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Industrial Concentration in a Liberalising Economy: a Study of Indian Manufacturing

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Abstract

This paper studies industrial concentration in Indian manufacturing sectors over the period 1970 to 1999. Given that Indian industry was highly regulated till the mid-1980s, the market structure in most manufacturing sectors was largely shaped by government policy. Deregulation after 1985 allowed greater scope for competitive processes, so that concentration levels are now more likely to be determined by industry characteristics rather than government policy. We find that, on the whole, concentration levels were indeed more significantly related to industry characteristics after deregulation. However, even after controlling for these characteristics, there is considerable heterogeneity in the patterns of concentration in individual industries.

Keywords: industrial concentration, liberalisation, India

I Introduction

Through much of the 1960s and 1970s Indian industry was highly regulated. All activity in the formal manufacturing sector was subject to licensing and rigid capacity controls. Access to stock markets and other sources of finance was carefully regulated. In many sectors there were administrative controls over input and output prices, and the government rationed access to many key inputs, especially imported capital goods. Some sectors were reserved for public-sector enterprises and some others were reserved for small-scale firms. These controls on industry must be seen against the backdrop of a regime in which most organised economic activity was regulated, including substantial tariffs and quantitative restrictions on imports. In this regulated phase, market structure and patterns of industrial concentration were shaped, wittingly or unwittingly, by government policy. For instance, market shares of individual firms in any manufacturing sector were determined largely by licensed capacity allocations. It is hardly surprising that sectors in which licenses were restricted to a handful of firms tended to display high levels of concentration. On the other hand, sectors that were reserved for small-scale firms tended to have a relatively fragmented structure. With economic reforms that arguably began in the 1980s, but gained prominence after 1991, many sectors in Indian industry have been progressively deregulated and exposed to foreign competition. It is reasonable to expect that, after deregulation, the market structure would be determined less by government policy and more by normal competitive processes. This paper studies the determinants of industrial concentration before and after liberalisation.

What determines the market structure in an unregulated industry? One factor that plays a major role is the aggregate size of the market. If the market is large relative to setup costs in an industry, competitive entry tends to create a fragmented market structure. This suggests that the degree of concentration may be inversely related to the size of the market. Sutton (1991, 1998) argued that this traditional size-structure relationship may not hold in industries that are technology intensive or advertising intensive. In such industries larger markets may provide incentives for competitive escalation of advertising and technology expenditures, and the escalated levels of such expenditures may not be compatible with a fragmented market structure. One testable hypothesis that emerges from this framework is that in advertising intensive or technology intensive industries concentration levels are unlikely to be very low, that is, they are bounded away from zero. Sutton's framework also suggests a list of variables that may explain patterns of industrial concentration: notably, set-up costs, advertising intensity and technology intensity of firms.

This paper is an empirical study of concentration in the Indian manufacturing sector. We seek answers to three questions. First, the simple question: has concentration increased or decreased in the deregulated phase? It is often claimed – especially by advocates of reform – that deregulation creates a more competitive environment and lowers concentration. This expectation is not obvious: deregulation may well increase levels of concentration. In fact, we find evidence that in the post-deregulation period, mergers and consolidation have led to a significant increase in concentration in industries such as aluminium, brewing and woollen textiles.

Second, we ask if the determinants of industrial concentration changed as Indian industry moved from the regulated to liberalised phase. Industry was heavily regulated through the 1970s, but there was progressive deregulation after 1985. If market size, advertising and technological intensity are crucial determinants of industrial concentration in unregulated markets, these variables should be more significant in explaining concentration in the post-liberalisation phase than in the earlier phase. Indeed, whether or not these variables prove significant could be viewed as a measure of the effectiveness of reform. In particular, if concentration levels in an industry continue to be at variance with what the technological and competitive characteristics of the industry predict; one plausible inference is that the industry has not moved out of the shadow of regulation.

Third, we study the evolution of concentration individually for eleven manufacturing sectors over the period 1970 to1999 to assess if concentration is influenced by similar factors in different sectors. Given that the process of deregulation has not been uniform across sectors, and some industries are still subject to extensive controls, we should expect differences. A disaggregated approach allows us to explore the specificities of individual industries.

Why does industrial concentration matter? In a market economy, high concentration is usually indicative of lack of competition, with direct implications for prices, profits and economic welfare. Further, in the long run, absence of competition may affect the technological dynamism of firms. This is a natural concern in the Indian context, where the lack of competition, domestic or foreign, is usually held responsible for the technological stagnation of Indian industry through the 1970s and 1980s. It is then natural to ask if deregulation has created a more competitive environment, both in terms of its likely impact on consumer prices and on technological stance of firms. Further, any observed heterogeneity of experience across industry would suggest that future policy reform may need to discriminate between sectors.

The paper is organised as follows. Section II describes the industrial policy regime in India and its impact on market structure. Section III reviews the theoretical and empirical literature on industrial concentration. Section IV describes our data and methodology and Section V discusses our empirical findings. Section VI concludes with a summary and some suggestions for the ongoing design of competition and industrial policy.

II Industrial Policy in India

Early development planning in post-Independence India emphasized self-reliance and rapid industrial growth. Industrial licensing, introduced in 1991, was considered essential to conserving scare capital and to align domestic production capacity with developmental priorities. The chosen strategy emphasised import substitution and promotion of heavy industry. The Industrial Policy Resolution of 1956 reserved certain core sectors (steel, aviation, petrochemicals) for public sector enterprises by prohibiting fresh entry by private firms. In order to mitigate the perverse employment consequences of capital-intensive industrialization in a labour-surplus economy,

some sectors were reserved for the small-scale sector. Table lA provides an overview of these policies.

