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Research Article

A COMPARATIVE STUDY ON ECONOMIC AND ENVIRONMENTAL PERFORMANCES BETWEEN SAIL AND TISCO STEEL PLANTS IN INDIA

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ABSTRACT

The paper attempts to conducts comparative study between two largest public and private steel plants in India namely Steel Authority of India Limited (SAIL) and Tata Iron and Steel Company (TISCO) respectively regarding the issues on their economic and environmental performances. We collect the data on crude steel production and carbon dioxide emission for both plants from various annual reports of the plants and some primary sources over the period of 2001-2015 and employ the method of time series econometrics. Our empirical findings imply that production of crude steel significantly enhances the CO_2 emission in both plants but degree of influence is notably greater in TISCO than in SAIL.

INTRODUCTION

Steel as a product is so versatile and basic for our life that it is considered necessary to increase economic growth. As a result, for the majority of the past 50 years, the world is increasingly producing more steel - at the same time, it produces a cost-effective product and spreads aggressive competition among its producers. All major industry based countries are characterized by the existence of a strong steel industry, and these economies are primarily at the initial stage of development with the strength of their steel industry. But during the last few decades the scenarios of steel industry across the world have changed remarkably and a rapid progress in steel industry aggravates the issues on environmental management problems. The major causes of environmental contamination and energy inefficiency in most of the steel production country include traditional technology and infrastructures, coal dominated energy structures and lack of managerial skills. It is a fact that emphasis given to environment management related issues is much lesser than the production performance issues by the steel plants in almost every steel producing nation. In this context both economic and environmental performance are vital for the current goal of inclusive and sustainable development mainly in the top steel producing developing countries like India, China etc.

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Indian steel industry has emerged as one of the key sectors in the Indian economy, which has a very important impact on economic growth. India, with the abundant availability of high grade iron ore, the necessary technical base and cheap skilled labour are thus placed for the development of good steel industry and provide a strong production base for the metal industry. In almost all regions, the non-regulation Indian steel industry is performing at its peak level. Iron and steel industries in India are covered under the Environment Protection Act (EPA) as well as Environment Protection Rules and Regulations enacted and published by Ministry of Environment and Forest, Government of India. At the beginning, the entrepreneurs are required to obtain statutory clearances from the union or state governments required under the EPA for setting up of any new iron and steel plants or its substantial expansion.

Further, the steel companies are required to install specified pollution control equipments or facilities and also operate well within the prescribed standards or norms in respect of air, water and noise pollutions as also solid waste generation and utilization. These are monitored by union or state Pollution Control Boards. Ministry of Steel, Government of India helps and facilitates formulation or amendment of norms and standards. Energy consumption in most of the integrated steel plants (ISPs) in India is generally high at 6 to 6.5 Giga Calorie per tonne of crude steel as compared to 4.5 to 5.0 Giga Calorie per tonne of crude steel in steel plants abroad. The higher rate of energy consumption is mainly due to obsolete technologies including problems in retrofitting modern technologies in old plants, old shop floor and operating practices, poor quality of raw material viz. high ash coal or coke, high alumina iron ore etc. The energy consumption in steel plants is however, gradually reducing because of technological up-gradation, utilization of waste heats, use of better quality inputs, etc.

This is an initiative of Ministry of Environment and Forest, Government of India and Central Pollution Control Board (CPCB) in association with Ministry of Steel, Government of India and the major steel plants to reduce environment pollution, water consumption, energy consumption, solid waste and hazardous waste management etc. as per mutually agreed targets with the purpose to go beyond the compliance of regulatory norms for prevention and control of pollution through various measures including waste minimization, in-plant process control and adoption of clean technologies. A National Task Force (NTF) has been formed for implementation of CREP recommendations. Ministry of Steel, Government of India facilitates compliance of CREP action points in association with the steel plants. NTF has recently been reconstituted. The major wastes produced in ISPs include Blast Furnace Iron Slag Steel Melting Shop (SMS) Slag accounting for nearly more than half a ton for each ton of steel produced in ISPs.

