable is plant level markups

Source: Author’s estimation using ASI plant level data

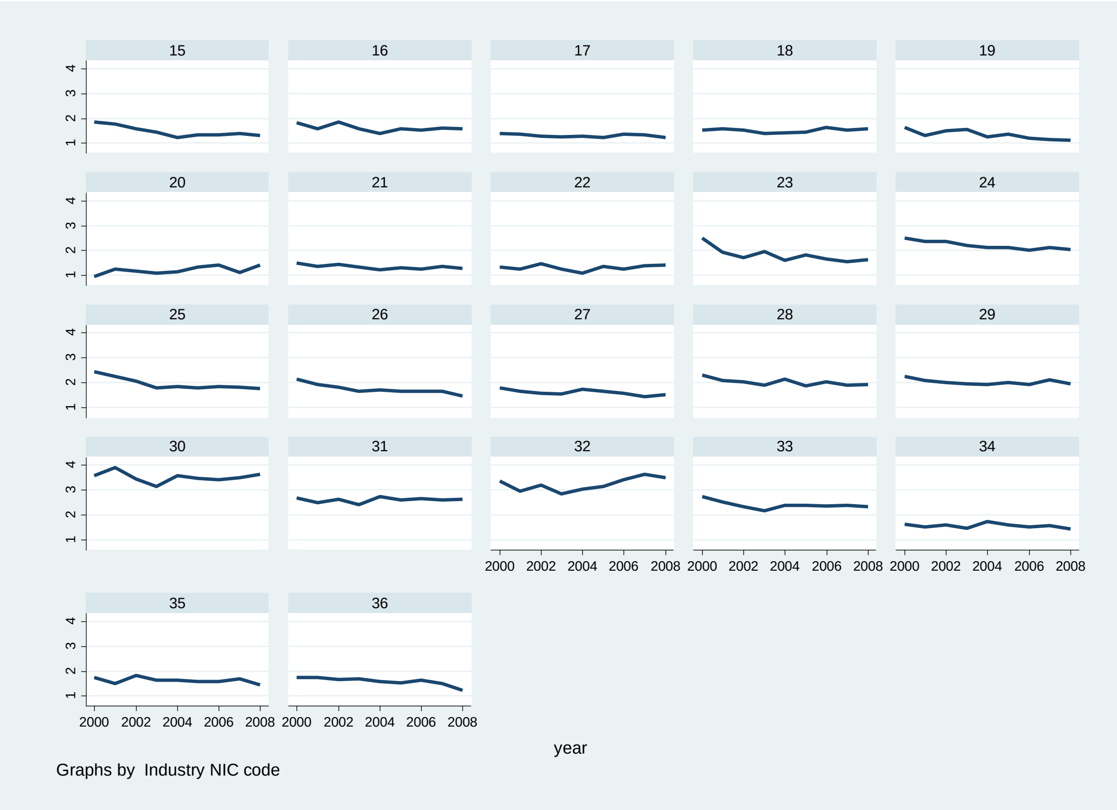

Figure A.1: Trends in Industry level aggregate markup

Note: The above graphs display industry level mark-ups based on two digit industry classification See the note under Figure 4 for industy description.
Source: Author's estimation using ASI plant level data