Table 1A India's Industrial Policy Regime, 1950–1984

Industries (Development and Regulation) Act, 1951	Imposed licensing requirements for firms with fixed investment above particular thresholds in a specified list (Schedule I) of industries.
Industrial Policy Resolution, 1956	Specified the role of public sector by reserving some industries exclusively for state enterprises (Schedule A) and in others restricting future expansion to state enterprises (Schedule B).
Monopolies & Restrictive Trade Practices Act (MRTPA), 1969	All applications for production licenses from firms belonging to big business houses and subsidiaries of foreign companies were referred to the MRTP Commission which invited objections and held public hearings before granting licenses.
Industrial Policy Notification, 1973	Made licensing mandatory for all firms above certain investment limits. In specified industries (Schedules IV and V), licensing was mandatory for all firms irrespective of size. Some industries were reserved for small-scale firms.
Industrial Policy Statement, 1973	Large business houses and foreign firms confined to a specified list of 'core' industries.
Foreign Exchange Regulation Act, 1973	Foreign companies operating in India were required to reduce their share in equity capital to below 40 per cent, except where the company was engaged in 'core' activities, used sophisticated technology or deemed to be export intensive.
Industrial Policy Resolution, 1977	Expanded the list of industries that were restricted to small-scale firms, to include over 800 products.

The strategy of planned development ran into unforeseen crises in the 1960s (foreign exchange crises, two wars, two droughts). Industrial policy was quite reactive at this stage, but perversely moving towards more restriction to mitigate the visible symptoms of these crises. For instance, the foreign exchange crises paved the way for the Foreign Exchange Regulation Act of 1973 requiring foreign-owned firms in India to dilute their foreign equity holdings and mandating greater regulation of their technology and foreign exchange flows. Where existing regulation had created undesirable outcomes, this was countered with further regulation. Large firms that were able to negotiate the regulatory maze with greater ease often ended up acquiring licenses if only to preclude rivals. The Monopolies and Restrictive Trade Practices

Act (MRTPA) of 1969 aimed to control the perceived abuse of the licensing system by large business houses, but only added administrative delay to the licensing process. There was regulatory creep: while only nine industries were reserved for the small-scale sector initially, by the late 1970s reservation had expanded to cover most products that could be produced on a small scale, regardless of quality or cost.

Regulation affected the pattern of industrial concentration through a variety of channels. The preferential policy towards small-scale firms created artificially low levels of concentration in many sectors, with plants often operating much below minimum efficient scale. According to Gang (1995), a substantial number of small firms were involved in mechanical engineering, chemical products and auto ancillaries. Small-scale production is not necessarily advantageous in these sectors, but given that firms risked losing their preferential status if they expanded output or investment, this artificially low pattern of concentration in these sectors was quite persistent.

The licensing mechanism too affected levels of industrial concentration. The number of firms and their market shares were directly determined by capacity allocations. In some sectors licenses were restricted to a handful of firms, usually in order to prevent 'unnecessary duplication of investment', resulting in relatively concentrated markets. In other cases, allocation paid little heed to production efficiency, allocating multiple licenses for output levels below minimum efficient scale: for these, concentration levels were artificially low.

While the licensing mechanism controlled entry, a complicated set of regulations controlled the exit of firms. Any production unit other than small-scale units required permission to cease operations: this regime was intended to preserve employment and assets. Permission to exit was rarely granted, with the government preferring to nationalize firms that were in financial distress. The extreme specificity of production licenses meant that failing firms could not easily alter their product mix. Overall, the severe restrictions on exit meant that concentration levels were not very responsive to changing market conditions.

Anti-monopoly restrictions on the growth of large firms also affected the size distribution of firms. After 1969, anti-monopoly restrictions on large business houses dampened the tendency towards growing concentration in some sectors. In some cases, a dualistic structure emerged with some large firms and a fringe of small producers, with little movement between categories of firms. Where sectors were reserved for small-scale manufacture, but incumbent large firms were allowed to continue at frozen capacities (as in the soap industry), such a dualistic structure was the natural outcome.

Levels of concentration in Indian industry were also influenced by the policy towards foreign investment and imports. In the wake of the foreign exchange crises of the 1960s, the economic regime became relatively hostile to new investment by foreign firms. This tended to preserve the relatively concentrated structure in some industries that were dominated by incumbent foreign firms (see Athreye and Kapur 2001). The wide-scale restrictions on imports through prohibitive tariffs and outright bans protected many sectors from foreign competition. Prior to 1978, capital-good imports were allowed only when they met the twin criteria of essentiality and domestic non-

availability – the latter was judged without reference to price. Tariff policy acted to complement these quantitative restrictions. According to World Bank (1989), at an average rate of 122 per cent, tariffs in India in the late 1980s were higher than most other countries. Tariffs insulated many sectors from price competition: this allowed many inefficient firms to survive, and may have supported a more fragmented structure relative to what stronger price competition may have created.

On the whole, the pattern of concentration during the regulated phase was a product of government design rather than market forces. By the early 1980s, a long period of industrial stagnation, especially technological stagnation, created pressure for deregulation. There was some liberalization of import policy and partial reform of industrial policy in 1985. 'Broad-banding' of production licenses was introduced: this change allowed firms to use their existing licensed capacity (previously tied to a narrow product specification) to manufacture a broader range of related products. This enabled easier output adjustments. After 1985, the licensing regime was relaxed gradually, and the government also introduced legislation to enable the limited exit of 'sick' (that is, chronically unprofitable) firms. Table 1B summarises these changes. It is interesting that unlike the previous crises that had led to a more restrictive environment, the crises of the late 1980s led to a liberalization of industrial policy.

Table 1B: Deregulation of Industrial Policy, 1985–1999

Amendment to MRTP Act, 1985	The Act was made less restrictive: the threshold asset limit for identifying monopolies was raised; large business houses were permitted to invest in previously-prohibited sectors if they located such investment in industrially backward regions
New Industrial Policy, 1991	Abolished licensing for all except 18 industries. Number of industries reserved for the public sector (Schedule A) cut down from 17 to 8; Schedule B was abolished altogether. Small firms were allowed to offer up to 24 per cent of shareholding to large enterprises. Large firms no longer needed MRTP approval for capacity expansions. Limits on foreign equity holdings were raised from 40 to 51 per cent for many industries. EXIM scrips (import entitlements linked to export earnings) were introduced and were freely tradable. Actual user requirements for import of capital goods, raw materials and components under OGL were removed. Royalty limits increased to encourage technology imports.

