This chapter is devoted to a study of investment behaviour in the cement industry in India. The intention is to analyze whether investment in this industry is efficient or not. The cement industry is chosen here for three important considerations. First, it is a strategically important industry in the Indian economy, both in terms of its nature of product as well as its share in the manufacturing sector. Second, the private sector share in this industry, unlike other important industries in India, is very large, and hence amenable to the framework developed here. Third, due to its strategic importance this industry has been studied extensively both by institutions in the private and official sector which points to the fact that this industry is imperfectly competitive and thereby compatible with the present study of investment behaviour under conditions of increasing returns. The volume of existing literature also enables the availability of data in all important dimensions over a long period of time.

The main emphasis is on the nature of new investment taking place in the industry for an expansion of production. In this case, an increase in investment should be
accompanied by a change in the production structure because the latter forms the basis to study whether an increase in productive capacity due to new investment reflects an increase in productive efficiency. It is maintained, \textit{ex hypothesi}, that the changes in production structure accompanying new investment should be in line with investment elsewhere in the economy\textsuperscript{1}. In other words, an increase in investment is efficient when it is accompanied by favorable macroeconomic environment. In this perspective the aim of the overview of the cement industry in India is to highlight the growth inducing that is taking place in the industry.

In section 1 an overview of this industry is undertaken to bring out the nature of this industry as well as the important changes in the industry that have a bearing upon productive efficiency and this section also discusses the factors that have been responsible for an increase in investment in the industry.

\textbf{SECTION 5.1: AN OVERVIEW OF CEMENT INDUSTRY}

This profile of the industry is against the background of its development since its inception in 1914. The end period of this study is 1988-89, the period up to which important data are available. However, the time period 1914 to 1989 is marked by the independence of India in 1947 which
reflects important changes both with respect to government policy and entrepreneurial behaviour in India. Against this background the study period can be grouped into two distinct sub-periods, one is before independence (1914-1948) and the second is after independence (1951-1989).

(a). Sub-period 1914-1948

The important characteristics that evolved during this time period are studied with reference to two important studies on cement industry: one by Bagchi (1980) from 1914 to 1938 and the other by Rosen (1959) from 1938 to 1948. The main findings of these studies are given below separately in order to facilitate exposition.

Bagchi's study (1914-1937-38)

One of the important features of development, according to Bagchi, is that demand factors had played a major role in the establishment and subsequent development of cement industry in India. In the early 1900's it is maintained that it required a substantial change in the building methods in India and a substantial volume of demand before Indian or European capitalists ventured on the setting up of cement plants. It is a well-established fact that more than availability of raw materials, it is on account of the growth in consumption of cement and the short post-war boom
in investment and construction that cement factories sprang up fast.

It is on account of the increasing awareness on the part of builders of the possibility of cement as a building material that one could see a secular rise in consumption of cement (Indian production and import into India). This demand was unrelated to an increase in industrial investment or to a rise in agricultural income, but is partly due to the fall in price of cement, relative to the prices of other cementing materials.³ Hence it is justifiable to conclude that the increase in the consumption of cement was largely independent of the development of other industries. The growth in consumption of cement between 1922 and 1925 was connected with a decline in the price of Indian cement.

The fall in price of cement which is due to internal competition and the existence of excess capacity brings to notice these other characteristics of the cement industry that qualify the data for this period. The Indian industry had in fact worked with excess capacity almost from the beginning of the 1920s. According to Bagchi, "The problem here was not simply one of deficiency of demand in relation to some optimum scale of plant, excess capacity developed mainly because private investors invested largely independently of one another. Each investor over-estimated the extent of the market available and the advantages to be
enjoyed by the location of the plant in a new area. This over-estimation was natural since transport costs formed such a large fraction of the costs of cement".  

The main thing to be noticed is that the internal competition characterised by quasi-monopolistic organization owes to the fact that initial capital cost of a new unit of cement factory was not prohibitive as compared to import cost of cement. Moreover, investment in this industry also remained profitable in relation to investment in other industries (i.e. shortage of capital and foreign exchange did not depress the social profitability of such investment below its private profitability). According to Bagchi, in fact, it is this consideration that prompted government not to control the expansion in spite of the obvious appearance of excess capacity and wastage of scarce capital. Here the main emphasis was more on the expansion of demand rather than on curtailment of investment.  

Rosen's Study (1938-1948)  

In another important study Rosen also identifies demand factors as the main factor for the growth. In 1942, the government offtake of cement was about 90 per cent of total consumption, especially for military needs (cement was a basic raw material for military construction during the war). This apart, cement industry was also in an
advantageous position for expansion due to lack of foreign competition in an expanding domestic market. Expansion is a major method to increase the volume of profits in the face of stability of price. Second, this growth of the industry witnessed mostly a homogeneous product i.e., portland cement and a technique of production that varied little i.e., wet method (discussed in detail below in the subsection on "Technological Profile").

