Technical Report

ECONOMIES OF SCALE IN THE INDIAN CEMENT INDUSTRY

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ABSTRACT (within 250 words)

...The paper purports to investigate the existence or otherwise of economies of scale in the Indian cement industry. The investigation is attempted through the estimation of cost-output (sales) relationships both from the time series and cross-section data and both at the industry level and at the firm level. Furthermore, at the industry level the cost-output relationships have been estimated separately for All-India, Bihar, and Madras, the regional classification for which the time-series data are available. The relationships between the cost components (material cost, labour cost and depreciation cost) and the output have also been determined to identify the sources of economies or diseconomies of scale.....

It is found that the industry is dominated by the L-shaped average cost curve and horizontal marginal cost curve. In other words, the industry is found to be still operating in the first half of the U-shaped average cost curve and thus cement firms have not yet reached their optimum size. Significant economies of scale exist only with respects to labour costs in All-India and Bihar and total costs in All-India cement industry, and in the four cement firms studied, i.e. Associated Cement Companies Ltd., Jaipur Udyog Ltd., Mysore Cement Ltd and Sone Valley Portland Cement Company Ltd.; significant diseconomies exist only with respect to total cost and material cost in Madras industries. Inter-regional comparision has indicated that expansion of the industry in places other than Bihar and Madras and contraction of Madras firms will be beneficial from the side of cost. Among the four cement firms considered, the Associated Cement Companies is enjoying the maximum economies of scale. Its sales elasticity of total cost at sample means is 0.42.....

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Date 17. August. 1974 Signature of the Author

ECONOMIES OF SCALE IN THE INDIAN CEMENT INDUSTRY

G. S. Gupta*

The Indian Cement Industry is pretty old and it is now well-established. In India, Cement was first manufactured in Madras in 1904. Its production in 1969 stood at 13620 thousand metric tons and in 1971 at 14928 thousand metric tons. During 1950 to 1969, cement production increased at the average rate of 8.3 per cent per year. In terms of cement manufacture, India will soon be amongst the first six countries of the world.

The aggregate cement consumption in India stood at 13485 thousand metric tons in 1969 and it has increased at the average rate of 8.4 per cent during 1950 to 1969. As yet, per capita cement consumption in India is very low, particularly in comparison to that in advanced countries. It was 26 kgs. in 1969 as compared to that of 420 kgs. in Germany, 341 kgs. in U.S.A., 313 kgs. in Canada, and 224kgs. in U.K. in 1959. As the country develops, the cement demand is bound to increase at an accelerated rate. It is estimated that the cement demand in India is now increasing at the rate of about 10 to 12 per cent per annum.[1]

Cement being a bulky commodity, its export and import, particularly from far-off places, have to be minimised. To match the increased demand, the production must increase. It is certain that as production increases, total cost increases too. However, there is no such certainty about exactness of the relationship between cost and output. Nevertheless, the knowledge of this relationship is very useful in production planning. For, looking partially from the supply side alone, it is advantageous to expand output if cost increases less than proportionate increase in output and vice versa. Of course, even if cost increases more

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[1]Somani (1969), Gupta (1974).

the TC function should be cubic and that the coefficient of the output cube must be positive while that of the output square must be negative. A quadratic TC function will give a U-shaped AC curve only if the intercept term and the coefficient of the output square are positive and in such a case the MC curve will be a monotonously rising one. A linear TC curve implies a constant MC curve and a L-shaped AC curve only if the intercept term is positive; if intercept term is negative, AC curve will be of inverted L-shaped. A double-log TC function results into a constant; falling or rising AC and MC curves; it never yields a U-shaped AC or/and MC curves.

We have tried all the four forms for various cost functions estimated in this paper. A particular form has been chosen for each function on the basis of both economic theory and statistical inference. In particular, the best form for each function has been chosen on the basis of the a priori signs of the coefficients, significance of the coefficients as indicated by the t-test and the contribution of each new independent variable to the explanation of variation in the independent variable as measured by the coefficient of determination (R^2).

The various cost functions estimated in this paper are the total cost functions for All-India, for Bihar and for Madras cement industries, for Associated Cement Companies, for Jaipur Udyog Ltd., for Mysore Cement Ltd., and for Sone Valley Portland Cement Co. Ltd.[3]

While all these are estimated from time series data, the total cost function for All-India has also been estimated from cross section data separately for the years 1963, 1967, 1971, and 1972. Cost functions for the components of costs, viz., material cost, labour cost and depreciation cost, have also been estimated separately for All-India, Bihar, and Madras from time-series data.

The cost functions at the firm level and at the country level using cross-section data are estimated using cost and sales data rather than cost and output data, for their balance sheet cost data, which alone are published, include both production and distribution costs. As changes in inventory render sales to be different from production, cost-sales relationships cannot reasonably be used to infer economies or diseconomies of scale.