Most of the steel plants are utilizing 100 percent of the iron slag produced (mostly in cement making and some portion as aggregate, both of which are permitted in Bureau of Indian Standard (BIS) specifications) while others are closer to reach the 100 percent utilization. The utilization of SMS slag is limited due to its phosphorous content, high free lime content and higher specific weight. To resolve these issues, Ministry of Steel, Government of India has constituted a Task Force for promotion and utilization of Iron and Steel Slag. This Ministry has written to Indian Road Congress for development of codes and procedures allowing use of SMS slag as road aggregates, Research Designs and Standards Organization (RDSO) for framing standard for use of iron and steel as rail ballast, Ministry of Environment and Forest and Climate Change for considering making mandatory the use of iron and steel slag in road making, rail ballast and also to all the ISPs for setting up of commercial plant to produce processed SMS slag.

The area of the studies on economic versus environmental performance in case of Indian steel plants is very small. Schumacher and Sathaye (1998) reported on productivity, energy efficiency and carbon emissions of Indian iron and steel industry. Historical estimates of their study on productivity growth in iron and steel industry vary from indicating an improvement to a decline in the productivity. The variance can be traced to the time based trend, source of data for analysis and specifications econometric model used to report the productivity growth. World Steel Association (2012) has carried out a research on approximately 170 steel producers including 17 of the world's 20 largest steel companies and viewed the focal point for the steel industry, providing global leadership on all major strategic issues affecting the industry, particularly focusing on economic, environmental and social sustainability. But the further study regarding the issue on a comparative basis between public and private sector steel plants is almost absent in Indian context.

Against this backdrop, SAIL and TISCO are the most suitable in Indian steel scenario to be investigated separately to find the inter linkage between their economic and environmental performances respectively in this study over the period of 2001-2015 by applying some appropriate method of time series econometrics. The rest of the paper is organized as follows. We briefly make a discussion on SAIL and TISCO steel plants with a special emphasis on their economic and environmental performances. After describing data and methodological issues, we analyse the empirical results. Final section concludes the paper.

Brief Scenarios of SAIL and TISCO Plants

Steel Authority of India Limited (SAIL) is India's main steel maker. It produces a fully integrated iron and steel maker, both basic and special steel for domestic construction, engineering, power, railroad, automotive and defence industries and for sale in the export market and India's 86 percent ownership of SAIL's equity and control of the company is vote control. However, due to its 'Navratna', fleeing enjoys the leading financial and financial autonomy of the top ten public institutions in India, the cell sells productively and widely sells steel products and offers hot and cold-driven sheet and coils, galvanized sheets, electric roofs, Structural, rail products, plates, bars and rods, stainless steel and other alloy steels. SAIL produces iron and steel in five integrated plots and is located close to domestic sources of three special steel plants and raw materials in India, especially in the eastern and central regions, which are located in the company's iron ore, limestone and dolomite mines.

Iron ore is the difference between the companies being the largest producer of iron in the country's second largest mining network. It provides a competitive edge to SAIL, based on iron, limestone and dolomite settlement, which is the necessary equipment for steel making. The broad range of SAIL's of long and flat steel products is a lot more demanding in the domestic and international markets. This important responsibility is managed by SAIL's own Central Marketing Organization (CMO) and International Trade Division. CMO is the main branch of the year and there is a wide network of 34 branch offices located in the city and 54 stockings. This important responsibility is managed by SAIL's own Central Marketing Organization (CMO) and International Trade Division. CMO is the main branch of the year and there is a wide network of 34 branch offices located in the city and 54 stockings.

