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Some Aspects of Crisis in Indian Iron and Steel Industry under Liberalized Scenario

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Abstract

In 2008-2009, much of the industrialized world entered into a deep recession. This crisis has led to increased unemployment, and other signs of contemporaneous economic downturns in the major economies of the world. Sagging prices in the backdrop of economic slowdown have spelt turmoil in the steel industry worldwide in general and Indian steel industry in particular. This paper deals with multidimensional crisis being faced by Indian steel industry regarding productivity growth, capacity utilization, excess capacity, export, import, pricing of steel, production, demand doldrums etc. in the globally recessed post liberalized scenario. The present scenario has been studied cautiously and various issues have been identified and evaluated through econometric analysis. The econometric analysis demonstrates that total factor productivity growth was decreasing during post liberalized regime mainly due to technological regress. The utilization of capacity also declined gradually during reforms period which happened due to rapid expansion of capacity but comparatively slow growth rate of output. Moreover, analysis of several financial indices during post-reform regime reflects miserable display of the financial performance of the industry which is beyond our expectation. There exist falling price trend, lack of adequate demand, excess capacity as well as excess supply scenario and declining export of iron ore and steel which poses serious problem in the industry.

Introduction

In 2008-2009, much of the industrialized world entered into a deep recession. The complexity of vicious circles which contributed to this crisis included high oil prices, high

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food prices and the collapse of a substantial housing bubble, sub-prime lending crisis centered in the United States which sparked an interrelated and ongoing financial crisis. Around the world, many large and well established investment and commercial banks suffered massive losses and even faced bankruptcy. It has been argued that the huge increases in commodity and asset prices came as a consequence of an extended period of easily available credit and that the primary cause of the downturn was exceptionally financial. This crisis has led to increased unemployment, and other signs of contemporaneous economic downturn in the major economies of the world. Since October 2008, the global financial crisis, though originated in developed countries, led to the bankruptcy of many financial institutions in the USA and European countries, threatening the financial system of developing countries like India also.[§]

In the midst of economic slowdown worldwide, a snapshot at the steel prices in the last few years will ensure any economic analyst of the intensity of the problem in the industry worldwide, especially in India. The fluctuation of steel prices does not follow predictable cycle as is generally expected. The fluctuations are random which are beyond predictions .Generally, it displays explicit declining trend, accompanied by short boom period and lengthy recessionary condition at the same time. This indicates that the industry survives in chronic turbulence.

The objective of the paper is to deal with multidimensional crisis being faced by Indian steel industry regarding productivity growth, excess capacity, export, import, financial performance, capacity utilization, pricing of steel, production, demand doldrums etc. in the globally recessed liberalized scenario. The present scenario has been studied cautiously and various issues have been identified and evaluated.

Methodology

The study has been conducted and analyzed on the basis of econometric estimation as well as on the basis of calculations of various financial ratios and tabular presentation based on secondary data. Consequently, in the process of empirical investigation, industry-level time series data have been collected from several issues of Annual Survey of Industries, National Accounts Statistics, Centre for Monitoring Indian Economy (*CMIE)* and Economic Survey, Statistical Abstracts (several issues), Reserve Bank of India's Bulletin on Currency and Finance, Handbook of Statistics on Indian Economy, and Office of Economic Advisor, Ministry of Industry etc covering a period of 28 years commencing from 1979-80 to 2006-07. Selection of time period is largely guided by availability of data.

The entire appraisal procedure comprises of three typical methodologies. First, we use econometric model like Malmquist (output-based) productivity index (MPI) on the basis

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§ Global Financial Crisis, Summary of the media's coverage of the timelines, causes, implications, impact and recommended path forward, Grail Research, Sep.12, 2009,pp3-18,*www.grailresearch.com.*

of three inputs-capitals, labour and material including energy and one output framework to measure the productivity change. An econometrically tractable short-run variable cost function that assumes capital as a quasi-fixed input has been used to estimate capacity utilization. Second, financial performance is judged on the basis of some ratios and it is limited to post liberalization period only due to data constraint and other relevant performances are based on available current data. Lastly, export, excess supply scenario, pricing of steel, production, demand doldrums have been presented in tabular format based on secondary data.

Econometric Model for Malmquist TFP Index

In order to assess the performance of the Indian iron and steel industry, the Malmquist (output-based) productivity index (MPI) has been used (Here, model has been considered under three inputs,viz. material including energy,capital,labour and one output framework) to measure the productivity change and to decompose this productivity change into the technical change index (TECHCH) and the technical efficiency change index (EFFCH). And technical efficiency changes was further decomposed into pure technical efficiency (PEEFCH) and scale efficiency (SCH) components using the Data Envelopment Analysis (DEA) framework of Fare,et.al(1994).

We start by considering firms which use n inputs to produce m output. Denote $x \in R_+^n$ and $y \in R_+^m$ as, respectively, the input vector and output vector of those firms. The set of production possibilities of a firm at time t can be written as:

$$S^t = \{(x^t, y^t) \mid x^t \text{ can produce } y^t\} \quad \ldots\ldots\ldots\ldots\ldots \quad (1)$$

Fare, Grosskopf,Norris&Zhang(1994) followed Shepherd(1997) to define the output distance function at time t as:

$$D_0^t(x^t, y^t) = \inf\{\theta \mid (x^t, y^t/\theta) \in S^t\} = (\sup\{\theta \mid (x^t, \theta y^t) \in S^t\})^{-1} \quad \ldots.(2)$$

The subscript o is used to denote the output-based distance function. Note that, $D_0^t(x^t, y^t) \leq 1$, if and only if $(x^t, y^t) \in S^t$, and $D_0^t(x^t, y^t) = 1$, if and only if (x^t, y^t) is on the frontier of the technology.

