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CONCENTRATION, ENTRY BARRIERS AND PROFITABILITY IN THE INDIAN INDUSTRIES: AN EMPIRICAL ANALYSIS[1]

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Abstract

The conventional Structure-Conduct-Performance (S-C-P) paradigm is examined for the industrial sector in India. Empirical results obtained through panel data econometric analysis suggest that the S-C-P paradigm is tenable for the Indian industries, with concentration and a number of entry-barrier variables like R&D intensity and degree of vertical integration providing significant explanation for variation in rates of return across Indian industries. Advertising intensity, usually used to capture the effects of entry barrier as well as product differentiation on differences in profitability across industries, is also found to be important.

Keywords: Concentration, Profitability, S-C-P Paradigm, Vertical Integration

JEL Classifications: C13, C23, L16

1. Introduction

A description of market structure indicates the number of sellers in the market, degree of their product differentiation, their cost structures, the degree of vertical integration with suppliers and so on. And market structure determines what is called market conduct, i.e., the behavioral rules followed by the various agents – the buyers, the sellers or even the potential entrants – to choose the variables under their control. Finally, market performance (like efficiency, price-cost margin, profit etc.) is the result of market conduct. Such market 'structure-conduct-performance' (S-C-P) paradigm (*a la* Bain, 1951, 1956) has been an area of active research for a long time and a large number of studies – both theoretical and empirical – have come up in this domain of industrial organization. Although such studies have multiplied in the context of the developed countries, only a few exist in the case of Indian industries. The present paper likes to make some contribution in this area.

To be specific, the purpose of the present paper is to study empirically a part of this paradigm in the context of the Indian industries. In particular, we would like to examine, to what

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extent profitability of Indian industries has been affected by various features of industrial structure like concentration, several entry barrier variables such as advertising intensity, R & D intensity and so on.

The plan of the paper is as follows. Section 2 outlines the relevant theoretical analysis as well as some important empirical studies including the ones which have been done in the context of India. Section 3 describes the data set and the variables used in the present work. Section 4 presents the analytical framework used in the present study as well as the empirical results obtained. Section 5 makes final observations. Appendix gives some additional information.

2. Theory and Some Empirical Studies

The pioneering work in this area was carried out by Bain (1951, 1956). In an attempt to measure the effects of concentration and entry barriers on the profit performance on a sample of U. S. industries, Bain found that profit rates were substantially higher in the highly concentrated industries and further that high entry barriers had additional favorable effects on profit rates. The study of Mann (1966) also provides evidence that barriers to entry and concentration do affect profitability separately and favorably. Before we go into details, let us turn to some theoretical discussion on the issue.

Theory

A perfectly competitive firm has no influence on the price of its product and hence, cannot have more than competitive profit. In contrast, by exercising control on price/production, a monopolist or even an oligopoly firm earns super-normal profit. Thus, profitability is closely related to the market power of firms. To get such a relation theoretically, let us consider an oligopolistic industry in which say N firms produce a homogeneous good. Suppose, p is price of the good, x_i is output of the firm i and X is industry output: $X = \sum_{i=1}^{N} x_i$. Let $X = F(p)$ be the demand function faced by the industry for this good. In other words, the (inverse) demand function is: $p = F^{-1}(X) = f(X)$, say. The firm i, with its cost function $C_i(x_i)$, maximizes profit

$$\Pi_i = x_i p - C_i(x_i) = x_i f(X) - C_i(x_i) \qquad \text{... (1)}$$

and the first-order condition for profit maximization is given by

$$p - C_i'(x_i) = -x_i f'(X)\frac{dX}{dx_i} = -\frac{x_i}{X} X f'(X)\frac{dX}{dx_i} = \frac{s_i}{\varepsilon}\frac{dX}{dx_i} f(X) \qquad \text{... (2)}$$

where $s_i = (x_i/X)$ is the output share of firm i and ε is the (absolute value of) price elasticity of demand $\left[\text{i.e.}, 1/\varepsilon = -Xf'(X)/f(X)\right]$. Since $X = \sum_{i=1}^{N} x_i$, dX/dx_i equals:

$$\frac{dX}{dx_i} = 1 + \frac{d\left(\sum_{j\neq i} x_j\right)}{dx_i} = 1 + \lambda_i, \qquad \text{... (3)}$$

where $\lambda_i = d \sum_{j \neq i} x_j \Big/ dx_i$ measures firm i's perception or belief about output responses of all other firms to its own output changes.

A measure of market power of firm i is provided by the Lerner index, L_i, which is defined to be the excess of price over its marginal cost as a proportion of price and hence, in view of (2) and (3), depends on s_i, ε and λ_i:

$$L_i = \frac{p - C_i' \;\, x_i}{p} = \frac{s_i}{\varepsilon}\frac{dX}{dx_i} = \frac{s_i}{\varepsilon} \;\, 1 + \lambda_i \qquad \text{... (4)}$$

In a perfectly competitive industry with a large number of firms profit maximization requires price (which is taken to be given by a firm) to be equal to its marginal cost so that Lerner index, $L_i = 0$ (which is obtained by putting $dX/dx_i = 0$ in equation (4)). The other extreme case is monopoly in which both s_i and dX/dx_i are equal to unity and hence, $L_i = 1/\varepsilon$. These two are the lowest and highest values of Lerner index obtaining in two extreme types of market structure. In between, of course, we have the Cournot duopoly – a structure where only two firms operate and each firm believes that the other firm will *not* change its output when it changes its own and hence $dX/dx_i = 1$, $\lambda_i = 0$ and the Lerner index equals $L_i = s_i/\varepsilon$.