(b). Sub-Period: 1951-1989

Table 5.1 brings out the data on cement industry from 1951 to 1989. From an installed capacity of 3.28 million tonnes in 1950-51, cement industry expanded to a capacity of 9.30 million tonnes in 1960-61 which was further almost doubled to 17.6 million tonnes in 1970-71. Thereafter, the growth is characterized by fluctuations; a rapid expansion of capacity between 1966 and 1970 reflecting the delicensing of cement industry; the decade of seventies witnessed a significant slowing down; however the eighties witnessed a marked expansion of capacity from a level of 27.9 million tonnes in 1980-81 to a further increase up to 59 million tonnes in 1988-89. On the other hand, data on production shows that, after keeping pace with installed capacity in the first decades, it gave a lackluster performance through most of the seventies (with the exception of 1975 and 1976
Table 5.1


(In million tonnes)

<table>
<thead>
<tr>
<th>Year</th>
<th>Installed Capacity</th>
<th>Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950-51</td>
<td>3.28</td>
<td>2.95</td>
</tr>
<tr>
<td>1951-52</td>
<td>3.75</td>
<td>3.29</td>
</tr>
<tr>
<td>1952-53</td>
<td>4.01</td>
<td>3.57</td>
</tr>
<tr>
<td>1953-54</td>
<td>4.38</td>
<td>4.03</td>
</tr>
<tr>
<td>1954-55</td>
<td>4.62</td>
<td>4.42</td>
</tr>
<tr>
<td>1955-56</td>
<td>5.02</td>
<td>4.60</td>
</tr>
<tr>
<td>1956-57</td>
<td>5.81</td>
<td>5.16</td>
</tr>
<tr>
<td>1957-58</td>
<td>6.96</td>
<td>5.98</td>
</tr>
<tr>
<td>1958-59</td>
<td>7.89</td>
<td>6.10</td>
</tr>
<tr>
<td>1959-60</td>
<td>8.48</td>
<td>7.29</td>
</tr>
<tr>
<td>1960-61</td>
<td>9.30</td>
<td>7.97</td>
</tr>
<tr>
<td>1961-62</td>
<td>9.47</td>
<td>8.28</td>
</tr>
<tr>
<td>1962-63</td>
<td>10.00</td>
<td>8.75</td>
</tr>
<tr>
<td>1963-64</td>
<td>10.50</td>
<td>9.43</td>
</tr>
<tr>
<td>1964-65</td>
<td>11.24</td>
<td>9.78</td>
</tr>
<tr>
<td>1965-66</td>
<td>12.00</td>
<td>10.82</td>
</tr>
<tr>
<td>1966-67</td>
<td>12.56</td>
<td>11.07</td>
</tr>
<tr>
<td>1967-68</td>
<td>13.78</td>
<td>11.48</td>
</tr>
<tr>
<td>1968-69</td>
<td>14.98</td>
<td>12.24</td>
</tr>
<tr>
<td>1969-70</td>
<td>15.98</td>
<td>13.82</td>
</tr>
<tr>
<td>1970-71</td>
<td>17.61</td>
<td>14.36</td>
</tr>
<tr>
<td>1971-72</td>
<td>19.56</td>
<td>15.08</td>
</tr>
<tr>
<td>1972-73</td>
<td>19.76</td>
<td>15.56</td>
</tr>
<tr>
<td>1973-74</td>
<td>19.76</td>
<td>14.67</td>
</tr>
<tr>
<td>1974-75</td>
<td>20.06</td>
<td>14.81</td>
</tr>
<tr>
<td>1975-76</td>
<td>21.61</td>
<td>17.29</td>
</tr>
<tr>
<td>1976-77</td>
<td>21.16</td>
<td>18.85</td>
</tr>
<tr>
<td>1977-78</td>
<td>21.46</td>
<td>19.38</td>
</tr>
<tr>
<td>1978-79</td>
<td>22.55</td>
<td>19.42</td>
</tr>
<tr>
<td>1979-80</td>
<td>24.29</td>
<td>17.69</td>
</tr>
<tr>
<td>1980-81</td>
<td>27.92</td>
<td>18.66</td>
</tr>
<tr>
<td>1981-82</td>
<td>29.26</td>
<td>21.01</td>
</tr>
<tr>
<td>1982-83</td>
<td>34.39</td>
<td>23.27</td>
</tr>
<tr>
<td>1983-84</td>
<td>37.04</td>
<td>27.07</td>
</tr>
<tr>
<td>1984-85</td>
<td>42.50</td>
<td>30.10</td>
</tr>
<tr>
<td>1985-86</td>
<td>44.00</td>
<td>33.11</td>
</tr>
<tr>
<td>1986-87</td>
<td>54.40</td>
<td>36.40</td>
</tr>
<tr>
<td>1987-88</td>
<td>57.47</td>
<td>39.37</td>
</tr>
<tr>
<td>1988-89</td>
<td>58.97</td>
<td>44.08</td>
</tr>
</tbody>
</table>

Source: Cement production and despatches, various issues.
and actual declines in 1979 and 1980). However there was a
turnabout in 1981. Production grew at an annual average
rate of 13 1/2 per cent in first few years of the eighties,
but slowed down to an increase of 8 per cent in 1985. The
period 1984-85 to 1988-89 showed a growth of around 10 per
cent per annum to average 11 per cent per annum for the
entire period of the eighties upto 1988-89.

A casual glance at the data shows that the trend of
cement production is very sensitive to government policy
initiatives, especially with respect to delicensing of the
cement industry in the late 60's for a short period of time
and the partial decontrol of prices after April 1982. To
study these important characteristics of the industry, this
study relies on the previous studies by Rosen (1959) for the
period 1951-1956 and BICP (Bureau of Industrial Cost and
Prices) study from 1981 to 1985.

