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ADJUSTMENT OF PRICING: EVIDENCE FROM INDIAN MANUFACTURING

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ABSTRACT

In India, manufacturing plays a significant role in economic development, growth and as a source of employment. This paper analyses the pricing behaviour in Indian manufacturing sector considering both domestic and external variables. Price adjustment models are developed based on Industrial Organization literature and are examined with 28 manufacturing industries at the 3-digit level over the period from 1963 to 2001. Domestic structural factors are found to be important in determining speed of price adjustment.

Keywords: Speed of price adjustment; Competitiveness; Indian manufacturing
JEL: D21, L11, L13, L16 , L60

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1 INTRODUCTION

Since the independence, industrialization was viewed as the engine of growth in India. The first phase of liberalisation program started in the mid 1980s, but gained momentum after 1991. The economic reforms in the early 1990s, result in deregulation and exposure to domestic and international competition to Indian industries.

Industrial development from 1950s till mid 1980s was regulated with substantial control from government. Licensing, capacity control in major industries led to concentrated market structure. On the other hand, some sectors were reserved for small-scale firms to support unskilled or semi-skilled employment. Price-setting behaviour by firms reflects competitiveness of industries and may vary across industries and over time. With liberalisation, the role of international prices become important with domestic prices in price-setting behaviour.

In a competitive market structure, .institutional framework ensures perfect price flexibility. In a quasi-competitive industrial market, price adjustment by individual firm may depend on his rivals. A seminal paper by Means (1935) has generated a large volume of literature on the effects of market structure on price adjustment. Domberger (1979, 1983) establishes a positive relationship between price adjustment and concentration (an indicator of market structure) in case of the U.K. manufacturing. On the other hand, for a newly industrialised country like Australia, Dixon (1983) reports a negative relationship, which implies that the evidence is not very conclusive in literature. This is due to the industrial structure and nature of the market in any particular economy.

The purpose of this paper is to explore new evidence on the relationship between price adjustment and market structure in a newly liberalised developing country like India Liberalisation of the economy has significant influences on domestic market structure and prices. Reduction of tariffs; non-tariff barriers and control in licensing have given access to multinationals and foreign competitors in domestic market. Most of the manufacturing firms are still very far from world class practices. The new competition from foreign market provides reduced cost; improved quality; better performance; a wider range of products and better service, all delivered simultaneously. Manufacturing in India is at a critical juncture. Due to all these changes, it is worthwhile to analyse the structural determinants of the speed of price adjustment at the industry level. The research will reveal the consequences of these on price changes in case of Indian manufacturing.

The rest of the paper sets as follows. Section 2 summarises the literature with major findings from related studies. Section 3 deals with the theoretical background explaining the determinants of the price adjustment. Section 4 analyses the data, methodology of the empirical investigation. Final section summarises our major findings with some indicative remarks for policy purposes.

2. OVERVIEW OF LITERATURE

Recent research on the speed of price adjustment links industrial organisation with macroeconomics. The consequences of imperfect competition on welfare have always been a crucial research question in industrial economics, while the effects of market imperfection have been investigated recently. A popular method to add price dynamics into a pricing equation is by incorporating a term with the costs of price adjustment directly into a firm's profit function. As part of a project in extending the microeconomic foundations of macroeconomics, Rotemberg (1982a, 1982b) models these costs as a quadratic function. Martin (1993) starts from a profit equation that incorporates a quadratic price adjustment cost function and takes the theoretical analysis a step further by deriving the speed of price adjustment as a function of market power. In case of oligopoly, price adjustment is slower in concentrated industries.

Establishing a relationship between firm size and the speed of price adjustment is widely analysed in literature. Domberger (1983) does suggest that large firms have large profit cushions and, as a result, are less risk averse, leading to faster speeds of price adjustment. He concludes that 'firms in concentrated industries with correspondingly higher price cost margins are more likely to behave as price leaders than those of more fragmented industries' (p 52).

A natural corollary to Domberger's research is that firms have economies of scale over certain adjustment costs. This also happens to be a hidden assumption underlying quadratic price adjustment cost functions. In Section 3 of this paper, a model is derived that explicitly takes a positive relationship between economies of scale in regard to quadratic price adjustment costs and the speed of price adjustment. This assumes that firms with adjustment costs over a large range of output have less reason to slow their pace of price adjustment.