Policy announcements, 1992-1999	Number of industries requiring licensing steadily decreased. By 1998 the number of industries requiring licensing was down to 9. Oil exploration and Minerals were removed from list of reserved industries for the public sector, bringing the number of Schedule A industries down to six. Infrastructure industries like basic telecom and power opened to the private sector (including foreign ownership). Small scale industry reservations decreased: 15 items including ready made garments are removed from reserved list. Investment limit for defining a firm as small scale rose from Rupees 7.5 million to Rupees 30 million. Pricing of coal, drugs and pharmaceuticals de-regulated.
Tariff reductions, 1992-1999	Peak tariffs reduced to 110% in 1992 and gradually brought down to 40% in 1998. List of freely importable goods expanded Reform of structure of tariffs.

The New Industrial Policy of 1991 and subsequent reforms carried this process further. It abandoned formal licensing requirements in most but not all sectors. These changes facilitated fresh entry, lowering concentration levels in some sectors. In others, easier access to capital markets and a more liberal attitude to mergers increased concentration. Import liberalisation and reduced tariffs lowered the effective cost of capital good or embodied technology imports. Changes in patent laws and the relaxation of restrictions on royalty payments led to a marked increase in technology expenditures. In some sectors such changes allowed incumbent firms to increase their market dominance, causing concentration to rise. In other, these very changes may have eroded the advantages of incumbency, resulting in lower concentration.

III The Determinants of Concentration

Industrial concentration refers to the extent to which production is concentrated amongst firms in an industry. The number of active firms in the industry provides a simple measure of concentration: the greater is the number of firms, the less concentrated (or more fragmented) is market structure. Another commonly used measure is the n-firm concentration ratio: the share of industry output controlled by the largest n firms. For instance, setting $n = 4$ results in the four-firm concentration ratio. Higher values of this index denote a more concentrated structure. The Herfindahl index provides yet another measure: for any industrial sector, this index is computed as the sum of the squared market shares of all firms in that sector. Its value ranges from 0 (denoting extreme fragmentation) to 1 (extreme concentration).

Why are some industries more concentrated than others? A long-standing and plausible approach relates concentration levels to set-up costs in that industry. Set-up costs refer to the cost of setting up a plant of minimum efficient scale, which is determined primarily by the technology in use. If the size of the market (that is, the

average level of demand) is large relative to set-up costs, a large number of firms may be able to exist profitably, creating a more fragmented structure. On the other hand, if the market is small relative to set-up costs, the industry would be more concentrated. In other words, we might expect concentration to be a decreasing function of the ratio of market size to set-up costs.[1]

Sutton (1991) argued that this size-structure relation may break down in industries in which advertising and technology play an important role. Suppose the nature of the industry or product is such that firms have an incentive to increase such expenditures to gain market shares. In the long run, the increased level of expenditures is sustainable only if profitability in that industry is high enough. Relatively fragmented market structures are unlikely to sustain such high levels of profitability. Even if the market structure was fragmented due to historical factors, exit and consolidation is likely to create a more concentrated structure eventually. In such industries, larger market size may be associated with an escalated expenditure on advertising and/or technology expenditures, rather than fragmentation. One direct implication of his theory is that in advertising-intensive and technology-intensive industries long-run equilibrium concentration levels are unlikely to fall below some lower bound. In contrast, in industries where advertising and concentration do not matter, as market size increases, concentration levels might fall without bound.

Sutton's approach is careful – he models the lower bound on the level of concentration rather than the level of concentration itself. His careful theoretical approach comes at a price, though. Given the emphasis on bounds, his theory constrains data only for specific configurations. His own empirical evidence (Sutton, 1991) is to some extent qualitative, seeking to demonstrate that observed concentration levels are never too low in advertising- or technology-intensive industries, and tend to be high in any industry where setup costs are high relative to market size. The emphasis on lower bounds in his model does not rule out the possibility that in some industries concentration may be high, say, due to historical considerations.

We adopt a more flexible theoretical approach, better suited to our more extensive empirical analysis. We posit that the actual level of equilibrium concentration – not its lower bound – in an industry is determined by the variables identified in Sutton's analysis: namely, the market size relative to the technologically-given set-up costs, advertising intensity, and technology intensity. We explore the extent to which concentration levels for industries in our data can be explained by these variables.

Our basic premise is that, given the tight regulatory framework prior to liberalisation, these factors were unlikely to have mattered much in the determination of concentration in that phase. After liberalisation, the emergence of a broadly competitive environment created greater scope for advertising and expenditure on technology, so that these variables may have significant explanatory power in the determination of concentration levels. We test for the hypothesis that these variables came to play a stronger role after liberalisation.

Of course, it is tempting to relate changes in concentration directly to the key regulatory policy changes in an industry – say the timing of policy changes such as de-licensing, import liberalisation or exit policy. If we could find suitable proxies for

the policy variables, these could be included directly in our econometric estimations. However, this is not quite straightforward. One, in an environment where industries have been constrained by a wide range of restrictions, it is not always possible to find a unique proxy variable for each policy change. In some of the industries we study, despite policy changes suggesting liberalisation, the market structure is still determined by institutional constraints on entry and exit. Two, the impact of deregulation on the direction of changes in concentration levels is not unambiguous. Specifically, deregulation may cause concentration to fall in sectors where regulation had induced it to be artificially high and to rise in sectors where it had been artificially low. In either case, we expect deregulation to allow concentration to move towards its natural or equilibrium value. The equilibrium value of concentration depends, ultimately on the underlying industry characteristics. In effect, we look at how the impact of policy changes was mediated through their impact on the industry characteristics that affect equilibrium concentration. For instance, rather than relate changing concentration levels in the passenger car industry to policy changes, we aim to study how policy changes affected the market size, setup costs, technology and marketing intensities.