To define the Malmquist index, Fare et al. (1994) defined distance functions with respect to two different time periods:

$$D_0^t(x^{t+1}, y^{t+1}) = \inf\{\theta \mid (x^{t+1}, y^{t+1}/\theta) \in S^t\} \quad \ldots\ldots\ldots\ldots\ldots(3)$$

and

$$D_0^{t+1}(x^t, y^t) = \inf\{\theta \mid (x^t, y^t/\theta) \in S^{t+1}\} \quad \ldots\ldots\ldots\ldots\ldots \quad (4)$$

The distance function in (3) measures the maximal proportional change in output required to make (x^{t+1}, y^{t+1}) feasible in relation to technology at time t. Similarly, the distance function in (4) measures the maximal proportional change in output required to make (x^t, y^t) feasible in relation to technology at time $t + 1$. The output-based Malmquist TFP productivity index can then be expressed as:

$$M_o(x^{t+1}, y^{t+1}, x^t, y^t) = \frac{D_o^{t+1}(x^{t+1}, y^{t+1})}{D_o^t(x^t, y^t)} \left[\frac{D_o^t(x^{t+1}, y^{t+1})}{D_o^{t+1}(x^{t+1}, y^{t+1})} \frac{D_o^t(x^t, y^t)}{D_o^{t+1}(x^t, y^t)} \right]^{\frac{1}{2}} \quad \text{.... (5)}$$

The term outside the brackets shows the change in technical efficiency while the geometric mean of the two ratios inside the brackets measures the shift in technology between the two periods t and $t + 1$; this could be called technological progress. So:

$$\text{Efficiency change} = \frac{D_o^{t+1}(x^{t+1}, y^{t+1})}{D_o^t(x^t, y^t)} \quad \text{..... ..... (6)}$$

$$\text{Technical change} = \left[\frac{D_o^t(x^{t+1}, y^{t+1})}{D_o^{t+1}(x^{t+1}, y^{t+1})} \frac{D_o^t(x^t, y^t)}{D_o^{t+1}(x^t, y^t)} \right]^{\frac{1}{2}} \quad \text{.....(7)}$$

In each of the formulas above, a value greater than one indicates a positive growth of TFP (an improvement) from a period t to t+1 and a value smaller than one represents deteriorations in performance over time.

We can decompose the total factor productivity growth in following way as well.

MTFPI = Technical Efficiency Change X Technical change

(Catching up effect) (Frontier Effect)

Malmquist total factor productivity (MTFPI) is the product of measure of efficiency change (catching up effect) at current period t and previous period s (average geometrically) and a technical change (frontier effect) as measured by shift in a frontier over the same period. The catching up effect measures that a firm is how much close to the frontier by capturing extent of diffusion of technology or knowledge of technology use. On the other side frontier effect measures the movement of frontier between two periods with regards to rate of technology adoption. In DEA-Malmquist TFP Index does not assume all the firms or sectors are efficient so therefore any firm or sector can be performing less than the efficient frontier. In this methodology we will use the output oriented analysis because most of the firms and sectors have their objective to maximize output in the form of revenue or profit. It is also assumed that there is constant return to scale (CRS) technology to estimate distance functions for calculating Malmquist TFP index and if technology exhibits constant return to scale , the input based and output based Malmquist TFP Index will provide the same measure of productivity change.

Econometric Model in Estimating Capacity Utilization

Simply, capacity output is defined as the maximum feasible level of output of the firm. Klein (1960) defined capacity as the maximum sustainable level of output an industry can attain within a very short time, when not constrained by the demand for product and the industry is operating its existing stock of capital at its customary level of intensity. In view of variations in capacity utilization (CU) as a short-run phenomenon caused by the quasi-fixed nature of capital, an econometrically tractable short-run variable cost function that assumes capital as a quasi-fixed input has been used to estimate CU.

Considering a single output and three input framework (K, L, E) in estimating CU, we assume that firms produce output within the technological constraint of a well-behaved production function.

$Y = f(K, L, E)$ where K, L and E are capital, labour and energy respectively. Since capacity output is a short-run notion, the basic concept behind it is that firm faces short-run constraints like stock of capital .Firms operate at full capacity where their existing capital stock is at long-run optimal level. Capacity output is that level of output which would make existing short-run capital stock optimal.

Rate of CU is given as

$$CU = Y/Y^* \quad \ldots\ldots\ldots (8)$$

CU is capacity utilization rate, Y is actual output and Y^* is capacity output.

In association with variable profit function, there exist a variable -cost function which can be expressed as

$$VC = f(P_L, P_E, K, Y) \quad \ldots\ldots\ldots (9)$$

Short run total cost function is expressed as

$$STC = f(P_L, P_E, K, Y) + P_K . K \quad \ldots\ldots\ldots\ldots\ldots (10)$$

P_K is the rental price of Capital.

Variable cost equation which is variant of general quadratic form for (9) that provide a closed form expression for Y^* is specified as

$$VC = \alpha_0 + K_{-1}\left(\alpha_K + \tfrac{1}{2}\beta_{KK}\left[\frac{K_{-1}}{Y}\right] + \beta_{KL}.P_L + \beta_{KE}.P_E\right)$$

$$+ P_L\left(\alpha_L + \tfrac{1}{2}\beta_{LL}.P_L + \beta_{LE}.P_E + \beta_{LY}.Y\right)$$

$$+ P_E\left(\alpha_E + \tfrac{1}{2}\beta_{EE}.P_E + \beta_{EY}.Y\right) + Y\left(\alpha_Y + \tfrac{1}{2}\beta_{YY}.Y\right) \quad \ldots\ldots\ldots (11)$$

VC is the variable cost and K_{-1} is the capital stock at the beginning of the year which implies that a firm makes output decisions constrained by the capital stock at the beginning of the year.

The variable cost function is based on the assumption that some input like capital cannot be adjusted to their equilibrium level. Therefore, the firm minimizes variable cost given the output and the quasi-fixed inputs.

Capacity output (Y*) for a given level of quasi-fixed factor is defined as that level of output which minimizes STC. So, the optimal capacity output level, for a given level of quasi-fixed factors, is defined as that level of output which minimizes STC. So, at the optimal capacity output level, the envelop theorem implies that the following relation must exist.

$$\partial STC/\partial K = \partial VC/\partial K + P_K = 0 \quad \text{..... (12)}$$

In estimating Y*, we differentiate VC equation (4) w.r.t K_{-1} and substitute expression in equation (5)

$$Y^* = \frac{-\beta_{KK}.K_{-1}}{(\alpha_K + \beta_{KL}P_L + \beta_{KE}P_E + P_K)} \quad \text{..... (13)}$$

The estimates of CU can be obtained by combining equation (13) and (8). Variables for measuring capacity utilization have been briefly explained in appendix 1.

Empirical Results

Productivity Performance -Malmquist TFP Growth

In this section, we will discuss the productivity change of India's iron and steel industry, measured by Malmquist Total Factor Productivity (TFPCH) Index and assign the changes in total factor productivity to technological change (TECHCH) and efficiency change (EFFCH). We have also attempted to attribute any change in efficiency (EFFCH) to change in pure technical efficiency (PECH) and /or scale efficiency change (SECH). Year 1979-80 being the initial and reference year, the Malmquist TFPCH and its components take an initial score of 1 for the year 1979-80.