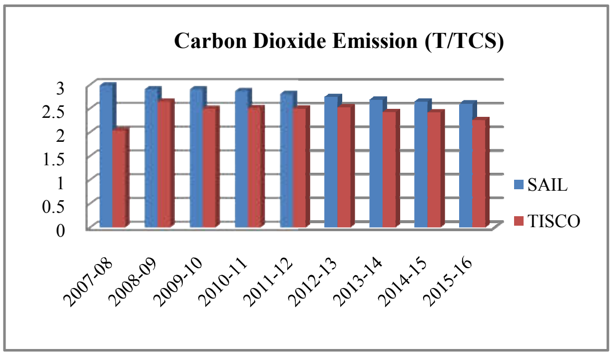

Figure 1 Carbon Dioxide Emission in SAIL and TISCO

Source: SAIL and TISCO, 2016

For four decades in technology and managerial skills and steel making, SAIL's Consultancy Division in New Delhi offers and advises clients worldwide. SAIL is a well-established Research and Development Center for the iron and steel (RDCIS), which helps in the development of standard steel for the steel industry and the development of new technologies. Besides, SAIL has its own in-house Centre for Engineering and Technology (CET), Management Training Institute (MTI) and Safety Organisation at Ranchi. Our captive mines are under the control of the Raw Materials Division in Kolkata. The Environment Management Division and Growth Division of SAIL operate from their headquarters in Kolkata. Almost all our plants and major units are ISO Certified.

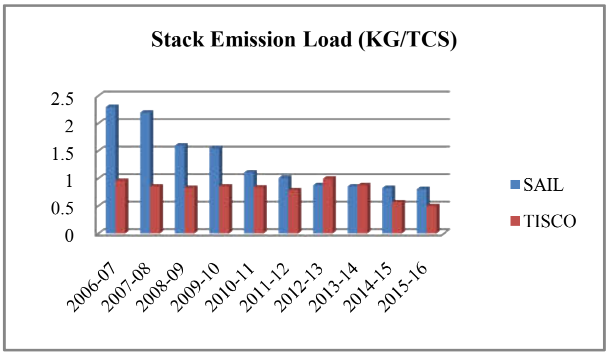

Figure 2 Stack Emission Load in SAIL and TISCO

Source: SAIL and TISCO, 2016

All plants and mines of SAIL cultivated in 200-acre remote terrain in Orissa in Orissa. Soil has been cultivated in abandoned canals and 300,000 fish have been released in the mine waters. Recently, medicinal cultivation of amla was started in Chhattisgarh; an agreement was signed with the Bureau of Biotechnology, the Government of India and the Center for Environmental Pollution-Free Environment, Delhi University, Environmental Rehabilitation of Forest Area, and Cell Mining Waste Dump sites.

The TISCO is India's largest integrated private sector steel company. Founded in 1907, iron-ore mines owned by the company are connected with the mine and the colonies. TISCO has an integrated steel plant; Jharkhand's Jamshedpur has the capacity to produce 50 million tonnes of annual raw steel. Steel works are located in Jamshedpur, Jharkhand, India. The factory covers over 800 hectares of land. West Bokaro sub division in Hazaribagh district overs 2000 hectares of land in which mining and coal beneficiation activities are performed. Jharia Division occupies 2500 hectares of land for its industrial, mining and domestic activities in the district of Dhanbad both in the state of Jharkhand.

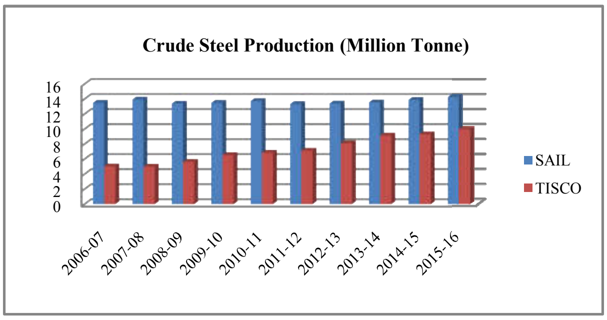

Figure 3 Crude Steel Production in SAIL and TISCO

Source: SAIL and TISCO, 2016

Constant modernization and introduction of state-of-the-art technology at TISCO has enabled it to stay ahead in the industry and completed the first nine months of fiscal 2006-07 with impressive increase in its production and sales volumes. The hot metal production at 4.1 million tonne is 8.2 percent more compared to the last year in the corresponding period and crude steel production at 3.7 million tonne is higher by 7.9 percent compared to the last year. The saleable steel production at 3.7 million tonne registered a significant increase of 11 percent. The total sales of 3.53 million tonne have grown by 11.7 percent over last financial year in the corresponding period. The domestic sale of long products has increased by 30 percent.