**Rosen's Study 1951-1958**

Rosen's study identifies to main factor of growth of the
cement industry as the thrust given to the demand side where
government off-take of cement output was around 80 per cent
for the requirements in the plans (e.g. heavily tilted
towards public investment).

Along with this expansion, another crucial feature was
the government intervention to fix the cement price. From
1954 onwards after a detailed investigation into the costs, the price formula adopted by the government provided for a price to cover operating costs. The cement industry, however, from the very beginning, has criticized the exact formulation of the price formula, but not the very basis of the price control since it is crucially linked to the government off-take. This criticism was on the basis of the ground that the costs covered by the price formula did not include such elements as bonus, Managing Agency’s commission, etc., so that the net return on gross block was around 4 per cent rather than 8 per cent. At the same time, the industry was also poised for ever faster rate of expansion given that the rate of return had far overshadowed by the opportunities for expanding the volume of profits (though possibly not the rate of profit) with the greater demand that was foreseen several year ago. This was viewed as an important characteristics of the industry. To quote Rosen, "this will continue unless it is interrupted by forces external to the industry, for example, prolonged labour disturbances or such bottlenecks as might occur in transportation".

**BICP Study 1981-1985**

BICP (1987) is by far the most comprehensive study on the cement industry in India. It has covered the longest period
with all available data on the important characteristics of this industry.

As far as the demand factors are concerned this industry is mainly dependent on government offtake for planned purposes in a protected environment. This has also resulted in a price control that regulated the price since 1942, except in the years 1966 and 1967. However, in later years, especially after 1967, a uniform retention price system replaced the earlier price system with a cost-plus principle for individual firms. This price system was followed in 1979 by a three tier system such that different retention prices were fixed for the three categories of low, medium and high cost plants. There was again a change in 1982 whereby a dual pricing system was introduced. In this system 66.6 per cent of the capacity output was fixed at a common (uniform, with certain premia for certain plants) levy retention price, while the remaining output could be directed at the open market. Because of higher capital costs for new plants, the levy proportion in their case was set at 50 per cent.13

It can be observed that price policy reforms have paid dividends in terms of growth of capacity and production in cement industry. This is true for the years 1966 and 1967 when there was decontrol and after 1982 which was a major liberalization attempt.14 This attitude is understandable.
since price control (especially a uniform rate) entails a low rate of return for the industry as a whole. This pricing policy was, however, tolerated when the major consumer was the government, and the profitability of this industry was high as compared to other industries. And price decontrol would have resulted in price competition to make prices unremunerative. On the other hand, a large domestic market in a protected environment do make the industry more responsive to price decontrol than a controlled price system.

However, there is a strong link between the evolution of price system and the change in the cost structure of the economy. The price which is cost plus has to keep pace with the prices of inputs that enter the cost of production. Secondly, different plants located in different regions do show a different pattern of cost within the industry. This can be seen in the following BICP study on the cost profile on the basis of the technological profile of the cement industry.

Technological Profile

In India, cement was produced exclusively by the wet process in 1960, although the first dry process plant was commissioned in 1958 with a capacity below 500 tpd. Thereafter, the structure of the Indian cement industry has
undergone a significant change with respect to plant size and technical process employed. Along with it, there is also a significant change in the products of the cement industry i.e., there is both a qualitative and a quantitative increase in the cement output. Since qualitative changes are not brought about by any fundamental alteration in the process itself, the technological profile includes both the changes in the product as well as process-mix in the industry. These characteristics of the cement technology are highlighted in the following pages for a better understanding of the changes that have taken place over the period. More importantly, it brings out the important features of modernization programs carried out in the industry.

I. **Product**

Altogether eleven different varieties of cement are produced in India. Ordinary Portland cement (OPC), Portland Pozzolana cement (PPC) and Portland Slag cement (PSC) are the most important, accounting for 99.2 per cent of the total production. (table 5.2). Here, even if the different products are not exactly technologically substitutes, there are differences in their application.18

The emergence of different varieties of cement is significant according to a high level committee (1978). The
<table>
<thead>
<tr>
<th>Year</th>
<th>OPC</th>
<th>PPC</th>
<th>PSC</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970</td>
<td>13.95</td>
<td>16.35</td>
<td>18.69</td>
<td>19.16</td>
</tr>
<tr>
<td>1975</td>
<td>19.78</td>
<td>19.66</td>
<td>18.33</td>
<td>17.89</td>
</tr>
<tr>
<td>1976</td>
<td>20.87</td>
<td>22.63</td>
<td>25.49</td>
<td>29.2</td>
</tr>
</tbody>
</table>

Note: OPC = Ordinary Portland Cement
PPC = Portland Pozzolanic Cement
PSC = Portland Blast Furnace Slag Cement
HSOPe = High Strength Ordinary Portland Cement
H/C = Hydrophobic Cement
LH/RHC = Low Heat/Rapid Hardening Cement
OWC = Oil Well Cement
WC = White Cement
CC = Coloured Cement
--- = Negligible

committee recommended provision of a suitable price system
to offer incentive for increasing the production of
different varieties (like PPC) along with OPC, which can
help relieve the overall shortage of cement in the country
and also to provide improved technical service to consumers.
Since PPC could not be used for all purposes for which OPC
was used, the absence of a price differential was distorting
customer preferences in that OPC was being demanded and used
for purposes for which PPC could do the job.