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[3] Please note that there are cement industries in places other than Bihar and Madras also and thus the industries in these two regions do not add up to all industries in All-India. ACC is the largest cement manufacturing firm, SVP is the

In time series regressions, time (trend variable) is used as a proxy variable for technical progress while in cross-section data the ratios of material cost to labour cost and operating cost to labour cost are used as the proxy variables for measuring the technologies of different firms.

The Data

The time series data for All-India, Bihar, and Madras are obtained from the Census of Manufacturing Industries and Annual Survey of Industries. The time series data for individual firms and the cross-section data for all cement industries in India are obtained from Bombay Stock Exchange Directory (1973). As the volume of data is pretty large, they are not reproduced here.

The Bombay Stock Exchange Directory provides firm-wise data for 17 firms manufacturing cement in India. They are Asoka Cement Ltd. (ACL), Associated Cement Companies Ltd. (ACC), Chettinad Cement Corporation Ltd. (CCC), India Cement Ltd. (ICL), Jaipur Udyog Ltd. (JUL), Saurashtra Cement and Chemical Industries Ltd. (SCC), Travancore Cement Ltd. (TCL), Andhra Cement Co. Ltd. (ANC), Bagalkot Udyog Ltd. (BUL), Dalmia Cement (India) Ltd. (DCL), Madras Cement Ltd. (MAC), Orissa Cement Ltd. (OCL), Panyam Cements and Mineral Industries Ltd. (PCM), Shri Digvijay Cement Co. Ltd. (DCL), and Sone Valley Portland Cement Co. Ltd. (SVP). The data from all these 17 firms, 16, or 14 firms, when the data for the remaining ones were not available for the particular year, are used in the cross-section analysis.

All rupee variables are measured in crores of rupees, and output variables are measured in crores of metric tons. Prices and wages variable are denominated in index numbers with base 1961=1.00. Ratios are measured in absolute numbers. Time variable is normalised to take a value of zero in the first period, 1 in the next period, and so on.

The following notations have been used:

TC = total cost

T = Trend variable (number of years)

X = output

S = sales

MC = material cost

LC = labour cost

DC = depreciation cost

P_W = wholesale price index

P_C = cement price index

W = wages in cement industry index

P_K = wholesale price of machinery and transport equipments index.

Results and Interpretation

The different forms of various cost functions were estimated by the ordinary least squares method. One form for each equation was then selected on the basis of both economic theory and statistical inference. Furthermore, other things remaining the same, we have preferred cubic form over all other forms, quadratic form over linear and double-log forms, and linear form over double-log form. The results of the best fitting total cost equations are provided in Table 1 and those of component cost equations in Table 2. In these tables all the pertinent statistics, i.e., t-values of the coefficients, coefficient of determination (R^2) and Durbin-Watson statistic (DW), have been recorded for each equation. The t-values of those coefficients which are significant by one-tail t-test at 5% and 1% levels are marked with * and **, respectively.

It will be seen from the results that all coefficients have a priori correct signs. Statistically, most equations appear to be equally acceptable. Of the 20 equations in Tables 1 and 2, 14 equations explain more than 92 per cent, one about 88 per cent, one about 81 per cent, three about 81-82 per cent and one nearly 64 per cent of the total variation in the corresponding dependent variable. Most coefficients are significantly different from zero and no equation is subject to serially correlated disturbance term.

It will be seen from Tables 1 and 2 that out of the total of 20 cost equations, one is cubic, two are quadratic, twelve are linear and five are of double-log forms. From the signs of the coefficients in all these equations it will be clear that the cubic equation will result into U-shaped AC and MC curves, linear equations into L-shaped AC and constant MC curves and the double-log into rising or falling AC and MC curves, depending upon whether the elasticity coefficient is greater than or less than unity. Thus, in the Indian cement industry, there is a predominance

Table 1

Total Cost Functions

Eq. No.	Cement industry in/cement firm	Time series data of the period	Dep. Variable	Coefficient (and t-ratio) Constant	X	$\frac{S}{P_C}$	log X	T	R^2	LW
1.1	All-India	1946-66	TC/P_W	0.83 (0.79)	37.52 (2.64)**			1.41 (1.90)*	.9876	1.21
1.2	Bihar	1947-66	TC/P_W	0.57 (1.27)	63.63 (16.43)**				[illegible]	1.56
1.3	Madras	1947-66	log TC/P_W	4.16 (37.00)**			0.99 (22.96)**		.9670	1.76
1.4	ACC	1963-72	TC/P_W	12.31 (4.18)**		.5120 (7.69)**			.8808	2.15
1.5	JUL	1963-72	TC/P_W	1.99 (1.80)*		.5967 (4.52)**			.7187	1.08
1.6	MCL	1963-72	TC/P_W	0.17 (1.22)		.7329 (11.26)**			.9407	1.29
1.7	SVP	1962-71	TC/P_W	0.18 (1.20)		.8591 (13.12)**			.9556	0.91

(Contd...)