IV Empirical Methodology

Determinants of equilibrium concentration

We aim to study the determinants of industrial concentration. The central organising principle is that equilibrium concentration in any industry depends on a range of variables:

$$C_{it}^{*} = \alpha_i + \beta_i' W_{it} + \varepsilon_{it} \qquad (1)$$

Here C_{it}^{*} denotes the equilibrium concentration at time *t* in industry *i*, assumed to depend on a range of explanatory variables, denoted by vector W_{it}. The influence of industry-specific factors, such as the price intensity of competition or the degree of import competition, is captured by a_i while ε_{it} is the usual error term.

We estimate equation (1) separately for two time periods, 1970–1984 and 1985–1999, corresponding to the regulated phase and the liberalised phase of industrial policy in India. Any change in the determinants of concentration or their explanatory power will be evident in the signs and values of the coefficients of the vector of explanatory variables, *W*. The choice of 1985 as the demarcation point between the two phases is supported by DeLong's (2003) study of Indian growth, which found the structural break in per capita GDP occurred in 1985 rather than later.

Evolution of concentration: industry-specific studies

We also study the evolution of concentration in industries for which a long span of data is available. For this we estimate a dynamic model for each industry individually. We allow that the actual concentration level in an industry, C_{it}, may diverge from its equilibrium value but assume that actual levels adjusts towards the

equilibrium value. We follow existing empirical studies in modelling adjustment as an adaptive process:

$$C_{it}^{*} = \alpha_i + \beta_i' W_{it}$$
$$\Delta C_{it} = \lambda_i (C_{it}^{*} - C_{i,t-1}) + \nu_{it} \qquad (2)$$

Here λ_i is an industry-specific partial adjustment coefficient $(0 \le \lambda_i \le 1)$ and ν_{it} is an error term. We estimate the reduced form[2] of equation (2) individually for eleven industries.

Data and Variables

The Reserve Bank of India (RBI) collects balance sheet data of medium and large, non-government, public limited firms. We use this data series from 1970 to 1999 to estimate our model.[3] The selection of firms in this data set has some implications for our analysis. The data excludes privately-held firms (though some firms not listed on the stock markets are included) and public-sector firms. Hence, the measured concentration is likely to be an overestimate in sectors where they had a significant presence. Also, changes in ownership structure – say, due to stock-market floatation of a state enterprise or a private-held firm – would represent entry in the data set, exaggerating the change in underlying market structure. Likewise, the exclusion of small-scale firms means that measured concentration is overestimated in sectors where such firms have a presence. The coverage of firms is not uniform across years, so the number of firms in an industry fluctuates due to reporting variations. It is hard to distinguish these reporting variations from entry of new firms or exit of existing firms. Nevertheless, it offers long data series for a substantial number of firms and coverage improves after 1983. Firms are assigned a three-digit industry code based on their primary activity, so our sectoral analysis is carried out at that level of aggregation.

We estimated equation (1) using panel data for 53 industries over the period 1970-1999.[4] We excluded industry categories that are residual groupings of heterogeneous firms, such as 'other rubber products', 'other non-ferrous metals'. The full list of the 53 industries included in the cross section analysis is detailed in Appendix I. We then estimated the reduced form of equation (2) individually for 11 industries for which consistent data was available for the entire period, 1970 to 1999.

Dependent variable

The measure of concentration we use as the dependent variable in our empirical analysis is the four-firm concentration ratio, denoted as *CR4*. This measure is less sensitive to reporting errors and enables us to compare our results to those of Sutton (1991) and Kambhampati (1996). We repeated our estimations with the Herfindahl index as the measure of concentration,[5] but the results are not reported here for reasons of space.

Explanatory variables

We construct two sunk cost variables, to capture the size-setup ratio and the marketing intensity of industries. The first, *SIZSETUP*, measures the size of the

market relative to the setup cost of a typical production unit. The size of the market for any industry is measured by aggregating the firm-levels sales in that industry, while setup costs are measured as median net fixed assets for firms in that industry. The choice of median net fixed assets as a proxy for a plant of minimum efficient scale is in the spirit of Sutton (1991). Our theoretical discussion suggests that increases in *SIZSETUP* would lower concentration, so that the expected sign of its coefficient in estimated equations is negative.

Our second variable, *MKTINT*, is a measure of the marketing intensity of the industry. Firms in our dataset report 'selling expenses' separately from advertising expenses. The former include sales commissions to retailers, which are important for the development and maintenance of distribution networks in rural areas and non-metropolitan settings with poor reach of conventional advertising channels. We consider marketing costs to include both categories of expenditure. *MKTINT* for any industry is computed as the ratio of total marketing expenses of all firms to the value of industry sales, expressed in percentage terms. In keeping with the earlier analysis, we expect that higher marketing intensity leads to higher concentration levels, so that the expected sign of the coefficient of *MKTINT* is positive.[6]

Our third variable, *TECHACQ*, is a measure of the technology acquisition intensity of an industry. Many Indian firms acquired technologies through licensing arrangements rather than in-house R&D, so expenditure on technology acquisition is perhaps a reasonable measure of technological intensity. We compute *TECHACQ* as the ratio of aggregate technology fees and royalty paid by all firms in the industry to the value of sales in that industry. Of course, royalty payments are an element of unit variable cost rather than sunk costs. However in the Indian context, the categories under which technology-related payments were made – royalty or technical fees – was dictated by regulatory restrictions that prescribed limits on payment levels. Some firms used these categories interchangeably. One of the early effects of liberalisation was to allow freer imports of technology, so that we expect this variable to become more significant in the later period. The sign of its coefficient is hard to predict: if disproportionately higher technology expenditures by large firms allow then to consolidate their market position, *CR4* would tend to rise. If it is the smaller firms (including new entrants) that take greater advantage of the new technological opportunities, *CR4* might fall.

The lagged value of the dependent variable, *CR4*, enters the dynamic system, so *CR4*[-1] is included as an explanatory variable. Table 2 summarises the variables used in the analysis, and indicates the hypothesised sign on the coefficients.