A second feature of the model is the negative relationship between market power and the speed of price adjustment, as discussed in Martin (1983). This proposition has some support in the empirical literature, as there are a number of studies that use industry concentration as a proxy for market power and find a negative relationship with the speed of price adjustment (for example, Dixon (1983), Bedrossian and Moschos (1988), Weiss (1993) and Shaanan and Feinberg (1995) for Australian, Greek, Austrian and U.S. manufacturing, respectively). Finally, averaging across the industry transforms the model into an error correction form, which places fewer restrictions on the short-run dynamics of the estimating equation when compared to a partial adjustment model.

A review of the empirical literature indicates that the length of the production period is also considered an important determinant of the speed of price adjustment. Domberger (1983) suggests that inventories being valued at historical cost, rather than opportunity cost, sets up a disequilibrium wedge. This results in firms with short production periods placing a greater weight on the costs of disequilibrium, leading to greater speeds of price adjustment. In support, Dixon (1983) finds a negative relationship between the speed of price adjustment and the production lag for Australian manufacturing industries.

In case of India, the literature is still scarce; we describe here the existing studies. In a labour-abundant country like India, demand pressure has a significant influence in determining pricing behaviour. In a study, Madhur and Roy (1986) develop models with variable mark-up rates for price adjustment and tested with annual data between 1961 and 1977 from four major sectors in India.[1] The role of demand pressure and international prices are incorporated in a price setting model both in case of short and long-run situations. They establish differences in lags in adjustment of prices to costs amongst these sectors. Also, capacity utilisation (a proxy for demand pressure on prices) is found to have a significant effect on mark-up while international prices have not much influence on price-setting behaviour of firms.

On the contrary, Chatterji (1989) analyses the behaviour of mark-up over the cycle for aggregate and six individual industries over the period of 1949-77. For aggregate industry price equation, demand was found to be an insignificant factor in determining prices.

Balakrishnan (1992) examines the price cycle behaviour in relation to mark-up over the period of 1952-80. Using error-correction model, a price equation is developed for aggregate industry. Considering different range of activities, price and costs are found to be cointegrated.

3 MODEL SPECIFICATION

In an imperfectly competitive industry suppose there are *N* firms, each firm producing a differentiated product. The short-run profit function of the i^{th} firm can be written as:

$$\pi(p_{it}) = (p_{it} - mc_{it})q_{it} - \alpha_i \left(\frac{p_{it} - p_{it-1}}{p_{it-1}}\right)^2 (q_{it}^*)^S \qquad (1)$$

where *i* and *t* represent firm and time subscripts, respectively, and p_{it}, q_{it}, q_{it}^*, mc_{it}, α_i and *S* indicate price, output, target output, constant marginal cost (excluding adjustment costs), a cost of adjustment parameter and an economies of scale parameter, respectively. The first term on the right-hand side of (1) is revenue minus non-adjustment related costs, while the second term is the cost of price adjustment.[2]

When *S* is zero, the cost of price adjustment in (1) is the standard quadratic price adjustment cost function. This implies larger imposts on the firm for larger percentage price changes. Rotemberg (1982a, 1982b) sites unfavourable customer reaction to higher prices as an example of this type of cost. Presumably, the firm imputes a value to the loss of current and future goodwill when prices are raised to levels above expectations or when prices are increased well in advance of competitor prices. In a similar but alternative scenario, firms uncertain about market conditions may be unsure *ex ante* that a given target price is optimal and so impute a cost to rapid price change (for a discussion, see Domberger; 1983, pp 54-59).

Adjustment costs can also arise in input markets, with many authors pointing to turnover costs in relation to labour (see Kraft, 1995; Kasa, 1998; and Lindbeck and Snower, 2001). Given the rationing role of prices, it seems reasonable to model these adjustment costs in the form of quadratic price adjustments under certain conditions. For example, during a demand slowdown firms often hoard labour rather than face the costs associated with retrenching employees and then rehiring during the next upturn. A way of achieving this outcome and limiting losses in labour productivity is to maintain output levels through smaller price changes. In this paper, the quadratic price adjustment cost function is interpreted as representing an amalgam of implicit costs that can arise from adjustments in both product and input markets.

