CHAPTER 5

This thesis presented an investment-planning model which aims to assist the steel industry in its programme for building up steel-making capacity in order to meet a given time-profile of demand for steel. Chapter 1 gave the background of the development of the steel industry in India and its present status. Chapter 2 presented a review of various investment-planning models and introduced the model which is expounded in the present thesis. Chapter 3 contained a discussion of the features of the latter model at length. The empirical application of this model was presented in Chapter 4 . The results of the empirical exercise were also presented there and analysed.

5.1 REVIEW OF MAJOR ASSUMPTIONS

5.1.1 RECENT CHANGES IN ECONOMIC POLICY

Reviewing all the chapters, it was felt necessary to mention here that the thesis was conceived and given shape in an era of planning and controls in the Indian economy. Till 1991, the policies pertaining to the Indian steel industry were formulated and closely monitored by the Government, as was the case for other major industries. The steel prices and distribution were controlled by Joint Plant Committee[1] till 1991. However, starting from July, 1991, the Government has undertaken various reforms in different sectors of the economy. These reforms aim at removing Government controls to a large extent, thereby moving towards a more free, market-

driven economy. These reforms have come to be known as the `New Economic Policies'. The broad outlines of these policies are given below.

The economic reforms introduced by the Indian Government in the recent past included the following:

(i) A programme of macroeconomic stabilization which seeks to reduce the fiscal deficit as a percentage of GDP and to slow down the rate of growth of money supply.

(ii) A medium-term strategy for carrying out structural reforms in the foreign trade and payment regime, the tax system, industrial policy, financial policy and other areas.

Some of the structural reforms which have important repercussions for the Indian steel industry are discussed below in greater detail:

1) Industrial Policy Reforms:

a) Industrial licensing was abolished for all except a select list of hazardous and environmentally sensitive industries.

b) The price and distribution controls on the Iron & Steel industry were removed on 16 January 1992. The distribution controls were retained for only a few areas of strategic importance.

c) The freight equalisation system for iron and steel products was replaced by a system of freight ceiling. The freight element charged to the consumers will be either the actual cost or the ceiling rate whichever is lower.

d) The list of industries reserved for the public sector was reduced from 17 to 6.

e) Access to foreign technology was made easier.

2) Trade and Exchange Rate Policies:

a) Import control through licensing was virtually abolished (except for consumer goods).

b) Import duties were reduced in stages to remove the umbrella of protection above the domestic industry and to enhance their efficiency through increased competition. In the 1993-94 and 1994-95 Union Budgets the customs duty on iron and steel products were substantially lowered, accompanied by duty-cuts in project imports and general machinery.

c) The Rupee was made fully convertible on trade account and partially convertible on current account. This implies that the rate of exchange for the Rupee is now determined by demand abd supply conditions in foreign exchange markets.

3) Foreign Investment Policies:

a) Foreign investments upto 51 % equity in a specified list of some priority industries was made automatic.

b) The procedure for Indian companies to invest abroad and develop global linkages in this way was streamlined.

c) India signed the Multilateral Investment Guarantee Agency (MIGA) convention along with other developing countries for promoting foreign investment.

4) Tax Reforms :

a) In order to reduce the high cost of imported inputs and to moderate excessive protection to domestic industry, a major thrust of indirect tax reforms was to level and simplify the structure of customs duties.

b) A process of simplification of excise duties was started in the 1993-94 budget. This included a moderation of the high rates of duties on some commodities and some reduction in the scope of exemptions.

A major implication of the reforms in the steel sector is that the producers in the secondary sector will increasingly gain importance. Since they no longer require licence from the Government, they are now free to enter and exit the market. Thus the uncertainty in the steel market will increase considerably. In addition, with a steady reduction in customs duties over the years, domestic producers are facing increasing competition from imported materials. At the same time, domestic producers are increasing their export to foreign countries. India is now a major steel-producing country, ranking 10th in the world in 1992 with a production of 18.1 million tonnes of crude steel. So the international steel market will affect the domestic market by a larger degree than before. Thus the situation in which the planning model was formulated has changed considerably at present.

The implications of the new policies for the investment-planning model M1 will be discussed in the

following section in detail. The first issue under discussion relates to the logic behind continuing with a domestic steel industry in case imports are cheaper than domestic production. The second issue relates to the need to continue to plan for investment of the domestic steel industry under the changed circumstances. The third issue refers to the revision in demand when export-possibilities are introduced. Here a slight detour is made to look at the potential of exporting Indian steel. An appraisal of the international competitiveness of the Indian steel industry is made based upon the estimates of production cost according to M1. The last issue relates to the possible spurt in the growth of the secondary sector following the liberalisation of policies.

