Research Innovator

International Multidisciplinary Research Journal

Vol II Issue II : April 2015

Editor-In-Chief

Prof. K.N. Shelke

www.research-innovator.com

Research Innovator

A Peer-Reviewed Refereed and Indexed International Multidisciplinary Research Journal

Volume II Issue II: April – 2015

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Total Factor Productivity and Financial Structure of Steel Industry

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Abstract

Firm's undertaking innovative activities typically hold specialized equipment and a large share of immaterial assets, such as patents, research knowledge, and project specific human capital. Therefore, more innovative firms tend to have a different financial structure from less innovative ones. Ultimately, differences in the propensity to innovate are likely to translate into different total factor productivity (TFP) levels. In this paper, cross sectional and pooled study of steel companies is used to study the empirical relationship between firms' financial structure and their TFP's. The period of study is 2006 -2010 (5 years). The empirical results show a negative relationship between leverage and productivity, consistent with theories of firms' financial structure based on bankruptcy costs, conflicts of interest between equity and-holders and debt-holders and control rights. The study suggests that book value is not a significant determinant of total factor productivity.

Key Words*:* Total factor productivity, financial structure, capital structure, debt-equity ratio

Introduction

Financial structure is the left side of a firm's balance sheet detailing how its assets are financed, including debt and equity issues. It is the way in which a company's assets are financed, such as short term borrowings, long term debt, and owner's equity. Financial structure differs from capital structure as capital structure only includes long term debt and equity.

A company's financial structure is influenced by a number of factors, including the growth rate and stability of its sales, its competitive situation (i.e., the stability of its profits), its assets structure and the attitude of its management and its lenders. It is the basic frame of reference for analysis concerned with financial leveraging decision.

The theoretical literature on corporate finance points to an equilibrium relationship between the firm's share of intangible assets and its financial structure. Firm's undertaking innovative activities typically hold specialized equipment and a large share of immaterial assets, such as patents, research knowledge, and project specific human capital. Hence, more innovative firms tend to have a different financial structure from less innovative ones. Ultimately, differences in the propensity to innovate are likely to translate into different total factor productivity (TFP) levels. Financial systems are more capable of providing the type of funding used by firms with a higher productivity

should therefore also guarantee higher aggregate productivity.

The relationship between a firm's leverage and its share of immaterial assets is not obvious, because many different mechanisms link a firm's financing choice and its propensity to innovate.

A number of recent studies like, Griliches, Z. and Lichtenberg, F. (1984), Harris, M. and Raviv, A. (1990), Hubbard, R.G., (1998), Beck, T., Levine, Loayza, N. (2000), Cingano, F. and Schivardi, F (2004), etc., have shown that more developed financial systems foster economic growth, owning to their ability to allocate the available resources to more productive tasks. The proposed study will try to answer the question of what financial systems allocate most efficiently the available economic resources by analyzing the relationship between a firm's financial structure and its productivity. The study is be based on select Indian firms of steel industry in order to study the relationship between firm's financial structure and their productivity. The concentration will be on exogenously (i.e., flow of capital, growth of capital market etc.) driven variations of the firm's financial structure in order to avoid the endogenous problems that would otherwise affect the regression of total factor productivity (TFP) on leverage.

Objective of the Study

1. The study will examine the relationship between firm's leverage and its factor of productivity. It is observed that firms with lower leverage have a higher level of productivity.

2. The findings will try to probe various issues of firms which are less reliant on debt finance. It will justify whether the firms should hold a larger portions of debt or equity which will maximize the total factor productivity.

Review of Literature

Mainly, they hinge on the degree of efficiency of financial markets in channeling funds from sectors in financial surplus to sectors in deficit, focusing, for example, on the ability of financial intermediaries to evaluate investment opportunities Greenwood and Jovanovich, (1990); King and Levine,(1993) or to provide liquidity in front of illiquid investment Bencivenga and Smith, (1991).

The empirical literature on the determinants of capital structure has searched for the effect of a number of firms' characteristics on their capital structure. Titman and Wessels (1988) find that firms with higher growth opportunities as measured by the growth rate of total asset, capital expenditure over total assets and R&D expenditures over total sales have lower debt financing, consistent with the first class of theories discussed above. Titman and Wessels (1988) and Bradley et al. (1984), similarly find that firms

with more unique products proxied by the sales expenses over total sales (a measure of marketing and advertising costs), the number of voluntarily quitting employees (a measure of the specificity

of the human capital employed in the firm) and R&D expenses are less likely to use debt financing provide empirical evidence in favor of this hypothesis. Among the other variables that have been found to positively affect the equilibrium share of debt financing are also size Warner, (1977); Smith and Warner, 1979), earnings' volatility Marsh, (1982); Bradley, Jarrel and Kim, (1984), and the probability of bankruptcy Castanias, (1983). Finally, in partial contrast with Bradley et al. (1984), Aghion et al. (2004) find that firms with no R&D expenses and with high R&D expenses have a large share of new equity financing, while firms with positive but low R&D expenses have a larger share of debt financing. Schiantarelli and Sembenelli (1997), studying a different sample of UK firms and a sample of Italian firms, find instead a positive relationship between labor productivity and leverage and a negative relationship between labor productivity and debt maturity.