With the standard quadratic price adjustment cost function, the implicit cost to the firm of a given proportional price change remains the same regardless of firm size. Therefore, the absolute value of the cost of price adjustment would be the same for a multinational company as for a local artisan (given the same α_i). This only makes sense if there are extreme economies of scale. In order to allow for varying scale effects, the price adjustment cost is also a function of the firm's target output level. For a given price adjustment, it can be seen from (1) that the average cost of price adjustment declines with target output (economies of scale) when *S* is less than one; that it increases with target output (diseconomies of scale) when *S* is greater than one; and that it is constant when *S* is equal to one.

In the absence of adjustment costs, the first-order condition for profit maximisation is as follows:

$$q_{it}^* + (p_{it}^* - mc_{it})(dq_{it}^* / dp_{it}^*) = 0 \qquad (2)$$

where * indicates the equilibrium values of price, output and the slope of the demand function. When adjustment costs are taken into consideration, q_{it}^{*} and p_{it}^{*} become the firm's target output and target price, respectively (this assumption is standard in the literature). Given that the actual price and the target price differ, firm output can be approximated using the following first-order Taylor series:

$$q_{it} \approx q_{it}^{*} + (dq_{it}^{*} / dp_{it}^{*})(p_{it} - p_{it}^{*}) \tag{3}$$

Substituting (3) into (1) explicitly expresses profit as a function of price. After calculating the first-order profit maximising condition and incorporating (2) into the analysis, it can be shown that the firm chooses to change prices according to the following model:

$$\Delta p_{it} = \lambda_{it} (p_{it}^{*} - p_{it-1}) \tag{4}$$

$$\lambda_{it} = [1 - (\frac{\alpha_i \beta_{it}}{\eta_{it} p_{it}^{*} q_{it}^{*1-S}})]^{-1} \tag{5}$$

$$\eta_{it} = \frac{p_{it}^{*}}{q_{it}^{*}} \frac{dq_{it}^{*}}{dp_{it}^{*}} \tag{6}$$

where $\Delta p_{it} = p_{it} - p_{it-1}$, λ_{it} is the speed of price adjustment, η_{it} is the elasticity of demand and $\beta_{it} = (p_{it}^{*} / p_{it-1})^2$. It is readily apparent that the range of λ_{it} is from zero to one and that (4) is just the partial adjustment model. Holding other things constant, it can be seen from (5) that the firm's speed of price adjustment increases/decreases with target output when the firm has economies/diseconomies of scale with respect to the costs of price adjustment; that firm revenue is positively correlated with the speed of price adjustment when *S* is zero; and that as demand becomes more/less elastic the firm's speed of price adjustment increases/decreases.

In order to give further direction to the empirical analysis in this paper, it is necessary to aggregate firm effects across the industry. Taking a weighted average of (4) across all firms in the industry and manipulating gives the following error correction model:

$$\Delta p_{dt} = \gamma_{dt} \Delta p_{dt}^{*} - \lambda_{dt} (p_{dt-1} - \delta_{dt} p_{dt-1}^{*}) \tag{7}$$

where d is an industry subscript and $\Delta p_{dt} = \sum w_i \Delta p_{it}$, $\Delta p^*_{dt} = \sum w_i \Delta p^*_{it}$, $p_{dt-1} = \sum w_i p_{it-1}$, $p^*_{dt-1} = \sum w_i p^*_{it-1}$, $\gamma_{dt} = \left(\frac{\sum w_i p^*_{it} \lambda_{it}}{\sum w_i p^*_{it}} \right)$, $\lambda_{dt} = \left(\frac{\sum w_i p_{it-1} \lambda_{it}}{\sum w_i p_{it-1}} \right)$ and $\delta_{dt} = \gamma_{dt} / \lambda_{dt}$. Following Bloch (1992), w_i represents the i^{th} firm's share of the value of industry shipments at a point in time. Therefore, the industry prices and target prices given in (7) are share-weighted averages. The error correction form of the model comes about because γ_{dt} and the industry speed of price adjustment (λ_{dt}) are differently weighted averages of each firm's speed of price adjustment.[3] If all firms in the industry have the same speeds of price adjustment, then the industry model reverts to the partial adjustment form.

