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Product Inventory and Economies of Scale: A study of Indian Industries

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This paper attempts to find out whether the firm holds finished product inventory to enjoy the advantage of economies of scale in the production process. Economies of scale in the production process means a reduction in average cost of production as the level of output is expanded. The decision whether to hold inventory to enjoy the advantage of economies of scale depends upon the magnitude of the production cost savings and the inventory carrying costs. If the magnitude of production cost savings is more than the inventory carrying costs, the firm should hold finished product inventory, otherwise not. For this, the theoretical model is framed and is tested for different Indian industries at the firm level. The overall results show that the firms belonging to consumer non-durable group and producer non-durable group and most of the firms belonging to the consumer durable group gain by holding finished product inventory from the point of view of economies of scale. On the other hand, the firms belonging to producer durable gorup of industries should not hold inventory to enjoy the advantage of economies of scale. This is because the value of the product produced by the firms under producer durable group is quite high.

Product Inventory and Economies of Scale : A Study of Indian Industries

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One of the main aims of a firm to hold inventories is to enjoy the advantage of economies of scale in the production process [Arrow, Harris and Marchan (1951), Gravelle and Rees (1981), Arvan and Moses (1982), Carlton (1989), and Banerjee (1990)]. By inventories here, we mean inventories of finished product only. If the firm is experiencing economies of scale in its production process, it may be profitable for the firm to produce in excess of its total sales to exploit the resources in an efficient way.

Economies of scale means a reduction in average cost of production as the level of output is expanded. If a firm is experiencing economies of scale in the production process, it can reduce the average cost of production by producting in excess of its total sales. For a given level of price, a decrease in average cost of producing means an increase in profit. This can be understood clearly with the help of the following diagram.

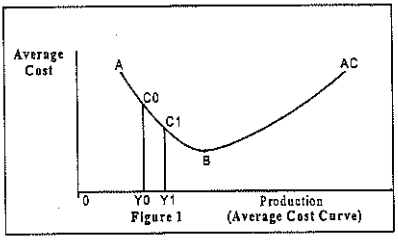

Figure 1

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In figure 1, AC is the average cost curve of the firm. Suppose that OY_0amount of output of the firm is the current demand of that firm's product in the market. If the firm produces in excess of OY_0, it will increase its inventory. Over the range AB, an increase in inventory will reduce the average cost of production. By producing excess output equal to Y_0Y_1, the firm reduces its average cost of production from C_0Y_0 to C_1Y_1. Thus, if the firm is experiencing economies of scale in the production process an increase in inventory holding (equal to Y0Y1) will reduce the average cost of production (from C_0Y_0 to C_1Y_1).

Holding of inventory means incurrence of extra expenses in terms of storage cost and interest cost (that is, inventory holding costs). Thus, the economies of scale motive is valid only when advantages accruing from reduction in the average cost of production outweigh these costs. If the firm is also experiencing economies of scale in inventory holding, an increase in inventory holding means a reduction in both average cost of production and average cost of inventory holding and thus inventory holding is profitable for the firm. On the other hand, if the firm is experiencing economies of scale in the production process and diseconomies of scale in inventory holding, holding of inventory is profitable only when the reduction in average cost of production is more than the increase in average cost of inventory holding.

The objective of this paper is to explain whether the economies of scale motive of inventory holding influence the inventory policy of the firm or not.

This paper is divided into five sections. Section 1 deals with the model, section 2 deals with the sample of the study, section 3 deals with the data base, section 4 deals with the empirical results and section 5 gives concluding remarks.

1. THE MODEL :

Let us assume that average cost is a function of output produced. That is , the average cost function is :

$$AC = a_0 + a_1Y, \text{ with } a_1 < 0 \qquad (1.1)$$

where AC is the average cost of production which also includes inventory carrying costs and Y is the output produced.

In equation (1.1), a_1 is the change in average cost of production due to one unit change in output. By assigning negative value to a_1, we assume that the firm is experiencing economies of scale in the production process even after considering inventory carrying costs.

The finished product inventory (F) has not been included in the average cost function. This has been done because whenever there is any increase in cost (including the inventory carrrying costs), it is distributed over the entire production and not just the level of inventory. Whenever the firm plans to increase the finished product inventory through increase in production, it increases production cost, storage cost, interest cost, etc. All these costs are distributed over the entire production and thus the level of production is shown as variable in the average cost function and the effect of inventory on average cost is judged through increase in production. This has also been done to avoid the multicollinearity problem

between inventory (F) and production (Y).