However, once we move out of these extreme or simple forms of market structure, profitability or price-cost margins are affected by other features as well e.g., the degree of concentration, the extent of product differentiation, various other entry barrier variables and so on. To see how, say, degree of concentration affects profitability, consider expressions (3) and (4) and assume the following conjectural behaviour (introduced by Dixit and Stern, 1982 in the case of a homogeneous good industry), namely that a one per cent change in i^{th} firm's output is believed to induce a θ per cent change in the output of each of the remaining firms and hence in their total output. Then, for each $j \neq i$, we have[3]

$$\frac{dx_j}{dx_i} = \theta \frac{x_j}{x_i} = \theta \frac{s_j}{s_i} \qquad \text{... (5)}$$

and hence, $$\lambda_i = \frac{d\sum_{j \neq i} x_j}{dx_i} = \sum_{j \neq i}\left(\frac{dx_j}{dx_i}\right) = \theta \frac{\sum_{j \neq i} s_j}{s_i} = \theta \;\, \frac{1 - s_i}{s_i} \qquad \text{... (5)}'$$

The Lerner index now also depends on θ:

$$L_i = \frac{p - C_i'(x_i)}{p} = \frac{s_i}{\varepsilon} \;\, 1 + \lambda_i \;\, = \frac{s_i}{\varepsilon}\left[1 + \theta \frac{1 - s_i}{s_i}\right]$$

$$= \frac{1}{\varepsilon}\left[s_i + \;\, 1 - s_i \;\, \theta\right] = \frac{1}{\varepsilon}\left[\theta + \;\, 1 - \theta \;\, s_i\right] \qquad \text{... (6)}$$

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3 Note that $\theta = 0$ corresponds to the case of Cournot behaviour and $\theta = 1$, to that of complete collusion. The case $\theta < 0$ may also arise when, say, the firms agree to adjust their output for keeping price constant. We, however, consider the case of positive θ.

Can we have some expression for the average rate of profit in an industry? Multiply (6) throughout by s_i and then sum across firms with the assumption that for each firm i, its marginal cost C_i' coincides with its average cost (say, c_i). Since $\sum s_i = 1$ and $x_i = s_i X$, equation (6) will yield the following expression for an industry's profit Π :

$$\Pi = pX - \sum_i c_i x_i = X\left(\sum_i ps_i - \sum_i c_i s_i\right) = pX\sum_i\left(\frac{p-c_i}{p}\right)s_i = pX\sum_i L_i s_i$$

$$= pX\frac{1}{\varepsilon}\sum_i\left[\theta s_i + (1-\theta) s_i^2\right] = pX\frac{1}{\varepsilon}\left[\theta + (1-\theta) H\right] \qquad \text{... (7)}$$

The symbol H on the extreme right hand side (RHS) is the Hirfindahl-Hirschman index of concentration, being given by the sum of the squares of shares of firms, $H = \sum s_i^2$. (It may also be alternatively called the (share weighted) averaged share of the firms in an industry ($H = \sum s_i s_i$)).[4] Now writing *R* for total revenue $= pX$, we get a very simple relation among profitability, θ, ε and concentration index in an industry:

$$\frac{\Pi}{R} = \frac{\theta}{\varepsilon} + (1-\theta)\frac{H}{\varepsilon} \qquad \text{... (8)}$$

If we assume θ to be a nonnegative fraction $(0 \le \theta < 1)$, profitability (strictly speaking, profit as a proportion of revenue, Π/R) is a weighted average of $1/\varepsilon$ and H/ε and hence would increase whenever θ and/or H would increase. Further, quite expectedly, profitability would fall, if price elasticity were to rise,[5] *ceteris paribus*.

We have examined above how concentration of market power affects industrial profitability in a homogeneous good industrial framework. We now consider models in which not only concentration but the extent of product differentiation also affects profitability. Assuming that firms produce different brands, with the i^{th} firm selling its brand at price p_i, Clarke, Davies and Waterson (1984) considered the following relation:

$$\frac{\partial p_i}{\partial x_j} = \psi \frac{\partial p_i}{\partial x_i}, \; 0 \le \psi \le 1 \qquad \text{... (9)}$$

in which the parameter ψ is taken to represent the degree of closeness as regarded by the consumers across various brands – a higher value of ψ indicating a higher degree of similarity. With R denoting total industrial revenue ($\sum_j p_j x_j$), the market share of firm i and collusive parameter θ are now defined as follows:

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4 Note that *H* takes the value 1, when there is one firm (monopoly) and the value 1/*N*, when all firms are of equal size.

5 Interestingly, as (6) shows, even *within* an industry profitability is larger for a larger firm (i.e., one with a larger output share, s_i).

$$s_i = \frac{p_i x_i}{\sum_j p_j x_j} = \frac{p_i x_i}{R} \text{ and } \frac{dx_j}{dx_i} = \theta \; \frac{s_j}{s_i},\; 0 \le \theta < 1 \qquad \text{... (10)}$$

Using profit-maximizing condition of firm i and writing c_i for its marginal as well as average cost, its Lerner index can be shown to be equal to[6]

$$L_i = \frac{p_i - c_i}{p_i} = \frac{1}{s_i\,\varepsilon_i}\left[\theta\psi + \; 1-\theta\psi \;\; s_i\right] \qquad \text{... (11)}$$

where ε_i is (absolute value of) the price elasticity of demand for firm i's product.