Table - 1 (Contd.)

Total Cost Function

Eq. No.	Cement industry in	Cross-section of the year	Dep. Variable	Coefficient (and t-ratio) of					R^2	DW
				Constant	S	S^2	$\frac{MC}{LC}$	$\frac{OC}{LC}$		
1.8	All India	1967	TC	0.09 (2.43)*	.8710 (221.98)**				.9997	1.55
1.9	All India	1967	TC	0.06 (0.33)	.8630 (25.57)**	0.006 (1.22)			.9993	2.45
1.10	All-India	1971	TC	0.04 (0.19)	.9260 (103.45)**				.9986	1.74
1.11	All-India	1972	TC	0.43 (0.41)	.9587 (15.58)**	.0014 (0.21)	-.041 (0.53)	-.063 (0.32)	.9986	1.86

Table 4

Output Elasticities of Component Costs

Equation No.	Cement industries in	Time series data of the period	Cost item	Output elasticity			
				Constant elasticity	Variable elasticity		
					at sample means	lowest (year)	highest (year)
2.1	All-India	1946-66	MC/P_R	-	0.99	0.87 (1962,1963)	1.69 (1948)
2.2	All-India	1950-66	LC/W	-	0.39	0.22 (1950)	0.63 (1966)
2.3	All-India	1946-66	DC/P_K	1.05	-	-	-
2.4	Bihar	1950-66	MC/P_R	1.06	-	-	-
2.5	Bihar	1950-66	LC/W	-	0.28	0.17 (1950)	0.42 (1960)
2.6	Bihar	1947-66	DC/P_K	-	0.80	0.46 (1947)	1.33 (1952)
2.7	Madras	1947-66	MC/P_R	1.10	-	-	-
2.8	Madras	1950-66	LC/W	-	0.75	0.41 (1950)	1.24 (1966)
2.9	Madras	1947-66	DC/P_K	0.95	-	-	-

Table 4

Output Elasticities of Component Costs

Equation No.	Cement industries in	Time series data of the period	Cost item	Output elasticity			
				Constant elasticity	Variable elasticity		
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2.1	All-India	1946-66	MC/P_R	-	0.99	0.87 (1962,1963)	1.69 (1948)
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2.3	All-India	1946-66	DC/P_K	1.05	-	-	-
2.4	Bihar	1950-66	MC/P_R	1.06	-	-	-
2.5	Bihar	1950-66	LC/W	-	0.28	0.17 (1950)	0.42 (1960)
2.6	Bihar	1947-66	DC/P_K	-	0.80	0.46 (1947)	1.33 (1952)
2.7	Madras	1947-66	MC/P_R	1.10	-	-	-
2.8	Madras	1950-66	LC/W	-	0.75	0.41 (1950)	1.24 (1966)
2.9	Madras	1947-66	DC/P_K	0.95	-	-	-

Coming to inter-firm comparison, the maximum economy is enjoyed by the Associated Cement Companies Ltd. ($\eta = 0.42$), the largest cement firm in India, and the minimum economy is available to Sone Valley Portland Cement Co. Ltd. ($\eta = 0.81$). All the individual firms under study are reaping the fruits of economies of scale.

Output elasticities of component costs indicate that economies of scale are arising mainly from labour cost; material and depreciation costs are subject to nearly constant returns to scale.

In this paper we have not worked out the optimum size of the cement industry or firm, for this can be obtained only from the total cost-output (not total cost-sales) relationship and only when this relationship is either quadratic or cubic. However, from our finding of the predominance of the L-shaped average cost curve, it can be concluded that neither the industry nor any firm has yet reached its optimum size. The industry is still operating on the left part of the U-shaped average cost curve. This means that from the cost side alone at least, there is a good scope for cement industry's further expansion.

Conclusion

In this paper we have estimated the cost-output relationship in the Indian cement industry both from time-series and cross-section data. It is found that in general the industry is still operating on the first half of the U-shaped average cost curve and thus cement firms have not yet reached their optimum sizes. The investigation into economies or diseconomies of scale has suggested that significant economies exist only with respects to labour costs in All-India and Bihar and total cost in All India Cement Industry and in all the four cement firms studied; significant diseconomies exist only with respect to total cost and material cost in Madras industries. Inter-regional comparison has indicated that expansion of the industry in places other than Bihar and Madras and contraction of Madras firms will be beneficial from the side of cost. Among the four cement firms considered, the Associated Cement Companies is enjoying the maximum economies of scale, its sales elasticity of total cost is 0.42.

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