Research Paper Economics

Total Factor Productivity trends in selected Indian steel firms

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ABSTRACT

Productivity is a measurement of efficiency; broadly, it is a relation between output and inputs, single or a combination of a few or all. In this paper analysed Total Factor Productivity (TFP) indices and their growth rates of ten selected Indian steel firms. The results revealed that six out of ten firms exhibit technological progress and technological retrogression is observed in two firms, and in the remaining two firms technical neutrality is observed during the period1989-2009.

Keywords: Indian steel firms, Divisia TFP Indices, Growth rates of TFP.

1. Introduction

In general the productivity can be considered as related to efficiency. Broadly, it is a relation between output and inputs, single or a combination of a few or all. Total factor productivity growth (TFPG) is of crucial significance in the context of economic growth in developing countries as these economies are often faced with an acute shortage of productive resources. The importance of productivity growth in raising the standard of living, it is not surprising that productivity analysis receives substantial attention from the economic and political communities.

Different researchers, namely, Goldar (1986), Ahluwalia (1991), Pradhan and Barik (1998), Mongia and Sathaye (1998), Schumacher and Sathaye (1999), Mongia et al. (2001), Kathuria (2002) and Mohanan (2009), have attempted to study the productivity and related aspects of steel industry in India. However, these studies do not throw light on the relative total factor productivity performance of the different firms in the industry. Therefore, the present study is an attempt to bridge this gap with the objective of examining the steel firms in India using the Total Factor Productivities (TFP). So, it is hoped that this study will make an important contribution to the literature of growth and productivity analysis for the steel industry in India.

2. Objectives of the study

In view of the importance and the need of the steel, an attempt has been made to study the following objectives for the selected firms in Indian steel industry. The main objective of the study is to analyse the total factor productivity indices trends and their growth rates of selected Indian steel firms during the period 1989-2009.

3. Database and Methodology Database

The present study is based on secondary data and covers the period from 1989-2009. To examine the objectives of the study, the data has been drawn from PROWESS, compiled by Center for Monitoring Indian Economy (CMIE). For this study, we have taken ten Indian steel firms on the basis of their performance in terms of market share and sales during the period 1989-2009. Keeping in view of the study objectives, we have collected the time series data on value of output, fixed capital, number of employees, fuel and material consumed of the following firms. 1. Steel Authority of India Ltd. (SAIL) 2. Tata Steel Ltd. (TSL) 3. Rashtriya Ispat Nigam Ltd. (RINL) 4. Maharashtra Elecktrosmelt Ltd. (MEL) 5. National Aluminium Co Ltd. (NALCO) 6. Hindustan Zinc Ltd. (HZL) 7. Hindalco Industries Ltd. (HIL) 8. Hindustan Copper Ltd. (HCL) 9. Bharat Aluminium Co Ltd. (BALCO) 10. GKW Ltd. (GKW).

Deflators

Since the data collected are at current prices, to bring the data into constant prices, we have used appropriate deflation techniques for the different variables. To bring the data into constant prices, we have taken 1993-94 as the base year for ten firms throughout the study.

The value of output is deflated by the respective wholesale price index of industrial production. For estimating the capital stock, the present study adopts standard practice of perpetual inventory method. This Capital stock is deflated by the composite price index of machinery (electrical and non-electrical). Number of employees is deflated by consumer price index of industrial workers. Energy and Material inputs are deflated by the respective wholesale price indices of power & fuel and raw material. The price indices are taken from the various issues of Reserve Bank of India (RBI) bulletins. The consumer price index (General) for industrial workers is collected from http://labourbureau.nic.in/indtab.html

Methodology: Total Factor Productivity

A measure of Total Factor Productivity (TFP) was first suggested by Morris A. Copeland (1937) at the first meeting of the conference on research in income and wealth at New York. But first empirical attempt to measure TFP was made by Jan Tinbergen in 1942 the first estimates of TFP was prepared in the United States by George Stigler for manufacturing and they were presented in 1947 volume of National Bureau of Economic Research. The concept of TFP was further elaborated by John Kendrick at an Income and Wealth Conference in 1951. During 1950's several other economists includes Robert, M., Solow (1957), explicitly used a production function frame work to establish TFP as an observational concept. Several methods have been suggested for estimation of TFP. Here we are using one method of measuring TFP namely, Divisia or Translog indices.