The Malmquist result suggests that India's iron and steel industry exhibits positive growth rate of 3.90 percent during pre-reform period (1980-81 to 1991-92) and the growth rate declined during the post-reform period which is estimated to be -1.74 percent. Steel sector has exhibited a slight efficiency improvement of 0.14 percent during post-reform period from a meager 0.02 percent in pre-reform period which is an indication of positive efficiency change during post-reform period. From Table 1, it is apparent that technological changes in steel sector have declined also during post- reform period at -1.74 percent from a positive growth rate of 3.90 percent as is seen in pre-reform period.

Table: 1 Change in Total Factor Productivity and its Components

Pre reforms period (1980-81 to 1991-92						Post reforms period(1991-92 to 2006-07)					
YEAR	Components of TFPG		Components of Technical Efficiency Change			Year	Components of TFPG		Components of Technical Efficiency Change		
	EFFCH	TECHCH	PECH	SECH	MTFPCH		EFFCH	TECHCH	PECH	SECH	MTFPCH
1979-80	1	1	1	1	1	1991-92	0.983	0.879	0.993	0.990	0.864
1980-81	1.008	0.914	1.000	1.008	0.922	1992-93	1.014	0.949	1.007	1.007	0.963
1981-82	0.998	1.068	0.992	0.996	1.056	1993-94	0.973	0.877	0.994	0.978	0.854
1982-83	0.990	0.888	1.008	0.982	0.879	1994-95	1.020	0.886	1.004	1.016	0.904
1983-84	1.017	0.989	1.000	1.017	1.006	1995-96	0.989	1.285	0.983	1.006	1.271
1984-85	1.005	1.002	1.000	1.005	1.006	1996-97	1.008	0.943	1.007	1.002	0.950
1985-86	0.960	1.035	0.990	0.969	0.994	1997-98	0.868	0.947	0.922	0.941	0.822
1986-87	1.039	0.973	1.010	1.029	1.011	1998-99	1.122	0.896	1.083	1.036	1.005
1987-88	0.984	0.969	0.983	1.001	0.954	1999-'00	1.006	0.864	1.013	0.993	0.869
1988-89	1.007	0.976	1.017	0.990	0.983	2000-01	1.011	0.957	0.983	1.028	0.967
1989-90	0.999	0.907	0.999	1.001	0.907	2001-02	0.997	1.457	1.005	0.992	1.452
1990-91	1.012	1.907	1.001	1.010	1.929	2002-03	0.955	0.895	0.947	1.008	0.854
1991-92	0.983	0.879	0.993	0.990	0.864	2003-04	1.046	0.834	1.068	0.979	0.872
						2004-05	1.028	0.978	1.000	1.028	1.005
						2005-06	0.933	1.138	0.964	0.968	1.062
						2006-07	1.070	0.942	1.037	1.031	1.008
Mean	1.0002	1.0390	0.9995	0.9998	1.0393	Mean	1.0014	0.9829	1.0006	1.0002	0.9826

Source: Estimated by authors by DEAP, version 2.1.

Now, converting the productivity growth into percentage form, we assign the changes in total factor productivity, technological change (TECHCH) and efficiency change (EFFCH) in Table 2.

Table: 2 Growth Rate of Malmquist Productivity, Technical Change and Technical Efficiency Change

Sub sector	Pre-reform period (1980-81 to 1991–92)			Post- reform period (1991–92 to 2006–07)			Entire period (1980-81 to 2006–07)		
	EFFCH	TECHCH	MTFPCH	EFFCH	TECHCH	MTFPCH	EFFCH	TECHCH	MTFPCH
Iron Sponge	-0.24	-8.09	-8.29	0.16	-13.76	-14.19	-0.10	-12.0	-12.0
Pig Iron	0.33	3.86	3.92	0..39	-11.33	-11..34	0.80	-6.6	-6.5
Steel	-0.058	5.13	5.02	0.11	0.54	0.61	0.00	0.00	0.00
Ferro Alloy	0.083	10.38	10.71	0.13	7.50	7.56	0.00	5.5	5.5
Alloy Steel	-0.12	11.6	11.5	-0.094	8.5	8.68	0.00	11.2	11.2
Mean	0.02	3.93	4.26	0.14	-1.71	-1.74	0.14	-0.40	-0.40

Source: Authors' own estimate.

Table 2 above shows that total factor productivity growth during pre-reform period shows positive TFP growth rate which is posted as 3.93% and in post-liberalization period, it further declined to -1.74%. Table 2 displays the average growth rates of efficiency change (EFFCH), technical change (TECHCH) and total factor productivity (TFP) in each sub-sector of India's iron and steel industry. Table 2 illustrates that the growth rate of TFP is abruptly declining in the post-reform period (-1.74 %) than in the pre-reform period (4.26%). Two sub-sectors-namely Iron Sponge and Pig Iron (1&2) evidenced negative TFP growth in the post-reform period, whereas one sub-sector- Iron Sponge (subsector-1) had negative TFP growth in the pre-reform period. Only subsector 3, 4 and 5(Steel, Ferro Alloy and Alloy Steel) evidenced positive but declining TFP growth in both periods. In the post-reform period, technical change decreases in negative fashion and efficiency change slightly increases. As a result, since there was decrease in technical change, it results in a modest decrease in total factor productivity growth. After economic reform, in all sub sectors, slight efficiency improvement is noticed. But, all sub-sectors display technical regress during post-reforms period.

Capacity Utilization performance

In a capital-scare economy like India, as a parameter for judging economic performance, manufacturing capacity utilization is a key indicator which not only determines how much more output can be obtained by fuller utilization of existing capacity but also defines the required expansion of capacity for a targeted output and also explains changes in investment, inflation, level of resource utilization etc. Therefore, the estimation of capacity output and its utilization will be very useful to evaluate the variations in the performance of an industry over a period of time. Therefore, capacity utilization measures as a pro-cyclical indicator have been widely used to explain economic fluctuations. This section presents the results of a multiple regression analysis applied to measure capacity output. The variable cost equation shown as equation (11) above has

been estimated by the ordinary least square methods (OLS). Table 2, 3 and 4 presents the trend in capacity utilization estimated from equation 13 for Indian Iron and Steel industry at aggregate level during pre and post-reform period. Estimated coefficients for the variable cost equation are presented in appendix 2: *Estimated Coefficients for the Variable Cost Equation*, at the end of the article. From the estimate, we get a broad picture regarding variation in CU ratios.