The weighted average of margins given in (11), where the weights are firms' market shares, then yields the industry profit – revenue ratio:

$$\frac{\Pi}{R} = \sum_i \left(\frac{p_i - c_i}{p_i}\right)\frac{p_i x_i}{\sum_i p_i x_i} = \sum_i L_i s_i = \sum_i \left[\frac{1}{\varepsilon_i}\;\theta\;\psi + (1-\theta\psi)\;s_i\;\right] \qquad \text{... (12)}$$

We observe that the basic predictions of the previous model namely that profitability rises whenever s_i and/or θ rise (s) carry over. As it is clear, the equation (11) does not imply a monotonic relationship between profitability and market share nor does the equation (12) imply a monotonic relationship between industry profitability and concentration. However, such results can be obtained if we consider a special case where $s_i\varepsilon_i$ is the same for all firms within a particular industry. This assumption along with the assumption of product differentiation (equation (9)) is consistent with the following demand function for the i^{th} firm's product

$$x_i = A_i + \frac{B}{p_i} - \psi\sum_{j\neq i} x_j \qquad \text{... (13)}$$

Clearly, $\varepsilon_i = -\;p_i/x_i \;\; \partial x_i/\partial p_i \;=\; p_i/x_i \;\; B/p_i^2 \;= B/\;p_i x_i \;= B/\;s_i R$ which thus yield $s_i\varepsilon_i = B/R$ where R is the total revenue of all firms within the industry. In this special case we get $1/\varepsilon_i = \;R/B\;\; s_i$ and hence we have

$$L_i = \frac{p_i - c_i}{p_i} = \frac{R}{B}\left[\theta\psi + \; 1-\theta\psi \;\; s_i\right] \qquad \text{... (14)}$$

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6 With the i^{th} firm's profit equaling $p_i x_i - c_i x_i$, its profit-maximization condition is

$$p_i - c_i = -x_i\left[\frac{\partial p_i}{\partial x_i} + \sum_{j\neq i}\frac{\partial p_i}{\partial x_j}\frac{dx_j}{dx_i}\right] = p_i\left[-\frac{x_i}{p_i}\frac{\partial p_i}{\partial x_i} - \frac{x_i}{p_i}\sum_{j\neq i}\psi\frac{\partial p_i}{\partial x_i}\frac{dx_j}{dx_i}\right] \text{ using (9)}$$

$$= p_i\left[\frac{1}{\varepsilon_i} + \frac{\psi}{\varepsilon_i}\sum_{j\neq i}\frac{dx_j}{dx_i}\right] = \frac{p_i}{\varepsilon_i}\left[1 + \psi\theta\frac{\sum_{j\neq i} s_j}{s_i}\right].$$ The expression (11) in the text is obtained once we note that $\sum_{j\neq i} s_j = 1 - s_i$.

and

$$\frac{\Pi}{R}=\frac{R}{B}\left[\theta\psi+(1-\theta\psi)H\right] \qquad \text{... (15)}$$

which depends not only on H and θ, but also on the degree of product differentiation as reflected in ψ. We further assume a special case where R/B is the same across industries which obtains if, say, the average price elasticity of demand, ε, in an industry is proportional to the total number of firms[7] within the industry where ε is the (weighted) average of price elasticities faced by different firms: $\varepsilon=\sum_i \varepsilon_i s_i=\sum_i \varepsilon_i (p_i x_i) \big/ \sum_i p_i x_i$. Thus larger an industry's H, θ or ψ, larger will be its profit-revenue ratio.

As we have mentioned earlier, ψ is a measure of degree of product differentiation. In our empirical analysis we have considered a number of variables to capture effects of product differentiation and also entry barriers on industry's profitability, e.g., advertisement to sales ratio, research and development expenditure (as a proportion of output), etc.

Some empirical studies

Bain's hypothesis was that firms in an industry with high concentration could earn excess profits and more so if they were protected by entry barriers. A different view, known as the *Chicago School's hypothesis* (pioneered by Demsetz, 1973), states that high profits are in fact a consequence of greater or differential efficiency of some firms in the industry. These firms capture a large proportion of market share on account of their relative efficiency and consequently market concentration increases and efficient firms earn economic rent. This view also implies that market concentration and industry profit are positively related.[8]

Bain's (1956) results were corroborated in many subsequent works, e.g., Caves (1974), Comanor and Wilson (1967), Connor and Mueller (1982), Mann (1966), Orr (1974, 1974a), Porter (1979) to mention a few. Most of the above studies have, however, been carried out for the developed countries like the UK, the USA and Canada while that of Connor and Mueller (1982) is for the US multinationals operating in developing economies like Brazil and Mexico. An exhaustive survey of these studies can be found in Chakravarty (1995).[9] Among the recent ones, Delorme et al (2002) study the relationship among structure, conduct and performance in the US manufacturing in 1980s and 1990s. They use a simultaneous equations framework to expand the earlier S-C-P paradigm by using a lag structure to signify that structure, conduct and performance do not affect one another contemporaneously. One of the major findings of their study is that concentration does not depend on profitability, though profitability depends on concentration while

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7 Note that $\varepsilon_i s_i = B/R$. Summing both sides across i, we have $\varepsilon = N(B/R)$, where N is the number of firms within the industry in question.

8 Obviously, if one's objective is to see whether both of these two alternative but related views are actually valid or not in a chosen sample, (s)he should follow a simultaneous equations structure to estimate the model parameters, see Delorme et al (2002), Wang and Wang (2008) etc. However, since our consideration is explicitly on Bain's argument, we do not follow this structure.

9 Interested readers may also look at Schmalensee (1989) and Tirole (1988) for some further readings on the topic.

advertising has been found to have no effect on profitability. However, studies on inter-industry differences in profitability in the context of developing economies are not large in number. Based on an open-economy oligopoly model and using a simultaneous-equations system Wang and Wang (2008) study the causalities among domestic firms' price-cost margin (PCM), domestic concentration, and import and export shares. Three-stage least squares is used to estimate the system by utilizing the data spanning over the period 1989-1997 of Taiwan's midstream petrochemical industries. Some of their empirical results are as follows: (a) there exist simultaneous relationships among domestic PCM, domestic concentration, import and export shares; (b) import concentration affects domestic concentration positively, but affects domestic PCM, import and export shares negatively; (c) diversifying international markets improves domestic firms' PCM; etc. Bhattacharya and Chen (2009) consider a model of dynamic adjustment of structure in Taiwanese manufacturing allowing for both the speed of adjustment and the long-run market concentration to vary across industries. They use 118 four-digit manufacturing industries for empirical analysis spanning between 1981 and 1991. Empirical findings show that both the speed of adjustment and long-run industry concentration are predominantly determined by minimum efficient scale. The speed of adjustment is much faster in a small open economy like Taiwan compared to mature economies like the US and Australia. In addition, the dichotomous nature of the market is supported in their findings for both the two sub-periods, i.e., 1981-1986 and 1986-1991, albeit weaker for the later period. We survey below a few such studies for the Indian economy.