Table 2 Variables used in the analysis and expected sign of coefficient

Variable	Description	Expected sign of estimated coefficient
CR4	Share of sales of four largest firms to industry sales, expressed as percentage	
SIZSETUP	Ratio of industry sales to median net fixed assets	Negative (can be positive in presence of endogenous sunk costs)
MKTINT	Marketing intensity: advertising and selling expenses as share of industry sales	Positive
TECHACQ	Technology acquisition intensity: royalties and technology fees as share of industry sales	?
CR4[-1]	Lagged value of CR4	Positive

V Results

Explanatory Variables and Concentration Levels

Table 3 shows the average values of the explanatory variables in the two time periods. The size-setup ratio fell after liberalisation, quite possibly reflecting the higher cost (at least in terms of a devalued domestic currency) of acquiring capital goods. Advertising intensity and the technological intensity rose after liberalisation. In terms of our theoretical model, some of these changes would create a tendency for concentration to rise.

Table 3 Sunk cost variables before and after liberalisation (Averaged over 51 and 53 industrial sectors respectively)

Variable	Pre-liberalisation (1970-1984) 596 observations	Post-liberalisation (1985-1999) 792 observations
Advertising to sales ratio (%)	0.39	0.83
	(0.68)	(1.29)
Marketing costs to sales ratio (%)	1.58	1.70
	(1.79)	(1.54)
Technology acquisition costs to sales ratio (%)	0.23	0.49
	(0.94)	(1.70)
Industry sales to median net fixed assets	170.0	133.1
	(280.2)	(144.4)

Note: Standard errors in parentheses

The change in concentration was not uniform across industrial sectors. Comparing concentration levels in 1999 with values in 1978, we find that *CR4* rose in 22

industrial sectors (most notably, cotton textiles, man made fibres, paints and wood products) and fell in 25 industrial sectors over this period (notably, plastic products, chemical fertilisers and silk and rayon textiles).

Determinants of the level of concentration

Table 4 reports the estimations of equation (1). We had conjectured that our chosen variables will have greater explanatory power in explaining concentration levels the post-liberalisation phase, 1985–1999. Our data supports this conjecture.[7] We find that *SIZSETUP* was significant in both periods, although a larger absolute value of the coefficient in the second period suggests that concentration became more sensitive to this variable. This is quite plausible. In the initial period, licenses had been allocated with limited regard for economies of scale, and capacity allocations were seldom adjusted to changes in production technologies. We would expect that de-licensing and broad-banding in the second period would have allowed firms to exploit economies of scale to a greater extent. The second variable, *MKTINT* is statistically significant in explaining concentration in the post-liberalisation period while it was not in the earlier period. However, *MKTINT* has a negative rather than the expected positive sign. This is hard to explain, though it might reflect the possibility that marketing expenditure of some firms sometimes expands demand for all firms in an industry and can thus be associated with falling levels of concentration.[8] We did not find *TECHACQ* to be significant in either period. Adding a time trend to the specification shows that there was an increasing trend in concentration in the post-liberalisation phase.

Table 4: The determinants of concentration before and after liberalisation

Period	1970-84		1985-1999	
	649 observations		792 observations	
Constant	76.06***	75.61***	77.75***	73.35***
	(0.57)	(0.85)	(0.67)	(1.39)
MKTINT	0.20	0.21	-0.41*	-0.60**
	(0.26)	(0.26)	(0.25)	(0.25)
TECHACQ	0.55	0.56	-0.04	-0.10
	(0.64)	(0.65)	(0.26)	(0.20)
SIZSETUP	-0.004***	-0.005**	-0.01***	-0.008***
	(0.00)	(0.002)	(0.00)	(0.00)
TIME		0.04		0.20***
		(0.06)		(0.05)
F-statistic	4.15	3.24	4.03	6.34
(deg freedom)	(3,593)	(4,592)	(3,736)	(4,735)

Notes: *,**, and *** represent significance at 10 per cent, 5 per cent and 1 per cent, respectively.
The panel is unbalanced and we estimated equation (1) as a one-way fixed effects model.
The F-test for the inclusion of TIME suggests that the specification improves after the inclusion of the variable.
Chow test statistic for the null hypothesis of equality of slope coefficients in the two periods rejects the hypothesis of equality at the 1% level of significance.

Estimation of the dynamic model for individual industries

Table 5 reports the estimates for the dynamic model in equation (2) for 11 industries over the period 1970 to 1999. (Appendix II reports the associated descriptive statistics). We carried out the estimations with and without a time trend. If a time trend is included the estimated coefficient of time is significant in six of the eleven industries. Of these, four exhibit a declining trend while two display a rising trend. However, inclusion of time as a variable may potentially mask the significance of other explanatory variables with a time trend. Kambhampati and Kattuman (2003) too find that the inclusion of dynamic variables (time, lagged values of the dependent variable) in their model diminishes the role of sunk cost variables. Since, we are interested in testing the relevance of the Sutton approach we report industry regressions without a time trend.

We discuss our findings for individual industries. We complement the discussion of findings that emerge from our estimations with more recent descriptive data from the Centre for Monitoring the Indian Economy (CMIE). This latter data has wider coverage of firms than the RBI data, and also considers sub-segments within the industry sectors.

We begin with the **sugar industry**. India is the second largest producer of sugar in the world. The sugar industry is one of the larger agro-processing industries in India, with as many as 45 million people dependent on sugarcane cultivation. The government has intervened directly in the pricing process of this essential consumption good: firms are forced to sell a substantial proportion of their output to the government at sub-market prices for sale through the public distribution system. Licensing restrictions probably kept the typical plant capacity at below efficient levels. Not surprisingly, the sugar industry in India is relatively fragmented: our data suggests a mean value of *CR4* is 29.6 per cent over the period 1970 to 1999, with a significantly increasing time trend. (By way of comparison, *CR4* in the sugar industry was 94 per cent for the UK and 46 per cent for US in 1986.) The industry is characterised by low marketing and technological intensity. As expected, our regression shows that *SIZSETUP* has a significant negative impact on concentration levels. More recent data from CMIE shows that concentration rose over the period 1991 to 2003, mainly through mergers and consolidation.