Table: 3 Trends in Utilization of Capacity of Indian Iron and Steel Industry at Aggregate Level, Pre –reform Period

Year	Economic capacity (Cr. Rs) output (Y*)	Actual output (Y) (Cr. Rs)	Economic Cu = Y/Y*	Growth in capacity (%)	Growth in output (%)
1991-92	4056	3595	0.8863	--	--
1992-93	5570	4681	0.8404	37.33	30.21
1993-94	5536	4902	0.8854	-0.6104	4.72
1994-95	7402	5177	0.6994	33.71	5.61
1995-96	12447	6427	0.5163	68.16	24.15
1996-97	13484	7139	0.5294	8.33	11.08
1997-98	11314	8321	0.7355	-16.09	16.56
1998-99	9750	8266	0.8478	-13.82	-0.6609
1999-00	11162	9378	0.8402	14.48	13.45
2000-01	19623	10435	0.5318	75.8	11.27
2001-02	12097	10821	0.8945	-38.35	3.70
2002-03	16221	11046	0.6809	34.09	2.079
2003-04	22100	10735	0.4881	36.24	-2.35
Average			0.7212	18.40	9.22

Source: Authors' own estimate.

Table: 4 Trends in Utilization of Capacity of Indian Iron and Steel Industry at Aggregate Level, Post-reform Period

Year	Economic capacity (Cr. Rs) output (Y*)	Actual output (Y) (Cr. Rs)	Economic Cu = Y/Y*	Growth in capacity (%)	Growth in output (%)
1979-80	2453	1548	0.6311	-6.16	-1.53
1980-81	2529	1530	0.6050	3.10	-1.16
1981-82	2543	1901	0.7475	0.55	24.25
1982-83	2720	2349	0.8668	6.96	23.56
1983-84	3003	2313	0.7702	10.40	-1.53
1984-85	3215	2683	0.8345	7.06	16.0
1985-86	3317	2487	0.7498	3.17	-7.31
1986-87	3314	2646	0.7984	-0.09	6.39
1987-88	3598	2880	0.8004	8.57	8.84
1988-89	3892	2961	0.7608	8.17	2.81
1989-90	4231	3454	0.8163	8.71	16.65
1990-91	4306	3651	0.8479	1.77	5.70
1991-92	4056	3595	0.8863	-6.16	-1.53
Average			0.7781	4.02	7.13

Source: Authors' own estimate.

The estimate in Table 3 and 4 shows that industry's average economic capacity utilization (CU) declined from 0.77 to 0.72 during post- reform period (1991-92 to 2003-04) and further declined to 0.54 during subsequent time periods, 2004-05 to 2007-08. Capacity expanded rapidly during post-reform period accompanied by similar trend in output growth in spite of facing demand doldrums and it is reflected in the average growth rate of capacity and output during post-reform period. During pre-reform period, capacity expansion was not improved rapidly probably due to licensing restriction but abolition of license-raj during post-reform period paved the way for drastic expansion of capacity.

Table: 5 Trends in Utilization of Capacity of Indian Iron and Steel Industry at Aggregate Level (Sub- period: 2003-04 to 2007-08)

Year	Economic capacity (Cr. Rs) output (Y*)	Actual output (Y) (Cr. Rs)	Economic Cu = Y/Y*	Growth in capacity (%)	Growth in output (%)
2003-04	22100	10735	0.4881	36.24	-2.35
2004-05	24372	12642	0.5187	10.28	17.76
2005-06	23145	13753	0.5942	-5.03	8.79
2006-07	26854	14431	0.5374	16.02	4.92
2007-08	26962	15161	0.5623	0.40	5.06
Average			0.5401	11.58	6.84

Source: Authors' own estimate.

During third sub-period (as indicated in table-5), industry facing excess supply reduced their utilization rate, capacity expansion and output growth. A comparison of the average utilization of capacity in the three sub- periods (Table 3, 4 & 5 above) showed that utilization rate declined in post- reforms and subsequent sub-periods.

Financial Performance

The long-term financial performance of Indian iron and steel industry has been analyzed from 2000-01 to 2007-08.The sample for analysis includes 42 companies like SAIL, Tata steel, Essar, Ispat Negam etc.Important performance indicators like Debt-Equity ratio (D/E), Return on Investment (after tax), Fixed asset- turnover, profitability, liquidity and earning power ratios have calculated and depicted in Table 6.

Table: 6 Performance Indicators

Year/indicator	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08
D/E ratio	2.70	3.81	3.30	3.15	9.31	8.02	2.86	4.73
ROI=PAT/Net Worth	-1.57	-3.67	-5.07	-11.63	18.75	5.03	9.53	1.62
Fixed Asset turnover = sales/fixed asset	1.15	1.24	1.03	1.11	1.64	1.35	1.49	1.28
Profitability=PAT/Sales	-0.86	-2.37	-2.87	2.63	-2.03	3.43	6.67	4.6
Liquidity=CA/CL	0.85	0.90	0.52	0.56	0.75	0.96	1.24	0.82
Earning power ratio = PAT/Total asset	-0.86	-1.3	-1.93	1.6	3.43	3.07	5.9	1.41

Source: Centre for Monitoring Indian Economy, Financial Aggregates & Ratios, (various issues), compiled.

Table 6 reveals the rising trend of D/E from 2.70 in 2000-01 to 4.73 in 2007-08 which indicates that the industry is shouldering an increasing debt burden which involves more interest burden and repayment liability. Return on investment ratio, being a good indicator of judging the utilization of resources and capital of the industry, indicates a sharp decline of -11.63 percent in 2003-04 from -1.57 percent in 2000-01 before making a partial recovery of around 2 percent in 2007-08.This, in general, signifies that its net worth is gradually depleting and hence industry is becoming unattractive to the equity stakeholders. The industry should try to increase the ratio gradually at least at a level over and above the standard bank interest rate to cover the risk involved. Slight improvement in fixed turnover is noticed which implies that the industry is trying to utilize its assets in an efficient manner. Profitability ratio, an indicator of operational efficiency, exhibits the decreasing profit levels from -0.86 Percent in 2000-01 to a low of -2.04 percent in 2003-04 and to some extent recovered in 2005-06 onward endangering the survival of the unit and indicating heightening of competition in the industry. Low liquid ratio implies that there exist insufficient current assets to meet current liability inducing instable solvency position of the industry. These indices considered together exhibits that the steel industry has been passing through turbulent phases characterized by enhanced debt burden, low utilization of assets, industry-wide losses and above all huge liquidity crunch. There have been revolutionary changes in the global scenario with fierce competitive pressure on performance, price reduction and customers' satisfaction. Indian steel industry faces serious turbulence along with unprecedented turmoil in the global steel market. During recent times, problems in steel industry are numerous but solutions are rare with the system and it shows an inclination to worsen further into serious volatility under the slightest external instability. This period witnessed sweeping changes in the iron and steel arena – transformation of self contained national market to linked global market and consequent fierce competition; oversupply of most kinds of steel resulting in no real appreciation of steel prices. The problem was multiplied by a slow down in the growth of steel intensive industries indicating negligible growth in demand in the economy worldwide .The crisis in the world steel market might be attributed to the disbalance between capacity, demand and production and consequent drop in prices. According to IISI, the companies have been selling their product below cost to survive in the global competition. Such pricing practices have distorted the global market dynamics.

