DOES MARKET STRUCTURE MATTER? EVIDENCE FROM THE INDIAN CEMENT INDUSTRY

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Abstract:

The main objective of this paper is to answer the question; does the market structure explain the variation in profitability of Indian cement industry? If yes, which measure; if no, why not? To answer this question, we used the empirical technique, the Davidson-MacKinnon's J test, to test the non-nested hypotheses to choose among the three competing measures of the market structure, CR4, HHI, and CV of market share. We found that none of the measures of market structure are able to explain the variation in profitability of the Indian cement industry. In other words, neither concentration (measured in terms of CR4 and HHI) nor efficiency of the firms (measured in terms of CV of market share) is able to explain the variation in profitability. This result is in line with our expectation since, unlike industry profitability, none of the measures of market structure changed significantly during the sample period. Since Competition Commission of India in June 2012 found 11 cement companies indulging in a price cartel, it is clear from the findings that market structure alone cannot explain the behavior of firms in certain market such as cement industry in India. To detect cartel in such market, more detailed examination is required both at industry as well as firm level.

Key words: *Cement industry, Market Structure, Profitability, and India*

1. Introduction

In the classical tradition, following Bain (1951, 1956), it was propounded that increase in the market concentration, measured by the Four Firm Concentration Ratio Index (CR4) and/or Hirschman Herfindahl Index (HHI), tend to raise industry profit by assuming that it facilitates collusion. In this tradition, industry profit is assumed to be primarily determined by the ability of the established firms to restrict rivalry and to protect themselves by creating barriers to entry. Most of the classical studies included

CR4 and/or HHI as independent variables in the regression analysis of industry profitability and reported the coefficient of the same to be positive and statistically significant (see, Weiss (1974) and Scherer (1980) for a survey of cross-sectional studies in the classical tradition).

An anti-classical revisionist view of industrial economics which emerged in 1970s and 1980s propagates that all markets are competitive and scale economies are either absent or negligible. Although revisionist view seems to have been articulated explicitly first by Demsetz (1973), interesting formal models consistent with this view have been developed by Peltzman (1977), Jovanovic (1982), Lippman and Rumelt (1982), and others. The key assumption is that within an industry there are persistent efficiency differences among firms. An efficient firm will be able to increase its market share only at the expense of its rivals and therefore, experiences higher level of profitability. In other words, an increase in inequality of market share of firms in an industry will lead to higher level of profits for the leading firms and consequently for industry as well. The revisionists' view implies that the Market Share (S) and/or the inequality in market share (e.g., measured in terms of the Coefficient of Variation (CV) of the same) should appear as the main determinant of the profitability in the regression analysis.

Ravenscraft (1983) found that the impact of market share on profitability is positive and significant, while the coefficient of CR4 in the same regression is negative and significant. He interpreted his results as providing strong support for the revisionist argument that the significance of CR4 in traditional industry-level cross-sectional regressions arises because it is correlated with market share (and thus efficiency) differences, not because it facilitates collusion. Branch (1980), Gale and Branch (1982), and several others have obtained similar results. The strong relation between market share and profitability found in many studies is difficult to interpret within the classical tradition, given the apparent absence of scale economies in many industries.

The approach in many of the previous studies for instance, Kwoka (1979), Kwoka (1981), and Ravenscraft (1983) has been to use statistical tests of nested hypotheses to make the choice among the market share, the inequality of market share, the four firm concentration ratio index, and the Hirschman Herfindahl index. Furthermore, most of the studies are based on the industry data from developed countries. There are not many studies using industry data from developing countries in general and India in particular (see, Singh and Sharma (2006) for a study on Indian car industry).

The prime objective of this paper is to find out whether any measure of market structure can explain the variation in profitability of Indian cement industry. If yes, which measure; if no, why not? To answer this question, we used the empirical technique, the *Davidson-MacKinnon's J* test, to test the non-nested hypotheses. In this paper, we have tried to provide the estimates of the relative significance of the four firm concentration ratio, the inequality of market share, and the Hirschman Herfindahl index

in determining the profitability of the Indian cement industry. We did not consider the market share of leading firm (S1) as an important determinant of industry profitability because its share is not only less than 20% but also insignificantly different from that of second leading firm almost every year of the sample period. Therefore, market share of leading firm alone is not expected to explain the variation in profitability of Indian cement industry. Recently, cement industry in India has been in news for wrong reasons; 11 cement manufacturers, ACC, Ambuja Cement, Grasim Industries (now merged with Ultratech Cement), Jaiprakash Associates, JK Cement, India Cements, Madras Cements, Century Cement, Binani Cement, Lafarge Cement, and Shree Cement, were found to be guilty of cartelization. The Competition Commission of India (CCI) in June 2012 had imposed a penalty of Rs. 6,300 crore on these 11 cement companies. Penalty was equivalent to 50% of their average profit for fiscal year 2009-10 and 2010-11, the period for which they were investigated. The top 4 cement companies, ACC, Ambuja Cement, Ultratech Cement, and Jaiprakash Associates, were fined in excess of Rs. 1,000 crore each. In this paper, we have also tried to find out the evidence of cartelization among leading firms in the industry and the lessons learned from the same.

The remainder of the paper is organized as follows: Section 2 deals with the data description and data sources. Section 3 outlines the specification of the model used for the study. Section 4 presents the empirical results. The concluding remarks are presented in the final section of the paper.

