IOSR Journal Of Humanities And Social Science (IOSR-JHSS)
Volume 22, Issue 7, Ver. 4 (July. 2017) PP 06-17
e-ISSN: 2279-0837, p-ISSN: 2279-0845.
www.iosrjournals.org

Impact of Market Concentration on the Growth of Selected Manufacturing industries in India using Mauldon Distribution

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Abstract: This paper tries to explain whether an industrial sector belonging to Indian Manufacturing Industries with high (or low) market concentration ratio has a high (or low) growth rate. In addition, the paper checks whether the k firm concentration in an industry (the share of market supplied by the top k firms in an industry) improves or diminishes with an increase or decrease in n (number of firms), and how the growth pattern of the industry behaves alongside. As number of firms (n) in an industry increases, k firm concentration in an industry (C) may increase or decrease. However, this does not necessarily imply that the market concentration has improved or deteriorated, because, the size of the industry itself (n) has changed. The existing measures of concentration do not provide a benchmark which defines a significant concentration level for a specific value of n, in comparison to which an actual market concentration C can be identified as significant. This paper applies the Mauldon Distribution to provide a hypothetical benchmark for an industrial sector where it is assumed that none of the firms have any advantage in terms of efficiency, so that they can affect the market concentration. Finally the paper tries to explain changes in the growth pattern in different industrial sectors with changes in number of firms in those industries, by comparing growth pattern with the movement of their k firm concentration ratios.

Keywords: Market concentration, Mauldon Distribution, Growth, Critical concentration ratio.

I. INTRODUCTION

Market concentration of an industrial sector is primarily based on the share of the output produced or supplied by each of the firms within a specific industrial sector. On the other hand, the output growth of an industry is simply measured by checking the change in total output between two consecutive periods, and depending on this change in output, it is determined whether an industrial sector is growing or deteriorating. Next, depending on the rate of growth (if the sector shows an increase in output over time), it is determined whether a specific industrial sector is showing a higher or lower growth in comparison to other industrial sectors. Thus, high or low growth rate of an industrial sector is always a concept relative to other industrial sectors with which it is compared. Most of the commonly used measures of market concentration depend on the share of total output supplied or produced by each firm in an industrial sector. Hence, changes in market concentration of one or more firms in an industry imply a change in that particular industry's total output and hence can affect that particular industry's growth.

In light of the above discussion, this paper tries to check whether an industrial sector with high (or low) market concentration ratio has a high (or low) growth rate. Alongside, the paper also tries to find out the effect of changes in number of firms (depicted as *n*) in an industrial sector on its market concentration, and in turn, on its growth pattern. Precisely, the paper checks whether the *k* firm concentration in an industry improves or diminishes with an increase or decrease in *n* (number of firms), and how the growth pattern of the industry behaves along with it. Thus, an attempt can be made to explain whether and how the growth pattern of an industry is getting affected by the new entrants in the market (an increase in *n*), or the exodus of firms from an industry (a decrease in *n*).

A study in 2006 [1] has revealed that the stability of ranks (of market share) might not capture the actual changes in market share and the level of competition faced by the firms. Studies have also revealed that higher market share or market concentration does not necessarily imply higher profit [2]. Thus, it is important to know how exactly market shares of different industrial sectors with different *n* can be compared and in which direction do these market shares and the growth patterns of these industries move with changes in *n*.

In addition, this study also brings up another important question: when can a specific sector be identified as "concentrated"? In this respect, a few standard measures of market concentration available in literature and their empirical studies have been discussed next. The most commonly used method for calculating market concentration is the Concentration Ratio.

If s_i be the market share of the i^{th} firm, then *k* firm concentration ratio for the market share held by the largest *k* firms in an industry sector is:

$$CR_k = \sum_{i=1}^{k} s_i \text{.......................... (1)}$$

where, s_i = market share of ith firm.

Another very common method of calculating market concentration in an industrial sector is the Herfindahl index or the Herfindahl – Hirschman Index (HHI). The Herfindahl index is defined as:

$$H = \sum_{i=1}^{n} s_i^2 \text{............................... (2)}$$

where s_i is same as defined in equation 1.

It is the sum of square of market shares of all the firms belonging to a specific industrial sector. Using the Herfindahl index as the basic measure of market concentration and extending it, other measures of market concentration have been derived.

The Absolute Concentration Index [3] [4] is calculated as:

$$X_1 = \sum x_i^2 / x_i = \sum x_i H \text{............... (3)}$$

where x_i is the output of the i^{th} firm in a specific industrial sector.

The Comprehensive Concentration Index [5] is:

$$CCI = s_1 + \sum_{i=2}^{n} s_i^2 (2 - s_i) \text{.............(4)}$$

where s_1 is the share of the largest firm and s_i are the shares of the remaining (*n-1*) firms, in a total of *n* firm industry.

The common measures for calculating market concentration simply provide the percentage of market concentration (say 60%). However, it does not tell us whether an industrial sector with say 60% *k* firm concentration can be recognized as significantly concentrated or not. Also, the question remains whether an industrial sector having 20 firms and a 60% *k* firm concentration is more concentrated than an industrial sector having 10 firms and a 45% *k* firm concentration. If the two above cases have same number of firms, the answer will be simple and obvious. However, the industry sector with a higher *k* firm concentration has higher *n* in comparison to the industry with a lower *k* firm concentration with a lower *n*. Commonly used methodologies do not provide a benchmark for comparing industries having different *k* firm concentrations corresponding to different values of *n*. More specifically, does the same value of Herfindahl index of say 0.425 (42.5%) for an industrial sector having 10 firms and another sector having 100 firms signify equal level of concentration in both the sectors? Does the number of firms in a particular industrial sector play any role?