Sagging Price Trend

The recent crisis of Indian steel industry is best reflected in the falling price trend for steel product as is presented in table 9. It is acknowledged that hazardous price trend of the industry cannot be captured within this short time span due to unavailability of authentic data, but it is true that the prices of steel show downturn, rather behave erratically within this time period. The heavy periodic decline in price have reduced profitability in the industry and at times, compelled stronger firms to incur huge losses. This, in turn, has increased debt-capital liability for a section of firms within the industry. Consequently, the industry's weak financial position consequent to financial crisis get reflected in the poor performance of steel shares and stocks in the capital market and

consequent change and decline in shareholding pattern as shown in table 7 and 8. CMIE monthly return on share price index in iron and steel sector posted a negative return of 78.5% and interest of different stakeholders in steel shares except promoters suddenly dropped down after slowdown heat felt in Sepember, 2008.

Table: 7 Monthly Returns on CMIE Sectoral Share Price Indices (%)

Sector	Nov. '07	Dec. '07	Jan. '08	Feb. '08	Mar. '08	Apr. '08	May. '08	June. '08	Jul.'08	Aug. '08	Sep. '08	Oct. '08	Nov. '08	13 months ended on Nov.08
Iron &Steel	-0.5	15.5	-25	9.5	-23.4	9.0	0.4	-19.5	-1.2	-0.00	-23.8	-39.7	-25.0	-78.3
Industry	-0.1	11.8	-20	0.1	-12.7	11.4	6.5	-19.5	8.0	0.9	-12.9	28.1	-6.5	-58.3

Source: Monthly Review of Indian Economy, Centre for Monitoring Indian Economy, December, 2008.

Table: 8 Change in Shareholding Pattern Weighted by Market Capitalization (%)

Sector	Promoter		Institutions		FII		Non-Institution		Individual	
	June '08	Sep. '08	June '08	Sep. '08	June '08	Sep. '08	June '08	Sep. '08	June '08	Sep. '08
Iron &Steel	58.67	62.96	24.91	21.58	12.97	10.47	16.22	15.22	11.52	10.54
Industry	56.99	56.95	23.45	23.30	13.74	13.23	16.65	17.02	9.45	9.21

Source: Monthly Review of Indian Economy, Centre for Monitoring Indian Economy, December, 2008.

Steel industry may face a further slow down and could be forced to bring down prices on account of global turmoil in tandem with dip in domestic demand. Increased volume of imports eroding the bottom line of the domestic producers, stagnating demand due to slowdown in real estates and auto-sector since Sepember,2008 and domestic oversupply contributed to the sagging price trend. Consequently, the industry has been suffering from unremunerative prices to the extent that companies have been finding it difficult to maintain capital cost.

Table: 9 Recent Domestic Price of Hot Rolled Coils

Period.	Hot Roll Coil Prices, Delhi		Hot Roll Coil Prices, Kolkata		Hot Roll Coil Prices, Mumbai	
Month	Rs./tonne	% change	Rs./tonne	% change	Rs./tonne	% change
Nov. '07	35550.0	1.46	37000.0	10.61	34250.0	4.78
Dec. '07	35525.0	3.99	35987.5	9.89	34250.0	4.98
Jan. '08	35725.0	8.34	37175.0	9.10	34750.0	6.31
Feb. '08	37750.0	11.69	38337.5	11.69	35500.0	7.56
Mar. '08	41000.0	18.54	42125.0	22.10	41600.0	19.71
Apr. '08	48950.0	33.52	46837.5	32.68	45975.0	32.30
May. '08	43500.0	24.02	47200.0	31.38	44125.0	27.9
June. '08	48500.0	33.24	47875.0	31.98	45125.0	32.72
July.'08	45477.0	28.10	45409.5	27.29	45198.0	31.01
Aug. '08	45378.0	34.75	45381.0	28.60	45349.0	29.57
Sep. '08	45377.0	29.19	45502.0	26.79	45133.0	32.26
Oct. '08	45110.5	27.93	45375.0	22.93	44966.0	33.23
Nov. '08	43286.0	21.76	43440.5	17.41	43270.0	26.34

Source: Monthly Review of Indian Economy, CMIE, December, 2008.

The falling prices of Indian steel may not always be due to excess supply or demand shortage. But price reduction may be a part of industry's strategy that facilitates a firm to hold market shares in the intense competitive backdrop. Generally, a firm's competitiveness in the market is judged by its capability of lowering prices below the offers of the other competing firms. Theoretically, its ability to bring down prices depends on its cost efficiency- the lower the costs; better it is placed to price its products competitively. The sluggish growth in the steel industry has resulted in enhanced rivalry among existing firms. As the industry is not growing, the only other way to grow is by increasing one's market share. As a result, the Indian steel industry has witnessed spurts of price wars and heavy trade discount to the customers. Sometimes, a firm within the industry may lower price of steel products below cost temporarily with a view to avoid market loss in such a situation which emerges suddenly out of sluggish demand or increased supply through additional capacity creation and firms would not continue such practice if chances for long term revival of demand are dim and competition becomes intense and stronger.

Demand Doldrums

The global crisis started since the last quarter of 2008 has a deep impact on the Indian steel industry from both supply and demand side. On the demand side, although the impact of the economic crisis could not be fully assessed, by rough estimates, it is estimated that there is a fall in finished steel demand by nearly 27 million tonnes in the year 2008-09(up to Dec.'08) implying a sharp decline of 57.3% over previous year. A slowdown in economic activities engulfed almost all the industrial segments leading to a steep drop in the growth rate of steel consumption. Apparent consumption (i.e. Production + import - export + / -variation in stocks) of finished steel, year wise, has been shown below. Apparent consumption represents the actual demand of steel in a particular period/year.