In order to further inform the empirical analysis, the industry target price is derived when firms have log-linear and linear demand functions. The workings are shown in Appendix 1. In the former case, the elasticity of demand is exogenous and the industry target price is a linear function of the weighted average of each firm's marginal cost. In the latter case, the industry target price is a linear function of the weighted averages of each firm's marginal cost and demand shift variables. Generally, pricing equations will be a function of cost and demand shift variables, except when the demand function is iso-elastic and moves proportionally (see Bloch, 1992; and Olive, 2002).

4 DATA, ESTIMATION AND EMPIRICAL FINDING

4.1 Data

In this section we examine the determinants and stability of the industry speed of price adjustment for 28 Indian manufacturing industries at the three-digit International Standard Industry Category (ISIC) level during the period 1963 to 2001. Data used to construct series for industry price, industry average cost, manufacturing production, manufacturing price, competing foreign prices, average industry size and within industry competitiveness are obtained from IndiaStat, and from the United Nations Industrial Development Organisation (UNIDO) database. Additional import and export data used to construct measures of openness and import competition are taken from the International Economic Database (IEDB)[4] Detail description of the data series and sources are in Data Appendix.

4.2 Empirical Test

Although cost plus pricing has been a common assumption in the industrial organisation literature since the survey work by Hall and Hitch (1939), there is plenty of evidence to suggest that industry price is a function of both demand and cost influences. Olive (2002, 2004) estimates a pricing equation for manufacturing industries in 11 countries and finds that while average variable cost is the dominant determinant of industry price, for all countries demand variables are also significant. In the case of India, average variable cost, competing foreign price and aggregate manufacturing price are found to influence industry price significantly. This supports the finding of variable mark-up rates for Indian industry by Madhur and Roy (1986).

Consistent with these findings, industry target price is modelled as a linear function of industry average cost (ac_{dt}), manufacturing production $(iman_{dt})$, manufacturing price $(pman_{dt})$, Japanese industry price (jp_{dt}) and U.S. industry price (usp_{dt}). It should be noted that manufacturing production and manufacturing price vary across industries as they exclude the d^{th} industry's own output and price. Also, the industry prices for Japan and the U.S. are included as proxies for competing foreign price, as no such series is available for India.

Given the error correction model developed above, the basic empirical pricing equation for each industry is of the form:

$$\begin{aligned}\Delta p_{dt} &= \theta_{d1} + \theta_{d2}\Delta ac_{dt} + \theta_{d3}\Delta iman_{dt} + \theta_{d4}\Delta pman_{dt} + \theta_{d5}\Delta jp_{dt} + \theta_{d6}\Delta usp_{dt} \\ &\quad - \lambda_d ECM_{dt-1} + \varepsilon_{dt}\end{aligned} \tag{8}$$

$$ECM_{dt-1} = p_{dt-1} - \phi_{d2}ac_{dt-1} - \phi_{d3}iman_{dt-1} - \phi_{d4}pman_{dt-1} - \phi_{d5}jp_{dt-1} - \phi_{d6}usp_{dt-1} \tag{9}$$

where Δ indicates first difference, θ_{d2} to θ_{d6} are short-run parameters, θ_{d1} and ϕ_{d2} to ϕ_{d6} are long-run parameters, ECM_{dt-1} is the error correction mechanism, and ε_{dt} is an error term. Also, the expected signs are shown in (8) and (9). Initially, the industry speed of price adjustment (λ_d) is taken to vary across industries but not across time.