5.2.1 RATIONALE FOR DOMESTIC PRODUCTION IN NEW REGIME

It is necessary to address the following question at this point. In a liberalised regime, with fixed coefficient technology and fixed prices of input and output in the world market, if unit import costs are lower than unit cost of producing steel domestically, why should the domestic steel industry produce steel at all? It will be seen from the following observations that importing the entire domestic requirement of steel may not be a feasible solution due to various reasons.

Firstly, as long as India imports small quantities of steel, it is a price-taker in the international market and its purchases will not affect the international prices. But with bulk imports, Indian consumers may face a rising supply

price of steel imports. Therefore imports may become costlier than domestic production in the future. As the `optimum tariff' argument[2] illustrates, protecting the domestic industry via tariff can improve a country's welfare vis-a-vis a situation of free trade. As mentioned above, when the importing country is a large buyer in the world market, then the marginal cost of import is higher than the import price and hence may be higher than the marginal cost of production in the domestic market. Therefore there is a case for protecting the domestic steel industry in spite of the fact that in a free-trade situation, it is cheaper to import steel.

In addition, it may be mentioned that the Indian main producers like SAIL and TISCO have improved their performance considerably in the last two years after the advent of the New Economic Policies. They are competing in the international market as is evident from the increase in their exports. The export of finished steel from the main producers rose from 0.183 million tonnes in 1990-91 to 1.559 million tonnes in 1993-94. International competitiveness in steel-production will ensure the existence and growth of the domestic steel industry. In case the Indian steel industry becomes internationally competitive, the investment-planning model M1 can be altered suitably to accomodate exports. These changes will be discussed in a subsequent section.

5.2.2 ROLE OF INVESTMENT-PLANNING FOR STEEL IN NEW REGIME

It was established in Section 5.2.1 above that despite a freer market regime leading possibly to cheaper imports, there is still justification for continued existence of the domestic industry. However, given the abolition of controls and reduced intervention by the state, it may be contended that investment-planning is no longer as important as before. But once it is acknowledged that the distribution of scarce resource inputs is still under control, it is clear that planning still retains its importance. However, planning is required now to be more `indicative' and less `interventionistic' in nature. Indicative planning is crucial for the Indian steel sector under the liberalised environment because of the following reasons :

a) Large investment requirement for setting up steel units. The large requirement of capital by the new steel-producing units will necessitate a major role for the financial institutions which will need some form of planning by the Government.

b) Existence of scale-economies in the steel industry which will involve planning for setting up few steel-producing units of an optimum size rather than numerous small-sized units. There is also a large cost of uncoordinated investment by different individual producers, since investment is irreversible.

Again, allowing prices to be determined entirely by market forces means that prices may shoot up considerably,

causing distress for common people. The basic case for monitoring and control of steel prices arises from the fact that by its very nature the steel industry is likely to have an oligopolistic structure. In that case the ruling prices may be much above the marginal cost of production. Therefore, in case of restrictions on imports, there is a need for exercising control over steel prices.

5.2.3 THE DEMAND SITUATION

The investment-planning exercise has been carried out on the basis of the argument that demand will never be a constraint for the main producers. This demand will also include export demand, which becomes especially important under the liberalised regime. While the level of export demand depends on supply and demand conditions in the international market, and the ability to export will depend on international cost-competitiveness, there is sufficient reason to believe that domestic demand will continue to increase in the future.

5.2.3.1 EXPORT-POSSIBILITIES

With the new liberal economic policies, export of steel is expected to increase (export of steel in 1993-94 has crossed 1.5 million tonnes), so that a substantial export demand will be added to the domestic demand. A study by Economic Research Unit, Joint Plant Committee (1994) on the Potential, Perspective and Policy of Export of the Indian steel industry[3] mentions export projections by the Indian steel producers of 4 million tonnes and 6.5 million tonnes of

crude steel by the years 1996-97 and 2001-02 respectively.

