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Research Article

TOTAL FACTOR PRODUCTIVITY IN STEEL INDUSTRY

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ABSTRACT

Total factor productivity growth (TFP) is the best known measure of productivity.TFP is a costless growth. TFP growth is a disembodied technological progress; therefore, it cannot be attributed to any single factor of production. TFP is also dynamic as it can only be captured over a period of time. It turns into unanticipated residual profits. The period of study is 20 years, i.e. from 1991 to 2010, based on steel industry. It is observed that there is significant productivity growth in few steel companies. The malleability of technologies needs to be kept in mind. It is on account of the rigidities in the case of steel industry that real factor productivity is not significant in some steel companies. It also appears that under such circumstances even the costless growth alternative of TFP is not available because TFP is the practice of technology but if the technology is rigid, it is not possible to have TFP growth.

INTRODUCTION

TFP (Total factor productivity) growth is the best know measure of productivity. Comin (2006) described TFP as 'Total Factor Productivity (TFP) to be the portion of output not explained by the amount of inputs used in production'. This paper argues that TFP growth is disembodied technological progress. Therefore, it has three characteristic:

i. It cannot be attributed to any single factor of production.
ii. It is dynamic because it arises over a period of time.
iii. It is real.
iv. It leads to residual profit which is unanticipated.

Nucci, Pozzolo and Schivardi (2005) said that higher productivity is a consequence of opaque activity. They refer to R&D activity as opaque activity. Opaqueness is a characteristic whose effect is not clearly known. On the other hand it can be argued that TFP growth is unobservable. The factors of production are paid to their contribution in real terms. Any residual growth, in real terms, is over and above the contribution that is accounted for. Therefore, it is not observable. It is unrelated to the capital of the firm. Capital is clearly a result of anticipated changes in the structure of the firm (e.g., ownership structure). All of the above decisions are conscious decisions.

Objectives of the Study

The objectives of the paper are as under

i. To study the production theories.
ii. To measure variables of TFP.
iii. To measure productivity growth.
iv. To estimate productivity of steel industry.

Hypothesis

The hypothesis for the study is:
H_0: There is no productivity growth in steel industry.
H_A: There is productivity growth in steel industry.

Profile of Steel Industry

India maintains its position of being the 4th largest producer of crude steel in the world and is expected to become the 2nd largest producer of crude steel, as per the annual report of 2014-15 by Ministry of Steel, Government of India. As per the official estimates, the Iron and Steel Industry contributes to around 2 per cent of the GDP (Gross Domestic Product). From a negligible global presence, the Indian steel industry is now globally acknowledged for its product quality. From the fledgling one million tonne capacity status at the time of independence, India is the largest producer of sponge iron. India ranked as the fourth largest producer of crude steel in the

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world after China, Japan and the USA based on data released by the World Steel Association.

Review of Literature

In this section of review of literature, studies related to productivity are discussed as under

Robert Solow (1956), in the landmark article has shown that long-run growth in income per capita in an economy with an aggregate neoclassical production function must be driven by growth in TFP. Clark and Griliches (1982) studied the results of a study of productivity growth and R&D in the 1970s using data on narrowly defined 'business units within a firm. The calculations suggested that reduced investment in R&D may have accounted for at least 10 percent of the decline in total factor productivity growth in the l970s.Comin (2006) described TFP as 'Total Factor Productivity (TFP) to be the portion of output not explained by the amount of inputs used in production'. As such, its level is determined by how efficiently and intensely the inputs are utilized in production.

Productivity

It is assumed that production takes place through **Cobb-Douglas technology**. The function for the standard form for production of a good with 2 factors is:

$$Y = A\,L^{\alpha}\,K^{\beta} \quad \text{... (1)}$$

where

Y = Real Value Added
L = Labour input
K = Capital input
A = Total factor productivity

α and β are the output elasticities of labour and capital, respectively. These values are constants determined by available technology.

Further, If $\boldsymbol{\alpha + \beta = 1}$, the production function has constant returns to scale

If $\boldsymbol{\alpha + \beta < 1}$, the returns to scale are decreasing,
If $\boldsymbol{\alpha + \beta > 1}$, the returns to scale are increasing.

In the case of a C-D function, constant returns to scale operate by definition.

It is therefore clear that both 'A' (Technical efficiency) and 'b' (TFP growth) are parts of the same phenomenon and represents residual output. As such this output is not measurable ex- ante. It is in the nature of 'unpaid' services of both capital and labour. Since it cannot be measured ex-ante it cannot be paid for. It is therefore TFP growth is both 'residual' and 'opaque'. The costing cannot be incorporated in the technology. It is therefore known as disembodied technological progress. In financial terms, the residual output gets added to the cash inflows but, since the TFP is 'unpaid' it is opaque.