4.3 Panel Estimations and Related Testings

A consequence of non-stationary errors can be a spurious OLS regression that over-rejects null hypotheses. In order to test whether the error term is indeed stationary, the time series properties of the data are investigated, with the results presented in Table 1. The Im, Pesaran and Shin (IPS, 2003) test for unit roots in panel data indicates that industry price, industry average cost, manufacturing production, manufacturing price, Japanese industry price and U.S. industry price each have a unit root in levels but are first-difference stationary. A maximum of eight lags and a time trend are allowed for in all of these time series and the results hold at the one percent level of significance. If these variables in levels are cointegrated, then the error correction mechanism and the error term are both stationary. Using Pedroni's (1999) Group ADF test for panel data, the null of no cointegration is rejected at the one percent level of significance. Therefore, the results presented in Table 1 give us confidence in the inferences made below.

Table 1: Tests for non-stationarity of series in natural logarithm form

Variable	Level	First Difference	Test Type
p_{dt}	1.54	-11.72**	IPS
ac_{dt}	2.06	-12.92**	IPS
$iman_{dt}$	8.16	-19.12**	IPS
$pman_{dt}$	1.89	-12.98**	IPS
jp_{dt}	3.43	-12.76**	IPS
usp_{dt}	4.95	-7.70**	IPS
cointegration	-3.77**		Group ADF

Panel data tests are carried out using Pedroni program for RATS

IPS indicates Im, Pesaran and Shin (2003) test for unit roots in panel data.

Group ADF indicates Pedroni (1999) test for cointegration in panel data.

For each test the null hypothesis is non-stationarity. The panel data test statistics are z distributed under the null and all unit root tests have a maximum eight lags and a time trend, while the test for cointegration has no time trend.

** indicates significant at the 1 percent level for a one-tailed test.

* indicates significant at the 5 percent level for a one-tailed test.

Estimating the industry speed of price adjustment in (8) is carried out using a two stage procedure. The first stage is to estimate the parameters of the error correction mechanism for each industry. When the appropriate short-run dynamics are excluded, Patterson (2000) shows that long-run parameter estimates may be biased for finite series and Kremers *et al.* (1992) show that hypothesis tests of the speed of adjustment are likely to have low power. Therefore, (9) is estimated for each industry using non-linear least squares and allowing for an additional lag in the short-run difference variables. In the second stage, industry speeds of price adjustment are obtained by estimating (8) as a system of equations (with ECM_{dt-1} calculated from the first stage) using the method of dummy variable least squares (DVLS).

With reference to the economic model, industry speed of price adjustment is modelled as a linear function of average firm size and variables that are likely to affect the industry elasticity of demand. In the first instance, we take the traditional approach and assume that structural variables that influence the speed of price adjustment change across industry, but not (rapidly) across time (for example, see Domberger, 1983; Dixon, 1983; Bedrossian and Moschos, 1988; Kardasz and Stollery, 1988; Weiss, 1993; Shannan and Feinberg, 1995). By regressing the industry speed of price adjustment estimates on these structural variables we can assess their influence.
Given economies of scale with regard to price adjustment costs, it is expected that average firm output will be positively correlated with the industry speed of price adjustment. Here, industry output divided by the number of establishments for 1981 is used to represent average firm size (SIZ_d).

With regard to heterogeneous goods, Sawyer (1982) suggests that industry concentration may act on firm price conjectures, results in slower prices adjustment. . In case of Indian manufacturing, major sectors were controlled by government (examples include steel, aviation, petrochemicals, automobile) with licensing requirement and capacity control. Before 1990s, manufacturing prices were quite rigid. One would expect that an increase in industry concentration will decrease the industry speed of price adjustment. We use inverse of number of establishments (N_d) for 1981 as a proxy i.e. we expect a positive relationship between the number of establishments and the industry speed of price adjustment.

In a formal model, Bloch (1994) shows that higher import shares reduce the elasticity of price conjectures, thus making demand more elastic. In light of our model, we expect greater import competition to increase the speed of price adjustment. The measure of import competition (MSH_d) employed is the value of industry imports divided by the value of industry output averaged over the 1963-2001 period.

Table 2 shows the results from the regression of the industry speeds of price adjustment on SIZ_d, N_d and MSH_d and on their square roots $SIZR_d$, NR_d and $MSHR_d$ using OLS and WLS. In the latter case, the standard errors from the estimated speeds of price adjustment are used as weights. It can be seen that there is some support for our economic model as SIZ_d and $SIZR_d$ are significantly positive at the 5 percent level for OLS and significantly positive at the 10 percent level for WLS, while N_d and NR_d are significantly positive at the 5 percent level and 1 percent level, respectively, for WLS. Notably, the results also show that import competition is not significant in any of the regressions.