Table: 10 Apparent Consumption of Finished Steel (carbon) (in million tones)

Year	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09(up to Dec.08)
Apparent consumption	22.12	22.63	23.15	25.01	26.87	27.35	28.9	31.17	34.39	38.15	43.74	47.02	20.06
Growth (%)[1]	-	2.3	2.3	8.03	7.44	3.1	5.32	7.88	10.33	10.9	14.65	7.5	-57.3

Note: The figures indicate the percentage increase over the previous year.
Source: Annual Report,2009-10, Ministry of Steel, Government of India, www.steel.gov.in

Steel demand started displaying softening trend as the off take declined from the user industry especially the infrastructure firms during the monsoon season (June-July) which lead to marginal easing of rates in the domestic market. The demand for the Indian steel products also went down in the Middle East where construction activities slowed down due to excessive heat in the period. Steel prices continued the downward trend as market sentiments continued to deteriorate mainly on bad news in form of sub prime lending crisis and then the worsening Wall Street scenario. Tremors of failure of US-based merchant and commercial banks were felt across the globe and the world was faced with

an apparent liquidity crunch. Infrastructure sector globally was hit hard due to lack of credit availability to undertake projects, which also hitherto impacted the demand for steel in the steel industry in India also.

As a result, domestic steel prices followed the global trend as major producers in India including SAIL, JSW Steel, and Essar announced a cut in prices and production by as much as 30 per cent during 2008-09.This has not happened in a day. The long term failure to tap overseas market is responsible for that to some extent. The countries which have achieved major growth including growth in steel industry, like Japan, China and South Korea have largely used their trading houses to embed their market abroad. Indian steel sector failed to make its presence felt even in the neighboring countries due to lack of profit motive, wrong scale of assets, no coordination between market and plants, poor investment decision etc.

Excess Supply Scenario

On the supply side, there were troubles of versatile nature which stem from investment and capacity related problems. It is to note that there has always been a tendency to relate these specific problems to shrinkage of demand. Despite well known global excess capacity, enormous investments were made in Greenfield steel projects in India with the hope of attaining the massive prospective gain from the industry there. The fact is that steel capacity was continuously increased inspite of the so-called well known excess capacity in the industry because of some futuristic belief.

Table: 11 Excess supply scenario (in million tones)

Year	Production	Import	Apparent consumption	Export	Excess supply
1991-92	17.23	1.043	14.84	0.373	3.06 [2]
1992-93	18.65	1.115	15	0.895	3.87
1993-94	19.85	1.153	15.32	1.605	4.078
1994-95	24	1.936	18.66	1.272	6.004
1995-96	28.54	1.864	21.43	1.32	7.654
1996-97	31.07	1.822	22.12	1.922	8.85
1997-98	32.08	1.815	22.63	2.383	8.882
1998-99	31.91	1.637	23.15	1.944	8.453
1999-00	35.23	2.2	25.01	2.998	9.422
2000-01	38.25	1.632	26.87	3	10.012
2001-02	40.1	1.375	27.35	3	11.125
2002-03	45.87	1.51	28.9	4.966	13.514
2003-04	49.49	1.65	31.17	5.922	14.048
2004-05	53.57	2.109	34.39	4.903	16.386
2005-06	58.99	3.765	38.15	4.7	19.905
2006-07	70.12	4.1	43.74	5.125	25.355
2007-08	79.84	5.9	47.01	2.348	36.382
2008-09	66.47	1.14	20.02	1.753	45.84
2009-10 (April –December)	89.62	5.21	40.99	2.099	51.74

Note: Excess supply is calculated by adding production and import and deducting there from apparent consumption and export.
Source: Annual Report, 2009-10, Ministry of Steel, Government of India, www.steel.gov.in

First, this may perhaps be due to the reasons that there existed plenty of capital to invest and having no potential avenues to invest, it compelled investors to invest in the steel sector with cheap and assured source of capital. Second, the steel sector is always well thought-out as an ever prospective industry with a permanent future, irrespective of its recent dismal earning potential and current difficulties and speculated that long term boom of prosperity will wipe-out the prevalent crisis in the industry but on the contrary, shortened boom period exaggerated the intensity of crisis. Third, the demand for steel is a derived demand and the purchase quantity depends on the end-use requirements. Recent volatility of demand affects the integrated steel manufacturers because of their inability to tune their production in line with the market demand fluctuations because of its inherent nature of being a high fixed cost industry. On the other hand, total export of steel during this meltdown situation is showing dismal display and therefore, the industry is forced to undercut prices to maintain market shares. Finally, there are several other reasons which cannot be ignored in creation of excess supply. Decreasing import duty on steel, dumping of steel by developed countries; high quality products from developed countries available for import at very competitive prices join the race in creating excess supply.

Export Performance

Although India started exporting steel way back in 1964, exports were not regulated and depended largely on domestic surpluses. However, in the years following economic liberalization, export of steel recorded a quantum jump. Iron and steel constitutes approximately 8 percent of the total export in 2007-08.

Table: 12 Export of Indian Iron and Steel (in '000 Tonnes)

Year	Pig Iron	Semi-Finished	Finished Carbon Steel	Total Steel	Total Value (Rs. Crores)
1991-92	-	5	368	373	283
1992-93	16	154	741	895	708
1993-94	620	585	1020	1605	1678
1994-95	466	399	873	1272	1438
1995-96	502	395	925	1320	1939
1996-97	451	300	1622	1922	2231
1997-98	785	503	1880	2383	2512
1998-99	281	174	1770	1944	N.A
1999-00	290	328	2670	2998	N.A
2000-01	230	195	2805	3000	N.A
2001-02	242	270	2730	3000	N.A
2002-03	629	460	4506	4966	N.A
2003-04	576	701	5221	5922	N.A
2004-05	393	261	4381	4903	N.A
2005-06	300	350	4350	4700	N.A
2006-07	359	375	4750	5125	N.A
2007-08	176	181	2167	2348	N.A
2008-9 (upto December)	151	162	1440	1753	N.A

Source:Annual Report,2009-10, Ministry of Steel,Government of India, www.steel.gov.in

Indian steel industry's share in the global market has been showing a distinct improvement since mid-nineties'. But, during the period commencing 2007-08, it is showing a dismal declining export scenario. Total export of steel declined from 5123thousand tonnes in 2006-07 to 2348 thousand tonnes in 2007-08 and further declined to 1753thousand tonnes in 08-09(upto Dec,08).In spite of the fact that India has considerable export potential in bars/ rods/ structure etc. export performance shows during the current financial year 2008-09 a sharp decline as meltdown affected steel sector. Surprisingly, it has been noticed that fall in demand of Indian steel abroad, especially in Indonesia, Malaysia, Italy, Japan, Nepal and UK etc.join hands to decline further the export of Indian steel.