Regarding non-inclusion of exports in the model M1, it may be pointed out that the model can easily be modified to take the export market into account. If all the trade barriers are removed so that the domestic prices are equalized with the international prices, then the inclusion of export demand will amount to inflating the levels of demand considered in the given time-profile of demand. The export revenue will enter the cost function as a negative cost item. In case the international and domestic prices are different, then exporting steel or selling it in the domestic market will be decided by the relative prices. If export prices remain the same regardless the amount of sales, then the profitable option will be exhausted first and then the next tried. For instance, if export prices are greater than domestic prices, then the export demand will be fully satisfied before the producers move on to satisfy the domestic demand. Therefore, the model can easily incorporate the export market and can be used in the changed situation. The competitiveness of Indian steel in the export market as estimated by the investment-planning model M1 has been discussed in the following section.

The production cost of crude steel as given by the optimisation results of Chapter 4 has been estimated for the Base Case and other sensitivities. The average production cost is then compared with the international price of billets in order to assess the cost-competitiveness of Indian steel

in the world market.

5.2.3.2 ESTIMATION OF PRODUCTION COST OF CRUDE STEEL

The production cost of crude steel has been estimated in the following section using the results obtained from applying M1 in section 4.4 of Chapter 4.

The summary results in Table 2 and the detailed results of optimisation of the previous chapter show the total optimal cost of meeting a given demand-profile of crude steel at each demand-stage. The capital cost and the operating cost of producing steel are also indicated there for each stage along with the tonnage of crude steel for which these costs were incurred.

However, the entire capital that comes on stream at each demand-stage is not utilised for production at that stage. In order to apportion a part of the capital to the production of steel, a concept of capital servicing factor is used here. This factor is used to estimate that portion of capital which has been used to produce the output at a particular demand-stage. This factor, referred to henceforth as f, is obtained by assuming that capital is used up at a uniform rate over the life-time of the investment project.

Let k = Undiscounted capital cost of an investment project;

c = Uniform capital charge which gives the following relation :

$$k = \frac{c}{1+r} + \frac{c}{(1+r)^2} + \ldots\ldots\ldots\ldots + \frac{c}{(1+r)^n} + \frac{0.05k}{(1+r)^n}$$

where r = Annual rate of discount;

n = Lifetime of the project

and 5% is the norm for salvage value of the capital.

Given that k, r and n are known for a particular project, the above relation can be solved to find the corresponding value of c.

Then the capital servicing factor f is defined as

$$f = \frac{c}{k}$$

Using the above relation, and actual data for each plant, the following calculations are carried out for 00 BaseCase and for each sensitivity to obtain estimates of production cost of steel at each demand-stage. The capital cost at each stage will be multiplied by the value of f for the investment project under consideration. Since there is a one-period lag between the optimal cost shown at each stage and the corresponding output, the cost must be multiplied by a discount factor such that it may be divided by the output to arrive at the unit cost. The Annexure contains the calculations for estimating the production cost of all the cases for each demand-stage.

As the comparison of international billet prices with domestic crude steel shows, Indian steel manufactured by the main producers can compete in the international market at the crude steel stage. Although the export price of Indian billets will be slightly higher than the range of 5000-6000 Rs./T as shown in the calculations due to addition of export-

related charges, the extra cost is likely to be small. The study on export of Indian steel by Economic Research Unit, Joint Plant Committee (1994) shows that this cost will be in the range of 200-300 Rs./T for most steel products. This is because while there are additional export-related costs, the producers gain simultaneously by various export-incentives[4].

Regarding the production cost figures, some additional observations may be made.

1) In general, production cost of crude steel has increased after stage 2 because the cheapest option has been exhausted first. Subsequently it has fallen, except for 04, 06 and 08 sensitivities although the cost at stage 4 is higher than that at stage 2. The decline in cost from stage 3 to 4 may be because of a larger increase in demand as compared to the increment from stage 2 to 3, resulting in a higher capacity utilisation.

2) The import price changes clearly do not affect production costs, as can be seen from the 06 and 07 sensitivities.

3) In only the case of 04 and 02 sensitivity, production cost has fallen from stage 2 to stage 3. For the latter, it may be because, with a high discount rate, domestic production is bunched toward the end of the planning period.

4) Production cost has changed very little with 03 sensitivity, i.e. with taking credit for gases.

5) For 04 sensitivity, the production cost has declined steadily as demand has risen which is a distinctly different

pattern from the other cases considered. So the production cost is very sensitive to changes in the demand-profile.

6) The production cost is not very sensitive to changes in the premium on foreign exchange. It may be mentioned here that, with convertibility of the rupee on the trade account, there is a single, market-determined rate of exchange. So there is no longer a premium for foreign exchange. Since the production cost is relatively insensitive to changes in the premium on foreign exchange, it is not likely to be altered substantially if the new single rate of exchange is incorporated in the model.