An attempt was made in 2002 [6] to find a consistent relationship between the whole set of Hannah-Kay [4] industry concentration indices (equation 3) and the classical general entropy inequality measures from the income distribution literature. From there, they obtained an explicit additive decomposition of the change in concentration into the change in its two components: one being the inequality in market share and the other being the number of firms in different industrial sectors. However, in that literature the definition of the income of the household (X_i) was extended to define a proxy for the output of the industry, also defined as X_i. In addition, number of households, *n* was also defined as the proxy for the number of firms defined as *n*.

Thus, given the existing literature, it is not possible to know how the market concentration ratios of a specific industry behave if there are new entrants in the market, or if some firms exit from the market (that is, if *n* changes). It is not possible to compare two industrial sectors, or the same industrial sector at two different time points, with two different *n* and correspondingly, two different *k* firm concentration ratios (as already mentioned above). In other words, the above mentioned methods simply calculate the concentration ratio of an industrial sector. They do not provide us with any kind of benchmark, to which, the calculated concentration ratios of the industrial sectors can be compared, in order to identify an industry as “Concentrated” or “Not Concentrated”.

While the introduction section has discussed the commonly used measures for calculating market concentration for an industrial sector, the paper next proceeds with the methodology of calculating the benchmark c* in Section 2 using the Mauldon Distribution [7], referring to a study of manufacturing sectors in Canada by S.C.Parker [8]. Section 3 provides an overview of the Indian Manufacturing Sector data used for our analysis. Computations for Market Concentration analysis have been provided in Section 4. In addition, we try to interpret and infer the meaning and significance of all the variables affecting the benchmark concentration level c* and original concentration level C. This section also tries to check the possible effects of changes in *n* on the other variables and hence on c* and C. Details of Computation and results attained are shown in Section 5. It also includes the changes in growth patterns of the industrial sectors alongside the changes in their market concentration with changes in number of firms, *n*. Finally, we conclude the paper in Section 6.

II. METHODOLOGY

The existing measures for calculating market concentration ratios in an industrial sector, give us the percentage of market concentration in an industry. However they do not tell us, for example that whether an industry sector with 55% market concentration and *n*=20 firms can be called a significant concentration. There is no benchmark in comparison to which an industry sector can be called significantly concentrated or not. If there is a benchmark level of significant concentration for each value of *n*, then it will be possible to compare industries with different *n* and different corresponding concentration levels.

In this respect, a paper by S. C. Parker [8] has calculated a benchmark, against which a concentration ratio can be compared. This benchmark is the hypothetical concentration ratio which would arise if the market structure is not influenced by any concentrating force. This benchmark, having the notation c* has been termed as the critical concentration ratio. An industrial sector is said to be significantly concentrated, if the observed *k*-firm concentration ratio of that industry sector is higher than its critical *k*-firm concentration ratio. Parker's paper points out that there are several factors like technology, entry barriers, competition, etc. affecting the market concentration in a specific industrial sector. The paper tries to determine whether, in reality, these factors have sufficient influence to result in a concentration strong enough to be significantly higher than a critical ratio benchmark.

The benchmark is taken to be the level of concentration arising in a market in which market shares are allocated randomly, and in which all factors leading to concentration, are absent. This means, difference in efficiency and productivity of any particular firm, which may be a factor towards a firm's high or low market power, are assumed to be absent. Among these firms, the market shares are randomly distributed so that any of the firms have the equal probability to get a particular market share. The paper assumes that there is no difficulty in defining market, and *n*, the total number of firms, is fixed in a particular period (say one year). However, *n* does not include peripheral firms, that is, the firms having a market share of less than 1%.

Given these assumptions, the *k* firm concentration ratio is:

$$S_k = \sum_{i=1}^{k} \max(s_i),\ 1 \le k \le n \quad \text{.........................(5)}$$

where s_i are the market shares of different firms ($0 \le s_i \le 1$, for all i).

In a hypothetically unconcentrated market, market shares are randomly allocated. Since the market shares are randomly distributed among different firms, (none of which have any advantage in terms of efficiency), each of the firms have equal probability to get a particular market share. Hence, s_i are uniformly distributed variables.

For calculating the cumulative distribution of S_k, Parker [8] refers to a study by Mauldon [7]. Mauldon considered a uniformly distributed variable μ_i and studied the distribution of λ_k, as:

$$\lambda_k = \sum_{i=1}^{k} \max(\mu_i)\ 1 \le k \le n \quad \text{.........................(6)}$$

Parker [8] has used the Mauldon distribution to find the cumulative distribution function of S_k where $s_i = \mu_i$ and $S_k = \lambda_k$.

Study by Mauldon showed that the cumulative distribution function of S_k is:

$$\text{Probability}\ [S_k \le c^*] = \sum_j (-1)^{n-j}\ \{(jc^*-k)^{n-1}/j\}\ [n!/k^{n-k-1}(j-k)^{k-1}(n-j)!(j-k)!k! \quad \text{............(7)}$$

This being a cumulative distribution function, j indicates that, the summation is over the range, $k/c^* < j \le n$ for integer values of *j*.

Parker [8] defines c as the *k* firm concentration ratio in a hypothetically unconcentrated market and c* has been defined as the critical concentration ratio. Parker points out that it is possible to calculate a c* value above which α proportion (say 5%) of the distribution lies. Then, given *k*, *n*, and α, it is possible to find c* from the equation

$$\text{Probability}\ [S_k \le c^*] = 1 - \alpha \quad \text{........................ (8)}$$

Using the above paper as a reference, next, the industrial sectors can be identified as significantly concentrated or not concentrated.