Studies on the Indian industries have produced mixed results. On the basis of the Annual Survey of Industries (ASI) data and some relevant information from earlier studies of Saluja (1968) and Panchamukhi (1974), Katrak (1980) finds that price-cost margin is higher in Indian manufacturing industries with relatively little import competition, high export orientation and high rate of protection. He, however, finds this margin to increase with the increase in concentration up to a certain level and falling thereafter. The study by Siddharthan and Dasgupta (1983) observes that inter-industry differences in skill and advertisement intensity are the two major determinants of inter industry differences in profitability in India while such differences in R&D intensity and concentration ratio are not. Kumar (1990) uses an unpublished database on 43 (three-digit) Indian manufacturing industries for the years 1976-77 through 1980-81 compiled by the RBI and observes that the degree of seller concentration, advertisement intensity and protection from imports accorded to the local (Indian) industries are not related to their profitability. He, however, finds knowledge (skill and technology) intensity to be an effective entry barrier variable for the multinational enterprises and intra-industry structure (in terms of strategic heterogeneity) to have played an important role in affecting industry profitability. Agarwal (1991) considers vehicles manufacturing industry (like jeeps, trucks, buses etc.) in private sector for the years 1966-67 to 1986-87 but fails to find much support for either the S-C-P paradigm or the relative efficiency hypothesis. On the other hand, the study by Kambhampati and Parikh (2003) observes profit margins in the Indian industries to be significantly influenced by the market structure variables like market shares, advertising, R&D and exports. In particular, both advertisement and R&D intensity are observed to have favorable effect on profit margins. Kambhampati (1996) surveys a few additional Indian studies in this area. We thus observe that the Indian industries display mixed results on the issue in question. None of the above studies, but the one by Kambhampati et al (2003), used panel data.

We use *panel data* spanning over as long as thirteen years after liberalization. We believe this study contributes substantially to the existing literature in understanding the behavior of the Indian industries, specifically those related to the S-C-P paradigm for at least three reasons: (a) earlier such studies on Indian economy has been carried out mostly in the pre-liberalized regime when domestic business environment were largely protected through various restrictive laws and regulations and, understandably therefore, it was far from having the developed market characteristics. Since the S-C-P paradigm is essentially a developed market phenomenon, it is necessary to validate this paradigm in the post-liberalized era (as liberalization was essentially a drive to make Indian economy more free and relatively developed one); (b) the number of such longitudinal studies on S-C-P paradigm for the Indian industries is indeed scanty. Since panel aspect allows more of a causal interpretation of the estimates, this study being able to show somewhat more robust results about the relationship exists among the relevant variables in the Indian industries. and (c) recent study of Delorme et al (2002) on US manufacturing based on the recent trend of using simultaneous equations framework (to see whether performance is influenced by the market structure or whether market concentrates as a result of better performance, i.e., the debate of S-C-P paradigm vs. the Chicago School Hypothesis) got some evidence in favor of S-C-P paradigm, but no evidence to the other. To be specific, one of the major results of the study is that concentration does not depend on profitability, though profitability depends on concentration. Thus, we find some rationale to study the old wine again in the new bottle of liberalized Indian economy.

3. Data Set and Variables

Our empirical analyses use Prowess database made available by the Centre for Monitoring Indian Economy (CMIE). This source releases company-level annual data on several important economic variables for different industries. Data on thirty-seven industries are used for years spanning almost one and a half decade (1993-2005) since the early nineties and hence a balanced panel data set is constructed with total number of observation being 481, viz., 37×13. Thus ours is an industry-level study. We give below a brief description of the variables along with the corresponding notations used in our industry-level study.

Three measures of performance have been proposed in the literature on industry S-C-P: *rate of return*, *price-cost margins* and *Tobin's q* (Tobin, 1969, 1980). The available data do not directly provide any information on price-cost margins or *Tobin's q* at the firm or the industry level. So, we have compiled information on profit and used rate of return as our primary variable for explanation.

Rate of Return (*ROR*): Bain (1951) carried out the first empirical study relating *ROR* to concentration for 42 U. S. industries. Several profit variables could be constructed from our data set such as profit after tax, profit before tax, profit before depreciation and tax, profit before depreciation, interest and tax etc. We have used all of these four, however, in view of better results we report only for 'profit after tax' (PAT) variable to compute rate of return of a firm/industry. Interestingly, Bain (1951) also used PAT to define *ROR*.[10]

[10] In the study of Bain (1951) the denominator of the *ROR* variable was the book value of stockholder's equity instead of paid-up equity capital, which we have used in denominator.

Concentration (*Con*): Several alternative measures of economic concentration have been suggested in the literature, of which $k-$firm concentration ratio and Herfindahl Index H are the two most popular ones. Of these two again the first one is most widely used, with the value of k depending on the choice of the researcher. If s_i be the share of the i^{th} firm in the total output of an industry with N number of firms, then the $k-$firm concentration ratio is given by the sum of the s_i's of the k largest firms, while H is defined as the sum of the squares of the shares of all firms: $H = \sum_{i=1}^{N} s_i^2$. In our analysis, we have used both the indices and for the first one, we have considered the 4 – firm concentration ratio (to be denoted by $CR4$). Net sales rather than outputs of the individual firms have been used for computing individual shares (s_i's).