II. processes\textsuperscript{19}

The structure of the Indian cement industry has undergone a
significant change with respect to plant size and technical
process employed. There are three different processes which
are used to produce cement, i.e. wet, dry and semi-dry. The
dry and semi dry are less fuel intensive but more power
intensive than the wet process. The wet process, however,
affords easier handling and mixing of raw materials. To
study it in more detail it is pertinent to give the stages
of cement manufacturing and its basic requirements.

1. Quarrying of raw materials, mainly through employment
   of open cast operations. The equipment here, is
   usually heavy and expensive, requiring considerable
   maintenance and is subject to heavy wear and tear.
2. Raw material processing:
   a. In wet processor, clay is slurred with water and then used to slurry chalk or vice-versa.
   b. In the dry process, harder raw materials pass through primary and secondary crushers for size reduction.

   Here, the raw material is ground, homeogenised and tested for its calcium oxide, iron oxide and alumina proportions, homogeneity and particle size distribution before being fed into the kiln.

3. The clinker is burnt in a long cylindrical kiln slightly inclined and rotating over its longitudinal axis. Heat is introduced at the lower end.
   a. In the wet process, raw materials are ground to a slurry having moisture content of 34 per cent to 36 per cent which is then blended and fed straight to the kiln.
   b. In the semi-dry process, the raw materials are ground in the dry form and then nodulised with about 12 per cent to 14 per cent moisture. The resultant nodules are then fed into the kiln through a grate pre-heater.
   c. The dry process comprises of dry grinding of raw materials followed by homogenization before the raw material is fed into the kiln.
4. The hot clinker from the kiln needs to be cooled to about 60°C before it can be stored or ground. This is done by planetary or grate coolers or the counter current model.

5. Clinker is ground with gypsum in cement mills to produce portland cement. Other additions are added at the grinding stage to produce other varieties of cement.

The requirements of cement manufacturing are as follows:

- Limestone and clay are the principal raw materials for the manufacture of clinker.
- Gypsum is a supplementary material ground with clinker to produce OPC.
- Slag (as a waste product of steel plants) is granulated to acquire hydraulic properties and is inter-ground with clinker and gypsum to produce PSC.
- Again, different Pozzolanic materials are used to produce different varieties of cement. The common types are brick bats, broken tiles, burnt shale, calcined clay and fly-ash.

The two main forms of energy required in the cement industry are fuel and power.

Coal is the principal fuel used in cement manufacturing. The consumption of coal per tonne of clinker varies with the quality of coal as well as the process employed. The coal consumption norms, according to the high level committee are:
### Table: Consumption/per tonne of Clinker

<table>
<thead>
<tr>
<th>Process</th>
<th>1978</th>
<th>1980-81</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wet</td>
<td>300 kg</td>
<td>308 kg</td>
</tr>
<tr>
<td>Semi-dry</td>
<td>210 kg</td>
<td>232 kg</td>
</tr>
<tr>
<td>Dry</td>
<td>190 kg</td>
<td>200 kg</td>
</tr>
</tbody>
</table>

The highest consumption of coal is in the wet process because the moisture content of the slurry fed into the coal absorbs nearly 40 per cent of the total heat spent per tonne of clinker.

Again, the tariff commission study (1972-73) set the power consumption norms at 120 kwh per tonne of cement. NCAER (1975-76) worked out the norm at 127 kwh per tonne.

In 1978, the high level committee found that there were wide variations in the overall consumption of power even within the wet, semi-dry and dry process. The range is

<table>
<thead>
<tr>
<th>Process</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wet</td>
<td>93 to 129 kwh per tonne of cement</td>
</tr>
<tr>
<td>Semi-dry</td>
<td>106 to 136 kwh per tonne of cement</td>
</tr>
<tr>
<td>Dry</td>
<td>112 to 147 kwh per tonne of cement</td>
</tr>
</tbody>
</table>

Power consumption among plants of different sizes and processes varied widely for production up to the clinker stage. The highest power requirement up to the clinker
stage was in dry and semi-dry process plants in the size group up to 600 tpd. For production beyond the clinker stage the maximum power requirement was in the manufacture of portland slag cement.

Cement manufacture is a continuous process and availability of power on a regular and sustained basis is essential. However, due to uncertainty of power, many units in the cement industry have attempted to have captive power plants to meet minimal requirements of power so as to avoid loss of production, or damage to equipment, arising from thermal shocks.