The **wool textiles** industry is relatively concentrated, with a mean value of 85 per cent for *CR4* over the reference period. The industry is relatively marketing intensive, but the coefficient of *MKTINT* is not significant in our estimations. CMIE data for the last twelve years shows that concentration levels remains high (*CR4* was around 68 per cent for woollen yarn and over 90 per cent for woollen fabrics in 2003, with the market leader, Raymond's, controlling 70 per cent of the latter market).

The **jute textiles industry** had a mean value of 39 per cent for *CR4* over the reference period, with a rising trend. As we might expect, the industry has low marketing and technological intensity. Our estimations show that *SIZSETUP* is significant, with the expected negative sign; *MKTINT* is significant too, but with the wrong sign. However the estimated equation displays autocorrelation, which suggests specification error. Recent CMIE data shows a marked rising trend in concentration for the post-liberalisation phase.

Table 5: Time series estimations for eleven industry groups (1970–1999)

Variable	Sugar	Jute Textiles	Wool Textiles	Brewery	Auto Vehicles	Machine Tools	Chemical Fertilisers	Dyes & Dyestuffs	Medicinal prep.	Cement	Paper
CR4 Ratio											
Constant	16.11*	22.66**	3.02	29.84**	24.17**	28.00*	18.80**	25.36**	13.01*	39.09***	32.76***
MKTINT	10.77	-0.86*	1.55	0.01	-2.80	-0.11	6.09	-3.55*	-0.44	-3.64	-1.20
TECHACQ	2.59	-17.84	0.23	-5.43**	12.09**	-3.09*	-1.28	-19.59**	-2.07	3.64	2.99
SIZSETUP	-0.03**	-0.04***	-0.01	0.03	0.00	-0.02	-0.01	-0.02	-0.00	-0.074***	0.02
CR4[-1]	0.52**	0.60***	0.90***	0.56***	0.64***	0.07***	0.73***	0.80***	0.67***	0.51***	0.26
Diagnostics											
R-squared	0.72	0.85	0.91	0.74	0.69	0.47	0.69	0.60	0.51	0.87	0.20
Adjusted R-squared	0.67	0.83	0.90	0.69	0.64	0.38	0.64	0.54	0.43	0.85	0.06
Sum squared residuals	356.94	553.83	268.93	599.60	313.35	228.23	889.80	270.88	110.20	250.99	959.91
F-statistic (4,24)	15.07	34.23	50.06	16.82	13.66	5.32	13.47	9.14	6.26	40.29	1.49
Autocorrelation (third order)	No	Yes	No	No	No	No	No	No	No	No	No

Notes: (i) *,**, and *** represent significance at 10%, 5% and 1%, respectively

(ii) Autocorrelation is detected using a Lagrange Multiplier test and testing the null hypothesis of no Autoregressive Conditional Hetroscedasticity at the 5% level of significance

Breweries and distilleries had a mean value of 72 per cent for *CR4* over the period 1970 to 1999. This industry shows an interesting pattern: concentration fell from 1970 to the early 1990s, after which there has been a rising trend overall. For distilleries concentration has declined in the post-liberalisation phase, mainly due to the entry of multinationals, but the breweries sector has shown a marked increase in concentration. The industry has very high marketing intensity and technology acquisition costs. In our estimations, *TECHACQ* is significant, though with the wrong sign.

The **automobiles** sector is quite concentrated, with a mean value of 72 per cent for *CR4*. It has relatively high technology acquisition costs, and *TECHACQ* emerges as significant and positive in our estimates. There is no clear time trend and as the CMIE data shows, patterns differ across the sub-segments of this sector. The commercial vehicles segment has only eight producers, with Tatas controlling two-thirds of the market for medium and heavy vehicles (up from 45 per cent in 1992), and nearly half of the market for light commercial vehicles. The passenger vehicles sector currently has 13 firms, with Maruti Udyog controlling a 46 per cent market share (down from over 80 per cent in 1992). The four-firm concentration ratio in this segment is 83 per cent, and quite notably, the current top four firms do not include the two firms that dominated the industry in the regulated period. The two-wheeler segment is relatively concentrated, with *CR4* being around 90 per cent for motorcycles and scooters.

The **machine tools** sector too shows high levels of concentration, with the measured value of the average four-firm concentration ratio in our data being 86 per cent. Our data shows no clear time trend. More recent data from CMIE suggests that concentration fell in the 1990s, with a substantial decrease in the market share of the leading firm, Hindustan Machine Tools. The reduction in concentration in the recent period has to be seen against the backdrop of a dramatic increase in imports. (Significant import liberalization resulted in imports from 30 per cent in 1991 to 46 per cent in 1996. In recent years, the share of imports has dropped a little). The sector is technology-intensive: our estimations show *TECHACQ* to be significant, though with the wrong sign.

Extensive regulation persists in the **fertilizer industry**. Our data suggests an average four-firm concentration ratio of around 71 per cent. Capacity controls persist in this sector. In addition, there are price controls in some segments of this industry. There is a 'retention price scheme' for urea, which aims to provide producers with a 12 per cent return on their net worth, while keeping prices low for farmers. CMIE data shows that the four-firm concentration ratio for urea has remained high, at round 55 per cent in 2003. Phosphatic fertilisers were decontrolled in 1992: here *CR4* has fallen from around 43 per cent in 1992 to below 35 per cent in 2003. For ammonium nitrate, *CR4* is close to 100 per cent in 2003. Given the persistence of regulation in some segments, it is not surprising that none of our variables emerge as significant in the estimations.

The **dyes and pigments** industry shows a mean value of 77 per cent for *CR4* in our data. Our estimations show that *MKTINT* and *TECHACQ* are significant, though with the wrong sign. The more recent data from CMIE suggests de-merger activity in this sector as some leading firms separated their dyes and pigments from other chemicals. For instance, Hindustan Ciba-Geigy spun off its specialty chemicals unit and amalgamated the rest with Sandoz to form Novartis (India) in 1996.