In Parker's methodology [8], *n* (number of firms) appears directly within the formula to calculate c*. Hence it is clear that *n* directly affects c*. For different values of *n*, and a particular value of *k*, different values of c* can be calculated and hence plotted. Calculating the actual *k* firm concentration ratios (C) for changes in *n* in a particular industrial sector, and comparing them with c* for those particular values of *n*, it can be checked whether with changes in *n*, an industry moves towards or away from being significantly concentrated. So, it can be summarized as:

n = Total number of firms in the industry
k = Number of leading firms
c = k firm concentration in the hypothetically unconcentrated market
c* = Critical concentration ratio in the hypothetically concentrated market
C = Actual k firm concentration in the industry

As *n* changes, so does C. Apparently, if C increases (or decreases), it may appear that the industry is getting more (or less) concentrated. However, as *n* changes alongside, we get back to the initial question of comparing two situations with two different values of *n* and C. Had *n* remained unchanged, the increase or decrease in C would have given an obvious conclusion. However, with change in *n*, it is necessary to compare C with the benchmark c* in order to conclude about the market concentration behavior of the industrial sectors.

III. OVERVIEW OF INDIAN MANUFACTURING SECTOR DATA

To study the relation between growth pattern and market concentration, it is necessary to know about the growth pattern of the industries. Hence we next tried to classify 17 industries of Indian Manufacturing sector into high growth and low growth, based on their values of output collected from 1959 to 2012 from Annual Survey of Industries (ASI) database. These values of output were next calculated at the constant price of 2012. For this purpose, the sector wise Wholesale Price Indices for the period 1959-2012 have been used, which are published by The Ministry of Commerce, Government of India. Medians of the arithmetic mean of growth rates of these values of output over time were calculated for different industrial sectors. Comparing these medians of mean growth rates, the industries were classified as low growth or high growth or medium growth. It is to be noted that, though Geometric mean is considered to be the best measure for calculating the average of growth rates, it was not possible to calculate Geometric mean as the growth rates calculated for the value of output of different industrial sectors at 2012 constant price gave a negative growth rate due to a fall in the value of output in many of the industrial sectors. Hence, the arithmetic mean of the growth rates was calculated.

This calculation was done in two steps. Initially the mean growth rate was calculated for the entire data for 52 years (1960-2011). Next, to study the fluctuations in growth patterns further, the data was divided into five different parts of 10 years' time span each, except for the last period where number of years was 12 (2001-2012). Then a similar calculation and classification was done for each of the data sets for 10 years. Also, for all these periods, the industrial sectors were ranked according to their growth rates. Conclusions drawn from both the studies were compared, giving rise to several interesting results. According to the study of five different decades, many of the industrial sectors have shown different growth patterns during different periods.

Having an idea about the growth pattern of different industrial sectors, we next considered the market concentration behaviour of the industrial sectors. Analysis of growth pattern of industrial sectors was done for 17 different industries. For analysing the market concentration of these industrial sectors, firm level data of the manufacturing sector industries were used from CMIE Prowess database. Given the diverse list of products coming out of these industries, a final list of 19 industries was prepared, which was compatible with the earlier list of 17 industrial sectors in the following manner as shown in Table 1.

Table-1 Final list of products

Classification for market concentration Analysis	Classification for Growth Analysis
Food Products	Food Products
Chemical	Chemical
Iron and Steel	Basic Metals
Minerals	
Beverages and Tobacco	Beverages and Tobacco
Electric Machineries	Electric Machineries
Leather	Leather
Metal Products except machineries	Metal Products except machineries
Machine Tools	Non-electrical machineries
Cement, Asbestos,etc	Non-metallic mineral products
Glass, Ceramic, etc	
Pearls & Precious Stones	
Paper	Paper
Professional and Scientific Tools	Professional and Scientific Tools
Rubber	Rubber
Textile	Textile
Jute and Jute products	
Transport Equipments	Transport Equipments
Wood	Wood

It is to be noted that CMIE reports the unit level data of the firms listed in both National Stock Exchange and Bombay Stock Exchange, along with thousands of unlisted companies and private limited companies. On the other hand, ASI provides data on the registered manufacturing sector. The analysis for market concentration only considers those firms which cater to more than 1% of the total market sales. Hence, the market concentration analysis does not consider the small, unregistered peripheral firms. Thus industry set for growth and concentration analysis become compatible. However, firm level data collected from the Prowess database published by CMIE, is available from 1989. Thus the period of study is from 1989 to 2011. For calculating the critical concentration ratio, we have considered only those firms, which have market share more than 1% (as per the assumption of Parker's model). Hence, the number of firms in each industrial sector varies from 9 to 33. Of these industrial sectors belonging to the New Classification, the Minerals and Pearls & Precious Stones sector were discarded later due to non-availability of data. Hence, it was a final list of 17 industrial sectors again.

IV. COMPUTATIONS AND ANALYSIS

With this set of data, it was next needed to know the possible number of leading firms, in order to decide the value of *k* for calculating the critical concentration ratio. For this purpose, number equivalent was calculated from the Harfindahl indices of each of the industrial sectors. When all the firms in an industry with *n* number of firms have equal market shares, we get $H = 1/n$. Thus, in case of all the firms having equal market share, the inverse of Herfindahl index gives the number of firms in the industry.

However, when the firms have unequal market share, this inverse of *H* tells us how many firms would have been enough to constitute the whole market given these firms had equal contribution in the market. This *1/H* is known as the number equivalent, which can be used as a proxy for the number of leading firms in an industrial sector, having sufficient output to serve the market demand, leaving the small followers far behind. In this analysis, the number equivalent has been calculated for all the industries to get an idea about the number of leading firms.