2. The Data

This study is carried out using firm as well as industry level annual data. The data has been obtained from the Centre for Monitoring Indian Economy's Prowess data base from the period 1997 to 2011. The study uses data on number of variables; Table 1 presents the same along with their definition and sources. The list of firms included in the study is presented in the Appendix along with their market share (ratio of individual firm's sales revenue to industry sales revenue) for selected years. List includes 76 firms including all large size firms for which consistent data are available. The Indian cement industry is somewhat concentrated since top 20 firms capture the 90% of the market. The CR4 concentration index, aggregate market share of top 4 firms in the industry, is close to 50% (see, Table 2).

Table 2 presents industry profitability, advertising intensity, capital intensity, four-firm concentration ratio index, Hirschman-Herfindahl index, and Coefficient of Variation of market share over the sample period. These variables have been used for the analysis presented in next sections. However, it is interesting to note that industry's profitability, profit after tax to sales revenue ratio, varied from -5% in 1998 to 16% in 2007. In fact, industry made the financial losses till 2002. This may be because Indian cement industry has witnessed huge capacity addition in the expectations of increase

in demand during 1990s. Also, in the late 1990s further capacities were added to take the advantage of sales tax benefits before they were phased out in 2002. But the increase in demand for cement was not as much as it was expected which left the industry with huge surplus capacity, leading to fall in prices and consequently decline in profit (Anand, 2009). After the period 2002, profitability of industry has been positive in the range of 0.5% to 16%. Moreover, industry experienced unduly high level of profitability from 2006 to 2009. The decline in profit in the recent period after 2009 can be attributed to economic slowdown in the country due to financial crisis in the US and CCI's investigation against 39 cement companies on a complaint filed by the Builders Association of India (BAI), a lobby group of engineering and construction contractors. After the investigation, the commission felt that cement companies had deliberately underutilized available production capacity to reduce the supply and raise the prices. As a result, in June 2012, the commission slapped a fine on top 11 cement manufacturers in India for indulging in a price cartel. The fine was 50% of their average profit for fiscal years 2009-10 and 2010-11, the period for which they were investigated.

Huge variability in industry profitability from 1997 to 2011 despite the fact that none of the measures of market structure has changed significantly during the same period shows that there is enough reason to suspect cartelization in the industry particularly during the period of excessively high profitability. A simple regression analysis, where CR4, HHI, and CV of market share are regressed over time, shows that none of the measures of market structure are changing significantly over the time since coefficient of time in all the three cases is statistically insignificant. This shows that neither concentration (measured in terms of CR4 and HHI) nor efficiency (measured in terms of CV of market share) in the market is changing significantly. If profit of industry is varying significantly without significant change in concentration or efficiency, suspecting cartelization in the industry is obvious particularly during the period of unduly high prices and consequently excessive profitability. Table 2 also shows that the advertising intensity of the industry is relatively low during 2006-09 period when industry profitability is very high. Although advertising intensity, advertising and marketing expenditure to sales revenue ratio, in the industry is in the range of 2.3% to 3.1% during the sample period, it was in the range of only 2.3% to 2.6% during 2006-09. Although advertising intensity is expected to be low in cement industry since cement is somewhat homogenous product, reduction in advertising intensity during certain period particularly when profits are high indicates that the competition is lessening in the industry due to may be because of cartelization. If we analyze the trend in capital intensity, net fixed assets to sales revenue ratio, over the sample period, we can find that the intensity is relatively low during recent period particularly during 2006-09. Lower capital intensity should have made the industry more competitive during recent period; however, as discussed before, industry

profitability increased tremendously after 2005. All these are clear indicators of cartelization in the industry during recent period.

Table 3 presents the correlation coefficients between profitability and various structure measures. It should be noted that the correlation coefficient measures the degree of linear association only. A simple method to test the null hypothesis that the correlation coefficient is zero can be obtained using the Student's t-test. Table 3 shows that the profitability of cement industry in India is statistically insignificantly correlated with CR4, HHI, and CV of market share. This is in line with the expectation since, unlike profitability, none of the measures of market structure has changed significantly during the sample period. As expected, CR4 is statistically significantly correlated with both HHI and CV of market share. However, HHI and coefficient of variation of market share is not correlated significantly since they cover different aspects of market structure (see, section 4 of this paper and Forgey, Mullendore and Rutherford (1997)). One should note that a high correlation between two measures of market structure and substantial correlation between one measure and industry profitability need not imply any relationship whatsoever between the other measure and profitability. Certainly, they do not imply a relationship of similar size and/or significance (Kwoka (1981)).

Table 1: Variable definition and their measurement

Variable	Definition & Measurement	Sources
Profitability	Profit after tax (PAT) divided by sales revenue	CMIE, Prowess
Advertising Intensity	Advertising and marketing expenditure to sales revenue ratio	CMIE, Prowess
Capital Intensity	Net fixed assets divided by sales revenue	CMIE, Prowess
Four Firm Concentration Ratio Index (CR4)	Aggregate market share of the top four firms in the Industry (in terms of sales revenue)	CMIE, Prowess and Authors' Construction
Hirschman-Herfindahl Index (HHI)	Sum of squares of the market share of all the firms in the industry	CMIE, Prowess and Authors' Construction
Coefficient of Variation (CV)	Ratio of standard deviation of market share to the mean of market share	CMIE, Prowess and Authors' Construction

Table 2: Profitability, advertising intensity, capital intensity, and various structure measures for the Indian cement industry

Year	Profitability	Adv. Intensity	Capital Intensity	HHI	CR4	CV
1997	-0.003	0.030	0.794	0.073	0.449	1.767
1998	-0.052	0.029	0.847	0.074	0.474	1.896
1999	-0.053	0.026	0.841	0.074	0.468	1.928
2000	-0.030	0.030	0.800	0.074	0.467	1.904
2001	-0.016	0.028	0.861	0.075	0.464	1.902
2002	-0.006	0.025	0.824	0.074	0.464	1.930
2003	0.005	0.028	0.860	0.071	0.410	1.795
2004	0.037	0.027	0.730	0.069	0.465	1.862
2005	0.083	0.026	0.600	0.080	0.494	2.067
2006	0.152	0.026	0.503	0.073	0.479	1.936