Advertising Intensity (*Adv*)*:* Product differentiation plays a dual role in the market structure-conduct-performance paradigm. It directly influences the character of competition among established firms and at the same time it is one of the widely used entry barrier variables in the literature. *Advertising intensity* is usually measured by the ratio of the advertising expenditure made by a firm (all firms in an industry) to the firm's (industry's) net sales. We have also used this measure. It may be noted that this variable is presumed to measure, at least indirectly, the extent of product differentiation within an industry and also of goodwill. As Bain (1956) pointed out, in markets with differentiated products consumers usually prefer the existing brands to the unfamiliar brand of a new entrant. Therefore, an entrant would have to offer its product at a price substantially lower than the ones charged by the existing firms and also have to undertake heavy advertisement to nullify such preference barrier. If the existing firms themselves do high levels of advertisement, it then becomes all the more difficult for a new comer.

Minimum Efficient Scale (*MES*)*:* A second entry barrier variable usually considered in the literature is the minimum efficient scale (*MES*) of an enterprise. By *MES* of a plant we mean the point at which average cost is minimized. If an analysis of inter-temporal movement in size distribution of firms reveals that firms are moving into one particular size class, in an overall sense, the size class that gains is likely to contain the *MES* (Shepherd, 1967; Stigler, 1968; Rees, 1973). The usual scenario is that an entrant faces greater difficulty in raising money from the capital market compared to an existing firm which probably operates at an *MES* size. Alternative measures of *MES* of an industry have been suggested/used in the literature. Firms or plants are arranged first in descending order of their values of outputs, starting with the plant having the largest value of output. The plants are then classified into two halves[11] – the upper and the lower halves and plants in the upper half are only considered. One measure of *MES* is the *average size* of plants in the upper half. An alternative measure, also used by some authors, is the value of output of the *smallest* plant in the upper half. However, we have used both of these measures and report the former measure only for its relatively better results.

R&D intensity (RD)*:* A third entry barrier variable usually considered in the literature is the R&D intensity of an industry. It is defined as the ratio of aggregate expenditure on research

[11] These halves are not made on the basis of number of firms but on the basis of volume of total output they produce. In other words, the upper half contains the minimum number of firms that produce more than or exactly equal to the 50% of industry output.

and development (R&D) activities of an industry to its aggregate net sales. More and more R&D expenditure incurred by any producing unit (relative to its net sales) is likely to have a higher prospect of inventing and adopting advanced method of production which helps to lower its unit cost of production, and/or improve the quality of its product. Thus, an increased R&D intensity for all existing firms in general is likely to act as an effective entry-barrier to a potential new entrant into the industry.

Value Added to Sales Ratio (*Vas*)***:*** One another important entry barrier variable usually considered in the literature is value added to sales ratio (*Vas*). The proportion of value added in the total value of output of a firm (*Vas*) indicates the extent to which the firm has to depend on outside supply for raw materials/intermediate inputs needed for its production. The less it has to depend, the larger is likely to be the stability and smoothness of its production process. At an industry level, this ratio reflects the degree of vertical integration of the industry and is likely to act as an effective entry barrier. In fact, vertical integration, by assuring timely availability of inputs, yields distinct advantages and higher the degree of vertical integration in an industry, less favorable is likely to be the platform for a potential entrant, owing to its cost disadvantage relative to the existing rivals.

Capital-Sales Ratio (*Kas*)***:*** We use another important market structure variable namely capital-sales ratio (*Kas*), which, as shown below may account for some important part of the variability of *ROR*. We have sought to explain rate of profit/return across industries.[12] Relation (15) indicates that industry profit as a proportion of total revenue depends positively on both $\theta\psi$ and concentration index, H. We could get an expression of the rate of profit from this relation by multiplying Π/R by R/p^kK, where p^kK is the value of capital, with K denoting the (column vector of) physical quantity (quantities) of its capital good (s) and p^k, the (row vector of) corresponding price (s). If we express relation (15) in terms of rate of profit we get

$$\frac{\Pi}{p^kK} = \left[\sum_i L_i s_i\right] \times \frac{R}{p^kK} = \text{Some Constant} \times \left[\theta\psi + 1 - \theta\psi\ H\right] \times \frac{R}{p^kK}$$

The rate of profit is now seen to vary positively with the industry's average Lerner index $\left(\sum_i L_i s_i\right)$, but inversely with the capital-output ratio (in value terms), $p^kK/\sum p_i x_i$. Thus, other things remaining unchanged, higher the capital-output ratio, the lower is expected to be the rate of return.

4. Framework and Empirical Findings

Standard regression techniques for the panel data have been used for our empirical analyses. To give a brief idea about this technique, suppose we have a balanced panel data, i.e.,

[12] An alternative dependent variable, widely used in the literature, is the price-cost margin. Since, as we have already mentioned, we do not readily get information on such margin from the data set, viz., Prowess database, we could not use this as an alternative dependent variable.

observations on N units for each of T number of time periods.[13] Let the panel data regression model involving L explanatory variables be written as

$$y_{it} = \sum_{j=1}^{L} \beta_j x_{jit} + a_i + u_{it} \qquad (i = 1, 2, 3, \ldots, N; \quad t = 1, 2, 3, \ldots\ldots, T) \qquad \ldots (16)$$

where y_{it}, x_{jit}, and u_{it} are respectively the value of the dependent variable, the j^{th} explanatory variable and the idiosyncratic error term, corresponding to the i^{th} unit in the t^{th} period. Equation (16) also include the case where a time invariant factor, a_i, may affect y_{it}. The u_{it} is assumed to be uncorrelated with each explanatory variable across all time periods and distributed, conditional on x's and a_i, as identical and independent normal variable with zero mean and constant variance.