One noticeable factor found from the data is, though number equivalent varies from 5 to 11, all the industries had 5 leading firms for most of the years. Thus 5 could be considered as the value of the mode. Even when the number of leading firms was more than 5, the top 5 firms always contributed the most. Also, the mean of all the number equivalents rounded up to 5. Thus to compare the industries on the basis of their market concentration and to relate it with their growth pattern, finding a 5 firm concentration ratio can be fruitful.
Hence, we calculated the 5 firm c* and C (actual 5 firm concentration ratios) for each of these 17 industry sectors over the years from 1990 to 2011 at 5% level of significance in the formula defined in Parker's paper (Equation-7). Over this span of 22 years, for each year, firms having a market share of less than 1% have been ignored for calculating *n*. The results are shown in Table 2.

Table-2 Comparison of Growth and market concentration results

Sectors	**Growth Conclusion '90-'99**	**Rank of growth rates'90 to'99**	**C and c* '90-'99**	**Growth Conclusion '00-'12**	**Rank of growth rates '00to'12**	**C and c* '00-'12**
Food Products	High	**2**	c*<C	Low	**10**	c*<C (except for 2012)
Chemical	High	**3**	c*>C	Low	**12**	c*>C
Iron and Steel	Medium	**6**	c*>C	High	**6**	c*>C
Beverages and Tobacco	Low	**7**	c*>C	Low	**9**	c*>C (except for 2012)
Electric Machineries	Low	**10**	c*>C	Medium	**7**	c*>C
Leather	High	**4**	c*>C	Low	**10**	c*>C
Metal Products except machineries	High	**3**	c*>C	Low	**11**	c*>C
Machine Tools	High	**5**	c*>C	High	**6**	c*>C
Cement, Asbestos,etc	Low	**8**	c*>C	Low	**8**	c*>C
Glass, Ceramic, etc	Low	**8**	c*>C	Low	**8**	c*>C(except for 2007, '08, '09)
Paper	Medium	**6**	c*>C	Low	**9**	c*>C
Professional and Scientific Tools	High	**1**	Ambiguous	High	**5**	Ambiguous
Rubber	Low	**7**	c*>C	High	**1**	c*>C
Textile	Medium	**6**	c*>C	Medium	**7**	c*>C
Jute and Jute products	Medium	**6**	c*>C	Medium	**7**	c*>C
Transport Equipments	Low	**9**	c*>C	High	**2**	c*>C
Wood	Low	**9**	c*>C	High	**4**	c*>C (except for 2012)

Table 2 makes it very clear that for most of the industrial sectors, c* is higher than C. Of course there are a few deviations in 2012 for the Wood and Beverages & Tobacco sector, and a marginal deviation in 2007,'08 and '09 in the Glass sector. In fact out of all the sectors, only one sector, that is Food, shows a higher c*<C for all the years except 2012. Thus Food was the only sector which had significant market concentration. Also, for the Professional tools sector C is higher than c*for some of the years. Thus for some of the years, the Professional Tools sector had significant market concentration. However, since this significant market concentration is not consistent over the years, hence, the Professional Tools industry cannot be considered to have overall significant market concentration.

Thus, except Food industry, all other sectors have an insignificant market concentration, except for the Professional Tools sector, which has a significantly concentrated market in some of the years. On the contrary, the growth behaviour and ranks of growth of the industrial sectors show changes over time, though their concentration pattern remains unchanged. However, there is no specific relation between the pattern of growth and the pattern of concentration experienced by each sector.

We, therefore, can conclude that an industry's growth pattern is not directly affected by its market concentration level in any manner, or vice versa. So the question remains that whether there is any indirect association between the two behaviours. If there is even an indirect pattern of relation between the growth and concentration behaviour, then we can try to find out the common factors affecting both. To check that, we next tried to relate and interpret each of the variables in Parker's formula (equation 7) [8] for calculating c*, and tried to find out how they affect c*, and even, C. The main focus was on the fact that how these two patterns behave with entry and exodus of firms (changes in *n*) within the industrial sectors.

Interpretations and Inferences

Following Parker's formula, for calculating the benchmark c*, we have:

n: number of firms having a market share of more than 1%.

k: number of leading firms.

j: number of firms that will control c^* ratio of the total market sales with 95 per cent probability.

Initial difference of firms are assumed away in the market where c* is calculated. c^* can be interpreted as: in case all firms has uniform probability distribution of market share (so there is no inherent difference in firm efficiency) and peripheral firms (having market share less than 1%) are ignored, then c* is the ratio, below which the observed C will lie with 95% probability, if the industry is not significantly concentrated.

'C' is the actual *k* firm concentration ratio assuming firms do have differences in efficiency by construction of Parker's model [8], $j > k$ (equation 7). According to the formula, c* is calculated by summing over *j* to *n*. Thus the minimum value of *j* can be denoted as the minimum number of firms that will control c^* ratio of the total market sales with 95 per cent probability.