2007	0.163	0.023	0.497	0.068	0.447	1.833
2008	0.125	0.023	0.549	0.065	0.435	1.763
2009	0.131	0.026	0.586	0.067	0.436	1.763
2010	0.080	0.030	0.700	0.083	0.492	1.932
2011	0.086	0.031	0.623	0.091	0.493	1.897

Table 3: Correlation matrix

	Profitability	HHI	CR4	CV
Profitability	-			
HHI	-0.11 (-0.39)	-		
CR4	-0.02 (-0.08)	0.75 (2.64)	-	
CV	-0.14 (-0.50)	0.58 (2.06)	0.81 (2.86)	-

Note: Figures in parentheses are their respective t-values.

3. Empirical Model Specification

The approach in early empirical studies has been to use statistical tests of nested hypotheses to make the choice among the four firm concentration ratio index, the Hirschman Herfindahl index, and the inequality of market share. Equation (1) presents the basic specification of such regression models:

$$Profitability\ \left(\frac{\Pi}{R}\right) = \beta_0 + \beta_1 X_1 + \cdots + \beta_m X_m + \gamma_1 Z_1 + \cdots + \gamma_n Z_n + \varepsilon \qquad (1)$$

where *X's* denote explanatory variables other than the structure measures, *Z* denote various structure measures, and ε represents an error term.

By comparing t-statistics for the coefficients of structure measures and performing F test for restricted models, previous empirical studies have made the choice among different structure measures. The F test allows us to decide, at a particular significance level, whether at least one variable in the group affects the dependent variable or not. This test does not allow us to decide which of the variable has an effect (Gujarati, 2012). It is evident that the four firm concentration ratio index, the inequality in market share and the Hirschman Herfindahl index capture different aspects of the market structure. Kwoka (1981) has argued that high correlation among the market structure variables does not imply that all these will have same correlation with the profitability. Thus, we are facing the issue of the relative pertinence of the structure measure vis-à-vis other measures. The approach adopted to tackle this specification problem is to assume that the choice problem is simple with only one of the many structure measures being relevant to be included in the empirical analysis of industry profitability. This approach treats the choice among CR4, CV and HHI as a test of non-nested hypotheses and utilizes the J test technique developed by Davidson and MacKinnon (1981). This technique also overcomes the problem of correlation among explanatory variables (Gujarati, 2012). Statistically significant correlation

among few of the concentration measures used in this study further necessitates the use of the J test (see, Table 3).

Let us assume that CR4 is the relevant measure of market structure for the Indian cement industry. It then becomes possible to predict what results will be obtained when other measures like CV and HHI are substituted for the CR4. If the assumption holds, this would imply for the testable hypothesis that, for the sample considered, the results obtained for the CR4 model can account for those obtained with say CV or HHI as explanatory variable and not *vice versa*. To illustrate this test, suppose we want to compare the two "competing" hypotheses with CR4 (equation 2) and CV (equation 3) as alternate regressors, for explaining the profitability of the industry:

$$\left(\frac{\Pi}{R}\right)_t = \beta_0 + \sum_{i=1}^{m} \beta_i X_{it} + \gamma_1 CR4_t + \varepsilon_{CR4t} \quad (2)$$

$$\left(\frac{\Pi}{R}\right)_t = \beta_0 + \sum_{i=1}^{m} \beta_i X_{it} + \gamma_2 CV_t + \varepsilon_{CVt} \quad (3)$$

where t denotes time and all other variables have their previous meaning.

The simplest approach for testing non-nested hypotheses involves the technique that has come to be referred as artificial nesting (Gujarati, 2012). This involves performing F test on the combined equation:

$$\left(\frac{\Pi}{R}\right)_t = \beta_0 + \sum_{i=1}^{m} \beta_i X_{it} + \gamma_1 CR4_t + \gamma_2 CV + \varepsilon_{CR4CVt} \quad (4)$$

The null hypothesis then is:

H_0: Equation (2) represents the true model; and

H_A: Equation (2) does not represent the true model.

Since, the hypotheses test CR4 against a hybrid of CR4 and CV rather than against CV, artificial nesting fails to solve the model selection problem (Gujarati, 2012). A non-nested test requires that CR4 be tested against CV, not against a hybrid of CR4 and CV. Davidson and MacKinnon (1981) have suggested an alternative to this, which is represented by equation (5).

$$\left(\frac{\Pi}{R}\right)_t = (1-\alpha)\left(\beta_0 + \sum_{i=1}^{m} \beta_i X_{it} + \gamma_1 CR4_t\right) + \alpha\left(\beta_0 + \sum_{i=1}^{m} \beta_i X_{it} + \gamma_2 CV_t\right) + \varepsilon_t \quad (5)$$

The null hypothesis tests that $\alpha = 0$. If null hypothesis is not rejected, it suggests that equation (2) represents the true model. After testing CR4 against CV, it is required to test CV against CR4 as well. A difficulty arises since α is not identified. Davidson and MacKinnon (1981) have suggested substituting the least square estimators obtained from equation (3) to identify α. In other words, predicted value of $(\pi / R)_t$ obtained from equation (3) could be used to replace the α variable. Therefore, equation (5) can be written as:

$$\left(\frac{\Pi}{R}\right)_t = (1-\alpha)\left(\beta_0 + \sum_{i=1}^{m} \beta_i X_{it} + \gamma_1 CR4_t\right) + \alpha * Predicted\left(\frac{\Pi}{R}\right)_{CVt} + \varepsilon_t \quad (6)$$

where $Predicted\left(\frac{\pi}{R}\right)_{CVt}$ represents predicted value of profitability obtained from equation (3).