TFP (Total Factor Productivity)

'Total Factor Productivity (TFP) is the portion of output not explained by the amount of inputs used in production. As such, its level is determined by how efficiently and intensely the inputs are utilized in production' Comin (2006).In this study,a four factor production function is used, i.e. Labour, Capital, Material and Energy are used as four factor inputs. The function will be represented as shown in Equation 2.

$$Y_t = A\,L^{\alpha}\,K^{\beta}E^{\gamma}\,M^{\delta} \quad \text{...(2)}$$

Where

Y = total output, L = labour input, K = capital input, E = Energy input, M = Material input, A = total factor productivity, t = Time and α, β, γ and δ are the output elasticities of labour, capital, energy and material respectively. These values are constants determined by available technology.
Data has been collected from prowess for the computation of total factor productivity.

The five variables which are needed for computation are as under:

Output: It is an amount produced or manufactured during a certain time. As per National income accounting, Choudhury (1995) and Miron and Zeldes (1987) output is defined as:

Output = Sales + Change in stock ...(3)

where,

Change in stock = Closing stock – Opening stock ...(4)

OR ...(1)

Output=Sales+(Closinstock–Openingstock) ...(5)

i. Wages and salaries: It is the factor payment (remuneration) made to labour for his services.
ii. Energy: It means the sources of energy like power, fuel, water etc used by the manufacturers for the production of goods and services.
iii. Material: It is basically the raw material used for the production of finished goods. It is used for the primary production or manufacturing of a good.
iv. Capital: It is a measure of the flow of capital services available for production from the stock of capital goods.
'Prowess' Database gives information on these five components of TFP as shown in Table 1.

Table 1 Heads of the Five Variables of TFP under Prowess

S.No.	Variable Name	Heads under Prowess***
1	Sales	Sales
2	Change in Stock	Change in stock of finished and semi-finished goods
3	Wages	Salaries & Wages
4	Energy	Power, fuel (including wheeling charges paid by electricity companies) & water charges
5	Material	Raw material expenses

***All the above variables are denoted in 'Rs. Million'.

TFP is calculated for a period of 20 years i.e. from 1991 to 2010. Time series analysis is used for measuring TFP.

METHODOLOGY FOR TFP MEASUREMENT

i. Total output, total wages, total amount of material input used and total amount of power input used is calculated from the above mentioned five variables
ii. As productivity is a real variable so it is required to convert output, wages, energy and material into real output, real

wages, real energy and real material by deflating the variables by their deflators.

iii. For finding out deflators, '*Handbook of Statistics*' from RBI website is used. The Consumer Price Index is used for the finding the deflator of wages and Wholesale Price Index is used for finding the deflators of output, energy and material. The deflators are given in Table 2.

Table 2 Deflators Selection for each Variable

Variable	Index	Deflator Name
Wages	Consumer Price Index	IW (Industrial Worker)
Output	Wholesale Price Index	MP (Manufactured Products)
Energy	Wholesale Price Index	F&P (Fuel and Power)
Material	Wholesale Price Index	NF (Non-Food articles)

1993-94 is taken as the base year for all the deflators in the 20 years. For formulating the same base 'Splicing method' is used because the WPI and CPI indexes are based on different base years. The Table 3 is the final table of deflators.

The real output, real wages, real energy and real material are calculated by dividing variables from their deflators shown as under

Real Output = Total Output / Output Deflator
Real Wages = Total Wages / Wage Deflator
Real Energy = Total Energy / Energy Deflator
Real Material = Total material / Material deflator.

Table 3 Final Deflators

Year	Wage Deflator	Material Deflator	Energy Deflator	Output Deflator
1991-92	0.85	0.92	0.76	0.84
1992-93	0.93	0.91	0.87	0.93
1993-94*	1	1	1	1
1994-95	1.1	1.24	1.08	1.12
1995-96	1.21	1.35	1.14	1.21
1996-97	1.82	1.34	1.26	1.24
1997-98	1.95	1.37	1.43	1.28
1998-99	2.2	1.51	1.48	1.33
1999-00	2.28	1.43	1.62	1.37
2000-01	2.36	1.46	2.08	1.41
2001-02	2.46	1.52	2.26	1.44
2002-03	2.56	1.65	2.39	1.48
2003-04	2.66	1.86	2.54	1.56
2004-05	2.77	1.87	2.8	1.66
2005-06	2.88	1.81	3.18	1.7
2006-07	3.08	1.91	3.39	1.8
2007-08	3.28	2.14	3.39	1.89
2008-09	3.57	2.42	3.78	2
2009-10	4.02	2.55	3.7	2.05
2010-11	4.43	3.12	4.16	2.16

*Base year 1993-94

iv. After deducting real wages, real energy and real material from real output, the value of real capital is calculated. So, real capital is a residual value, i.e. the leftover after making the all the other factor payments from real output. It can be represented as

[Real Capital = Real Output – (Real Wages + Real Material + Real Energy)] …(6)

v. After step five, LOG of all the five real variables, i.e. Real Output (LRO), Real Wages (LRW), Real Energy (LRE), Real Material (LRM) and Real Capital (LRK), is taken for all the 20 years (1991-2010). It gave a semi log equation as under

$$Y_t = e^{a+bt} L^{\alpha} K^{\beta} E^{\gamma} M^{\delta} \quad \ldots(7)$$

$$LogY_t = A + bT + \alpha LogL_t + \beta LogK_t + \gamma LogE_t + \delta LogM_t + \cup_t \quad \ldots(8)$$

vi. On the above semi-log equation, regression is applied by taking LRO as dependent variable and the four inputs, i.e. LRW, LRK, LRE, LRM and Time (1991-2010) as independent variables.

vii. The output sheet of regression of each company gives the TFP coefficient. It gives 1 value of TFP for 20 years because TFP effect comes over a period of time.