A change in inventory can be brought about by changing production or by changing sales (Rao, 1991). Whenever the inventory is held to enjoy the advantage of economies of scale, a change in inventory is brought about by changing production. That is, one unit change in inventory means one unit change in the level of production.

That is,

$$dY = dF = 1 \qquad (1.1)$$

There exists an identity which describes the relationship between production, sales and change in inventory -

$$Y = S + \blacktriangle F \qquad (1.2)$$

Where,

S : Sales

$\blacktriangle F$: Change in inventory

By differentiating (1.1) with respect to F, we get

$$\frac{dAC}{dF} = a_1 \frac{dY}{dF}$$

If the inventory is held to enjoy the advantage of economies of scale, a change in inventory is brought about by changing production, that is,

$$\frac{dY}{dF} = 1 \qquad (1.3)$$

If $a_1 < 0$, it means that the firm is experiencing economies of scale and it may be profitable for the firm to hold inventory from the cost point of view.

2. THE SAMPLE :

Firm level data for selected Indian industries is being used for this study. To ensure adequate representation of the firms, the following considerations were borne in mind in selection of the sample of the firms for this study.

(a) The firm must be a major producer in the industry concerned. In the modern world, most of the firms are multiproduct firms. Therefore, it is very difficult to categorise a firm into a particular group or industry. To categorise different firms into different product groups, the following consideration was taken. If the contribution of the major product in total sales was more than 50 percent, the firm was classified into that major product group or industry. If there was no product the contribution of which was more than 50 percent, the firm was classified as diversified firm.

(b) The sample must, as far as possible, be representative of the industry concerned.

(c) To ensure the quality of data, the sample must be restricted to the organised sector of the industry.

The sample of the firms taken for this study represented only the public limited companies of the organised sector. Such companies are large and medium units of the concerned industries. Both Indian and multinational firms are included in the sample of the firms for the study. By and large, in our opinion, the sample is fairly representative of the organised sector of Indian industries.

There was not much difficulty in categorising different firms into different groups. A look at the product structure of the firms initially considered, reveals that only in the case of approximately 10 percent firms, the contribution of the major product in total sales turnover of a particular firm was less than 50 percent. Such firms were calssified as diversified firms and they have not been included in the sample considered for this study. The remaining 90 percent of the firms were easily categorised into different product groups or industries as they had one product each, the contribution of which in total sales was more than 50 percent.

3. THE DATA :

The study is based on firm level time series data. The basic data on production, sales, cost, etc. was taken from the Stock Exchange Official Directory, Bombay and supplemented by the alternative source - 'Key Data on Large Business Units' published by the Centre for Monitoring Indian Economy (CMIE), Bombay, for missing gaps and series of data for the firms. For example, data on finished product inventory which is a key explanatory variable in this study was not available separately in the Stock Exchange Official Directory. This was taken from the CMIE publication.

Both the Stock Exchange Official Directory and the CMIE publication provide data on sales and inventory, etc., in money terms. The conversion of data from money terms to physical terms was itself a problem. The Stock Exchange Official Directory provides the output data for different years. For a single product firm, we did not face much problem in converting the data. In this case, the data was converted into physical terms by using the following well known identity :

$$TC_M = = CS_M + \blacktriangle F_M \qquad (3.1)$$

Where,

TC_M : total cost of production in money terms

CS_M : cost of goods sold in money terms

$\blacktriangle F_M$: change in finished product inventory in money terms

TC_M is defined as average cost multiplied by output produced in physical terms. Thus, the above identity (3.1) can be written as -

$$ACxO_P = CS_M + \blacktriangle F_M$$

Where,

Op : production in physical terms

AC : average cost

Thus, we have data on all the variables (that is, production in physical terms and average cost) which are required to estimate the average cost function. In this way, we computed the different variables for single product firms.

In the case of multiproduct firms, the above procedure for computation of different variables could not be used because the profit and loss accounts and balance sheets available in the Stock Exchange Official Directory source and the CMIE source do not provide information about each product separately. These sources provide data on net sales, cost of goods sold, etc. for all the products may be very much different, the above mentioned method was not used for computation of the variables for multiproduct firms for estimation of their average cost functions.