**Change in Technical Profile**

Given the stages of manufacturing and requirements of production, it is necessary to give a profile with respect to number and capacity of kilns (table 5.3). The period between 1960 and 1985 witnessed an almost five-fold increase in capacity. The increase in capacity was associated with increasing scale of the plants and a gradual shift towards dry process plants. These two tendencies are discussed in more detail in the following:

a. **Increasing Scale of Plants**

In 1960 kilns below 500 tpd dominated the industry but its dominance decreased steadily, accounting for half of the
Table 5.3

Technological Profile of Cement Industry: Number and Capacity of Kilns\(^1\): by Plant

<table>
<thead>
<tr>
<th></th>
<th>1960</th>
<th></th>
<th>1970</th>
<th></th>
<th>1980</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>W</td>
<td>D</td>
<td>SD</td>
<td>TN</td>
<td>W</td>
<td>D</td>
</tr>
<tr>
<td>Below 500 tpd</td>
<td>48</td>
<td>1</td>
<td>3</td>
<td>52</td>
<td>4.8</td>
<td>53</td>
</tr>
<tr>
<td>500-999 tpd</td>
<td>14</td>
<td>-</td>
<td>1</td>
<td>15</td>
<td>2.9</td>
<td>35</td>
</tr>
<tr>
<td>1000-1999 tpd</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2000-2999 tpd</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>3000 tpd &amp; above</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total number of kilns</td>
<td>62</td>
<td>1</td>
<td>4</td>
<td>67</td>
<td>88</td>
<td>13</td>
</tr>
<tr>
<td>Clinker Capacity</td>
<td>7.0</td>
<td>1</td>
<td>.6</td>
<td>7.7</td>
<td>11.5</td>
<td>2.6</td>
</tr>
</tbody>
</table>

Key: \(W = \) Wet, \(D = \) Dry, \(SD = \) Sem day, \(TN = \) Total number of kilns, \(CC = \) Clinker Capacity

1. Excluding mini-cement units.

2. Annual, in million tonnes, assuming 330 working days.

total numbers in 1970. The size range of 500-999 tpd had emerged as an important category by 1970. In 1980, it is

<table>
<thead>
<tr>
<th>No. of kilns</th>
<th>Capacity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>500 - 999 tpd</td>
<td>63</td>
</tr>
<tr>
<td>below 500 tpd</td>
<td>63</td>
</tr>
<tr>
<td>1000-1999 tpd</td>
<td>-</td>
</tr>
</tbody>
</table>

The expansion between 1980 and 1985 was almost exclusively in the size ranges above 1000 tpd and mostly in the range of 1000-1999 tpd.

The steady move towards higher capacity kilns is in keeping with international trends. While there has been a tendency in some countries (like Japan) to go for plants up to 8000 tpd mostly it has been a case for 3000-4000 tpd kilns.

b. Shift Towards Dry-Process Plants

In 1960, wet process was the exclusive process in the industry, though in 1958, the first dry process (below 500 tpd) was commissioned, almost 28 years behind Japan; though the importance of dry process is increasing overtime, since 1970. Between 1970 and 1980, dry process was introduced in the kilns mostly in the capacity range of 500-999 tpd and
1000 to 1999 tpd. In the last five years, such introduction has been mostly in the capacity of 1000-1999 tpd while larger plants are coming up (to some extent in larger kilns including four units of 3000 tpd and above).

**Analysis of Technological Profile**

It is useful to note certain characteristics of cement plants discussed above. First, cement manufacture is a continuing process and its output rate depends essentially on the size of the kiln and its accessories. Accordingly, the kiln capacity is the binding factor in the production process whereas the plants generally have excess capacity both for raw material preparation and cement grinding. Besides, the raw mill as well as the grinding plant have a much longer useful life than the kiln in a cement plant. For this reason, a plant may be old but it may introduce new kilns. The age distribution of kilns is therefore a significant indicator of the degree of modernization of cement plants (table 5.4). Second, cement industry has seen very rapid technological progress, such as to render many alternative modernization programs helpful.

The alternative modernization programs are outlined below. 21

1. The improvement in wet process plants to reduce their cost of production (at the face of rising costs of
Table 5.4
Age Distribution of Kilns

|-----------|-------------------|-------------------|-------------------|-------------------|-----------------------|------------------------|

**A. Wet Process**

1. Upto 10 years  | 5 | 1 | 21 | - | - | - | - | - | 26 | 1 |
2. 11-20 years    | 24 | 3 | 12 | 19 | - | - | - | - | 36 | 22 |
3. 21-30 years    | 9 | 16 | 1 | 14 | - | - | - | - | 10 | 30 |
4. 31-40 years    | 12 | 17 | 1 | 4 | - | - | - | - | 13 | 21 |
5. Above 40 years  | 3 | 17 | - | 1 | - | - | - | - | 3 | 10 |

Total A: 52 54 35 38 - - - - - 88 92

**B. Semi Dry Process**

1. Upto 10 years  | - | - | 4 | - | 2 | - | - | - | - | 6 | - |
2. 11-20 years    | 1 | - | 1 | 3 | - | - | - | - | - | 3 | 3 |
3. 21-30 years    | - | 2 | - | 1 | - | - | - | - | - | - | 3 |
4. 31-40 years    | 1 | - | - | - | - | - | - | - | - | - | 1 |
5. Above 40 years  | - | 1 | - | - | - | - | - | - | - | - | 1 |

Total B: 3 3 5 4 2 - - - - - 10 7

**C. Dry Process**

1. Upto 10 years  | 4 | 4 | 8 | 9 | - | 24 | - | 2 | - | 4 | 12 | 43 |
2. 11-20 years    | 1 | 3 | - | 10 | - | - | - | - | - | - | 1 | 13 |
3. 21-30 years    | - | 2 | - | - | - | - | - | - | - | - | - | 2 |
4. 31-40 years    | - | - | - | - | - | - | - | - | - | - | - | 0 |
5. Above 40 years  | - | - | - | - | - | - | - | - | - | - | - | 0 |

Total C: 5 9 8 19 - 24 - 2 - 4 13 58

**Grand Total** 61 66 48 61 2 24 - 2 - 4 111 157

1. Excluding mini cement units.

production), increase production at the lowest feasible costs and improve efficiency. The high level committee of 1978 has pointed out that several improvements are feasible, such as the energy costs can be reduced by undertaking modification which reduce slurry moisture.