Profile of Steel Industry

India is the 5th largest producer of steel in the world and produced about 71.77 million tonnes (MT) of steel in FY 11, thus accounting for approximately 5% of the world's total production. Globally, with the financial crisis spilling into the real economy, demand has slowed down. However, India is the only country in the world apart from China to post a positive overall growth in crude steel production over the last year. The recovery in steel production has been aided by the improved sales performance of steel companies. China and India are expected to provide the impetus for steel demand for the next few years. India, being one of the fastest growing countries, showed significant increase in steel consumption during the last 3-4 years. Finished steel demand in India registered a CAGR of 9.3% between 2004-05 and 2008-09, to reach 52.4 million tonnes. Major steel consuming sectors such as construction, infrastructure, pipe and tubes and machinery recorded significant growth over the last few years, driving the country's steel demand.

The Methodology

As shown in the previous sections, the theories of capital structure point to an optimal relationship between the intensity of innovative activities and the financial structure[1]. There are, however, different theoretical views on the equilibrium relationship between the capital structure and the extent to which firms innovate.

This aspect needs to be empirically scrutinized which may shed light on the merits of competing models of corporate finance. The framework of empirical investigation is as follows. First, the variations in firms' financial structure induced by factors that do not directly affect their productivity are identified. Second, it is investigated, whether the exogenous variations in leverage induce firms to change their propensity to innovate and, as a consequence, their productivity. The reason for considering exogenously driven variations of the firm's financial structure is that a

straight regression of TFP on leverage would be subject to serious endogeneity problems. To meet this problem we restored to instrumental variables. Indeed, the equilibrium relationship that a firm with a certain leverage is bound to a given level of intangibles and hence of TFP. At the same time, however, a firm wishing to innovate by increasing its share of immaterial assets is bound to change its leverage. Causality may therefore run in both directions, i.e., a more specific potential bias, determining a negative relationship between leverage and productivity, owes to the fact that firms with higher TFP are likely to generate higher profits and cash flows, and therefore makes lesser use of debt. In light of these problems, in order to pin down the implications for productivity of a firm's financial structure, the following instrumental variable specification is applied:-

$$\mathbf{LTFP_{it} = \alpha + \beta LEV_{it} + Z_{it} + \eta_i + \varepsilon_{it}} \quad \text{.....} \mathbf{(1)}$$

Where $LTFP_{it}$ is the natural logarithm of the total factor productivity of firm i at time t and LEV_{it} is the leverage of firm i at time t; the regression include a set of control variables (Z_{it}), represented, among others, by time (calendar year), size and geographical (provinces) dummies. ηi reflects the fixed latent heterogeneity and ε_{it} is a random error that is assumed to be independently and identically distributed (i.i.d.) with mean zero and variance σ2ε.

To take into account of heterogeneity problem we have divided each variable by the variance of the error term which was found by using O.L.S (Ordinary least square) regression of the variable.

The above equation is estimated by using the between-group estimator, that ignores the over time variation of firms' characteristics, and the fixed effect instrumental-variable estimator, which only accounts for within-firm variation in TFP.

In order to instrument leverage, the formula, i.e., debt by total assets has been used. In principle, one could object that the user cost of capital or the cost of financing, which is its major component, are themselves powerful and valid instruments for our regression. The argument would be that variation in the cost of financing, induced by either change in the cost of debt or in the cost of equity, is likely to affect the firm's capital structure without being driven by other factors that influence productivity. The firm's leverage, however, directly enters the definition of the cost of financing (and, thus, of the user cost of capital), as being the weight for the cost of debt. Therefore, the relationship between leverage and the cost of

financing largely owes to the fact that the former is simply part of the definition of the latter and, as such, cannot be a valid instrument. On the contrary, the tax variables included in the definition of the cost of capital are likely to affect the firm's financial structure to a significant extent, without, however, being influenced by the latter and, thus, potentially, by productivity. The second instrument we used is an indicator of local financial development at the regional level. This measure is drawn from the study of Guiso et al. (2004), who construct such indicator consistently with the notion that more developed financial markets, where they constructed index to indicate the stage of development of financial markets and used this index as an instrument for explaining total factor productivity.