RESULTS OF TFP

For the analysis part of the study, 45 steel companies are taken into consideration based on the availability of 20 years data. From the output sheet of regression of each company, the TFP coefficients are shown in Table 4.

Table 4 Total Factor Productivity Growth

S.No.	Name of Companies	Coefficient	p value
1	Aarti Steels Ltd.	0.00520795	0.257540517
2	Aditya Ispat Ltd.	-0.01187376	0.064995361
3	Anil Special Steel Inds. Ltd.	0.00010592	0.820216672
4	Ashiana Ispat Ltd.	0.01536206	0.007524449
5	B P Alloys Ltd.	0.00181403	0.525020316
6	Balaji Galvanising Inds. Ltd.	0.00188558	0.517119364
7	Balaji Industrial Corpn. Ltd.	-0.00151134	0.677077878
8	Bhoruka Steel & Services Ltd.	-0.01043588	0.34401188
9	Bhushan Steel Ltd.	0.00337571	0.670135315
10	Bhuwalka Steel Inds. Ltd.	0.00828859	0.000454007
11	Ensa Steel Inds. Ltd.	-0.01182857	0.009747266
12	Essar Steel Ltd.	-0.00304334	0.25195426
13	Gangotri Iron & Steel Co. Ltd.	-0.00032994	0.861520937
14	Gontermann-Peipers (India) Ltd.	-0.00252679	0.212503432
15	Gopal Iron & Steels Co. (Gujarat) Ltd.	-0.00305669	0.268152795
16	Graham Firth Steel Products (India) Ltd.	0.0057859	0.619696
17	Haryana Steel & Alloys Ltd.	-0.0012397	0.724883896
18	Hisar Metal Inds. Ltd.	0.00226818	0.123021629
19	I P I Steel Ltd.	-0.00142855	0.129980388
20	I S M T Ltd.	0.02570379	1.11519E-06
21	India Steel Works Ltd.	0.00011525	0.98469214
22	Indo-Germa Products Ltd.	-0.00363602	0.686727168
23	Indore Steel & Iron Mills Ltd.	-0.05301909	0.00200851
24	Kalyani Steels Ltd.	-0.00136135	0.743813921
25	Mahindra Steel Service Centre Ltd.	0.02034899	0.350697623
26	Mahindra Ugine Steel Co. Ltd.	0.00269386	0.119730436
27	Marmagoa Steel Ltd.	0.00089611	0.886514355
28	Modern Steels Ltd.	0.00088512	0.587717769
29	Mohan Steels Ltd.	0.00191748	0.818400846
30	Mukand Ltd.	0.00148023	0.083142058
31	Narbada Steels Ltd.	0.00199055	0.310904896
32	Prakash Industries Ltd.	0.00312357	0.522270868
33	Raajratna Metal Inds. Ltd.	-0.00194484	0.299992729
34	Rashtriya Ispat Nigam Ltd.	-0.00159147	0.468125827
35	Rathi Ispat Ltd.	-0.04803606	0.014156277
36	Rathi Steel & Power Ltd.	-0.00647271	0.412595292
37	Real Strips Ltd.	0.01184547	0.06747161
38	Shri Bajrang Alloys Ltd.	0.00091572	0.491500051
39	Steel Authority Of India Ltd.	-0.0051192	0.000243293
40	Steel Complex Ltd.	-0.02322687	0.035990683
41	Steelco Gujarat Ltd.	0.00154038	0.526962334
42	Stelco Strips Ltd.	0.00123649	0.447605411
43	Tata Steel Ltd.	0.0033788	0.501082807
44	Tulsyan N E C Ltd.	0.04011219	0.001732184
45	Viraj Alloys Ltd. [Merged]	0.00492551	0.247980981

Source: Estimated by author
Note: Bold coefficients represents significant

Out of 45 steel companies, the TFP coefficients of 8 companies are significant at 5% level. Out of these 8 companies, the TFP for three companies is positive and for the remaining five, TFP coefficient is negative. It means approximately TFP is

significant for approximately 18% of the companies. In totality for 19 companies out of 45, the TFP coefficients are negative and for the remaining 26, the TFP coefficients are positive. It shows that for 42% companies, TFP is negative and for remaining 58% companies the TFP is positive. The results of

TFP also reject our null hypothesis

H_0: There is no productivity growth in steel industry.
The results show that there is productivity growth in steel industry.

CONCLUSION

It is observed that there is productivity growth in only few steel companies. It shows that for 42% companies, TFP is negative and for remaining 58% companies the TFP is positive. For a positive TFP, the malleability of technologies needs to be kept in mind. It is on account of the rigidities in the case of steel industry that real factor (TFP) has not shown up as significant results in many companies. It also appears that under such circumstances even the costless growth alternative of TFP is not available because TFP is the practice of technology but if the technology is rigid, it is not possible to have TFP growth.

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