2. At the face of rising cost of production in wet process the attitude for replacement assumes special significance through the switch from wet to dry process of production. However, such a conversion is of limited success. The consultant companies (appointed by GOI) opines that in the majority cases, the conversion is uneconomical due to heavy capital expenditure required in modifying kilns and increasing the capacity of clinker coolers, raw mills and the material handling system. The high level committee (1978) has observed that conversion to dry process with precalcining arrangements is much less than the cost of setting up of new units in greenfield sites. However they have also reported that owing to the high cost of servicing of capital, the conversion presents special problems where significant increases in output are ruled out because of limitations of limestone availability or other factors.
3. An alternative course is to convert a wet process plant to a semi-dry one, involving the installation of a filtration system with the necessary ancillary facilities. This brings about a reduction of the moisture content of the fuel slurry from 34 to 14. The filter cake is further dried in an open drier and fed into a pre-heater before it is introduced into the kiln. The process offers considerable economy in energy costs due to reduction of moisture content in the slurry. However, a satisfactory technological breakthrough has failed to occur i.e. mechanical problems recur in plants which have converted to the semi-dry process.

4. The operational problems associated with large sized kilns have been simplified by the development of precalcination (semi-precalcination) technology, since the technology eliminates the decarbonation reaction inside the kiln. Hence, it becomes economical in the use of coal and electricity and also allows for the possibility of using coal of higher ash content and limestone of relatively inferior quality. The precalcination system can be installed in an existing plant if it uses the dry process, if its preheater system permits such installation in terms of space and modifications and provided the necessary balancing
The study of high level committee (1978) on the basis of comparative analysis of investment costs and operational costs of different sizes with and without precalcinators suggests that in new plants of sizes above 1700-2000 tpd, the adoption of precalcinators system is desirable.

5. The other major development in cement manufacturing includes the move towards split location plants in lieu of integrated plants i.e. while the location of manufacture of clinker near the source of limestone is the most economical choice in view of the transport cost of moving limestones, the location of clinker grinding near the source of clinker may not be the economical one. This choice is dependent on

i. optimal balance between the cost of transportation of clinker (open wagons) and the cost of transportation of cement (closed wagons).

ii. higher investments and operational costs associated by splitting the locations of clinker manufacturing and grinding factories.

iii. the availability of other grinding materials like fly ash and slags.
For example, the capital costs of a split location plant was about 11 per cent higher than an integrated cement plant. The direct labour cost, per tonne of cement was 5 per cent more; the cost of production of cement, if only OPC is produced was 6 per cent higher than that in an integrated cement plant, on production of PPC for the entire quantum of cement possible from the entire clinker, the above disadvantages could be neutralized.

**Pattern of Cost**

The cost of production of cement has been rising (as given by the estimates of Tariff commission and BICP). Because of changes in the classification of costs components, it is not possible to identify the differential contribution of different cost components to the increase in costs. The high level committee, 1978 instituted by government has observed that there was evidence of wide divergence in costs within the Industry. Table 5.5 presents estimated costs of production of OPC, PPC and PSC by processes. While the production cost of OPC by wet process is the highest, it is interesting to note that the high cost factories producing PPC and PSC were producing these varieties of cement at costs higher than that of the least cost factory producing OPC by wet process. One important factor leading to divergence in costs was the wide variation in the age and
<table>
<thead>
<tr>
<th>Cement Type &amp; Process</th>
<th>Cost of cement</th>
<th>Fair Return</th>
<th>Fair Price</th>
<th>Selling Price</th>
<th>Packing Expenses</th>
<th>Outward freight</th>
<th>FOR destination Price (excluding duty and other charges)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. OPC, Wet Process, 9 units</td>
<td>149.76</td>
<td>28.56</td>
<td>186.72</td>
<td>1.13</td>
<td>41.95</td>
<td>25.43</td>
<td>284.14</td>
</tr>
<tr>
<td>OPC, Dry Process, 5 units</td>
<td>105.11</td>
<td>31.94</td>
<td>157.09</td>
<td>2.27</td>
<td>42.45</td>
<td>41.38</td>
<td>262.68</td>
</tr>
<tr>
<td>OPC, Overall, 14 units</td>
<td>166.08</td>
<td>37.11</td>
<td>203.19</td>
<td>3.80</td>
<td>45.80</td>
<td>52.62</td>
<td>305.41</td>
</tr>
<tr>
<td>II. PPC, Wet Process, 6 units</td>
<td>130.09</td>
<td>26.87</td>
<td>161.56</td>
<td>2.91</td>
<td>43.61</td>
<td>25.43</td>
<td>261.03</td>
</tr>
<tr>
<td>PPC, Dry Process, 4 units</td>
<td>102.51</td>
<td>31.95</td>
<td>152.60</td>
<td>2.27</td>
<td>42.45</td>
<td>41.38</td>
<td>262.68</td>
</tr>
<tr>
<td>PPC, Overall, 10 units</td>
<td>141.27</td>
<td>38.69</td>
<td>179.96</td>
<td>3.30</td>
<td>45.44</td>
<td>51.68</td>
<td>280.38</td>
</tr>
<tr>
<td>III. PSC, Wet Process, 7 units</td>
<td>137.79</td>
<td>29.05</td>
<td>170.04</td>
<td>2.67</td>
<td>44.10</td>
<td>27.94</td>
<td>261.84</td>
</tr>
<tr>
<td>PSC, Dry Process, 1 unit</td>
<td>128.46</td>
<td>30.85</td>
<td>159.31</td>
<td>3.72</td>
<td>49.37</td>
<td>93.10</td>
<td>105.50</td>
</tr>
<tr>
<td>PSC, Overall, 8 units</td>
<td>166.42</td>
<td>35.40</td>
<td>181.82</td>
<td>3.85</td>
<td>47.37</td>
<td>63.55</td>
<td>296.59</td>
</tr>
<tr>
<td>IV. Overall, All Types</td>
<td>154.45</td>
<td>35.87</td>
<td>191.32</td>
<td>3.71</td>
<td>46.33</td>
<td>55.96</td>
<td>297.22</td>
</tr>
</tbody>
</table>