In the case of panel data the literature suggests the selection of an appropriate regression equation model from two alternative models – fixed effect (FE) model and random effect (RE) model. When a_i is likely to be correlated with some explanatory variable (s) in any time period, FE model appears to be the proper one. Estimates of the various parameters could then be obtained through a pooled ordinary least squares (OLS) regression based on the following modified form of the equation (16):

$$\ddot{y}_{it} = \sum_{j=1}^{L} \beta_j \ddot{x}_{jit} + \ddot{u}_{it} \qquad \ldots (17)$$

where each variable is expressed as deviation from its mean value (over the total time period T), such deviations being denoted by putting two dots •• over the corresponding symbol (e.g., y_{it} is replaced by $\ddot{y}_{it}$, where $\ddot{y}_{it} = y_{it} - \bar{y}_i$ and $\bar{y}_i = \frac{1}{T}\sum_{t=1}^{T} y_{it}$). However, if we have reasons to believe that a_i is uncorrelated with each explanatory variable in all time periods, then the use of a transformed/modified model so as to eliminate the effect of a_i would result in inefficient estimators. In such a case one has to use the RE model and the generalized least squares (GLS) estimation procedure may be used to obtain consistent estimates of the regression parameters (see Wooldridge (2003) for more discussion on panel data models).

Thus, as far as the choice between a RE and FE approach is concerned, the key consideration is whether or not a_i and x_{jit}'s are correlated. It is, therefore, important to have a method for testing this assumption. Hausman (1978) proposed a test for accepting/rejecting null hypothesis, H_0 :RE model, against the alternative hypothesis, H_1 :FE model, on the basis of a test statistic – known as the Hausman Statistic. This statistic, reported in most of the econometric packages, is distributed asymptotically as χ^2_L under H_0 .

We have fitted both the FE as well as RE models and then used the Hausman test to arrive at the appropriate model for estimating the parameters of regression equation. Statistical

13 The estimation methodology discussed here is also applicable to the case of the so-called 'unbalanced' panel data set in which the total number of observations falls short of NT .

package TSP (version 4.5) and SHAZAM have been used for our empirical analyses. To facilitate our subsequent discussion we write below the general form of the regression equation involving all possible explanatory variables we have tried:

$$y_{it} = \alpha_i + \beta_C \, Con_{it} + \beta_M \, MES_{it} + \beta_A \, Adv_{it} + \beta_R \, RD_{it} + \beta_V \, Vas_{it} + \beta_K Kas_{it} + u_{it} \qquad \text{... (18)}$$

Regression Results

As far as our regression exercises are concerned, we have proceeded in a step-by-step fashion. We have not introduced at one go all explanatory variables listed in equation (18). Rather we bring in these variables one by one and examine at each stage whether regression result improves in terms of value of $\bar{R}^2$ and levels of significance of the estimated coefficients of the explanatory variables included. We have proceeded in this fashion to understand the bivariate relationships between a pair of variables and to see whether there exists any possible multicollinearity problem among some of the explanatory variables and eventually ended up with an equation in which explanatory variables included have coefficients which are of expected signs and statistically significant (at least at ten percent level).

For an equation at each stage regression results for both the random effect (RE) model and fixed effect (FE) model are obtained first and then the appropriate model is chosen using the test results for the estimated value of the associated Hausman Statistic.

As mentioned earlier, we have considered two alternative measures of concentration – Herfindahl index (denoted by H) and four-firm concentration ratio (denoted by $CR4$). To begin discussion on our regression exercises we note, first of all, that whenever concentration is used as the only explanatory variable, $CR4$ has fared much better than H. This is clear from the first regression equation of Tables 1 and 2. In fact, $CR4$ alone explains about 49 per cent of total variation in profitability and its coefficient is expectedly positive and significant. When Adv or MES are added as additional explanatory variables, the coefficient of $CR4$ turns out to be non-significant. And the estimated coefficient of concentration variable remains non-significant, even if $CR4$ is replaced by the alternative measure, H. This is probably because of the fact that either of Adv and MES variables or both may have some correlation with the concentration variables. However, probable existence of such multicollinearity among some of the explanatory variables is not contaminating our analysis since, as we will see shortly, each of the explanatory variables is significant in the estimated final regression equation.

We have initially considered two alternative advertisement variables – advertising ratio during the previous year[14] and that in the current year and finally selected the former, in view of not only its better performance but also of the fact that presumably there should be some lag between initiation of advertisement and its effect on sale. Coming to report our empirical results involving MES as another explanatory variable, we note that when we use as additional explanatory variable (s) advertisement-sales ratio (adv) or minimum efficient scale (MES) either one at a time or jointly, regression results improve – in respect of both the values of $\bar{R}^2$ and the t-

[14] In fact, as mentioned earlier, advertisement-sales ratio has been found to be an important determinant of profit in the study by Siddharthan et al (1983). However, Kumar (1990) notes that product differentiation through advertisement is effective mainly in the case of consumer goods industry.

ratio of the estimated coefficient of the concentration variable (second and third equations of either of Table 1 and 2). One other important observation is that the coefficient of the constant term in each of these equations now turns out to be non-significant.