According to Parker's assumptions [8], market shares are randomly distributed among firms, and it is assumed that none of the firms enjoy any advantage in terms of productive efficiency. Thus, it is to be noted that market shares are randomly distributed among the firms. So, firms have uniform probability of having a high or low market share. Hence the summation from a specific value of *j* denotes the minimum number of firms required to control the c* ratio of the total market sales with 95 per cent probability, with the assumption that none of the firms enjoy any advantage in terms of efficiency. The minimum value of *j* denotes the maximum market power to the *j* firms. However, any addition to *n* denotes the reduction of market power to each firm, ending in a situation where all the firms have uniform market power, or no market power. In such a situation, $j=n$. Calculation of *j* does not take into account the actual C. Steps for calculating *j* are:

- Calculate *k/n* which gives the lower bound of c, where c is the hypothetical market concentration ratio. Upper bound of c is 1 for calculating the cumulative distribution of S_k.
- Starting from the lower bound, calculate *k/*c for each c varying from lower bound of c to c=1. *k*/c gives the minimum value of *j* (if *k*/c is fraction, *j* is the integer immediately greater than *k*/c).
- For different values of c and corresponding values of *j* find the values of the cumulative distribution function adding from the minimum value of *j* calculated from a specific c till $j=n$.
- Choose that c=c* corresponding to which the cumulative distribution function is equal to 0.95 and choose the *j* corresponding to that c*.

The c referred above is not the actual C, but the lower bound of c calculated from *k/n*. This c is varied from the lower bound, till 1 to get different values of *j*.

Since *j* is the ceiling function of *k*/c with c=1 being the upper bound of c, *j* will always be higher than *k*, or $j/k > 1$. Now, *k* is the variable affecting C and given *k*, *j* is the variable that affects c*. Thus an industry will be significantly concentrated if with ($k < j$) number of leading firms the industry provides an actual concentration ratio C (calculated in presence of market concentration factors) than the benchmark concentration ratio c* (calculated in absence of market concentration factors). Thus c*/C<1 or c*<C, implies significant concentration, and c*/C>1 or c*>C, implies no significant concentration.

In the above analysis, in most of the cases, we have c*>C. So, our primary concern is to check, whether over time, difference between C and c* is decreasing. So it is necessary to study whether with change in *n* and *j*, does an industry, which is significantly not concentrated, move towards concentration. In other words, does C move towards c* and does this movement have any effect on that industry's growth rate? Consequently we need to check, that over time, with changes in *n* and *j*, how are C and c* behaving, and what is the correlation between *j/k* and c*/C (*k* being a constant, and *j* and *k* affecting c* and C).

The range *k*/c* < *j* ≤ *n*, implies, *k/j* < c*, i.e. if *j* increases, lower bound of c* falls. Since c* is calculated from the cumulative distribution of $S_{k,}$, hence, c* decreases as well. Thus, if *j/k* increases, c*/C should fall only if, like *k*, C also remains unchanged. However, the actual behaviour of c*/C will depend on how C behaves with change in *n* and *j*.

V. RESULTS

As the correlation coefficients between *j* and c* were calculated, they showed a negative and significant correlation for all industrial sectors. It can also be shown that there is a strong positive correlation between *n* and *j* and a strong negative correlation between *n* and c*. For example, let us consider the following calculation results on wood industry as shown in Table 3.

Table-3 Wood Products

Years	*j*	*k*	*n*	c*	C
1989	6	5	10	0.92	0.780723
1990	6	5	11	0.89	0.724735
1991	6	5	12	0.86	0.704856
1992	6	5	12	0.86	0.710555
1993	7	5	14	0.81	0.629581
1994	7	5	15	0.79	0.620269
1995	7	5	16	0.76	0.599872
1996	7	5	14	0.81	0.640937
1997	7	5	16	0.76	0.574371
1998	8	5	20	0.68	0.539245
1999	8	5	23	0.64	0.435679
2000	8	5	22	0.65	0.50243
2001	9	5	24	0.62	0.390292
2002	9	5	24	0.62	0.372683
2003	8	5	21	0.67	0.405424
2004	8	5	20	0.68	0.478376
2005	8	5	20	0.68	0.431525
2006	7	5	16	0.76	0.561302
2007	7	5	15	0.79	0.597229
2008	7	5	16	0.76	0.558628
2009	8	5	22	0.65	0.549721
2010	8	5	20	0.68	0.570991
2011	7	5	17	0.74	0.715332
2012	8	5	21	0.67	0.717714

The above data apparently supports the correlation results. However for ready reference, we can next consider the calculated correlation results in Table 4A.

Table-4A Correlation between *n* and c* for Wood Products

		n	c*
n	Pearson Correlation	1	-.994(**)
	Sig. (2-tailed)		.000
	n	23	23
c*	Pearson Correlation	-.994(**)	1
	Sig. (2-tailed)	.000	
	n	23	23

** Correlation is significant at the 0.01 level (2-tailed).

Table-4B Correlation between *j* and c* for Wood Products

		c*	*j*
c*	Pearson Correlation	1	-.960(**)
	Sig. (2-tailed)		.000
	n	23	23
j	Pearson Correlation	-.960(**)	1
	Sig. (2-tailed)	.000	
	n	23	23

** Correlation is significant at the 0.01 level (2-tailed).

Table-4C Correlation between *n* and *j* for Wood Products

		j	*n*
j	Pearson Correlation	1	.963(**)
	Sig. (2-tailed)		.000
	n	23	23
n	Pearson Correlation	.963(**)	1
	Sig. (2-tailed)	.000	
	n	23	23

** Correlation is significant at the 0.01 level (2-tailed).

Thus, the number of firms, that is *n* is correlated to both *j* and c*, and a change in *n* will thus affect both *j/k* and c*/C. Our aim was to check the effect of change in *n*, on C. With a benchmark, c*, available, we can check the difference between C and c*. Thus we can check whether this difference between C and c* changes with the change in *n*, and what is the direction of that change (increase or decrease). Next we can check whether and how these movements in C towards, or away from c* affect the changes or movements in the growth rate. Now, it can be seen in Table-3, as *n* rises, *j* rises and so does *j/k* (as *k* is constant) and also, as *n* rises, c* falls. The correlation results of Tables 4A, 4B and 4C are in support of this relation between *n, j* and c*. Now, if the difference between C and c* decreases with the rise in *n*, then c*/C should also fall. This can happen if C rises with a rise in *n* or even if C falls, the fall in c* is higher than that in C. If C < c*, then in both the cases, C moves towards c*, that is towards the benchmark concentration ratio and the industrial sector moves towards significant concentration. However, the correlation coefficients between *j/k* and c*/C, are neither always negative, nor always significant.