Low Iron Ore Export from India

Worsening economic crisis has led to global steel companies pruning their capacity thereby, lower consumption of iron ore this year. The latest FIMI (Federation of Indian Minerals Industries) data indicates that iron ore export from India till December 15, 2008 declined over 13 percent inspite of huge price decline in steel making raw materials. Iron ore export plunged to 55.8 millon tons between Aprill to Dec,15 of the current fiscal as compared to 64.38 millon tons in the corresponding period last year. Low export demand of iron ore from India, despite fall in iron ore price, in the wake of global financial crisis is a consequence of production cut by global steel companied due to demand fall.

Table: 13 Total export of iron ore(lakh ton) between April 1- Dec. 15,2008.

Name of the ports	2007-08	2008-09	% change
Belekeri	20.34	9.63	-52.65
Chennai	72.69	53.38	-26.56
Ennore	15.21	7.61	-49.97
Haldia	64.89	53.78	-17.12
Hazira	0.49	2.16	340.82
Kakinada	26.26	15.69	-40.25
Karwar	8.54	9.77	14.4
Krishnapatnam	8.39	36.00	329.08
Mormugao	212.43	204.6	-3.69
New Mangalore	58.55	44.66	-23.72
Paradip	81.95	74.02	-9.68
Redi	2.27	1.05	-53.74
Vizag	62.76	45.73	-27.14
Total	643.77	558.07	-13.31

Source: Steelworld, January 18, 2009, p19.

Excess Capacity in Indian Steel Industry

In the recent time, the issue that has attained maximum attention in the context of Indian steel industry is its excess capacity. It is noticed that that the steel industry comes under the chronic distress as prices fall due to oversupply. The situation of oversupply

has not created from demand shortage but from the initiative to keep capacities utilized to the fullest possible inspite of the fact that there does not exist adequate demand for the product. As a result, in order to capture substantial market share, steel producers involved themselves into self induced declining price net that compels many of them to incur huge losses. Such a situation is argued to be plausible only if there exists excess capacity. This may so happen because the steel capacity comes in bulk and cannot be fragmented and therefore it is not possible to keep just as much capacity idle as is sufficient to meet the current demand (Firoz, 2003). Statistically, our capacity utilization data shows the existence of excess capacity in this industry.

Consequences of Imbalances between Demand and Supply and Excess Capacity of the Indian Iron and Steel Industry

The Indian steel industry has announced huge capacity expansion. With commissioning of these capacities, demand-capacity ratio is expected to decline in financial year 2009-10 and 2010-11.This will lead to a drop in prices of steel with commissioning of this capacity. The crisis of excess capacity and prevalence of market distorting practices in the global steel market has induced protectionist measures from a number of steel trading countries.

According to industry development cycles, product demand will not remain at a peak level for an unlimited period, and building up production capacity will take some time. Therefore, the demand peak will subside and even reach the bottom level when a plant commences operation, missing the optimum moment for commissioning. Excess capacity in Indian steel industry is mainly due to the product mix not being in line with the demand pattern. Excess capacity can also arise due to deficient effective demand which Keynesian in nature. The following reasons may be cited for the existence of excess capacity for iron and steel industry in India.

First, in the short run, given the technology of production, utilization of excess capacity in the said industry may lead, through the process of inter industry consumption, to demand for scarce industrial raw materials for which capacity may not exist. Second, industrial capacity can not be utilized because of shortage of demand. Third, utilization of excess industrial capacity may lead to additional import requirements of scarce raw industrial materials which may not be met through additional exports out of utilized industrial capacity, making the foreign exchange burden intolerable in the aggregate. Lastly, industrial relations and management bottlenecks may stand in the way of utilization of excess capacity. The Keynesian prescription for utilization of excess capacity, viz, raising of aggregate demand, may not be applicable in a developing economy like India where the supply function may be inelastic.

In present day scenario, our result shows that iron industry is constrained by demand which could mean that planning of investments is not consistent with demand trends. In case of the said iron industry experiencing excess supply and operating at a low capacity utilization rate, an increase in demand will improve capacity utilization until some input factor becomes a constraint or until a maximum possible utilization level is reached.

According to the Iron and Steel Statistics Bureau, a London-based monitor of the industry's health, excess capacity in the industry worldwide amounts to 250 million tonnes, or a quarter of world steel production. Much of this over-capacity (around 100 million tonnes) is in Eastern Europe and the former Soviet Union which were major steel producers in the past. Asia, afflicted by a financial crisis more recently, is burdened with another 70 million tonnes, while the countries of the E.C. (50 million tonnes) and the US are better off.

However, when markets rule, a situation of excess supply triggers a price decline. Producers from Korea to Brazil have cut prices by between 10 and 25 per cent, and supplies have been diverted to the relatively more buoyant markets in the U.S. and Europe. Faced with such competition, producers in the developed countries are proving unequal to the task of defending their existing markets.

In Europe, steel imports reportedly rose by 75 per cent in the first half of the year,2009-10 eroding the traditional market of major producers in the region. Similarly, steel imports into the U.S. are estimated to have risen to a record 30 million tones last year, and accounted for 50 per cent of domestic production in August. With recovery proving elusive in Asia, and other regions succumbing to the crisis, matters have only worsened in more recent times. These developments have combined with a collapse of export markets for developed country producers in Asia and elsewhere. India is not far from the truth. However, not surprisingly, the Indian Government has been quick to impose anti-dumping duties against a range of steel imports that have damaged the domestic industry. But other industries that suffer a similar fate as a result of imports from the U.S. and the countries of the E.C. cannot look forward to similar support. In a nut shell, the growing world financial crisis has created a new desperation in developing countries to push out exports. The situation has simultaneously put greater pressure on the industrial nations as well as developing nations like India to protect their domestic market for domestic suppliers.

Policy Measures to be Adopted

There is an urgent need for developing a strategic plan for the Indian Iron and Steel industry to get rid of crisis.

1) Development of a comprehensive plan for modernization of all existing steel plants should be given priority in order to be competitive in global perspective. Frequent downturns in the steel industry reflecting intense competition in the industry made the industry cost conscious which induces cost reducing strategy.

2) In order to ensure competitive advantage and to be ahead of competition, steel maker should lay stress on cost reduction through reduction in working capital cost, operating cost, reduction in unsold inventory, improving techno-economic parameter etc.

3) As result of lowering down of import and export duties, development of a trigger mechanism against dumping of iron and steel and also allied products is of crucial need. Merger may be a strategy against dumping of domestic market.