Table 2: Regression of industry speeds of price adjustment on various structural variables

Estimation	Structural variables					
method	SIZd	Nd	MSHd	SIZRd	NRd	MSHRd
OLS	3.15*	-1.10	-0.13			
	(2.60)	(-0.68)	(-0.42)			
OLS				1.78*	-0.39	-0.13
				(2.48)	(-0.17)	(-0.42)
WLS	4.91#	4.96*	-0.04			
	(1.79)	(2.35)	(-0.31)			
WLS				2.82#	6.80**	0.06
				(2.03)	(3.21)	(0.47)

t-statistics are in parentheses and there are 28 observations. Parameter values for SIZd, SIZRd, Nd and NRd should be multiplied by 10-10, 10-5, 10-5, and 10-3 ,respectively, when firm size is expressed in rupees and Nd is the absolute number of firms in an industry.

OLS indicates estimation by ordinary least squares.

WLS indicates weighted least squares, where the standard errors from the estimation of the industry speeds of price adjustment are used as weights.

** indicates significant at the 1 percent level for a two-tailed t test.

*indicates significant at the 5 percent level for a two-tailed t test.

# indicates significant at the 10 percent level for a two-tailed t test.

Thus far, our investigation suggests that particular cross-sectional variables are important determinants of industry speed of price adjustment. However, a different approach to that taken for Table 2 is necessary in order to examine the impact of time varying influences on industry speed of price adjustment. During the considered period, significant changes have taken place including the influence economic reforms in the early 1990s. The new pricing equation is given as:

$$\begin{aligned}\Delta p_{dt} &= \theta_{d1} + \theta_{d2}\Delta ac_{dt} + \theta_{d3}\Delta iman_{dt} + \theta_{d4}\Delta pman_{dt} + \theta_{d5}\Delta jp_{dt} + \theta_{d6}\Delta usp_{dt} \\ &\quad - (\lambda_1 + \lambda_2 SIZ_d - \lambda_3 N_d + \lambda_4 V_t) ECM_{dt-1} + \varepsilon_{dt}\end{aligned} \tag{10}$$

where λ_1 to λ_4 are parameters constrained to be the same across industries and V_t represents a time varying determinant of industry speed of price adjustment. Estimation of (10) now involves directly entering the determinants of the speed of price adjustment into the second stage and constraining their coefficients to be the same across industries.

However, estimating (10) introduces a bias into the estimates of λ_1 to λ_4 when prices are in index form. If a price index for an industry can be characterised as an unknown number multiplied by the true price, then constraining the speed of price adjustment across industries is the same as multiplying the dependent variable and the error correction mechanism in (10) by an arbitrary unknown variable. This problem can be overcome to some extent by transforming p_{dt}, ac_{dt}, $iman_{dt}$, $pman_{dt}$, jp_{dt} and usp_{dt} into natural logarithms. Under the null hypothesis that λ_4 is zero, estimation then leads to unbiased estimates of λ_1 to λ_3 and the unknown numbers simply fall out into the constant fixed effects for each industry. By similar reasoning, any non-zero estimate of λ_4 is likely to be biased when the above variables are transformed into natural logarithms.

We proceed by initially estimating the parameters for the error correction mechanism and for (10) assuming that λ_4 is zero. Then we move to test a range of variables that have changed relatively rapidly over time in order to see whether our null position is rejected. The first of these variables is a reform dummy variable (*RD*) that is zero from 1963 to 1990 and is one from 1991 to 2001. This is meant to capture the impact of the wide ranging liberalisation of the Indian economy on the industry speed of price adjustment. A more specific variable that has been influenced by these reforms is the degree of openness in each industry (OP_{dt}). This is measured as imports plus exports divided by imports plus domestic output. If either of these variables increases competitiveness in the economy, then we would expect them to increase the industry speed of price adjustment. A third variable is import share (MSH_{dt}), which we now allow to vary across time and industry. Finally, the growth in manufacturing output (MO_{dt}) is employed to capture the influence of the business cycle on industry speed of price adjustment.