Table 1. Estimated Linear Regression Equation for Rate of Return (*ROR*) using Four-Firm Concentration Ratio (*CR4*) as the Measure of Concentration

Regression Equation	*Independent Variables*							
	Constant	*CR4*	*Adv*	*MES*	*RD*	*Vas*	*Kas*	$\bar{R}^2$
1	0.192 (1.530)	0.374 (1.958)						0.49
2	0.117 (0.925)	0.267 (1.404)	12.110 (4.332)					0.51
3	0.068 (0.579)	0.284 (1.578)	10.713 (4.072)	0.00001 (5.033)				0.52
4	- 0.037 (- 0.316)	0.374 (2.094)	9.849 (3.841)	0.00001 (5.186)	22.492 (2.962)			0.53
5	----	0.448 (2.074)	7.106 (2.002)	0.00002 (5.539)		3.527 (7.902)		0.62
6	----	0.501 (2.308)	6.895 (1.948)	0.00002 (5.492)	16.266 (2.035)	3.484 (7.825)		0.62
7	----	0.531 (2.580)	10.410 (3.056)	0.00002 (6.195)		3.459 (8.155)	- 0.478 (- 6.951)	0.66
8	----	0.591 (2.864)	10.215 (3.014)	0.00002 (6.155)	18.207 (2.400)	3.411 (8.074)	- 0.484 (- 7.071)	0.66

Figure in parenthesis is the corresponding t-ratio.[15]

The equations with the constant term correspond to the RE models and those without it, the FE models.

We next consider R&D intensity (RD) of an industry. When we add RD (i.e., R&D expenditure in the preceding year as a proportion of sales) as an additional explanatory variable, the result improves marginally in terms of the value of $\bar{R}^2$, but now the $t-\text{ratio}$ of the coefficient of $CR4$ exceeds 2.

We next consider value added to sales ratio (Vas). When Vas is introduced as an additional explanatory variable, value of $\bar{R}^2$ improves considerably, the coefficient of Vas turns out to be of expected sign and highly significant and the coefficients of other explanatory variables remain significant with expected signs (equations 5 and 6 of Tables 1 and 2).

15 One can take into consideration Heteroscedastic as well as auto-correlated disturbances. On can even go further to consider heteroscedasticity for both the observation-specific fixed effects as well as the idiosyncratic errors and auto-correlation for time-specific effects (in a two-way error component framework) as well as the idiosyncratic errors. Model of dynamic panel can also be considered. However, we have not considered any of those advanced alternatives.

Table 2. Estimated Linear Regression Equations for Rate of Return (*ROR*) using Herfindahl Index (*H*) as the Measure of Concentration

Regression Equation	*Independent Variables*							
	Constant	H	*Adv*	*MES*	*RD*	*Vas*	*Kas*	$\bar{R}^2$
1	0.364 (4.561)	0.224 (0.970)						0.49
2	0.236 (2.806)	0.144 (0.636)	12.600 (4.477)					0.51
3	----	0.427 (1.690)	16.212 (4.466)	0.00001 (3.702)				0.56
4	0.132 (1.749)	0.230 (1.065)	10.479 (4.066)	0.00002 (5.177)	20.333 (2.696)			0.53
5	----	0.617 (2.600)	7.681 (2.162)	0.00002 (5.633)		3.608 (8.071)		0.62
6	----	0.621 (2.626)	7.474 (2.108)	0.00002 (5.560)	14.302 (1.805)	3.567 (7.991)		0.62
7	----	0.726 (3.219)	11.119 (3.264)	0.00002 (6.320)		3.554 (8.377)	- 0.483 (- 7.047)	0.66
8	----	0.732 (3.259)	10.919 (3.217)	0.00002 (6.247)	15.902 (2.118)	3.508 (8.293)	- 0.487 (- 7.135)	0.66

Figure in parenthesis is the corresponding t-ratio.
The equations with the constant term correspond to the RE models and those without it, the FE models.

Again, when we bring Kas as an additional explanatory variable, its coefficient is observed to be negative and significant, as expected. The overall regression result, i.e., the value of $\bar{R}^2$, improves, level of significance of the estimated coefficient of each of the remaining explanatory variables including concentration increases and is also of expected sign (equations 7 and 8 of Tables 1 and 2). In this connection it may be noted that Kas has been used by a number of researchers to explain price-cost margin of an industry and many of them have come up with positive sign of coefficient of Kas (Ornstein, 1975; Liebowitz, 1982; Domowitz et al, 1986; Martin, 1988); presumably the underlying argument is that Kas also acts as an entry barrier variable. In our case the dependent variable is not price-cost margin, but rate of return and it stands to reason that the rate of return would be lower if, other things remaining unchanged, capital-output (or its proxy capital-sales) ratio were higher.

We have tested some hypotheses regarding the fixed effects assuming both one-way and two-way error component models of panel data and results of these tests have been reported in Table 3. It shows that neither all of the individual specific fixed effects nor all of the time specific fixed effects become simultaneously insignificant. So, the error term in our model indeed including some fixed effects of both kinds which may induce it to be autocorrelated and/or heteroscedastic. We thus estimate two-way error component variation of equation (18) allowing for the possibility of cross-sectional heroscedasticity and time-wise autocorrelation (a la Parks, 1967) and results of such estimation is given in Table 4. It shows that our earlier results still hold good with the exception that the advertising intensity variable now becomes insignificant. Further, concentration becomes insignificant if we use H as its measurement, replacing the alternative one, i.e., CR4. So, four-firm concentration ratio may be a better proxy of market concentration in Indian industries.

5. Concluding Remarks

In the initial decades after Independence, various sectors of Indian economy were under several strong elements of government control. During this period both the public and the private industrial sectors faced almost no foreign competition. However, the overall economic scenario has started changing since the mid-1980s and the process of liberalization of the Indian economy gathered momentum in the early 1990s with gradual withdrawal of a series of government controls.