TISCO is continuing with its programme of expansion of steel making capacity of 18 tonne to reach the rated capacity of 6.8 million tonne in fiscal 2007-08 and thereafter to 10 million tonne by fiscal 2010. TISCO's greenfield projects in Orissa and Chhattisgarh are progressing. Jharkhand project is waiting announcement of Research and Development policy of the state Government. The construction work of ferrochrome project in South Africa is in full swing. Acquisition of Corus: Recently TISCO acquired the Anglo-Dutch steel maker Corus, thus emerging as the fifth largest steel producer in the world. The steel major has won the Prime Minister's Trophy four times. This award is instituted by the Indian ministry of steel and awarded to the country's best integrated steel plant. In 2000, it became the first Tata Company to win the JRD Tata QV award, given to the company with 'world class' operations under the Group's Tata Business Excellence Model.

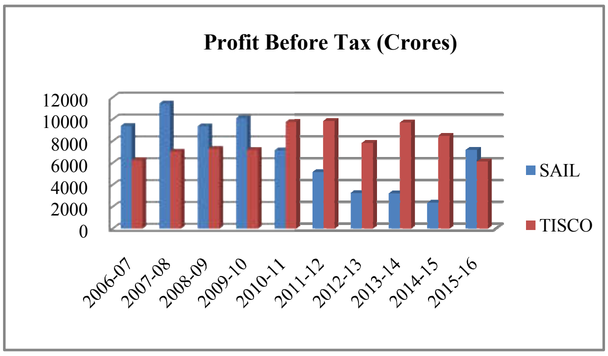

Figure 4 Profit before Tax in SAIL and TISCO

Source: SAIL and TISCO, 2016

The company's environmental management is managed by TISCO Climate Change Policy, TISCO Code of Conduct, Sustainable Policy, Environmental Policy, Vision and United Nations Compact Policy. In the last decade of the decade, TISCO has reduced the required amount of steel to produce a ton of steel over the last four decades, and by 20 percent by the end of the decade, the goal of reducing carbon dioxide emissions is set. Environmental management systems have been implemented on all mining and manufacturing sites, which are certified and regularly audited and reviewed under EMS ISO 14001. Environmental Management Committee monitors and evaluates environmental risks, likewise, the sound level, waste, water impact, air quality level, dust suppression system and record partners concerns, priorities and expectations

The above mentioned figure of 1, 2, 3 and 4 shows the trends of economic and environmental measures in SAIL and TISCO steel plants. The following figures show that trends of CO_2 emission in SAIL is slightly declining but in TISCO it is stagnant during last decade. Stack emission in SAIL is significantly decreasing and in TISCO it is also stagnant. On the contrary, crude steel production in SAIL follows a constant trend, but in TISCO production of crude steel is increasing over the period of last decade.

DATA AND METHODOLOGY

We carry out a comparative empirical analysis between SAIL and TISCO, the largest public and private sector steel plants in India respectively, to explore the dynamic impact of production on the suitable measure of environmental degradation over the period of 2001-2015. We collect the quarterly data on crude steel production in metric tonne and carbon-dioxide emission in tonne for both companies from various annual reports published by SAIL and TISCO and also from some primary sources. So we have sixty observations for each variable for each plant. We use different notations of the variables for SAIL and TISCO. Crude steel production and carbon-dioxide emission are denoted by PROS and COES respectively in case of SAIL. Similarly for TISCO the notations are PROT and COET respectively.

Against the background as mentioned above the general hypothesis to be tested for achieving our objective of the study in case of SAIL and TISCO is categorized as following:

The production of crude steel does not cause the carbon-dioxide emission and the scenario is indifferent in SAIL and TISCO plants in India.