Table-5 Correlation Results between *j/k* and c*/C

	Positive Correlation	**Negative Correlation**
Significant	Wood, Textiles, Transport Equipments	Food, Paper, Glass and Ceramic,
Insignificant	Beverages and Tobacco, Leather, Professional Tools, Rubber, Chemical, Jute, Machine Tools	Cement, Electric Machineries, Iron and Steel, Metal Products

Table 5 summarizes the correlation results between *j/k* and c*/C in different industrial sectors. From this table it is clear that all the industrial sectors do not have significant correlation between *j/k* and c*/C. Six industrial sectors, namely, Wood, Textiles, Transport Equipments, Food, Paper, and Glass & Ceramic exhibit significant correlation between *j/k* and c*/C.

Let's now consider a situation when against a significant positive correlation between *j/k* and c*/C, there is a positive correlation between *n* and *j* and a negative correlation between *n* and c*. So, if *n* rises, *j* rises and c* falls (there being a negative correlation between *j* and c*). Now *k* being a constant (*k*=5 in this case), as *j* rises, *j/k* rises as well. As there is a positive correlation between *j/k* and c*/C, as *j/k* rises, c*/C should also rise. However, c* falls as *j* rises. Thus for c*/C to increase along with an increase in *j/k,* C has to fall, and the fall in C should be more than that in c*. So the difference between C and c* should increase. As a result, for these industries, as *n* rises, C falls, thereby reducing *k* firm concentration and increasing competition. Moreover with the rise in *n*, difference between C and c* increases. As C moves away from c*, and C falls at the same time with increase in *n*, it is quite evident that the new entrants in the market definitely add to the competition. If the difference between c* and C had reduced, it would have meant that, though C falls, facing competition from the new entrants, that competition would not have been strong enough to stop the top *k* firms to move towards a

significant market concentration. However, as C falls more than c*, difference between C and c* increases, depicting a stronger competition from the new entrants.
The three industrial sectors which exhibit such behavior are: Textile, Transport equipment and Wood. So we next tried to check for the correlation coefficients between C and c* for these three industrial sectors, and found that there is a significant strong positive correlation between C and c* for all of these three sectors supporting our above analysis. It is actually true that as c* falls, so does C. If we check carefully in Table 3, we find that the fall in C is higher than that in c*. For example, we again present the result of the Wood Sector in Table 6:

Table-6 Wood: Correlation between j/k and c*/C

		j/k	**c*/C**
j/k	Pearson Correlation	1	.485(*)
	Sig. (2-tailed)		.019
	N	23	23
c*/C	Pearson Correlation	.485(*)	1
	Sig. (2-tailed)	.019	
	N	23	23

Correlation is significant at the 0.05 level (2-tailed).

However, if we need to know whether there is any actual inequality in terms of efficiency of the firms in these industries, then we need to do a study of the supply side factors as well.

Now let's consider the other situation, when there is a significant negative correlation between *j/k* and c*/C and there is a positive correlation between *n* and *j* and a negative correlation between *n* and c*. Hence, if *n* rises, *j* rises and c* falls (there being a negative correlation between *j* and c*).and *j/k* should also rise as *k* is a constant (*k*=5 in this case). There being a negative correlation between *j/k* and c*/C, as *j/k* increases, c*/C should fall. We already know that there is a negative correlation between *j* and c*. Thus c*/C can fall due to two different reasons:

- C rises and c* fall at the same time. If C rises with the rise in *n*, that implies that the top *k* firms are getting more hold on the market in spite of the increase in *n*. The new entrants in the market are not competing with the top *k* firms to get there place.
- Both C and c* falls, but fall in c* is higher than the fall in C. If C falls with the rise in *n*, then the new entrants are adding to the competition.

Thus, as *n* rises, we may get two sets of industries. The ones for which, C rises and the top *k* firms do not face competition from the new entrants and the others for which C falls and the new entrants add to the competition. However in both the cases, difference between C and c* gets reduced. If C rises and c* falls, then the difference between C and c* is getting reduced (if c*>C) and same is true if both C and c* falls and the fall in c* is higher (c*>C). However, if C>c*, then in both the cases, difference between C and c* decreases.
If difference between C and c* gets reduced with rise in *n*, then:

- If C rises and c* falls, then definitely the new entrants do not add to the competition and the power of the top *k* firms increases, and the market moves towards significant concentration.
- When both C and c* falls and the fall in c* is higher, then it means that though the new entrants are adding to the competition, resulting C to fall, yet that competition is not strong enough to prevent the top *k* firms to achieve a significant market concentration.

The three industrial sectors showing the above mentioned behaviours are Food, Paper and Glass & Ceramic. Of these three sectors, Glass & Ceramic shows significant positive correlation between C and c*.

For Food and Paper, the correlation is positive, but not significant. In both of these sectors, C and c* do move in the same direction for most of the years. However, for a few of these 23 years of analysis, the movement of C and c* is opposite, which reduces the significance of the positive correlation between C and c*. This can also be seen in the plots of C and c* against time. These opposite movements of C and c* often lead to a few contrasting conclusions that have been explained later.
Next section makes an attempt to relate the above results of these two sets of industries with their growth patterns.