Table 3: DVLS estimation results for the industry speed of price adjustment when it is a function of cross-sectional and time variables

	Results when time series (that are not part of λd) are in natural logs				
Variable	(1)	(2)	(3)	(4)	(5)
Constant	0.45**	0.46**	0.45**	0.45**	0.50**
	(9.46)	(9.58)	(9.52)	(9.49)	(6.70)
SIZd	0.34	0.28	0.29	0.31	0.28
	(0.53)	(0.44)	(0.44)	(0.49)	(0.42)
Nd	3.56**	3.45**	3.54**	3.55**	3.51**
	(3.31)	(3.23)	(3.31)	(3.30)	(3.22)
RD		0.01			
		(1.01)			
OPdt			0.02#		
			(1.71)		
MSHdt				0.01	
				(1.50)	
MOdt					-0.82
					(-0.86)

t-statistics computed from heteroscedastic-consistent standard errors are in parentheses. Parameter values for SIZd, and Nd should be multiplied by 10-10 and 10-5, respectively, when firm size is expressed in rupees and Nd is the absolute number of firms in an industry.

** indicates significant at the 1 percent level for a two-tailed t test.

# indicates significant at the 10 percent level for a two-tailed t test.

Table 3 shows that SIZ_d and N_d have the expected positive sign and N_d is significant at the 1 percent level, but that SIZ_d is no longer significant. By multiplying the coefficient estimate by the actual values we can get an idea of the contribution of SIZ_d and N_d to the speed of price adjustment. For formulation (1), the maximum contribution by firm size is 0.10 in Petroleum Refineries (353) and the maximum contribution by the number of firms is 0.65 in Food Products (311). Formulations (2), (3) and (4) show positive estimates for *RD*, OP_{dt} and MSH_{dt}, suggesting that the economic reforms have increased the speed at which firms adjust to their long-run equilibrium. However, only openness is significant at the 10 percent level and its contribution to the industry speed of price adjustment appears to be modest (as discussed above, the estimate for OP_{dt} may be biased). It can also be seen from Table 3 that manufacturing output growth is not significant, which suggests that industry speed of price adjustment is not affected greatly by the business cycle.[5]

4 IMPLICATIONS AND CONCLUSIONS

The purpose of this paper is to analyse the speed of price adjustment in case of Indian manufacturing. An error correction model is considered in explaining adjustment. Industry average cost, manufacturing production and price, international price are used as independent variables. Both cross-section and time-varying effects are considered in explaining the model. Among cross-sectional variables, average firm size is found to have a positive significant effect on speeds of price adjustment for all specifications. There is some support that concentration has a positive and significant effect on the speed of price adjustment. The influences of time variables in our model have second order effects. This implies that the reform program and other time variables influence prices through their effects on the target price. Concentration is still a significant determinant of the speed of price adjustment. This is due to the protected Indian industrial structure which led to rigid framework to compete in world market. We could not establish that output growth in manufacturing is affected by business cycle. This implies industry speed of price adjustment is not influenced greatly by the business cycle. Also globalisation and liberalised market is increasing the speed of price adjustment.

In summary, our findings suggest the importance of domestic market structure is prominent both across industries and over time in determining price adjustment. Also recent liberalisation has some effects on price adjustment.

APPENDIX 1

Derevation of the industry target price when firms have log-linear demand functions and linear demand functions. Suppose, the log-linear demand function of the ith firm is:

$$\log q_{it} = A_{it} + \eta_i \log p_{it} \qquad \text{(A1)}$$

where A_{it} is a function of demand shift variables and η_i is the exogenous elasticity of demand. Rearranging the first-order condition as presented in (2), the firm's target price can be written as:

$$p_{it}^* = (1 + 1/\eta_i)^{-1} mc_{it} \qquad \text{(A2)}$$

It can be seen from (A2) that that the target price is a linear function of marginal cost at the firm level. Taking a weighted average across firms, the industry target price can be written as:

$$p_{dt}^* = e_d mc_{dt} \qquad \text{(A3)}$$

where $p_{dt}^* = \sum w_i p_{it}^*$, $mc_{dt} = \sum w_i p_{it}^*$ and $e_d = \frac{\sum w_i mc_{it} (1 + 1/\eta_i)^{-1}}{\sum w_i mc_{it}}$. Given that the elasticity of demand and marginal cost are uncorrelated in this case, $E(e_d) = \sum (1 + 1/\eta_i)^{-1} / N$ where *E* is the expectations operator and *N* is the number of firms in the industry.