Economic intuition behind this specification is that $Predicted\left(\frac{\pi}{R}\right)_{CVt}$ contains all the information provided by the equation (3) (for further discussion on this issue, see Amato (1995)). The hypothesis that $\alpha = 0$ can be tested using the t-test. If the hypothesis that $\alpha = 0$ is not rejected, we can accept (i.e., not reject) equation (2) as the true model. If the null hypothesis is rejected, equation (2) cannot be the true model. As mentioned above, we need to reverse the role of models that is to test CV against CR4. In that case, we will use the predicted value of $(\pi / R)_t$ obtained from the equation (2), that is, $Predicted\left(\frac{\pi}{R}\right)_{CRt}$ instead of $Predicted\left(\frac{\pi}{R}\right)_{CVt}$ as presented in equation (7).

$$\left(\frac{\pi}{R}\right)_t = (1-\alpha)\left(\beta_0 + \sum_{i=1}^{n}\beta_i X_{it} + \gamma_1 CV_t\right) + \alpha * Predicted\left(\frac{\pi}{R}\right)_{CRt} + \varepsilon_t \quad (7)$$

We now again test the hypothesis that $\alpha = 0$. If this hypothesis is not rejected, we choose equation (3) over equation (2). If the hypothesis that $\alpha = 0$ is rejected, we will choose equation (2) over equation (3). There are a few problems with the J test. As mentioned by Gujarati (2012), a clear preferred/true model may not emerge. Either both the models could be rejected or neither could be rejected. In the earlier case, neither model helps us to explain the behavior of the industry profitability. In the latter case, we can use adjusted R-square to choose between them (Gujarati, 2012).

Application of the J test for this study would involve model selection focusing on the choice among the three competing market structure measures. These measures are CR4, HHI, and CV. We apply the J test to test each measure against all the other measures and delete individual measure if α is not significantly different from 0. The three models which have been tested in this study are as follows:

$$\left(\frac{\pi}{R}\right)_t = \beta_0 + \sum_{i=1}^{2}\beta_i X_{it} + \gamma_1 CR4_t + \varepsilon_{CR4t} \quad (8)$$

$$\left(\frac{\pi}{R}\right)_t = \beta_0 + \sum_{i=1}^{2}\beta_i X_{it} + \gamma_1 HHI_t + \varepsilon_{HHIt} \quad (9)$$

$$\left(\frac{\pi}{R}\right)_t = \beta_0 + \sum_{i=1}^{2}\beta_i X_{it} + \gamma_1 CV_t + \varepsilon_{CVt} \quad (10)$$

In all the models, besides market structure measures, advertising intensity and capital intensity are included to capture the product differentiation and entry barriers, respectively. Advertising intensity is expected to be positively related to profitability. Capital intensity is also expected to be positively related with profitability in the long-run; however, it may show negative relationship with profitability in the short-run due to

underutilization of capacity. The results presented in Section 4 show that coefficients of both the variables have expected sign.

4. Empirical Results and Analysis

The choice among the three competing measures of the market structure– CR4, HHI, and CV of market share has been made using the *Davidson and MacKinnon's J* test. The following example reveals that why CR4, HHI, and CV of market share are different measures of market structure. Since it is very obvious to understand the difference between CR4 and HHI, let us try to have an example to understand the difference between CR4/HHI and CV of market share. CR4 and HHI index is equal to 40 and 1000, respectively in each of the following cases: (i) an industry composed of one large firm with market shares of 25% and fifteen small firms selling 5% each; and (ii) an industry composed of ten firms with each having 10% of the market share. Although CR4 and HHI are same in both the industry, market structure is different for obvious reasons. Clearly, market concentration is higher in the first case as compare to the second one. The coefficient of variation of market share could capture this aspect of the market structure since it exhibits inequalities among the firms in an effective way. The value of CV of market share declines from 0.8 for the first industry to 0 in the second industry.

Tables 4 to 6 report the results obtained from the J test. Our first hypothesis is that Model (8), CR4, is the true model. It is to be tested against other competing models (Models 9 and 10). For the reasons mentioned in Section 3, all the competing models (Models 9 and 10) have to be tested separately against Model (8) to draw conclusive inferences. Table 4 reports the results of the first step of the hypothesis testing that CR4 is the true measure of market structure. Result of the table shows that $\alpha = 0$ could not be rejected when CR4 is tested against all other structure measures. It implies that CR4 is to be accepted as the true measure of market structure. Second step of the test involves testing CV and HHI against CR4 individually. Tables 5 to 7 contain the information for the same. We found that HHI cannot be accepted as the true measure of market structure against CR4 but can be accepted against CV. However, CV can be accepted as the true measure of market structure against both CR4 and HHI. This shows that both CR4 and CV can be accepted as the true measure of market structure in Indian cement industry. However, results presented in Tables4 and 6 show that the coefficient of CR4 and CV respectively is not only negative but also statistically insignificant at 5% level of significance. Therefore, we can conclude that none of the measures of market structure – CR4, HHI, and CV of market share are able to explain the variation in profitability of the Indian cement industry.