the type of critical equipments (relating to different processes i.e. wet, dry, semi-dry) used by the factories which affected their efficiency and norms of input consumption. The high level committee also found that except in some of the very distant and outlying plants, no clear pattern emerged as to the reasons for the high or relatively high costs of some units vis-a-vis others. By and large, old and wet process plants do have high production costs, although the lowest cost wet process plants are fairly close in terms of costs to the cost efficient better managed dry process plants.

The divergence of costs do point towards a desirability of multi-tier price formula instead of a uniform retention price system. In fact the three-tier price system had helped to attract investment in the cement industry. However, the study also notes the impracticability of implementing it. The existence of multitude of subsidies had concealed the true costs of different units. Secondly, since separate records were not kept for the cost of production of the different types of cement, an adhoc system was followed. The costs were computed on the basis of the consumption of materials, estimated differentials in the consumption of power and fuel, grinding media and other consumables and expenditure on repair and maintenance for different processes, subjected to the overall reconciliation
of the process-wise expenses with the corresponding records maintained under the Cost Accounting Record Rules.25

The cost-profile does point to the fact that the supply factors do play a major role. They have not only influenced the fluctuations in capacity utilization26 and thereby costs (e.g. cost plus principle is based on capacity output prices) but, in addition, technological changes make the cost-principle a plant-specific system rather than industry specific.

It can further be seen that when demand factors were the major determinant of growth (say, no change in the output-mix and process of production) then price system was acceptable both to the industry as well as the government. But when supply factors also played a major role in the growth process, the price system was not only a cumbersome process but also unfavorable to the industry. This particular finding is best seen in the light of technological changes that the industry underwent during the 70's.

SECTION 5.2: SUMMARY OF FINDINGS

The main findings of this overview of cement industry can be given here. The aim is to highlight the industry-specific characteristics that may influence investment behaviour. It should be mentioned that of the important studies covered
only Bagchi's study has a direct bearing on this perspective. However, to highlight the important characteristics it is pertinent to divide the findings into two groups. The first refers to the case where the growth of the cement industry is entirely influenced by demand considerations - a period that corresponds to a uniform retention price system, corresponding to the studies by Bagchi and Rosen. The second period corresponds to the emergence of supply factors as influencing the growth process in an important way. Supply factors not only refer to the technological change in the industry but also the supply side factors that influence the capacity utilization, e.g. shortage of electricity, shortage of wagons (for transport), teething/mechanical problems etc.

In the first period, the investment in the industry is associated with excess capacity and a low-return on capital employed. This is captured by Rosen as well. These studies point to the fact that investment in the cement industry is not related to other investments in the economy; not only that investment is also not related to the existence of excess capacity. These do point to an over-dependence of the cement industry upon only government off-take for war and plan purposes in a protected environment. It had its adverse fallout. This dependence was linked to a price system that regulated the prices on a cost plus principle.
that resulted in a return on capital that is very low. Secondly, even in the period under study by Rosen (1937 to 1953), the average capital output ratio rose (indicating inefficiency in resource use) and is unrelated to investment in that industry, i.e., investment was not deterred by excess capacity and high capital output ratio was in fact a reflection of the protection enjoyed by this industry.

This saw a growth pattern of this important industry that relied mainly on an increase in profits by expanding sales without a reduction in costs. This we can hold as a preliminary result showing a lack of appreciation of rate of return as a factor to guide investment behaviour.

Secondly, the overview of the growth process also points towards the importance of pricing policy as a factor which govern the investment behaviour in the industry. The study shows that partial liberalisation of the pricing policy as well as the multi-tier price formula instead of an uniform retention price system had helped to attract investment into the industry.