An alternative method was used to compute the different variables for such firms. Market and Market Share Data, published by CMIE provided us data on sales both in physical terms and in money terms of different products produced by a firm. The variables in the case of multiproduct firms were calculated as follows -

Step 1 : Price of the major product (that is, the product the contribution of which in total sales is more than fifty percent) was computed by dividing net sales in money terms by net sales in physical terms.

Step 2: Sales in physical terms of all products was converted in terms of sales in physical terms of the major product. This was done by dividing net sales (of all the products taken together) in terms of price of the major product (as computed in step 1).

Step 3: Average cost was computed by dividing cost of goods sold by sales in physical terms (as computed in step 2).

Step 4: Change in inventory in physical terms was computed by dividing the change in inventory in money terms by the average cost (as computed in step 3).

Step 5 : production in physical terms was computed by adding sales in physical terms (as computed in step 2) and change in inventory in physical terms (as computed in step 4).

The variation in average cost of production can be explained due to two reasons :

(i) due to general inflation that is prevailing in the economy

(ii) due to change in capacity utilisation rate or change in the level of output.

The average cost function explains the variation in average cost due to change in level of output. The firm sees the advantages or disadvantages that are accruing due to capacity utilisation in terms of average cost in real terms. Thus, the average cost function describes

the relationship between average cost in real terms and level of production, ceteris paribus. The way in which we computed the average cost and the level of production has already been described above. The average cost in real terms is computed by deflating current average cost by an index of the general price level.

4. EMPIRICAL RESULTS :

To study the relationship between finished product inventory and average cost empirically, the industries were divided into four broad categories, namely, consumer non-durable, consumer durable, producer non-durable and producer durable product categories.

The regression model specified in section 2 has been tested empirically for the above four categories of industries at the firm level. That is, the relationship between finished product inventory and average cost is studied to judge whether the finished product inventory is held to enjoy the advantage of economies of scale under the above four categories of industries at the firm level.

Here, average cost means the average cost of production after including the inventory carrying cost in real terms, and production and finished product inventory are measured in physical terms.

The results describing the relationship between the average cost and finished product inventory are presented in Table 1. A brief discussion and interpretation of the results for different group of industries is given below.

CONSUMER NON-DURABLE GROUP OF INDUSTRIES :

For all firms taken in the sample, the regression model performed fairly well as indicated by the value of R^2 and the t value of the coefficient. The slope of the average cost function has been found to be negative and significant for all the firms taken in the sample under the consumer non-durable group of industries. This shows that the firms under this category hold finished product inventories to enjoy the advantage of economies of scale in the production process. As AC is computed after including the inventory carrying cost, it means the savings in the production costs are more than an increase in inventory carrying costs. The inventory carrying costs depends upon the value of the product. The value of the product in case of consumer non-durable group of industries is not very high and this may be the reason why inventory carrying cost is relatively low in this case. The second reason may be that sales time of inventory is also low in the case of the products belonging to consumer non-durable group. The slope of the average cost function to be negative is also authenticated by the fact that capacity utilisation rate for the firms taken in the sample has been found to be less than 100%.

CONSUMER DURABLE GROUP OF INDUSTRIES :

For all the firms taken in the sample, the regression model performed fairly well. The regression results show that except for kelvinator of India Ltd., all the firms taken in the

Table 1

REGRESSION RESULTS : ESTIMATION OF AVERAGE COST FUNCTION

Name of the Industry and Firm	Average Cost Function $AC = a_0 + a_1 Y$		
	Intercept (a_0)	Coefficient (a_1)	R^2
Consumer Non-Durable Group :			
1. Cadbury India Ltd. (Food Product)	46959.58	-1351.29 (4.5239)	0.72
2. Warren Tea Ltd. (Tea)	17.24	-0.0005 (5.0)	0.66
3. Godfrey Phillips Ltd. (Cigarette)	0.14	-1.2×10^{-9} (1.7143)	0.26
4. Mohan Meakins Ltd. (Beverages)	44.59	-0.00078 (6.50)	0.87
5. Amrit Banaspati Ltd. (Vanaspati)	14172.96	-70.82 (3.753)	0.78
6. Alembic Chemical Works (Drugs)	2.05	-0.000003 (2.2667)	0.56
CONSUMER DURABLE GROUP :			
1. Laxmi Vishnu Textile (Cotton Textiles)	12.4337	-0.00011 (4.583)	0.74
2. Shri Dinesh Mills Ltd. (Woolen Textiles)	93.64	-0.02 (10.0)	0.91
3. National Rayons Corporation Ltd. (Man Made Fibre)	114617.7	-3809.49 (6.459)	0.84
4. Carona Ltd. (Footwear)	17.46	-0.0003 (3.6585)	0.62
5. Indoashi Glass Co. Ltd. (Glass)	24.64	-0.001 (1.6667)	0.30
6. Kelvinator of India Ltd. (Refrigerator)	1994.07	0.44 (1.7302)	0.35
PRODUCER NON-DURABLE GROUP :			
1. Dalmia Cement Ltd. (Cement)	865.2	-0.44 (2.0952)	0.36
2. The Mysore Paper Mills Ltd. (Paper)	6086.43	-5.33 (2.9286)	0.52
3. Fertiliser & Chemical Travancore Ltd. (Fertiliser)	2094.96	-0.53 (3.5333)	0.60