This result was somewhat expected since, unlike industry profitability, none of the measures of market structure changed significantly during the sample period. As discussed in Section2, it is clear that neither concentration (measured in terms of CR4

and HHI) nor efficiency (measured in terms of CV of market share) of the firms is able to explain the variation in profitability. Then, what explains the variation in profitability of Indian cement industry? Investigating a complaint filed by the Builders Association of India, the Competition Commission of India in June 2012 found 11 cement companies, including ACC, Ambuja Cement, Ultratech Cement, and Jaiprakash Associates, indulging in a price cartel. These top four cement companies were fined in excess of Rs. 1,000 crore each. Others that were fined include Grasim (now merged with Ultratech Cement), JK Cement, India Cements, Madras Cement, Century Cement, Binani Cement, and Lafarge India. These companies were fined 50% of their average profit for fiscal years 2009-10 and 2010-11, the period for which they were investigated. Therefore, variation in profitability of cement industry in India can be attributed largely to cartelization in the industry rather than change in concentration in the industry or efficiency of the firms.

If we analyze the change in advertising and capital intensity in the industry, we find that the advertising and capital intensity is relatively low during 2006-09 period when industry profitability is excessively high (see, Figure 1 for change in industry profitability from 2003 to 2011). Reduction in advertising intensity during certain period particularly when profits are high indicates that the competition was lessening in the industry may be because of cartelization. If we analyze the trend in capital intensity over the sample period, we can find that the intensity is relatively low during recent period particularly during 2006-09. Lower capital intensity should have made the industry more competitive during recent period; however, as discussed before, industry profitability increased tremendously after 2005. All these are important indicators of cartelization in the industry during recent period.

To examine the findings of the Competition Commission of India, we also tried to analyze the change in profitability and advertising intensity of the firms found to be guilty of cartelization. Since consistent data is available only for 8 out of 11 faulted firms, we used only 8 firms' data from 2003 to 2011 to analyze the change in profitability and advertising intensity. Figure 2 shows the change in profitability of faulted firms from 2003 to 2011. This figure clearly reveals that, as is the case with industry as a whole, faulted firms' profitability peaked in 2007. At least one faulted firm's profit after tax in 2007 was in excess of 25% of its sales revenue whereas some of the faulted firms' profit after tax was in excess of 15% of their sales revenue. In general, as is the case with industry as a whole, faulted firms' profitability was relatively higher during 2006-09 period vis-à-vis other period. When neither concentration in the market (measured in terms of CR4 or HHI) nor efficiency of the firms (measured in terms of coefficient of variation of firms' market share) changed significantly, such a high rate of profitability could be taken as a signal of cartelization in the industry.

Figure 3 presents faulted firms' advertising intensity from 2003 to 2011. This figure clearly shows that faulted firms' advertising and marketing expenditure as a proportion to their respective sales revenue has declined from 2005 till 2009. This

reiterates the possibility of cartelization during the same period since reduction in advertising intensity indicates lessening of competition among firms, which happened at a time when firms' profitability was increasing.

Moreover, it is important to note that the cement companies divide the territory of India into five zones (north, east, west, central, and south) from marketing perspective which can enable them to control the supply and fix high prices since each zone is dominated by only few players. For example, main suppliers in central zone are ACC, Ultratech, Jaypee, Century, Birla Corp, Shree, JK Lakshmi, and ACL. Similarly, in all other zones, number of main suppliers is less than 10. The price change across the five zones over the years reveals that, more often than not, prices in each zone got increased simultaneously. This happened even when capacity was underutilized and demand was sluggish due to economic slowdown in the country; for example, cement price per bag increased by Rs. 5 between December 2008 and February 2009, Rs. 10 to Rs. 27 between January-March and April-June 2009, and Rs. 5 to Rs. 39 between January and March 2010.

However, it is important to note that detection of cartel is difficult because it is difficult to differentiate between competitive behavior and a cartel. There are two methodological approaches to detect cartels – behavioral and structural. Behavioral approach rely on leniency and other information like whistle blowing and indirect evidence whereas structural approach uses indicators like supply and demand, price of the product and profit of the firms and industry, number of firms, firm size, and concentration in the industry. Since cartel agreements are usually verbal rather than in written form, detecting the same through economic indicators is very difficult. However, economic indicators do provide fairly good idea about competitive environment in the industry.