Study of Growth pattern of the industries alongside their pattern of Market Concentration

Table-7 Industries having significant positive correlation between *j/k* and c*/c

Sectors	**Growth Conclusion '90-'99**	**Rank of growth rates'90 to'99**	**C and c* '90-'99**	**Growth Conclusion '00-'12**	**Rank of growth rates '00to'12**	**C and c* '00-'12**
Textile	Medium	**6**	c*>C	Medium	**7**	c*>C
Transport Equipments	Low	**9**	c*>C	High	**2**	c*>C
Wood	Low	**9**	c*>C	High	**4**	c*>C (except for 2012)

Above three industrial sectors consistently have c*>C (except for the Wood sector in the year 2012). Now for all of these sectors, there is a negative correlation between *n* and c* and a positive correlation between c* and C. Thus, as *n* increases, c* falls, and with a fall in c*, so does C. A similar opposite movement happens when *n* decreases. To check, what is actually happening to C and c*, next, the graphs on *n*, C and c* were plotted over time. Here again, we can take Wood sector as an example.

The growth pattern of the Wood sector shifts from Low to High. The growth rank also shifts from 9 to 4. As we study the plots of *n*, C and c* in Fig.1A and Fig.1B, we find that with an increase in *n*, both C and c* fall with an increase in difference between C and c*. During this period, the sector exhibits a Low growth. As *n* decreases, and C and c* increase, the increase in C is higher than that in c*. In fact, in the year 2012, C becomes higher than c*. During this period, the sector shows a High growth. Thus, as the industry moves towards a significant concentration, its growth pattern improves from Low to High growth.

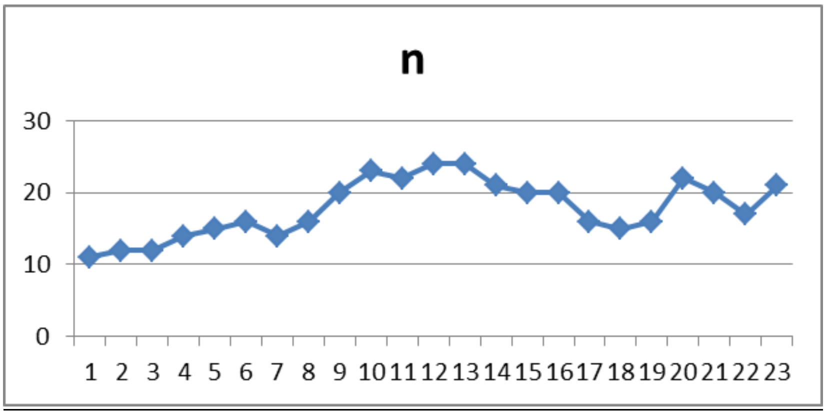

Figure-1A Movement of *n* over time for Wood Sector

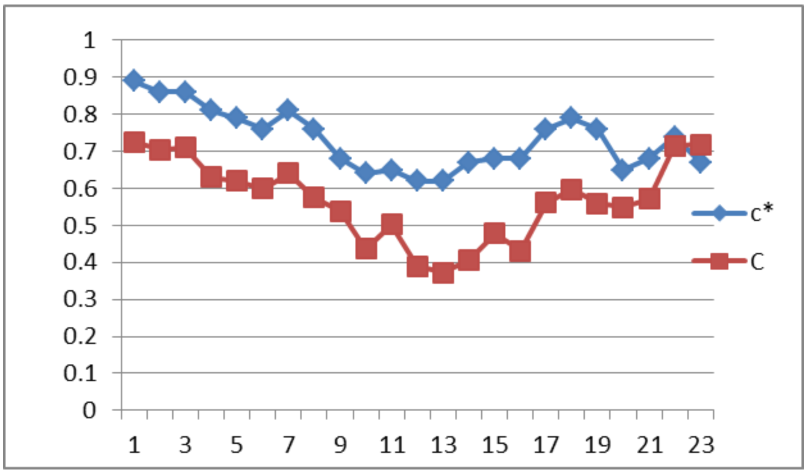

Figure-1B Movement of c* and C over time for Wood Sector

A similar behavior is exhibited in the Transport Equipments sector. Here also, the industry shifts from Low growth during 1990-'99 to High growth during 2000-'12. In the plots of C and c*, it can also be seen that during 2000-'12, except for one or two deviations, C moves closer towards c*. Thus the industry exhibits a higher growth pattern with an improvement in concentration.

In the Textile sector, the industry maintains a medium growth rate in these 23 years. Except for a few years, difference between C and c* also remains consistent over time. This phenomenon again supports our analysis of the relation between an industry's growth pattern and market concentration.

Table-8 Industries having significant negative correlation between *j/k* and c*/c

Sectors	**Growth Conclusion '90-'99**	**Rank of growth rates'90 to'99**	**C and c* '90-'99**	**Growth Conclusion '00-'12**	**Rank of growth rates '00to'12**	**C and c* '00-'12**
Food Products	High	**2**	c*<C	Low	**10**	c*<C (except for 2012)
Glass, Ceramic, etc	Low	**8**	c*>C	Low	**8**	c*>C (except for 2007, '08, '09)
Paper	Medium	**6**	c*>C	Low	**9**	c*>C

The Food sector moves from High to Low growth from 1990-'99 to 2000-'12. The sector consistently exhibits a significant market concentration except for the year 2012. In the Food sector, with rise in n, both C and c* decrease. The fall in c* is higher than that in C. Thus, the difference between C and c* increases. C being higher than c* already, the increase in difference between C and c* makes C even more significantly concentrated with increase in the number of firms (*n*). However, since the year 2008, an opposite movement of C and c* is noticed. As *n* falls, c* improves. However, fall of C implies an increase in competition from the rest of the market. This opposite movement of C and c* since 2008 reduces the significance of positive correlation between c* and C. The industry finally becomes insignificantly concentrated in the year 2012. Alongside, the growth pattern of the industry moves from High growth in 1990-'99 to Low growth in 2000-'12. Fig.2A and Fig.2B show the behaviour of *n*, C and c* over time for the Food sector.