5.2.4 GROWTH OF THE SECONDARY SECTOR

Another major assumption was that the capacity of the secondary-sector will not increase after 1999-2000. But with delicensing and decontrol of the steel sector, the capacity of the secondary sector is expected to grow very rapidly. At present there are 10 proposals for building fairly large steel plants in the secondary sector. The recent entrants include Lloyds Steel with a capacity of producing 0.45 million tonnes of steel annually and Essar Gujarat with a plan to produce 1.2 million tonnes of Hot Rolled Coils by the end of 1994. The rate of increase in capacity till 1999-2000 may also be higher than that assumed in the present thesis. This can be taken care of by revising the estimates of supply of steel from the secondary sector and netting out the revised estimates from the economy-wide demand for steel for the relevant years. It may be noted, however, that in the present liberalised scenario, it would be more relevant to

include secondary sector and TISCO in the model since the private sector is now expected to play an increasingly important role in the Indian steel scenario. In case data are available regarding the technical and cost parameters for the plants in the secondary sector, these plants can be included as part of the investment-planning model M1. The only change will be that the number of investment-options available will be more due to the inclusion of the choice of investing in the secondary sector.

The model M1 indicates the optimum scale and pattern of investment in the steel industry. Whether this investment takes place in the primary or in the secondary sector, or whether in the public or in the private sector will depend on the relative efficiency in production which will be reflected in the cost parameters. In this context, it may be mentioned that the distinction between primary and secondary routes of steel production is now slowly fading. This is because the two features which differentiate integrated steel plants from mini steel plants- namely, technology and size- no longer give clear signals for categorisation. DR-EAF route-based plants are now being built which have capacities upto 1.5 million tonnes. Again, mini Blast Furnaces are now being combined with Electric Arc Furnaces, breaking the traditional route of BF-BOF for the integrated steel plants. Therefore, for subsequent application of model M1, the only distinction that may be made within the steel industry may be between the public and the private sector plants rather than plants in

the primary and the secondary steel sector.

5.3 REVIEW OF POLICY RECOMMENDATIONS

The conclusions from the empirical application of M1 and the policy recommendations have already been discussed at length in Chapter 4. Among the investment-options available, IISCO modernisation, construction of Vizag Steel Plant and modernisation of Rourkela Steel Plant and Durgapur Steel Plant have been chosen consistently in that order. This seems to indicate the relative advantage of the plants in crude steel-making. Here it may be reiterated that the data supplied to the researcher were accepted at face-value. A realistic assessment of the data were thought to be outside the scope of the thesis since an economist is not equipped to tackle such problems. Also, the relative merits of the various investment-options were judged at the crude steel-making stage. The merit-wise ranking may change once finished-steel making is considered.

In conclusion, given the parameters of the given investment-planning exercise, it is optimal to concentrate on building up domestic capacity to produce steel rather than to import. With a lowering of import price, there is a shift away from domestic capacity-creation towards imports. The optimal investment-path arrived at in Chapter 4 was found to exhibit sensitivity to the time-profile of demand for steel and to the import-price of steel. It was found to be fairly robust with respect to the other parameters.

At the end it may be mentioned once again that an investment-planning model was developed in this thesis, which treated the steel industry as a process industry where multi-stage sequential decision-making for investment is viewed as a dynamic programming problem. The merit of this model lies in the fact that it combines the dynamic nature of the activity of investment with the realistic aspect of actual project-choice. An empirical application of the model M1 was carried out and the results were used for making policy recommendations. Models for other process industries may also be developed along similar lines to be used for investment-planning in these industries.

NOTES FOR CHAPTER 5

1. The Government of India appointed Raj Committee in 1962 in order to examine the system of planning and distribution of steel. The Committee observed that the pricing policy of different categories and sections of steel should reflect the relative costs of production. The Committee recommended that fixation of general level of prices (including inter-relationship between different products and in different regions and to different consumers) should be left to a body of main producers. The Government accepted the recommendations of the Raj Committee and Joint Plant Committee of the main producers was set up under the Chairmanship of Iron and Steel Controller with effect from 1.3.64.
2. It is possible for a country to improve its welfare by switching from free trade to a situation with a `right' tariff, provided that the trade partner does not retaliate. This tariff, the tariff that maximizes a country's welfare is called the `optimum tariff'. For details regarding the theory of optimum tariff, refer to Sodersten (1980).
3. This study has been carried out by Economic Research Unit, Joint Plant Committee and a report `Export of Steel from India: Potential, Perspective and Policy' based on the same has been brought out by the Ministry of Steel, Government of India.