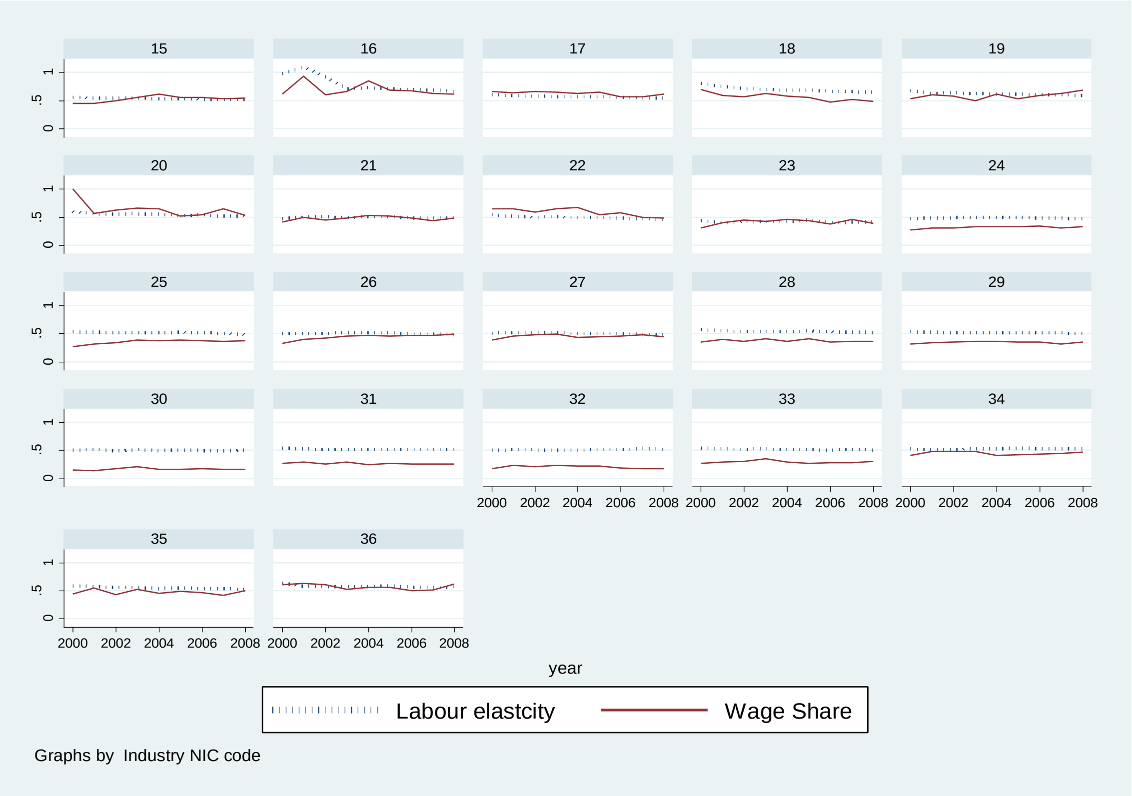

Figure A.2: Trends in Industry level labour elasticity and wage share

Note: The above graphs display industry level mark-ups based on two digit industry classification See the note under Figure 4 for industy description.
Source: Author's estimation using ASI plant level data

Table A.2: Trade liberalization and plant level markups (Random Effect Model with Plant TFP as a regressor)

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Outtariff	-0.135***	-0.150***	-0.000330	0.0376	0.0713***	0.0783***	0.110***
	(0.00603)	(0.00625)	(0.0234)	(0.0256)	(0.0270)	(0.0273)	(0.0296)
Inptariff	0.0559***	0.0517***	0.0547***	0.0546***	0.0542***	0.0535***	0.0489***
	(0.00530)	(0.00554)	(0.00530)	(0.00530)	(0.00530)	(0.00532)	(0.00556)
PAge	-0.119***	-0.121***	-0.119***	-0.119***	-0.0777***	-0.0791***	-0.0571***
	(0.00353)	(0.00384)	(0.00353)	(0.00354)	(0.0112)	(0.0113)	(0.0124)
k	0.129***	0.129***	0.153***	0.167***	0.167***	0.167***	0.172***
	(0.00192)	(0.00206)	(0.00441)	(0.00592)	(0.00592)	(0.00592)	(0.00644)
l	-0.142***	-0.144***	-0.143***	-0.173***	-0.179***	-0.178***	-0.183***
	(0.00241)	(0.00261)	(0.00242)	(0.00845)	(0.00859)	(0.00862)	(0.00929)
ω	0.786***	0.822***	0.786***	0.786***	0.786***	0.747***	0.769***
	(0.00590)	(0.00635)	(0.00590)	(0.00590)	(0.00590)	(0.0202)	(0.0215)
EV	1.942***		1.923***	1.927***	1.920***	1.906***	
	(0.116)		(0.116)	(0.116)	(0.116)	(0.117)	
IV	0.393***		0.391***	0.390***	0.383***	0.382***	
	(0.0925)		(0.0925)	(0.0925)	(0.0925)	(0.0925)	
fgv		-0.00290					-0.00240
		(0.00271)					(0.00272)
Outtariff * k			-0.00747***	-0.0120***	-0.0123***	-0.0123***	-0.0138***
			(0.00126)	(0.00176)	(0.00177)	(0.00177)	(0.00191)
Outtariff * l				0.00950***	0.0116***	0.0112***	0.0122***
				(0.00260)	(0.00265)	(0.00266)	(0.00285)
Outtariff * age					-0.0127***	-0.0122***	-0.0193***
					(0.00326)	(0.00327)	(0.00358)
Outtariff * ω						0.0117**	0.0157**
						(0.00584)	(0.00618)
Industry-year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	57,456	57,456	57,456	57,456	57,456	57,456	57,456
Number of plants	13,042	13,042	13,042	13,042	13,042	13,042	13,042

Note: (1) Dependent variable- Plant level markup. Outtariff= lagged output tariff, Inptariff = lagged input tariff,, ev= lagged export variety index, iv= lagged import variety index, PAge-plant age, k- plant capital stock, l- number of workers employed, w- plant level productivity (2) All values are in logarithms. (3) Standard errors in parentheses *** $p<0.01$, ** $p<0.05$, * $p<0.1$

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