The second period is characterized by the dominance of supply side factors that influenced the growth process. they are mainly in terms of technological change both in product-wise and process-wise aspects. They are mainly in terms of (i) a change in the scale of operation, (ii) a change in the
process of production from wet process to dry or semi-dry processes. The importance of these supply factors, as they influence the cost of production, can be given ex hypothesis in terms of long-run changes in labour productivity, capital productivity, raw material (given their importance in direct costs) and total factor productivity. These aspects have been studied in separate studies by Sinha and Swahney (1970), Arya (1981), Ahluwalia (1991). Both Sinha and Swahney and Arya found evidence for a negligible influence of supply factors, insignificant growth of total factor productivity as compared to the contribution of capital to account for the growth of output (or growth of labour productivity). Ahluwalia's (1991) study shows that productivity in fact declined in a period that also saw relative increase in the cement industry's share in total manufacturing output. It is one of the slowest growing industries in terms of total factor productivity growth. Between 1970-71 and 1985-86, the study finds that the share of value added of cement in the manufacturing value-added has increased from 1.66 per cent in 1970-71 to 2.22 per cent in 1985-86. Along with it, though the value-added in cement industry has increased at a rate of 5.1 per cent per annum from 1960-61 to 1985-86, the rate of growth of total factor productivity in the corresponding time period is negative (1.4 per cent per annum) where a rise in the capital
intensity is associated with a decline in capital productivity.\textsuperscript{28}

It is important to note that the study of Sinha and Swahney covers the period 1950-63, and the period covered in Arya's study is from 1950 to 1970. This is against the background of supply factors assuming importance only around in the early 1970s. The study by Ahluwalia, on the other hand covers the period from 1960 to 1985, and so the results do reflect the importance of supply factors in the growth process. However, in these analyses, there is no explicit analysis of the investment behaviour to link its inefficiency with the growth of the industry. It is assumed that factors other than investment are important. In other words, there is no independent representation of investment and its role in growth process to evaluate the performance of cement industry in these studies.

SECTION 5.3: TIME PERIOD CHOSEN IN THE PRESENT STUDY

The present study takes up the time period 1974-75 to 1988-89, as the relevant period to study the factors that influence the growth process in the cement industry. Ideally, it should have covered the period 1968 to 1974 as well, to bring out the importance of the change in price system that evolved during the period with respect to this industry. In fact, BICP study points to the nexus between
the cost of production and the price of output that crucially depend on technological change in this industry. However, the year 1973-74 is taken up as the beginning of the study, given that the data for the entire industry, on all its important characteristics, are available consistently only after this period. In fact, the ASI data on which this study relies are not available for the year 1970-71 and 1972-73.

However, the importance of the time period 1973-74 to 1988-89 is that, as the BICP study shows, the cement industry underwent important changes in this time period, in terms of both technological change and the change in the price system. It is maintained that these industrial characteristics along with other important macro-effects do influence investment behaviour in this industry in an important way. They also reflect the nature of growth process in the industry.

The emphasis of this study is on the rate of investment to judge whether it reflects efficiency of investment. In this case the overview of cement industry points towards two research issues which can be expressed as follows:

(i) whether demand factors and easy finance through government policy, facilitated by the pricing policy, governed investment behaviour or investment in the industry is primarily guided by an increase in
profitability that reflects an increase in productive efficiency;

(ii) whether changes in the production structure, which accompanied investment in the industry, entail an increase in productivity growth or not.

It should be emphasized that an increase in productive efficiency is not caused by investment in the industry but accompanies it due to favorable macroeconomic environment. This point can be discussed in terms of an increase in investment that reflects an increase in capital intensity. In study relating to cement industry in India, Arya (1979) maintains that an increase in capital intensity is a measure of embodied technical change and therefore, reflects an increase in productivity growth. This study, however, maintains that an increase in capital intensity that accompanies investment in an industry may have nothing to do with productive efficiency and an increase in capital intensity may be accompanied by a decline in capital productivity, e.g., due to unfavorable effects of investment elsewhere in terms of a small size of the market in relation to output expansion owing to an increase in capital intensity.

In this case it is maintained that a favorable macroeconomic environment, reflected by an increase in profitability and productivity growth, forms the basis of
efficiency of investment in an industry. In other words, investment in cement industry should primarily be guided by investment elsewhere. This aspect of investment behaviour is taken up in the following chapters.
NOTES:

1. Refer to Chapter III, Section 3.1.
9. For example, a 4 1/2 per cent return on working capital and an 8 per cent return on gross block plus a 2 rupee per ton allowance (after tax) for a special rehabilitation fund. For the newer firms, with higher construction costs and higher fixed capital and depreciation charges per unit of output, the price formula allowed higher prices. Refer to G. Rosen (1959), p. 17
15. This is in line with the finding of the studies by G. Rosen (1959), and A.K. Bagchi (1980).
16. Based on BICP (1987) study, especially chapter 2.
26. BICP (1987) study points to the fact that the underlying reason for variations in capacity utilisation is mainly due to supply constrains that is beyond the control of production unit (pp. 1-2).
27. J.N. Sinha and P.K. Sawhney (1970) takes a Kendrik index for the measurement of total factor productivity; Arya adopts the solow index on the other hand Ahluwalia's study is the most comprehensive in terms of the index of measurement is data specific. For a review, of different methods refer to Ahluwalia (1991), Annexure 2.1 and pp. 141-146; also see, B. Goldar (1986b), pp. 13-20.
28. See, I.J. Ahluwalia (1991), Table 2.3, 2.4, and 2.5 in Chapter-II.