The **drugs and medicinal preparations** sector in India displays lower concentration than in most countries. Our data shows a mean value of 32 per cent, with a slightly negative time trend over 1970 to 1995. Deregulation of the many price controls in the

1990s has led to an increase in marketing intensity, and concentration grew sharply in the late 1990s. Not surprisingly, given the extensive price controls, none of the sunk cost variables appear to be significant in our estimations.

The **cement** industry had strong control over prices and distribution till 1990, and some of these controls remain in place. In the regulated phase, the licensed capacity of many cement plants was probably below minimum efficient scale. The partial deregulation in 1990 was followed by merger activity, so that concentration rose in the 1990s. Our estimations show *SIZSETUP* to be significant with the expected sign. In our data, the average value of *CR4* was around 65 per cent. This figure probably overstates the extent of concentration, as our data classifies firms by their primary activity, thereby excluding some engineering firms like Larsen and Toubro that were also significant producers of cement. Lastly, we could not detect any marked trend in the paper industry.

Assessing our findings

The autoregressive parameter is significant in all but one of the eleven industries. This suggests that the partial adjustment framework that underlies equation (2) is relevant. The estimated values of λ (which equals 1 minus the coefficient of the lagged value of *CR4*) lie between zero and 0.5, suggesting that the adaptive process is not too fast. This is quite plausible as constraints on entry and exit imply that concentration adjusts only gradually to changes in the economy.

Looking across the eleven industries, we find that *SIZSETUP* is significant in explaining concentration in three of the eleven industries (sugar, jute and cement). In all three cases, the sign of the coefficient is negative. This suggests that at least in these three industries deregulation allowed firms to exploit economies of scale and scope. If the responsiveness of concentration to changes in *SIZSETUP* is expressed as an elasticity, we find that its absolute values range between 0 and 0.24.

Our measure of marketing intensity, *MKTINT*, is significant in two of the eleven industries and in both cases the coefficient has the wrong, negative, sign. Using similar data for a shorter (pre-liberalisation) time span Kambhampati (1996: 55–59) too found a negative relationship between advertising intensity and concentration. A negative relationship may arise in an industry where new entrants steal market share from the leading firms through marketing expenditure. Within the framework suggested by Sutton, this pattern may only be transitional. In the long run, marketing expenditure must be recouped through higher profitability and this is usually consistent with more concentrated structures. Many of the industrial sectors in our sample could be in the transitional phase, given that liberalisation started in the 1980s and gathered pace in the 1990s.

Our measure of technology acquisition intensity, *TECHACQ*, is significant in four sectors: in three of these, the coefficient is negative (brewery, machine tools, and dyes) while in the fourth it has the expected positive sign (auto-vehicles). As discussed earlier, the sign of the coefficient may be sensitive to whether it is the market leaders who exploit technology to increase their market shares (thereby increasing market share) or whether smaller or newer firms use expenditure on technology to steal market shares. In the post-liberalisation, the latter was more common. For instance, in their study of machining centres in India, Jacobsson and Alam (1994) noted that the liberalisation of technology imports had enabled a fringe of small firms to set up production using imported ‘completely knocked down kits’.

Basant and Saha (2004) find that manufacturing sectors that saw a higher number of entrants in the 1990s were those where technology purchases tended to be high.

Even after controlling for these variables, we find that there is considerable heterogeneity in the patterns across industries. This observed heterogeneity in the determinants of concentration calls into question the use of dynamic panel data methods (that is, those that contain a lagged term) to study industrial concentration. Pesaran and Smith 1995 have shown that, in the presence of heterogeneity, the use of dynamic panel models results in biased estimated coefficients.

Our results may have been compromised by incompleteness in our data. Variations in reporting make it hard to distinguish between exit (a firm dropping out of our data series permanently) and incompleteness in reporting (a firm dropping out of the dataset temporarily). Likewise, as our data covers only public limited companies, change in corporate status (say, a privately-held firm that an initial public offering) would count as entry, and record a spurious reduction in measured concentration.

Of course, concentration levels were also sensitive to import liberalization, through two potential channels of influence. One, easier imports of capital goods could affect scale economies, altering the relative advantage of large vs. small firms. The direction of the effect on concentration may well vary across the industries. Two, in some sectors, such as machine tools the process of liberalization exposed domestic firms to competition from imported goods. Here measured concentration among domestic firms (based on market shares of domestic producers alone) may not have changed, even though cheap imports could have altered the market structure dramatically. Consider, for instance, our account of the machine tools industry.

Even within a sector, the effect of deregulation on concentration may be complicated and potentially non-monotonic. In particular, concentration may rise in the early stages of deregulation and then fall over time. Consider, for instance, the passenger car industry. Till the early 1980s the Indian passenger car industry was, in effect, a duopoly with only two large manufacturers, Premier Automobiles and Hindustan Motors. In the early 1980s, Maruti Udyog was set up as a public sector firm in collaboration with Suzuki of Japan. Maruti imported technology (and, for a while, even the cars, in the form of knocked-down kits). Given that Maruti cars were technologically superior to the models sold by the incumbents, Maruti virtually displaced the incumbent duopolists, with a marked increase in measured concentration. However, as more manufacturers entered the fray, Maruti's early lead has been eroded and concentration levels have fallen.

VI Conclusions

Prior to liberalisation, market structure in Indian manufacturing was largely shaped by government policy. This was hardly surprisingly given the nature and extent of regulatory control. Our paper studies changes in industrial concentration for India through the period of liberalisation of its industrial policy. We find that the picture is mixed. Concentration levels fell in some sectors after deregulation while in others they rose. Two, we find that sunk cost variables have greater explanatory power in explaining concentration levels in the post-liberalisation phase. Controlling for these variables, we find a rising time trend in concentration in the post-liberalisation phase. Three, even after controlling for these variables, there is considerable heterogeneity in the patterns for individual industries. The observed heterogeneity – the fact that

implications of deregulation for concentration differ across sectors – makes a case for a sector-specific approach to industrial policy.