Figure 1. Change in profitability of Indian cement industry

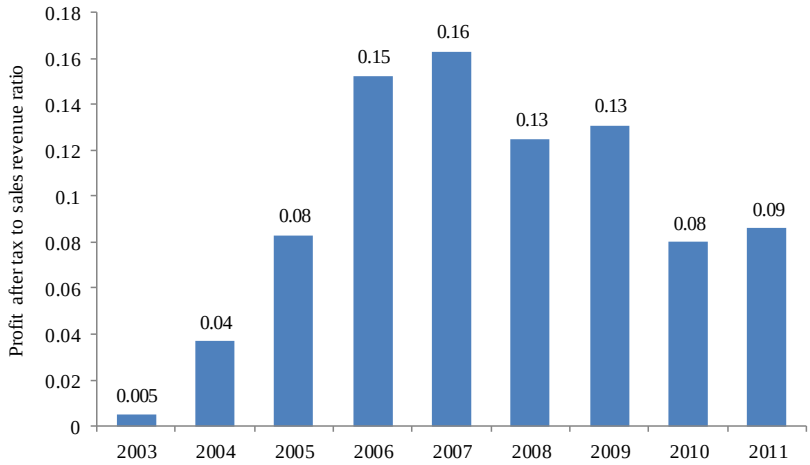

Figure 2. Change in profitability of faulted firms

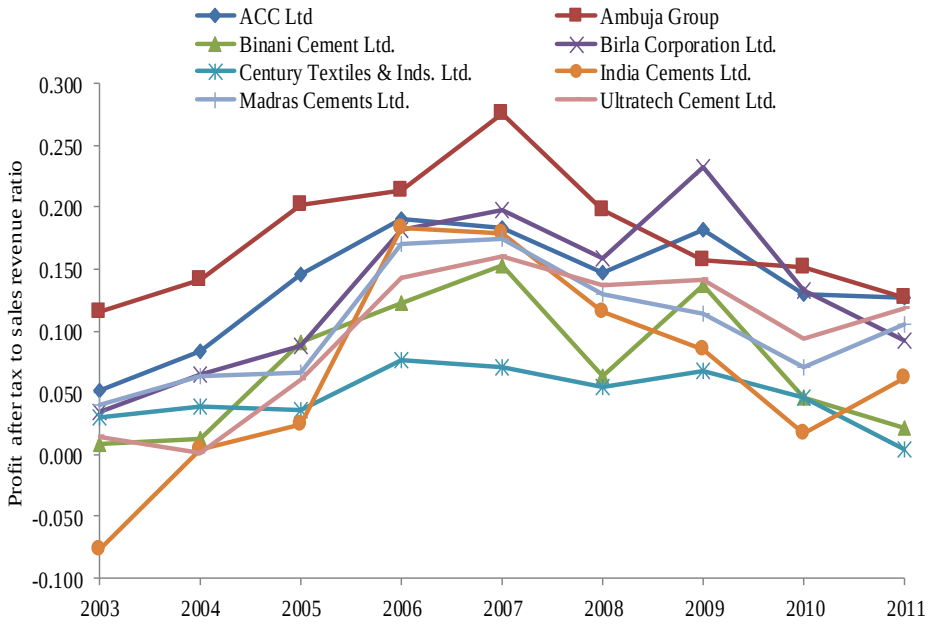

Figure 3. Change in advertising intensity of faulted firms

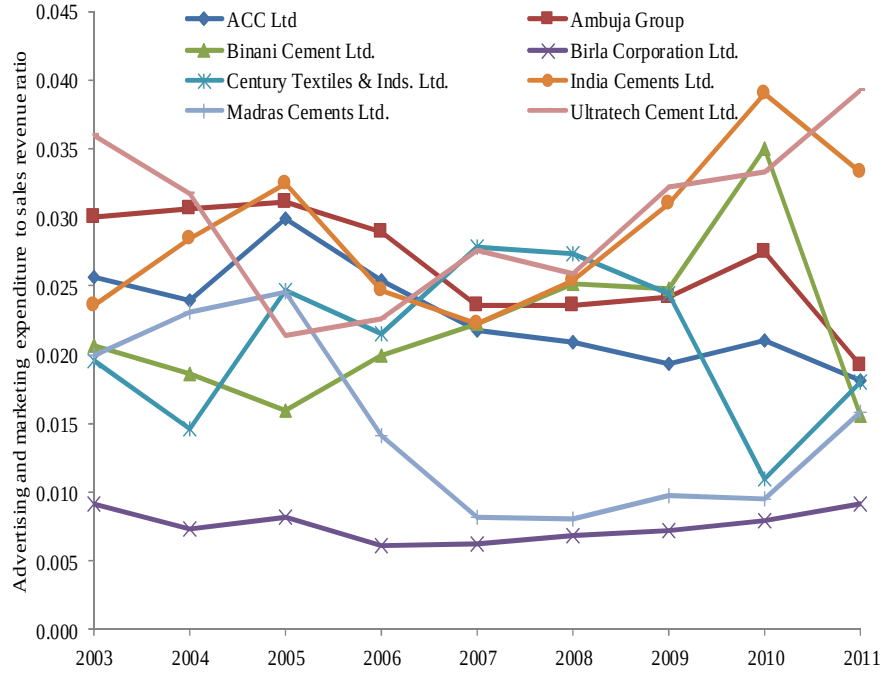

Table 4. Results of the J test for CR4 (t-values in parentheses)

	CR4	CR4 vs. CV	CR4 vs. HHI
Intercept	0.59 (5.34)	1.06 (1.35)	2.38 (2.17)
Adv Intensity	3.02 (1.04)	4.30 (1.16)	4.97 (1.67)
Cap Intensity	-0.56 (-11.67)	-1.04 (-1.32)	-2.65 (-2.08)
CR4	-0.49 (-1.96)	-0.77 (-1.77)	-0.89 (-2.64)
$\wedge$ $(\pi / R)_{CV}$	-	-0.87 (-0.60)	-
$\wedge$ $(\pi / R)_{HHI}$	-	-	-3.91 (-1.64)
R^2	0.94	0.94	0.95

Table 5. Results of the J test for HHI (t-values in parentheses)

	HHI	HHI vs. CV	HHI vs. CR4
Intercept	0.43 (5.56)	0.62 (3.69)	0.64 (5.27)
Adv Intensity	2.14 (0.51)	-1.06 (-0.22)	0.64 (0.17)
Cap Intensity	-0.54 (-9.72)	-0.52 (-9.02)	-0.55 (-11.32)
HHI	-0.75 (-0.58)	0.90 (0.50)	1.66 (1.04)
$\wedge$ $(\pi / R)_{CV}$	-	-	-
$\wedge$ $(\pi / R)_{CR4}$	-	-0.13 (-1.28)	-0.76 (-2.12)
R^2	0.94	0.93	0.92

Table 6. Results of the J test for CV (t-values in parentheses)

	CV	CV vs. CR4	CV vs. HHI
Intercept	0.58 (4.14)	-0.30 (-0.40)	1.95 (1.45)
Adv Intensity	0.83 (0.29)	0.32 (0.11)	1.06 (0.38)
Cap Intensity	-0.53 (-10.89)	0.22 (0.35)	-2.08 (-1.38)
CV	-0.95 (-1.37)	0.062 (0.69)	-0.17 (1.68)
$\wedge$ $(\pi / R)_{CR4}$	-	1.44 (1.28)	-
$\wedge$ $(\pi / R)_{HHI}$	-	-	-2.92 (1.03)
R^2	0.93	0.94	0.94