Now suppose the *i*th firm has the following linear demand function:

$$q_{it} = A_{it} - b_i p_{it} \qquad \text{(A4)}$$

where b_i is a parameter that incorporates the firm's price conjectural variations with regard to other firms in the industry (for the impact of price conjectures entering in this manner on the partial adjustment model, see Olive, 2004). The firm's target price is obtained by substituting (A4) into the first-order condition and rearranging to give:

$$p_{it}^* = \frac{A_{it}}{2b_i} + \frac{mc_{it}}{2} \qquad \text{(A5)}$$

Equation (A5) represents the target price as a linear function of marginal cost and the demand shift variables. Taking a weighted average across firms, the industry target price can be written:

$$p_{dt}^{*} = \frac{b_d^{-1} A_{dt}}{2} + \frac{mc_{dt}}{2}$$

where $b_d^{-1} = \sum w_i b_i^{-1}$ and $A_{dt} = \frac{\sum w_i b_i^{-1} A_{it}}{\sum w_i b_i^{-1}}$. Therefore, the industry target price is a linear function of the average influence of demand shift variables and marginal cost on firm target price.

DATA APPENDIX

UNIDO data are used to construct the variables p_{dt}, ac_{dt}, $iman_{dt}$, $pman_{dt}$, jp_{dt}, usp_{dt}, SIZ_d, N_d and MO_{dt}, while additional import and export data from IEDB are used to construct OP_{dt} and MSH_{dt}. The data in this study are at the three-digit ISIC level.

p_{dt} – Indian industry price is constructed by dividing gross output by the index of production. A similar process is employed to construct price indices for Japan and the U.S. However, jp_{dt} and usp_{dt} are converted into rupees by multiplying by the average annual rupee/yen and rupee/dollar exchange rates, respectively

ac_{dt} – Industry average variable cost is constructed by subtracting value added from gross output plus wages and salaries, and dividing this by the index of production.

$iman_{dt}$ – The manufacturing production index for a particular industry is an output chain weighted average of the indices of production for the other 27 industries. The output weights are changed for the years 1963, 1970, 1980 and 1990.

$pman_{dt}$ – The manufacturing price index for a particular industry is an output chain weighted average of the price indices for the other 27 industries. The output weights are changed for the years 1963, 1970, 1980 and 1990.

N_d – The number of establishments in each industry in 1981.

SIZ_d – The average establishment size is obtained by dividing industry output by the number of establishments in 1981.

MSH_{dt} – Import competition is obtained by dividing imports by output in the same industry category. Imports are only available on an annual basis from 1970 to 1996. Therefore, the values going forward from 1997 are an average of the 1991 to 1996 import competition values and the values going back from 1969 are an average of the 1970 to 1974 import competition values.

OP_{dt} – Openness is obtained by dividing imports plus exports by imports plus output in the same industry category. Imports and exports are only available on an annual basis from 1970 to 1996. Therefore, the values going forward from 1997 are an average of the 1991 to 1996 openness values and the values going back from 1969 are an average of the 1970 to 1974 openness values.

MO_{dt} - Growth in manufacturing output is the proportional rate of change in the manufacturing production index for a particular industry.

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NOTES

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[1] The four sectors are: capital goods, consumer goods, intermediate goods and basic goods.

[2] Zero fixed costs are assumed for simplicity. This does not affect the analysis.

[3] This method for obtaining an error correction model could be contrasted with those outlined by Nickell (1985).

[4] IEDB, Research School of Pacific and Asian Studies, Australian National University.

[5] The authors obtained similar results to those in Table3 when $SIZR_d$, NR_d and $MSHR_d$ are employed in the estimating equations.