While the sunk cost variables have greater significance in explaining patterns of concentration in the post-deregulation phase, our findings conform only weakly to the expectations of the Sutton framework. In particular, the signs of the estimated coefficients of technology intensity and marketing intensity do not always conform to the theoretical predictions of his model. There are two ways to interpret this finding. One, we could infer that the process of regulatory reform in Indian industry is not quite complete yet, or at least not complete in all sectors. If so, we should not expect patterns of concentration of to be in line with the theoretical framework designed for unregulated markets. Two, we could conclude that it is not the incompleteness of reform that results in mismatch between observed concentration patterns and theoretical prediction, but the slowness and possible non-monotonicity in the adjustment process. In other words, the market structure in countries like India may be in a transitional process (see Kambhampati and Kattuman 2003 for a similar conclusion).

The broad thrust of recent industrial policy reform in India has been to replace anti-monopoly restrictions with a new competition policy. The Competition Bill of 2002 set up a permanent commission, which aims to check anti-competitive agreements among firms, to prevent the abuse of dominant market positions and to regulate mergers. As Bhattacharjea (2003) points out, the formal elements of the necessary legislation in India have largely been derived from similar legislation in developed countries with mature market structures, notably UK. It is possible that legislation formulated for mature market structures may not be entirely appropriate for an industry in a transitional state. Bhattacharjea's plea for 'greater economic input into the formulation and enforcement of competition policy' sounds like a step in the right direction.

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Appendix I: List of 53 industries used in the cross section regressions

Industry code	Description
310	Grains and Pulses
320	Edible vegetable and hydrogenated oils
331	Sugar
341	Cigarettes
342	Tobacco (other than cigarettes)
351	Cotton textiles (spinning)
352	Cotton textiles (weaving)
353	Cotton textiles(composite)
354	Other cotton textiles
355	Jute textiles
356	Silk and Rayon textiles (spinning)
357	Silk & Rayon textiles (weaving)
358	Silk &Rayon textiles(composite)
359	Woollen textiles
360	Ginning pressing and other textile products
370	Breweries and distilleries
380	Leather & leather products
410	Iron & Steel
420	Aluminium
441	Auto vehicles
442	Automobile components
443	Railway equipment
445	Cables
446	Dry cells
447	Electric lamps
449	Machine tools
450	Textile machinery
452	Steel tubes and pipes
453	Steel wire ropes
454	Steel forgings
456	Aluminium ware

461	Chemical fertilisers
462	Dyes and dyestuffs
463	Man made fibres
464	Plastic raw materials
466	Medicines and pharmaceutical preparations
467	Paints, varnishes and allied products
469	Industrial and medical gases
470	Matches
510	Mineral Oils
521	Cement (hydraulic)
522	Asbestos and asbestos cement products
531	Structural clay products
532	Ceramics
541	Tyres and tubes
551	Paper
552	Products of pulp and board
553	Wood products, furniture and fixtures
561	Glass containers
571	Printing
572	Publishing
573	Printing, publishing and allied activities
580	Plastic products

Appendix II: Descriptive statistics, dynamic model (1970-1999)

Variable	Sugar	Jute Textiles	Wool Textiles	Brewery	Auto Vehicles	Machine Tools	Fertilisers	Dyes	Medicine	Cement	Paper
CR4											
Mean	29.60	38.86	85.58	71.87	71.38	85.60	70.62	76.72	32.03	64.87	49.13
Std devn	6.74	11.61	10.49	9.49	6.08	3.87	10.26	4.86	2.87	8.17	6.43
ADVINT											
Mean	0.07	0.03	1.38	2.66	0.40	0.28	0.14	0.19	1.76	0.31	0.07
Std devn	0.03	0.03	0.71	2.07	0.34	0.59	0.07	0.07	0.44	0.27	0.10
MKTINT											
mean	0.43	0.67	3.95	4.45	0.97	2.54	0.46	1.915	3.493	0.692	0.720
std devn	0.11	0.13	0.63	1.86	0.48	1.05	0.37	0.334	0.629	0.337	0.382
TECHACQ											
Mean	0.08	0.02	0.08	0.49	0.32	0.37	0.48	0.073	0.144	0.548	0.112
std devn	0.07	0.03	0.15	0.59	0.19	0.37	0.63	0.079	0.186	0.326	0.135
SIZSETUP											
Mean	241.09	141.19	57.92	147.50	232.04	70.54	281.59	72.67	601.56	90.94	173.57
std devn	130.94	107.83	21.70	43.05	122.69	22.77	183.17	28.14	172.63	52.49	79.45

ENDNOTE

1 Sutton (1991) pointed out profitability may also depend on other factors that affect the 'intensity of price competition'. In industries where intense price competition results in lower profit margins, fragmented market structure harder to sustain. Hence, other things being the same, equilibrium levels of concentration are likely to be higher in industries with more intense price competition.

2 The reduced form can be written as $C_{it} = \theta_{0i} + \sum_{k=1}^{3} \theta_{ki} W_{kit} + \theta_{5i} C_{i,t-1} + \omega_{it}$ where k=1,2,3

3 To maintain confidentiality of financial data, firms are identified by numeric codes rather than name.

4 The panel is unbalanced: data for many industries start at 1975 or 1978 rather than 1970.

5 Since the Herfindahl index combines information on the variance of shares and numbers it can be decomposed in interesting ways (see Kambhampati and Kattuman 2003).

6 We also compute, *ADVINT*, a similar measure of advertising expenses alone. We did not find *ADVINT* to be significant in explaining concentration in either period. Kambhampati (1996:55–59) finds similar results.

7 The conjecture receives less support if we choose the Herfindahl index as our measure of concentration. For this case, the significance of sunk cost variable does not change substantially after deregulation.

8 This could be the case when distribution channels penetrate new rural areas. Anecdotal evidence suggests this has happened for a range of consumer goods as shampoos, soaps and washing powder. Of course, it is unlikely that marketing expenditure that enhances aggregate demand will be individually profitable in the long run.

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