The Divisia or Translog index of technology change is based on Translog production function which, a priori, does not restrict the input substitutability to any particular value. It allows for variable elasticity of substitution and does not require the assumption of Hicks Neutrality [Christenson, and Jorgenson (1973)]. Krishna also held the opinion that Translog index of measuring productivity is a better method compared to the others, because, it provides rigorous foundations for the measurement of total factor productivity by incorporating recent developments in the theory of production and index numbers [Krishnamurthy (1986)]. Under the four inputs frame work, the Translog index of TFP growth is given by the following equation.

$$\Delta Ln\,TFP(t) = \Delta Ln\,Q(t) - \left[\frac{S_K(t)+S_K(t-1)}{2} \times \Delta Ln\,K(t)\right]$$

$$- \left[\frac{S_L(t)+S_L(t-1)}{2} \times \Delta Ln\,L(t)\right] - \left[\frac{S_E(t)+S_E(t-1)}{2} \times \Delta Ln\,E(t)\right] - \left[\frac{S_M(t)+S_M(t-1)}{2} \times \Delta Ln\,M(t)\right]$$

In this equation, Q denotes gross output, K-capital, L-labour, M-materials and E-energy inputs.

$$\Delta Ln\,Q(t) = Ln\,Q(t) - Ln\,Q(t-1)$$

$$\Delta Ln\,K(t) = Ln\,K(t) - Ln\,K(t-1)$$

$$\Delta Ln\,L(t) = Ln\,L(t) - Ln\,L(t-1)$$

$$\Delta Ln\,E(t) = Ln\,E(t) - Ln\,E(t-1)$$

$$\Delta Ln\,M(t) = Ln\,M(t) - Ln\,M(t-1) \text{ are defined.}$$

Sk is the income share of capital, SL is the income share of labour, SE is the income share of energy input and SM is income share of materials input. SK, SL, SM and SE add up to unity. Δ ln TFP is the rate of technological change or the rate of TFP growth. Using the above equation, the growth rates of TFP have been computed for each year. These have them been used to obtain an index of TFP in the following way. Let A denote the index of TFP. The index for the base year, A (O), is taken as 100. Then, the index for subsequent years is computed using the following equation.

$$A(t)/A(t-1) = \exp\left[\Delta \text{ h } TFP(t)\right]$$

4. Results and Discussions

From the analysis it is clear that out of ten firms, seven firms registered positive growth rates and are statistically significant at 5 per cent level. In the case of GKW and HCL the growth is declining and in BALCO there is low positive growth recorded during the study period 1989-2009. The highest growth rate of productivity is observed in RINL (5.43%), followed by HZL (5.12%), NALCO (4.17%), TSL (2.98%), SAIL (2.89%) and HIL (2.58%). This result reveals that six out of ten firms exhibit technological progress. The technological retrogression is observed in GKW and HCL. In the remaining two firms technical neutrality is observed during the study period.

Table-1, correspond to Total Factor Productivity (TFP) Indices of selected Indian Steel Firms.