Table 3. Results of Some Diagnostic Tests for Individual/Time Specific Fixed Effects using *H*[16] as Index of Concentration

Null Hypothesis	Calculated *F*	Tabulated *F* (at 1% Level)	Decision
Assuming One-Way Error Component Model: $y_{it} = \sum_{j=1}^{6} \beta_j x_{jit} + a_i + u_{it}$ (i = 1, ..., 37; t = 1,...,13)			
H_0: $a_i = 0; i = 1,...,36$	14.1 (36, 438)	1.67	Reject H_0
Assuming Two-Way Error Component Model: $y_{it} = \sum_{j=1}^{6} \beta_j x_{jit} + a_i + \lambda_t + u_{it}$ (i = 1, ..., 37; t = 1,...,13)			
H_0: $a_i = 0; i = 1,...,36$ and $\lambda_t = 0; t = 1,...,12$	13.6 (48, 426)	1.58	Reject H_0
H_0: $a_i = 0; i = 1,...,36$, Given that $\lambda_t \neq 0; t = 1,...,12$	15.5 (36, 426)	1.68	Reject H_0
H_0: $\lambda_t = 0; t = 1,...,12$, Given that $a_i \neq 0; i = 1,...,36$	6.22 (12, 426)	2.23	Reject H_0

Figures in Parenthesis is Degrees of Freedom of Chi-Squares in Numerator and Denominator Respectively

16 Test results of these hypotheses are exactly the same even when *H* is replaced by *CR4* as a measure of market concentration, while calculated values of *F*-statistic differ only marginally.

Table 4. Estimation Results of a Model allowing for Cross-Sectional Heroscedasticity and Time-Wise Autocorrelation (*a la* Parks, 1967)

Regression Equation	*Independent Variables*							
	CR4	H	*Adv*	*MES*	*RD*	*Vas*	*Kas*	R^2
1	0.161 (1.716)		0.495 (0.223)	0.00002 (5.736)	22.572 (6.332)	0.970 (7.805)	- 0.354 (- 8.210)	0.42
2		0.162 (1.074)	0.609 (0.279)	0.00002 (5.693)	24.069 (7.573)	1.122 (10.83)	- 0.358 (- 8.215)	0.45

Figure in parenthesis is the corresponding t-ratio.

Most of the empirical works regarding concentration-profitability relation in India have been done for the pre-liberalized Indian economy. Our principal concern in this paper is to ascertain whether the conventional S-C-P paradigm is valid for the liberalized industrial sector in India. Specifically, we have sought to examine how market concentration along with some important entry-barrier variables like advertisement-sales ratio, minimum efficient scale of a firm etc. affect profitability of the Indian industries. There are other factors that constitute the elements of 'market conduct' such as R&D expenses, degree of vertical integration, capital-sales ratio etc. which have considerable implications for profitability. Results, obtained through a rigorous panel data analysis, suggest that market structure variable like industry concentration has a significant positive effect on industry profitability in India. This is in contrast to some of the empirical findings for the Indian industries surveyed in section 2 and also for other countries. The entry barrier variables like advertisement intensity (with the exception for the case of unit-wise heteroscedastic and time-wise autocorrelated error model), minimum efficient scale, R&D intensity, degree of vertical integration etc. are also observed to have affected profitability significantly with theoretically proper signs. Needless to say, the results obtained here could have been enriched by including some other explanatory variables considered by some authors. But limitations of availability of proper data did not allow us to carry out these exercises. Still the empirical results obtained in this analysis seem to confirm, by and large, the prevalence of the conventional S-C-P paradigm in the Indian industries. Again, our results are more robust since these are obtained through analyzing a data panel on the Indian industries as a whole.

High concentration in an industry means that a few big firms account for a large share of the industry. In the Indian industries large firms operate in the organized capital and labor markets and small firms operate mostly in the unorganized input markets. Consequently, large firms get access to capital at a lower price but may have to pay higher wages to labor than the small firms. The regulatory policies pursued in India combined with such capital market imperfections and the presence of sub-optimal contractual arrangements cause higher market transaction cost, which is argued to be a source of long run market power to large firms and entry barriers to small ones (Patibandla, 1998). However, such regulatory policies have been removed to a great extent in India since its liberalization and, therefore, the extent of this source of market power, if at all, can be a debatable issue. In addition to that, the associated labor laws have been made much flexible relative to the earlier regime. Even in such an Indian economy the conventional S-C-P paradigm is still valid and thus it may be indicative of the validity of Chicago School's Hypothesis, which of course, we have not tested. Since complete liberalization that may be suitable for the Indian economy is yet to be achieved and this drive is still going on, the policy makers should approach forward in doing so as the industrial units probably become more efficient (a la Demsetz, 1973) after liberalization.

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Appendix

Table A.1. Industries Considered for Our Empirical Analysis

1. Beverages & tobacco
2. Books & cards
3. Cement
4. Clocks & watches
5. Communication services
6. Construction
7. Cosmetics, toiletries, soaps & detergents
8. Drugs & pharmaceuticals
9. Dyes & pigments
10. Electrical machinery
11. Electricity
12. Electronics
13. Fertilizers
14. Financial services
15. Food products
16. Health services
17. Hotels & tourism
18. Inorganic chemicals
19. Leather products
20. Metals & metal products
21. Mining
22. Non-electrical machinery
23. Organic chemicals
24. Other non-metallic mineral products (except Cement)
25. Paints & varnishes
26. Paper & paper products
27. Pesticides
28. Petroleum products
29. Plastic products
30. Polymers
31. Rubber & rubber products
32. Textiles
33. Trading
34. Transport equipment
35. Transport services
36. Tyres & tubes
37. Wood

Table A.2. Correlation Matrix among the Variables

	ROR	*CR4*	*H*	*Adv*	*MES*	*RD*	*Vas*	*Kas*
ROR	1							
CR4	0.112	1						
H	0.2422	0.836	1					
Adv	0.213	0.508	0.386	1				
MES	0.385	0.136	0.232	- 0.050	1			
RD	0.164	- 0.212	- 0.239	0.045	- 0.101	1		
Vas	0.084	0.240	0.270	- 0.020	- 0.109	- 0.235	1	
Kas	- 0.255	0.152	0.177	- 0.197	- 0.023	- 0.286	0.404	1

♦♦♦