One important property of time series data, not usually present in cross-sectional data, is the existence of correlation across observations. Income today, for example, is highly correlated with income of the last year. The stochastic properties of the time series used in this study have been examined by carrying out Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) unit root tests. Both the intercept and trend components have been incorporated in the ADF estimated relation as following:

$$\Delta X_t = \phi_0 + \beta t + \rho X_{t-1} + \sum_{i=1}^{P} \gamma_i \Delta X_{t-1} + \varepsilon_t \qquad (1)$$

The ADF statistic is the *t*-value associated with the estimated coefficient of ρ, the probability distribution of which is a functional of the Weiner process, the process used in explaining Brownian motion of a particle with large number of molecular shocks (Maddala and Kim, 1998). The PP test is the non-parametric extension of the DF unit root test by adding a correction factor to the DF t statistic. The tests have been performed for all the logarithmic series and their first differences. The choice of lag length is very much crucial at this stage and the number of lags used in the ADF regressions is selected by the Akaike (1969) Information Criterion (AIC).

We applied cointegration theory developed in Engle and Granger (1987) by utilising the methodology developed by Johansen and Juselius (1990). The concept of cointegration, first developed in Granger (1981), is relevant to the problem of the determination of long-run equilibrium relationships in economics in a sense that the variables move together over time so that short-term disturbances from the long-term trend will be corrected. Engle and Granger (1987) have shown that if two time series are cointegrated there will be a causal relation in at least one direction. For two variables Y and X, the model can be presented either of the following form:

$$\ln X_t = \theta + \sum_{i=1}^{p} \pi_i \ln X_{t-i} + \sum_{j=1}^{r} \phi_j \ln Y_{t-j} + v_t \qquad (2)$$

$$\ln Y_t = \alpha + \sum_{i=1}^{m} \beta_i \ln X_{t-i} + \sum_{j=1}^{n} \gamma_j \ln Y_{t-j} + u_t \qquad (3)$$

When the variables are not cointegrated then we have to examine the short run dynamic relationships between them by utilizing the unrestricted vector auto regression (VAR) structure shown as the following two equations. By incorporating one period lag as suggested by the minimum AIC rule, the bi-variate VAR used in this study takes the following form:

$$\Delta \ln X_t = \alpha_0 + \alpha_1 \Delta \ln X_{t-1} + \alpha_2 \Delta \ln Y_{t-1} + \varepsilon_{1t} \qquad (4)$$

$$\Delta \ln Y_t = \beta_0 + \beta_1 \Delta \ln X_{t-1} + \beta_2 \Delta \ln Y_{t-1} + \varepsilon_{2t} \qquad (5)$$

The lagged terms of ΔX_t and ΔY_t appeared as explanatory variables, in the VAR structure indicate short run dynamics or cause and effect relationship between the two series. Thus, if the lagged coefficients of ΔY_t appear to be significant in the regression of ΔX_t this means that Y affects X. Similarly, the opposite holds if the lagged coefficients of ΔX_t are significant in ΔY_t. If none of the lagged coefficient is significant anywhere this implies that there is no cause and effect relationship between the two series.

Empirical Findings

Econometric methodology has been employed as usual for time series data. To verify the stochastic property of the data series we employ Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests. The non-stationary variables can be made stationary by differencing the number of differencing (D) required to make the series stationary identifies the order of integration I(D) of the series. When the series are required to be differentiated, they are to be found stationary and integrated at same order to apply cointegration test. We utilize vector auto-regression (VAR) model to examine the causality between the variables.

Table 1 Estimated Statistics of Unit Root Tests

Series	ADF Test		PP Test	
	Level	First Difference	Level	First Difference
PROS	3.13	-7.59***	-2.09	-7.59***
COES	-1.65	-4.90***	-1.70	-4.91***
PROT	-3.73*	-7.12***	-1.93	-6.99***
COET	-1.64	-4.89***	-1.73	-4.92***

Note: ***, ** and * denote the level of significance at 1%, 5% and 10% respectively

Source: Authors' estimation by using data from SAIL and TISCO

Table 1 presents the test statistics of ADF and PP unit root test for variables of both SAIL and TISCO. The null hypothesis of the presence of unit roots is not rejected in the all original series indicating that none of the series is stationary at level. However, the presence of unit roots is conclusively rejected at the first differences of all the series. We also don't find any significant break in any series by applying suitable test (Zivot and Andrews, 1992).