4) Government as well as policy makers should play a very crucial role in ensuring turnaround of the Indian steel industry. The government should adopt a new steel policy considering all aspects of steel industry like demand and supply, capacity creation, export and import, boosting up of consumption etc which would enhance competitiveness of the Indian steel industry in the global market. Of late, the commerce ministry restored DEPB (duty entitlement passbook scheme benefits) benefits for steel exporters apart from initiating dumping probe on steel imports from countries like China and Ukraine. Battling the recessionary trends, government in the first week of December, 2008 announced a multi-billion dollar package to give a boost to the infrastructure sector witnessing a slump in activity. The move was welcomed by manufacturers of steel and related products. The package included a four per cent across the-board reduction in excise duty (CENVAT) aimed at making steel and steel-consuming products like automobile cheaper and thereby induce its demand in the domestic market. Steel industry welcomed the stimulating steps taken by the government and passed on the benefits to the consumers by reducing the effective rates, thereby making products further cheaper by up to Rs 1,600 a tone.

5) Sagging prices in the backdrop of economic slowdown have spelt turmoil in the industry the world over. As in the case of oil and natural gas, there is a felt need for the steel producing countries to come together and evolve an understanding on production and pricing of steel products. Some effort in this direction is being taken, but, it is yet to take firmer roots. Iron and Steel being a full-grown industry offers many good opportunities of expanding business through the chain of acquisition and merger as are taking place worldwide. This strategic tie-up will facilitate industry to fight against technological obsolescence by strengthening assets and absolute liquidity position of consolidated entity.

6) Revitalization process can be successful only in the long-run when proper infrastructure is available. Therefore development of infrastructure facilities will surge the demand of steel product. As is evident, most of the usage demand of steel comes from urban institutional segments. It is need of the day to expand the market to rural areas through effective marketing network and better customer services. It should be strive on the part of producers to penetrate among medium and small customers in a big way to capture high volume turnover and reduce financial risk.

7) Financial restructuring would invite improved financial health of the steel producers because where the industry is in deep financial crisis, it will ensure profitability of the producers through reduction of interest and depreciation as well as efficient deployment of capital. It will also help in mitigating the

financial risk by reducing the debt-equity ratio and improving debt servicing capability of steel industry. Non-tariff protection may be given by the govt. when industry suffers from high degree of financial crunch.

Last but not least, the factors for revival of Indian steel industry are buoyant global steel consumption, buoyant local steel consumption, lower cost of production and adequate rise in price against hike in input costs. Apart from this, backward integration, consolidation and branded product sales, marketing alliances, etc., are urgently needed for the revival of the Indian steel industry.

Summary and Conclusion

This study estimates performance of Indian iron and steel industry from various perspectives which depicts dismal display during recent times. The above analysis demonstrates that total factor productivity growth was decreasing during post liberalized regime mainly due to technological regress. The utilization of capacity also declined gradually during reforms period which happened due to rapid expansion of capacity but comparatively slow growth rate of output.

Moreover, analysis of several financial indices during post-reform regime reflects miserable display of the financial performance of the industry which is beyond our expectation. There exist falling price trend, lack of adequate demand, excess capacity as well as excess supply scenario and declining export of iron ore and steel which poses serious problem in the industry.

But, it is a temporary phase and the sector would hopefully bounce back to its previous peak levels. It is worth-mentioning that the industry is not hoping against hope as the steel sector faces certain cyclical slowdown. The off takes from the infrastructure sector is seen improving. Indian steel industry has just come out of the slowdown that affected its performance during 2008-09. Domestically, 2009 ended on a relatively better and encouraging note, with CSO reporting an overall improvement of economic situation through its GDP data, which showed a robust 7.9 per cent growth during July-September 2009-10 and also had registered a strong 7.6 per cent growth during April-November 2009-10, further bolstering the idea that the demand side is back on stable footing. For steel, this is of key importance and the growth rates registered for leading end-use segments like manufacturing, consumer durables, construction, the stable growth of the service sector and agriculture sector spell good news. April-December 2009 provisional data released by JPC indicates a 7.8 per cent rise in consumption of total finished steel. Globally also there are signs of improvement in economic conditions and firming up of demand and prices.

Therefore, the Industry has steeled itself against the downturn and is expected to lead the revival in the new years to come. The future is uncertain, but challenging, and holds great promise if the right steps are taken because of the inherent qualities of Indian steel.

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Appendix: 1 Variables Defined in Measuring Capacity Utilization

Output is measured as gross output produced by manufacturers ($Y = PLL + P_K.K_{-1} + P_E.E$) suitably deflated by Wholesale Index of Prices (WIP) for manufactured product (base 1981 – 82 = 100) to offset the influence of price changes variable cost is sum of the expenditure on variable inputs ($VC = PLL + P_E.E$).Total number of persons engaged in Iron and Steel sector are used as a measure of labour inputs. Price of labour (P_L) is the total emolument divided by number of labourers which includes both production and non-production workers. Deflated cost of fuel has been taken as measure of energy inputs. Due to unavailability of data regarding periodic price series of energy in India, some approximations become necessary. We have taken weighted aggregative average price index of fuel (considering coal, petroleum and electricity price index, suitably weighted, from statistical abstract) as proxy price of energy. Deflated gross fixed capital stock at 1981-82 prices is taken as the measure of capital input. The estimates are based on perpetual inventory method. Rental price of capital is assumed to be the price of capital (P_K) which can be estimated following Jorgenson and Griliches(1967).

$$P'_K = r_t + d_t - \frac{P^*_k}{P_k}$$

where r_t is the rate of return on capital in year t ,d_t is the rate of depreciation of capital in the year t and $\frac{P^*_k}{P_k}$ is the rate of appreciation of capital .Rate of return is taken as the rate of interest on long term government bonds and securities which is collected from RBI bulletin(various issues). The rate of depreciation is estimated from the reported figures on depreciation and fixed capital as available in ASI which Murty(1986) had done earlier.However, we have not tried corrections for the appreciation of value of capital in the estimates of price of capital services.

Appendix: 2 Estimated Coefficients for the Variable Cost Equation

Coefficient	Estimate	t-Ratio
α_0	-1623.6	-0.9123
α_K	-0.9385	-1.98
β_{KK}	0.1679	2.86
β_{KL}	228.53	1.23
β_{KE}	-0.4026	-2.16
α_L	-689887	-0.3562
β_{LL}	-0.0054	-2.011
β_{LE}	-924799	-0.542
β_{LY}	-1238.64	-2.43
α_E	91.69	1.37
β_{EE}	-1354.58	-0.649
β_{EY}	2.3781	2.302
α_Y	4.5884	1.73
β_{YY}	-0.00093	-2.69

*All the coefficients that are required to compute the CU have the expected signs and are significant with the exception of β_{KL}.