Table 7. Concise presentation of the J test results

Competing Model → / True Model ↓	CV	CR4	HHI
CV	-	Accepted	Accepted
CR4	Accepted	-	Accepted
HHI	Accepted	Rejected	-

5. Concluding Remarks

Previous empirical studies of the classical tradition on structure performance model have advocated four firm concentration ratio index or Hirschman Herfindahl index as the deterministic variable explaining the industry profitability. It has been argued that tacit collusion among the firms, captured by these measures of market structure, leads to higher industry profitability. An anti-classical view supports coefficient of variation of market share as a superior measure as it captures the efficiency aspect. The revisionists claim that efficiency rather than collusion explains variation in profit (Singh and Sharma (2006)).

Many empirical studies on these issues have treated the choice among market structure measures, CR4, HHI, and CV of market share, as a test of nested hypotheses. These studies have employed F test to compare among various structure measures. This technique is not an appropriate choice as these measures capture different aspects of the market structure. *Davidson and MacKinnon's J* test technique allows us to perform hypothesis tests on model that otherwise may be affected by specification error and multicollinearity problem. Since, the J test is based upon a single coefficient that captures the explanatory power contributed by the entire alternative model, linear correlation between individual explanatory variables fails to influence the test. For these reasons we have employed this technique to choose among the three competing measures of the market structure, CR4, HHI, and CV of market share.

However, we found that none of the measures of market structure, CR4, HHI, and CV of market share, are able to explain the variation in profitability of the Indian cement industry. In other words, neither concentration (measured in terms of CR4 and HHI) nor efficiency of the firms (measured in terms of CV of market share) is able to explain the variation in profitability. This result was somewhat expected since, unlike industry profitability, none of the measures of market structure changed significantly during the sample period. Since Competition Commission of India in June 2012 found 11 cement companies indulging in a price cartel, it is clear that market structure alone cannot explain the behavior of firms in certain market such as cement industry in India. To detect cartel in such market, more detailed examination is required both at industry as well as firm level.

6.References

Amato, L. (1995), *The Choice of Structure Measures in Industrial Economics*, Quarterly Journal of Business and Economics, Vol. 34, no. 2, pp. 39-52.

Anand, S. (2009), *Identifying Cartels using Economic Evidence: A Case Study of Indian Cement Industry*, Competition Commission of India, New Delhi, available online at http://cci.gov.in/images/media/ResearchReports/IDENCARTELSECO_20091211183651.pdf).

Bain, J. S. (1951), *Relation of Profit Rate to Industry Concentration: American Manufacturing, 1936-1940*, Quarterly Journal of Economics, Vol. 65, no. 3, pp. 293-324.

Bain, J. S. (1956): *Barriers to New Competition: Their Character and Consequences in Manufacturing Industries*, Cambridge: Harvard University Press.

Branch Ben, S. (1980), *The Laws of the Market Place and ROI Dynamics*, Financial Management, Vol.9, no. 2, pp. 58-65.

Davidson, R., MacKinnon, J., (1981), *Several Tests for Model Specification in the Presence of Alternative Hypotheses*, Econometrica, Vol. 49, no. 3, pp.781-793.

Demsetz, H. (1973), *Industry Structure, Market Rivalry, and Public Policy*, Journal of Law and Economics, Vol.16, no. 1, pp. 1-10.

Forgey, F. A., Mullendore, W. E., Rutherford, R. C. (1997), *Market structure in the Residential Real Estate Brokerage Market*, The Journal of Real Estate Research Vol. 14, no. 1, pp. 107-115.

Gale, B. T., Branch Ben, S. (1982), *Concentration versus Market Share: Which determines Profit and Does It Matter?,* Antitrust Bulletin, Vol. 27, no. 1, pp. 83-106.

Gujarati, D. N. (2012), *Basic Econometrics*, McGraw-Hill.

Jovanovic, B. (1982), *Selection and the Evolution of Industry*, Econometrica, Vol. 50, no. 3, pp. 649-670.

J. E. Kwoka, Jr. (1979), *The Effect of Market Share Distribution on Industry Performance*, The Review of Economics and Statistics, Vol.60, no. 1, pp. 101-109.

J. E. Kwoka, Jr. (1981), *Does the Choice of Concentration Measure Really Matters?*, The Journal of Industrial Economics, Vol.29, no. 4, pp. 445-453.

Lippman, S. A., Rumelt, R. P. (1982), *Uncertain Imitability: An Analysis of Inter-firm Differences in Efficiency under Competition*, Bell Journal of Economics, Vol.13, no. 2, pp. 418-438.

Peltzman, S. (1977), *The Gains and Losses from Industrial Concentration*, Journal of Law and Economics, Vol. 20, no. 2, pp. 229-263.

Ravenscraft David, J. (1983), *Structure-Profit Relationships at the Line of Business and Industry Level*, The Review of Economics and Statistics, Vol. 65, no. 1, pp. 22-31.

Scherer, F.M. (1980): *Industrial Market Structure and Economic Performance*, 2nd Ed., Chicago: Rand McNally College Publishing Company.

Singh, S. K., Sharma, R. (2006), *Does the Choice of Market Structure Measure Matter? Evidence from the Indian Car Industry*, The ICFAI Journal of Industrial Economics, Vol. 3, no. 1, pp. 7-22.

Weiss Leonard, W. (1974), *The Concentration-Profits Relationship and Antitrust* in Harvey J.Goldschmid, H. Michael Mann and J. Fred Weston edited Industrial Concentration: The New Learning, Boston: Little-Brown.