4. The export-related charges include interest on export credit, port-handling charges and inland freight to port. The benefits for exports include refund for duty on raw material and inputs used for producing exportables under Duty Drawback Scheme, duty-free import of inputs under Advance Licensing Scheme and similar benefits under various export-promotion schemes.

A N N E X U R E TO C H A P T E R-5

Estimation of f

1. Vizag Steel Plant

n = 23 years
r = 12 % p.a.
Undiscounted capital cost is valued at 1246.21 Rs.Cr.

$$1246.21 = C/1.12 + C/(1.12)^2 + \ldots\ldots\ldots + C/(1.12)^{23} + (0.05*1246.21)/(1.12)^{23}$$

$$1246.21 = C * \frac{1-(1/1.12)^{23}}{1-(1/1.12)} + \frac{62.31}{13.55}$$

The above relation gives

$C = 147.46$

$f = 147.46/1246.21$
$= 0.118$

2. Durgapur Steel Plant Modernisation

n = 25 years
r = 12 % p.a.
Undiscounted capital cost is valued at 517.97 Rs.Cr.

$$517.97 = C/1.12 + C/(1.12)^2 + \ldots\ldots\ldots + C/(1.12)^{25} + (0.05*517.97)/(1.12)^{25}$$

$$517.97 = C * \frac{1-(1/1.12)}{1-(1/1.12)} + \frac{25.9}{17}$$

The above relation gives

$C = 59.50$

$f = 59.50/517.97$
$= 0.115$

3. Rourkela Steel Plant Modernisation

n = 27 years
r = 12 % p.a.
Undiscounted capital cost is valued at 416.88 Rs.Cr.

$$416.88 = C/1.12 + C/(1.12)^2 + \ldots\ldots\ldots + C/(1.12)^{27} + (0.05*416.88)/(1.12)^{27}$$

$$416.88 = C * \frac{1-(1/1.12)^{27}}{1-(1/1.12)} + \frac{20.84}{21.32}$$

The above relation gives

$C = 48$

$f = 48/416.88$
$= 0.115$

4. Indian Iron & Steel Co. Modernisation

n = 27 years
r = 12 % p.a.
Undiscounted capital cost is valued at 499.19 Rs.Cr.

$$499.19=C/1.12+x/(1.12)^{2}+.....+C/(1.12)^{27}+(0.05*499.19)/(1.12)^{27}$$

$$499.19=C*\frac{1-(1/1.12)^{27}}{1-(1/1.12)}+\frac{24.96}{21.32}$$

The above relation gives

$C=57.48$

f=57.48/499.19
=0.115

Estimation of Production Cost
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00 Base Case

Stage 4

Capital Cost is 18037.9 Rs. million
f for Vizag Steel Plant is 0.118
18037.9*0.118=2128.47 Rs. million
Operating Cost is 2463.8 Rs. million
The discount factor is 2.2107
(2128.47+2463.8)*2.2107=10152.13 Rs. million
Additional output of crude steel at stage 4 is 17 million tonne
Production Cost at stage 4 = 10152.13/17 Rs./T
= 597.18 Rs./T

Stage 3

Capital Cost is 6012.63 Rs. million
f for Vizag Steel Plant is 0.118
6012.63*0.118=709.49 Rs. million
Operating Cost is 824.25 Rs. million
The discount factor is 2.2107
(709.49+824.25)*2.2107=3390.64 Rs. million
Additional output of crude steel at stage 3 is 5 million tonne
Production Cost at stage 3 = 3390.64/5 Rs./T
= 678.13 Rs./T

Stage 2

Capital Cost is 830.65 Rs. million
f for IISCO is 0.115
830.65*0.115=95.52 Rs. million
Operating Cost is 439.01 Rs. million
The discount factor is 2.2107
(95.52+539.01)*2.2107=1181.69 Rs. million
Additional output of crude steel at stage 2 is 2 million tonne
Production Cost at stage 2 = 1181.69/2 Rs./T
= 590.85 Rs./T

01 Sensitivity

Stage 4

Capital Cost is 18037.9 Rs. million
f for Vizag Steel Plant is 0.118
18037.9*0.118=2128.47 Rs. million
Operating Cost is 3516.75 Rs. million
The discount factor is 1.8997
(2128.47+3516.75)*1.8997=10724.22 Rs. million
Additional output of crude steel at stage 4 is 17 million tonne
Production Cost at stage 4 = 10724.22/17 Rs./T
= 630.84 Rs./T