Table 1 (Contd.)

REGRESSION RESULTS : ESTIMATION OF AVERAGE COST FUNCTION

Name of the Industry and Firm	Average Cost Function $AC = a_0 + a_1 Y$		
	Intercept (a_0)	Coefficient (a_1)	R^2
4. Polyoefin Ind. Ltd. (Chemical)	16511.05	-41.81 (2.7009)	0.48
5. Goodlass & Nerolac Paints Ltd. (Paint)	20576.68	-121.48 (1.7644)	0.89
6. Berger Paints Ltd. (Paint)	15679.96	-140.393 (2.1464)	0.80
PRODUCER DURABLE GROUP :			
1. Ferro Alloy Corpn. Ltd. (Iron and steel)	4040.63	109.51 (6.111)	0.82
2. Rathi Alloys & Steels Ltd. (Iron and Steel)	11639.61	102.91 (64.44)	0.24
3. Steel Tubes of India Ltd. (Iron and Steel)	4930.68	77.56 (1.8344)	0.30
4. Atlas Copco India Ltd. (Machinery)	101718.4	8918.44 (1.9879)	0.33
5. Punjab Tractors Ltd. (Machinery)	43075.34	211.97	0.24

(Figures in Parantheses show 't' value of the coefficient.)

sample hold inventory to enjoy the advantage of economies of scale. In the case of Kelvinator of India Ltd., the slope of the average cost function is found to be positive and significant. The reason for the positive relationship between average cost and finished product inventory may be that the value of the product produced by this firm is relatively high and thus an increase in inventory carrying cost is not compensated by savings in production costs.

PRODUCER NON-DURABLE GROUP OF INDUSTRIES :

Under this group, a sample of six firms has been taken. The results show that all the firms taken in the sample hold inventory to enjoy the advantage of economies of scale in the production process. That is, savings in production costs is more than an increase in inventory carrying costs. For all the firms taken in the sample, the coeffieient is found to be significant and negative.

PRODUCER DURABLE GROUP OF INDUSTRIES :

For all the firms taken in the sample under this group, the regression model has performed quite well. The slope of the average cost function is found to be positive and significant in

case of all the firms. This shows that an increase in inventory carrying costs is not compensated by production costs savings. The reason for the positive slope of the average cost function may be that value of the product in case of the firms belonging to the producer durable group of industries is quite high and thus the inventory carrying cost is high. Thus, in this case, holding finished product inventory is not profitable for the firm from the point of view of average cost.

5. CONCLUSION :

Many firms hold inventory to enjoy the advantage of economies of scale in the production process. The decision whether to hold inventory to enjoy the advantage of economies of scale depends upon the magnitude of the production cost savings and the inventory carrying cost. If the magnitude of the production cost saving is more than the inventory carrying cost, hold finished product inventory to enjoy the advantage of economies of scale in the production process otherwise not. The inventory carrying cost depends upon the value of the product. The firms belonging to consumer non-durable and producer non-durable groups of industries gain by holding finished product inventory from the point of view of economies of scale as the value of the product produced by the firms under these groups is relatively low. In the case of consumer durable group of industries, most of the firms gain by holding finished product inventory except those which are producing products (e.g., car, two-wheelers, refrigerator, etc.) of relatively high value. In the case of producer durable group of industries, the firms should not hold inventory to enjoy the advantage of economies of scale in the production process as the increase in inventory carrying cost is not compensated by the production cost savings. This is because the value of the product (machinery etc.) produced by the firms under this group is quite high.

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