TABLE-1: Total Factor Productivity Indices of Selected Indian Steel Firms

DIVISIA TOTAL FACTOR PRODUCTIVITY										
YEAR	SAIL	TSL	RINL*	MEL	NALCO	HZL	HIL	HCL	BALCO	GKW
1989	100	100	--	100	100	100	100	100	100	100
1990	107	111	--	119	144	118	113	98	105	106
1991	109	115	100	128	125	101	119	119	112	103
1992	124	132	189	158	130	126	137	106	126	120
1993	143	142	264	188	153	154	141	112	154	147
1994	129	128	357	140	146	123	131	87	152	129
1995	126	130	508	142	162	138	149	108	186	108
1996	118	144	536	155	172	124	163	67	187	58
1997	111	147	167	152	172	126	135	68	191	52
1998	114	140	191	169	193	159	150	88	210	43
1999	108	189	201	153	179	177	148	188	232	41
2000	114	197	235	158	219	204	166	6	221	57
2001	133	197	294	147	228	220	183	72	237	4
2002	129	160	351	177	213	293	184	31	221	4
2003	148	184	392	181	213	271	170	46	262	3
2004	169	209	502	153	225	294	167	42	171	4
2005	212	255	575	245	297	213	196	35	93	5
2006	175	209	474	190	291	306	191	19	112	7
2007	180	163	559	211	308	428	179	33	157	5
2008	196	167	537	229	224	271	167	33	155	6
2009	171	159	344	228	195	113	181	32	157	5

Source: Author calculations, * indicates Rashtriya Ispat Nigam Ltd. Overall period (1991-2009)

From the analysis it is observed that in the first sub-period eight firms had positive growth rates and remaining two firms had negative growth rates. In the second sub-period it is observed that seven firms registered positive and three firms registered negative growth rates. From the coefficient of variation, it is observed that there is more consistency in the Divisia indices of eight firms.

Table-2, stand for Annual Compound Growth Rates and consistency levels of Divisia Total Factor Productivity indices of selected Indian steel firms.

TABLE-2: ACGR of Divisia TFP indices of selected Indian steel firms

SELECTED INDIAN STEEL FIRMS	period-I (1989-1998)		period-II (1999-2009)		overall (1989-2009)	
	CV	ACGR	CV	ACGR	CV	ACGR
Steel Authority of India ltd.	10.7004	1.0775NS	21.4609	5.7659	23.4287	2.886
		(0.92)		(5.12)		(6.00)
Tata steel ltd.	12.1819	3.6178	14.9996	-1.1207NS	24.0076	2.9763
		(4.78)		(0.8)		(5.38)
Rashtriya Ispat Nigam Ltd.*	56.186	7.6051NS	32.5151	8.0945	42.9242	5.4281
		(0.83)		(3.39)		(3.18)
Maharashtra Elecktrosmelt Ltd.	17.4323	4.1077	18.6215	4.5526	22.2931	2.9468
		(2.65)		(4.31)		(6.29)
National Aluminium Co Ltd.	17.8791	5.6792	18.2632	2.161NS	28.9583	4.166
		(6.03)		(1.34)		(8.15)
Hindustan Zinc Ltd.	15.2944	3.4586	32.5023	0.6679NS	45.5706	5.1187
		(2.66)		(0.19)		(4.85)
Hindalco industries Ltd.	14.0141	4.0278	7.7994	1.0738NS	17.1126	2.5755
		(4.23)		(1.51)		(7.98)
Hindustan Copper Ltd.	18.6232	-4.1075NS	100.2844	-5.1158NS	61.5312	-8.1041
		(2.27)		(0.62)		(3.65)
Bharat Aluminium Co Ltd.	26.373	8.8388	29.8373	6.3654	29.5292	1.2741NS
		(13.79)		(2.51)		(1.15)
GKW Ltd.	35.969	-9.6359	143.4342	-15.6603NS	95.8021	-21.3966
		(2.74)		(1.89)		(8.36)

Source: Author calculations, Figures in parenthesis are t- value, NS indicates Insignificant.
*** indicates Rashtriya Ispat Nigam Ltd., period-I (1991-98), period-II (1999-2009) and overall (1991-2009)**
CV = Coefficient of Variation, ACGR = Annual Compound Growth Rate

5. Conclusions

The Divisia indices of TFP and their growth rates of ten selected Indian steel firms posted positive growth and are significant at 5 per cent level. In the case of GKW and HCL the growth is declining and in BALCO there is low growth during the study period 1989-2009. These results revealed that six out of ten

firms exhibit technological progress and technological retrogression is observed in GKW and HCL, and in the remaining two firms technical neutrality is observed during the study period. From the coefficient of variation, it is observed that there is more consistency in the Divisia indices of eight firms.

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