Stage 3

Capital Cost is 6012.63 Rs. million
f for Vizag Steel Plant is 0.118
6012.63*0.118=709.49 Rs. million
Operating Cost is 1118.09 Rs. million
The discount factor is 1.8997
(709.49+1118.09)*1.8997=3471.85 Rs. million
Additional output of crude steel at stage 3 is 5 million tonne
Production Cost at stage 3 = 3471.85/5 Rs./T
= 694.37 Rs./T

Stage 2

Capital Cost is 830.65 Rs. million
f for IISCO is 0.115
830.65*0.115=95.52 Rs. million
Operating Cost is 510.89 Rs. million
The discount factor is 1.8997
(95.52+510.89)*2.2107=1340.59 Rs. million
Additional output of crude steel at stage 2 is 2 million tonne
Production Cost at stage 2 = 1340.59/2 Rs./T
= 576.00 Rs./T

02 Sensitivity

Stage 4

Capital Cost is 21044.22 Rs. million
f for Vizag Steel Plant is 0.118
21044.22*0.118=2483.22 Rs. million
Operating Cost is 1820.49 Rs. million
The discount factor is 2.9301
(2483.22+1820.49)*2.9301=12610.3 Rs. million
Additional output of crude steel at stage 4 is 20 million tonne
Production Cost at stage 4 = 12610.3/20 Rs./T
= 630.52 Rs./T

Stage 3

Capital Cost is 4749.86 Rs. million
Contribution of VSP in capital cost, as calculated from
Unit capital cost and capacity is = (1066.07*2.82) Rs. million
=3006.32 Rs. million

f for Vizag Steel Plant is 0.118
3006.32*0.118=354.75 Rs. million
(4749.86-3006.32)Rs. million=1743.54 Rs. million
This is the contribution of Rourkela and Durgapur, both having f=0.115
1743.54*0.115=200.51 Rs. million
Operating Cost is 232.44 Rs. million
The discount factor is 2.9301
(354.75+200.51+232.44)*2.9301=2308.04 Rs. million
Additional output of crude steel at stage 3 is 4 million tonne
Production Cost at stage 3 = 2308.04/4 Rs./T
= 577.01 Rs./T

Stage 2

Capital Cost is 830.65 Rs. million
f for IISCO is 0.115
830.65*0.115=95.52 Rs. million
Operating Cost is 331.22 Rs. million
The discount factor is 2.9301
(95.52+331.22)*2.9301=1250.39 Rs. million
Additional output of crude steel at stage 2 is 2 million tonne
Production Cost at stage 2 = 1250.39/2 Rs./T
= 625.20 Rs./T

03 Sensitivity

Stage 4

Capital Cost is 18037.9 Rs. million
f for Vizag Steel Plant is 0.118
18037.9*0.118=2128.47 Rs. million
Operating Cost is 2426.49 Rs. million
The discount factor is 2.2107
(2128.47+2426.49)*2.2107=10069.65 Rs. million
Additional output of crude steel at stage 4 is 17 million tonne
Production Cost at stage 4 = 10069.65/17 Rs./T
= 592.33 Rs./T

Stage 3

Capital Cost is 6012.63 Rs. million
f for Vizag Steel Plant is 0.118
6012.63*0.118=709.49 Rs. million
Operating Cost is 811.18 Rs. million
The discount factor is 2.2107
(709.49+811.18)*2.2107=3361.75 Rs. million
Additional output of crude steel at stage 3 is 5 million tonne
Production Cost at stage 3 = 3361.75/5 Rs./T
= 672.35 Rs./T

Stage 2

Capital Cost is 830.65 Rs. million
f for IISCO is 0.115
830.65*0.115=95.52 Rs. million
Operating Cost is 433.38 Rs. million
The discount factor is 2.2107
(95.52+433.38)*2.2107=1169.24 Rs. million
Additional output of crude steel at stage 2 is 2 million tonne
Production Cost at stage 2 = 1169.24/2 Rs./T
= 584.62 Rs./T