Table 2 Estimated Statistics of Johansen Cointegration Test for SAIL

Unrestricted Cointegration Rank Test					
	Hypothesized No. of CE(s)	Eigenvalue	Statistic	5% Critical Value	Prob.**
Trace	None	0.40	43.19	47.85	0.12
	At most 1	0.31	23.67	29.79	0.21
Maximum	None	0.40	19.51	27.58	0.37
Eigenvalue	At most 1	0.31	14.01	21.13	0.36

Trace test indicates no cointegrating eqn at the 0.05 level
Max-eigenvalue test indicates no cointegrating eqn at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Source: Authors' estimation by using data from SAIL

The ADF and PP unit root tests suggest that all the variables are integrated of order one (I(1)). So they may have a common trend and in this situation to find the dynamic causal relationships between the variables we use Engle and Granger (1987) cointegration test. The estimated results of Johansen's cointegration tests for SAIL are shown in Table 2. Both both trace and maximum eigenvalue statistic report that variables are not cointegrated at 5 percent level. So there has been no long run relationship between the variables for both SAIL and TISCO.

Table 3 Estimated Statistics of Johansen Cointegration Test for TISCO

Unrestricted Cointegration Rank Test					
	Hypothesized No. of CE(s)	Eigenvalue	Statistic	5% Critical Value	Prob.**
Trace	None	0.39	29.80	97.95	0.35
	At most 1	0.35	15.49	57.86	0.19
Maximum	None	0.39	21.13	40.09	0.16
Eigenvalue	At most 1	0.35	14.26	34.81	0.14

Trace test indicates no cointegrating eqn at the 0.05 level
Max-eigenvalue test indicates no cointegrating eqn at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Source: Authors' estimation by using data from TISCO

Similarly for TISCO (Table 3) find insignificant cointegrating relationship between the variables. So to examine the short run dynamics between them we with the direction(s) of causality we utilize the model of unrestricted VAR structure for both SAIL and TISCO.

Table 4 Estimated Coefficients in Unrestricted VAR Model for SAIL

	D(PROS)	D(COES)
D(PROS)	-	0.31** [2.23]
D(PROS(-1))	0.22** [2.22]	-2.49 [-1.21]
D(COES)	-0.05 [-0.94]	-
D(COES(-1))	-0.35 [-0.12]	-0.05 [-2.94]
C	58.96* [1.419]	0.32* [1.97]
R-squared	0.35	0.29
Adj. R-squared	0.26	0.20

Source: Authors' estimation by using data from SAIL
Note: ** and * denote the level of significance at 5% and 10% respectively

Table 4 and 5 represent the estimated coefficients in unrestricted VAR model for SAIL and TISCO respectively. In both cases we find that production of crude steel is significantly enhancing the CO_2 emission.

Table 5 Estimated Coefficients in Unrestricted VAR Model for TISCO

	D(PROT)	D(COET)
D(PROT)	-	0.42** [2.04]
D(PROT(-1))	0.39** [2.16]	0.30 [-0.41]
D(COET)	-0.05 [-0.31]	-
D(COET(-1))	-0.13 [-0.89]	-0.04 [-0.34]
C	-0.00 [-0.06]	0.00 [0.12]
R-squared	0.51	0.49
Adj. R-squared	0.48	0.44

Source: Authors' estimation by using data from TISCO
Note: ** and * denote the level of significance at 5% and 10% respectively

However it is remarkably observed that degree influence of crude steel production on environmental degradation measured by carbon dioxide emission in TISCO is higher than that in case of SAIL. So we can conclude that SAIL performs better than TISCO in terms of environmental management.

CONCLUDING REMARKS

The paper has carried out a comparative study of economic and environment performances between of SAIL and TISCO, two largest public and private steel plants in India respectively by using some suitable statistics and econometric techniques, where the empirical results clearly indicate that public sector plant is performing better in environmental context compare to private plant, whereas economic performance of private sector plant is remarkably better than public sector plant over a specific period of time.

So we can argue that due to obligation of government rules and policies on environmental issues, performance of public sector steel plants towards sustainable development is significantly better than private steel plants. But it is mostly required in all types of plants irrespective of status of the company. Besides the economic performance, environmental performance should be another goal to each steel producer nowadays and government should have a positive role in this regard.

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