Appendix: Market share of major firms in Indian cement industry

Sr. No.	Company Name	1997	2006	2011
1	A C C Ltd.	0.162	0.137	0.112
2	Ambuja Cement Eastern Ltd. [Merged]	0.008	-	-
3	Ambuja Cement Rajasthan Ltd. [Merged]	0.018	-	-
4	Ambuja Cements Ltd.	0.078	0.149	0.103
5	Anjani Portland Cement Ltd.	-	0.002	0.002
6	Balaram Cements Ltd.	0.001	0.0002	-
7	Barak Valley Cements Ltd.	-	0.002	0.001
8	Bheema Cements Ltd.	0.002	0.002	0.002
9	Binani Cement Ltd.	-	0.017	0.025
10	Birla Corporation Ltd.	0.064	0.038	0.028
11	Cement Corpn. Of India Ltd.	0.016	0.007	0.004
12	Cement Manufacturing Co. Ltd.	-	0.004	0.004
13	Century Textiles & Inds. Ltd.	0.145	0.076	0.058
14	Chenab Cement Ltd.	0.000003	0.00003	-
15	Chettinad Cement Corpn. Ltd.	0.016	0.018	0.025
16	Cochin Cements Ltd.	-	0.0004	-
17	Damodhar Cement & Slag Ltd. [Merged]	0.003	-	-
18	Deccan Cements Ltd.	0.004	0.004	0.007
19	Deva Drill Tech (India) Ltd.	0.0003	-	-
20	Dharani Cements Ltd. [Merged]	0.001	-	-
21	Gangotri Cement Ltd.	0.000008	-	0.000011
22	Greygold Cements Ltd.	0.0006	0.0004	-
23	Gujarat Sidhee Cement Ltd.	0.014	0.009	0.005
24	Heidelberg Cement India Ltd.	0.028	0.010	0.012
25	Hemadri Cements Ltd.	0.002	0.001	0.001
26	India Cements Ltd.	0.062	0.055	0.050
27	J K Cement Ltd.	-	0.032	0.031
28	J K Lakshmi Cement Ltd.	0.052	0.021	0.021
29	K C P Ltd.	0.010	0.006	0.007
30	Kakatiya Cement Sugar & Inds. Ltd.	0.004	0.003	0.002
31	Kalyanpur Cements Ltd.	0.011	0.004	0.002
32	Keerthi Industries Ltd.	0.002	0.002	0.002
33	Lafarge India Pvt. Ltd.	-	0.029	-
34	Lemos Cements Ltd.	-	0.000021	0.000244
35	Madras Cements Ltd.	0.033	0.038	0.039
36	Malabar Cements Ltd.	0.008	0.005	-
37	Mangalam Cement Ltd.	0.015	0.011	0.008
38	Megha Technical & Engineers Pvt. Ltd.	-	0.0001	0.004
39	Meghalaya Cement Ltd.	-	0.003	0.004

40	My Home Inds. Ltd.	-	0.011	0.011
41	N C L Industries Ltd.	0.005	0.004	0.007
42	Namo Cements Ltd.	-	0.00005	0.00003
43	Narmada Cement Co. Ltd. [Merged]	0.013	-	-
44	Necem Cements Ltd.	0.0004	0.0001	-
45	Nirman Cements Ltd.	0.00019	0.00005	0.00002
46	O C L India Ltd.	0.020	0.019	0.018
47	Orient Paper & Inds. Ltd.	0.044	0.027	0.030
48	P R Cements Ltd.	0.001	-	0.00029
49	Panyam Cements & Mineral Inds. Ltd.	0.012	0.003	0.002
50	Penna Cement Inds. Ltd.	-	0.019	0.018
51	Raasi Cement Ltd.	0.032	-	-
52	Rain Cements Ltd.	-	0.012	0.011
53	Rajapalayam Cement & Chemicals Ltd.	-	0.000005	-
54	Sagar Cements Ltd.	0.005	0.005	0.008
55	Sainik Finance & Inds. Ltd.	0.0003	0.0002	0.0001
56	Sanghi Industries Ltd.	0.005	0.018	0.010
57	Saurashtra Cement Ltd.	0.015	0.010	0.005
58	Shiva Cement Ltd.	0.001	0.001	0.001
59	Shree Cement Ltd.	0.023	0.034	0.072
60	Shree Digvijay Cement Co. Ltd.	0.012	0.006	0.004
61	Shri Keshav Cements & Infra Ltd.	0.001	0.0002	0.0004
62	Singhal Cement & Allied Inds. Ltd.	0.00039	-	-
63	Someswara Cements & Chemicals Ltd.	0.0004	-	-
64	South India Cements Ltd.	-	-	-
65	Sri Mata Infratech Ltd.	-	0.0002	-
66	Sri Vishnu Cement Ltd. [Merged]	0.011	0.005	-
67	Srichakra Cements Ltd.	0.001	0.002	-
68	Tamil Nadu Cements Corpn. Ltd.	0.017	0.005	-
69	Travancore Cements Ltd.	0.002	0.001	-
70	Trinetra Cement Ltd.	0.005	0.00004	0.004
71	Udaipur Cement Works Ltd.	0.006	-	-
72	Ultratech Cement Ltd.	-	0.116	0.220
73	Varun Cements Ltd.	0.002	-	-
74	Vinay Cements Ltd.	0.003	0.001	0.0001
75	Visaka Cement Industry Ltd. [Merged]	-	0.006	-
76	Zuari Cement Ltd.	-	0.010	0.017

Note: (-) indicates either negligible market share or non-existence of the firm in Indian cement industry. Some of the firms have either left the market or got merged with other firms.