04 Sensitivity

Stage 4

Capital Cost is 6792.01 Rs. million
Contribution of RSP to capital cost as per its unit capital cost and capacity is (1558.75*0.5) Rs. million or 779.38 Rs. million.
f for Rourkela Steel Plant is 0.115
779.38*0.115=89.63 Rs. million
(6792.01-779.38) Rs. million
or 6012.63 Rs. million is the contribution of VSP
f for Vizag Steel Plant is 0.118
6012.63*0.118=709.49 Rs. million
Operating Cost is 727.11 Rs. million
The discount factor is 2.2107
(89.63+709.49+727.11)*2.2107=3374.04 Rs. million
Additional output of crude steel at stage 4 is 7 million tonne
Production Cost at stage 4 = 3374.04/7 Rs./T
= 482.01 Rs./T

Stage 3

Capital Cost is 3006.32 Rs. million
f for Vizag Steel Plant is 0.118
3006.32*0.118=357.75 Rs. million
Operating Cost is 491.25 Rs. million
The discount factor is 2.2107
(357.75+491.25)*2.2107=1876.88 Rs. million
Additional output of crude steel at stage 3 is 3 million tonne
Production Cost at stage 3 = 1876.88/3 Rs./T
= 625.63 Rs./T

Stage 2

Capital Cost is 830.65 Rs. million
f for IISCO is 0.115
830.65*0.115=95.52 Rs. million
Operating Cost is 219.51 Rs. million
The discount factor is 2.2107
(95.52+219.51)*2.2107=696.44 Rs. million
Additional output of crude steel at stage 2 is 1 million tonne
Production Cost at stage 2 = 696.44/1 Rs./T
= 696.44 Rs./T

05 Sensitivity

Stage 4

Capital Cost is 17868.70 Rs. million
f for Vizag Steel Plant is 0.118
17868.70*0.118=2108.51 Rs. million
Operating Cost is 2464.63 Rs. million
The discount factor is 2.2107
(2108.51+2464.63)*2.2107=10109.84 Rs. million
Additional output of crude steel at stage 4 is 17 million tonne
Production Cost at stage 4 = 10109.84/17 Rs./T
= 594.70 Rs./T

Stage 3

Capital Cost is 5956.23 Rs. million
f for Vizag Steel Plant is 0.118
5956.23*0.118=702.84 Rs. million
Operating Cost is 826.12 Rs. million
The discount factor is 2.2107
(702.84+826.12)*2.2107=3380.07 Rs. million
Additional output of crude steel at stage 3 is 5 million tonne
Production Cost at stage 3 = 3380.07/5 Rs./T
= 676.01 Rs./T

Stage 2

Capital Cost is 815.67 Rs. million
f for IISCO is 0.115
815.67*0.115=93.80 Rs. million
Operating Cost is 436.36 Rs. million
The discount factor is 2.2107
(93.80+436.36)*2.2107=1172.02 Rs. million
Additional output of crude steel at stage 2 is 2 million tonne
Production Cost at stage 2 = 1172.02/2 Rs./T
= 586.01 Rs./T

06 Sensitivity

Stage 4

Capital Cost is 18037.9 Rs. million
f for Vizag Steel Plant is 0.118
18037.9*0.118=2128.47 Rs. million
Operating Cost is 2133.53 Rs. million
The discount factor is 2.2107
(2128.47+2133.53)*2.2107=9422.00 Rs. million
Additional output of crude steel at stage 4 is 17 million tonne
Production Cost at stage 4 = 9422.00/17 Rs./T
= 554.24 Rs./T

Stage 3

Capital Cost is 6792.01 Rs. million
Contribution of RSP to capital cost as per its unit capital cost and capacity is (1558.75*0.5) Rs. million or 779.38 Rs. million.
f for Rourkela Steel Plant is 0.115
779.38*0.115=89.63 Rs. million
(6792.01-779.38) Rs. million
or 6012.63 Rs. million is the contribution of VSP
f for Vizag Steel Plant is 0.118
6012.63*0.118=709.49 Rs. million
Operating Cost is 1097.07 Rs. million
The discount factor is 2.2107
(89.63+709.49+1097.07)*2.2107=4191.91 Rs. million
Additional output of crude steel at stage 3 is 6 million tonne
Production Cost at stage 3 = 4191.91/6 Rs./T
= 698.65 Rs./T

Stage 2

Capital Cost is 830.65 Rs. million
f for IISCO is 0.115

830.65*0.115=95.52 Rs. million
Operating Cost is 439.01 Rs. million
The discount factor is 2.2107
(95.52+439.01)*2.2107=1181.69 Rs. million
Additional output of crude steel at stage 2 is 2 million tonne
Production Cost at stage 2 = 1181.69/2 Rs./T
= 590.84 Rs./T