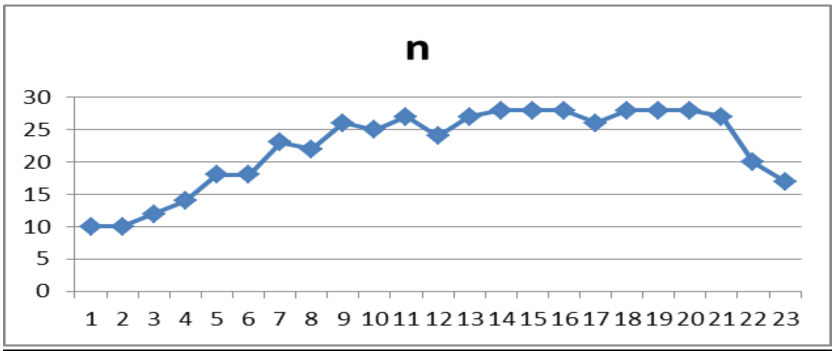

Figure-2A Movement of *n* over time for Food Sector

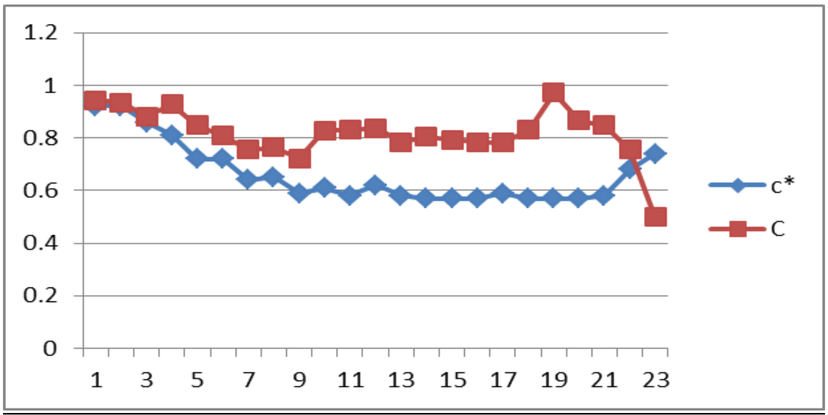

Figure-2B Movement of c* and C over time for Food Sector

In the Paper sector also, this opposite movement of C and c* is exhibited in the later years since 2010 where c* increases with decrease in *n* and C decreases. Like the food sector, here also, this opposite movement of C and c* reduces the significance of positive correlation between c* and C. However, in this sector difference between C and c* is lesser during the initial years, which increases during 2000-12. However from 2010, c* decreases with increase in *n*. During this period C increases, showing a negative correlation with c*. However, the fall in difference between C and c* is not strong enough to move the industry noticeably closer to significant market concentration level. Thus the industry moves from Medium growth in 1990-'99 (when difference between C and c* was lesser) to Low growth in 2000-12 (when difference between C and c* was comparatively higher).

The Glass & Ceramic sector more or less exhibits very close values and consistently correlated and close movements of C and c*. The difference between C and c* remains more or less constant for this industrial sector over time. Alongside, the sector maintains its Low growth pattern over the entire time span.

Thus, it is a general observation that an industry's growth pattern improves, if that industry's market concentration becomes more significant.

VI. CONCLUSION

The main aim of this paper was to find out whether market concentration is high in case of high growth industrial sectors, and low in case of low growth industrial sectors. This study also tries to find out, how the market concentration and growth pattern in a particular industrial sector behave with changes in number of firms (*n*) within the industry.

Although, analysis made in the paper does not provide any direct relation between the growth and the concentration behaviour of the industrial sector over time, it checks for the changes in the market concentration of the industries over time. The study has revealed that as the market concentration of the industrial sector moves towards significant concentration with a change in the number of firms, the industry exhibits a higher growth path. This implies that as the performance of the leaders in the industry improves, so does the industry's growth pattern and vice versa. The six industrial sectors which exhibit such behaviour are Food, Glass & Ceramic, Paper, Textile, Transport Equipment and Wood.

However, the analysis does not claim that higher market concentration is essential for an industrial growth. Instead, the analysis provides statistical findings to explain the growth pattern in an industrial sector, with reference to the market concentration as an indirect factor. In order to check what is actually happening, it is necessary to have a rigorous supply side analysis as well. This paper actually provides a foundation for a further research where it can be checked which industry is actually growing and also gaining in terms of efficiency, with a change in the number of firms. It also provides an overview of the possible relation between market concentration and growth in an industrial sector, which needs to be considered for policy prescriptions regarding inclusive growth.

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IOSR Journal Of Humanities And Social Science (IOSR-JHSS) is UGC approved Journal with Sl. No. 5070, Journal no. 49323.

Baishali Bagchi. "Impact of Market Concentration on the Growth of Selected Manufacturing industries in India using Mauldon Distribution." IOSR Journal Of Humanities And Social Science (IOSR-JHSS) 22.7 (2017): 06-17.