07 Sensitivity

Stage 4

Capital Cost is 18037.9 Rs. million
f for Vizag Steel Plant is 0.118
18037.9*0.118=2128.47 Rs. million
Operating Cost is 2463.80 Rs. million
The discount factor is 2.2107
(2128.47+2463.80)*2.2107=10152.13 Rs. million
Additional output of crude steel at stage 4 is 17 million tonne
Production Cost at stage 4 = 10152.13/17 Rs./T
= 597.18 Rs./T

Stage 3

Capital Cost is 6012.63 Rs. million
f for Vizag Steel Plant is 0.118
6012.63*0.118=709.49 Rs. million
Operating Cost is 824.25 Rs. million
The discount factor is 2.2107
(709.49+824.25)*2.2107=3390.64 Rs. million
Additional output of crude steel at stage 3 is 5 million tonne
Production Cost at stage 3 = 3390.64/5 Rs./T
= 678.13 Rs./T

Stage 2

Capital Cost is 830.65 Rs. million
f for IISCO is 0.115
830.65*0.115=95.52 Rs. million
Operating Cost is 439.01 Rs. million
The discount factor is 2.2107
(95.52+439.01)*2.2107=1181.69 Rs. million
Additional output of crude steel at stage 2 is 2 million tonne
Production Cost at stage 2 = 1181.69/2 Rs./T
= 590.84 Rs./T

08 Sensitivity

Stage 4

Capital Cost is 18545.8 Rs. million
f for Vizag Steel Plant is 0.118
18545.8*0.118=2188.40 Rs. million
Operating Cost is 2460.61 Rs. million
The discount factor is 2.2107
(2188.40+2460.61)*2.2107=10277.56 Rs. million
Additional output of crude steel at stage 4 is 17 million tonne
Production Cost at stage 4 = 10277.56/17 Rs./T
= 604.56 Rs./T

Stage 3

Capital Cost is 6181.95 Rs. million
f for Vizag Steel Plant is 0.118
6181.95*0.118=729.47 Rs. million
Operating Cost is 818.35 Rs. million
The discount factor is 2.2107
(729.47+818.35)*2.2107=3421.77 Rs. million
Additional output of crude steel at stage 3 is 5 million tonne
Production Cost at stage 3 = 3421.77/5 Rs./T
= 684.35 Rs./T

Stage 2

Capital Cost is 875.72 Rs. million
f for IISCO is 0.115
875.72*0.115=100.71 Rs. million
Operating Cost is 446.92 Rs. million
The discount factor is 2.2107
(100.71+446.92)*2.2107=1210.65 Rs. million
Additional output of crude steel at stage 2 is 2 million tonne
Production Cost at stage 2 = 1210.65/2 Rs./T
= 605.32 Rs./T

The following table gives the summary results of production cost obtained for various demand-stages for the 00 BaseCase and the sensitivity exercises

Production Cost of Crude Steel (Rs./T)

Case	Stage 2	Stage 3	Stage 4
00 Base Case	590.85	678.13	597.18
01 Sensitivity	576.00	694.39	630.84
02 Sensitivity	625.20	577.01	630.52
03 Sensitivity	584.62	672.35	592.33
04 Sensitivity	696.44	625.63	482.01
05 Sensitivity	586.01	676.01	594.70
06 Sensitivity	590.84	698.65	554.24
07 Sensitivity	590.84	678.13	597.18
08 Sensitivity	605.32	684.35	604.56

The production cost of crude steel at 1970-71 prices may therefore be taken to vary within a range of 600 Rs./T to 700 Rs./T.
Wholesale Price Index (WPI) for Iron Steel and Ferro-alloys for 1981-82 (Base 1970-71) is 332
Therefore the range of production cost at 1981-82 prices is

(600*3.32) Rs./T = 1992 Rs./T
and (700*3.32) Rs./T = 2324 Rs./T

WPI for Iron Steel and Ferro-alloys for 1992-93 (Base 1981-82=100) is 234
Therefore the range of production cost at 1992-93 prices is

(1992*2.34) Rs./T = 4661 Rs./T
and (2324*2.34) Rs./T = 5438 Rs./T

Assuming inflation @ 5.74% p.a., the range of production cost at at 1993-94 prices will be

(4661*1.0574) Rs./T = 4928 Rs./T
and (5438*1.0574) Rs./T = 5750 Rs./T

As per Metal Bulletin 28th February, 1994, the FOB price of billets is 225 $/T
Using an exchange rate of 31.3 Rs/$, the FOB price of billets is 7042 Rs./T