In this paper we specify the relationship between Total factor productivity as given at (1) above and Leverage1 (Lev1), Leverage2 (Lev2), Size(S) with one change. We have divided the debt into long term and short term debt indicated by:-

$$\mathbf{LogTFP = \alpha + \beta\ Lev1 + \gamma\ Lev2 + \delta S + \Psi\ DU_1 + \Psi\ DU_2 + \ldots\ldots\ldots\ldots\ldots\ldots + \Psi\ DU_{14}} \quad \ldots\ldots\ldots \mathbf{(2)}$$

Where the total factor productivity has been measured by the log of value added calculated as:-

Log {(Total Sales – Input Cost) /Capital Employed}

Lev1 = Long term Debt / total Assets

Lev2 = Short term Debt / Current Assets

S = Size (S1 represents the Capital Employed whereas

S2 represents the Book Value of the company)

We have used 14 dummies because there are 15 companies. The result of the fifteenth company is derived from the naïve form equation. We are doing pooling and cross-sectional study for the reason that pooling will explain industry behavior over time and cross sectional study will make us to understand the behavior of companies over time each year. The cross-section over time dimension, i.e., we have examined the relationship year wise in 2006, 2007, 2008, 2009 and 2010 in respect of both the industries. Since it is pooling of time series and cross-section data, therefore the error terms are bound to have hetroscedasticity. To remove hetroscedasticity the variables have been divided by the variance of the error term.

Estimated Models

The estimated models are given below. The results of steel industry are as under:

Results of Steel Industry

Table-1

Estimated results of Steel Industry --Pooling

Dependent variable = Log TFP

Variables	Model1	Model2	Model3
Lev1	0.039* (4.094)	0.039* (4.194)	0.0390* (4.061)
Lev2	-0.248* (-3.009)	-0.261* (-3.273)	-0.249* (-3.002)
SIZE1		-0.0001* (-2.228)	
SIZE2			-0.001 (0.425)
DU1	-0.899*** (-1.775)	-0.804 (-1.636)	-0.915*** (-1.788)
DU2	1.108* (2.220)	1.268* (2.525)	1.306** (1.907)
DU3	1.185* (2.363)	1.224* (2.525)	1.233* (2.381)
DU4	0.956** (1.913)	0.980** (2.030)	0.978** (1.933)
DU5	-0.381 (-0.763)	-0.200 (-0.408)	-0.346 (-0.679)
DU6	-0.458 (-0.913)	0.694 (0.980)	-0.451 (-0.892)
DU7	0.110 (0.218)	1.014 (1.597)	0.129 (0.252)
DU8	0.658 (1.316)	2.314* (2.610)	0.679 (1.340)
DU9	0.778 (1.489)	0.861*** (1.704)	0.808 (1.521)
DU10	-0.978 (-1.954)	-0.836*** (-1.717)	-0.965** (-1.912)
DU11	-1.989* (-3.289)	-1.926* (-3.293)	-1.974* (-3.234)
DU12	-1.969*** (-1.734)	-1.587 (-1.431)	-1.960*** (-1.714)
DU13	-0.307 (-0.616)	0.108 (0.209)	-0.167 (-0.278)

DU14	0.086 (0.172)	0.087 (0.180)	0.107 (0.211)
CONSTANT	3.681* (9.271)	3.696* (9.628)	3.684* (9.202)
R^2	0.866	0.877	0.866
R^2	0.827	0.838	0.824
DW	2.06	2.125	2.087
F	22.190	22.681	20.584

* Coefficient significant at 1 % level of significance
** Coefficient significant at 5 % level of significance
*** Coefficient significant at 10 % level of significance

The pooled regression of the steel industry is given in table-1, which shows that total factor productivity is significantly impacted by long term borrowings. However it is positively impacting the total factor productivity. The variable (Lev1) is significant at 1% level of significance in all the three models. (Lev2) is representing the short term borrowings as a ratio of current assets as expected is impacting adversely. The total factor productivity is indicating the riskiness of such borrowings. Size 1 measured by capital employed is adversely affecting the total factor productivity implying that in the industry there has been an over capitalization leading to low marginal productivity of capital employed. Size 2 was measured with book value, it also had an adverse effect, implying again that it is the over capitalization which is affecting total factor productivity adversely. However, book value as a measure of total factor productivity is insignificant at 5% level of significance. If we look at the significance of dummy variables, we find that there are particular conditions prevalent in Sesa Goa Limited, Kalyani Steels Limited, Mahindra Ugine Steel Company Limited, SAIL and Jai Balaji Industries Limited, which are impacting total factor productivity and providing efficiency to the factor of production and increase total factor productivity, whereas in the case of Prakash Industries Limited, Adhunik Metaliks Limited and Bellary Steels and Alloy Limited the particular conditions are impacting adversely to the total factor productivity.

The regression explains more than 85% of variations in the dependent variables and more than 82% when the R^2 is adjusted for degrees of freedom.

Table-2

Estimated results of Steel Industry -- Cross- Section 2006

Dependent variable = Log TFP

Variables	Model1	Model2	Model3
Lev1	-3.186* (-3.428)	-3.369* (-3.659)	-2.905* (-2.674)
Lev2	-0.372* (-5.852)	-0.368* (-5.919)	-0.364* (-5.379)
SIZE1		0.0001 (1.229)	
SIZE2			0.004 (0.552)
CONSTANT	5.600* (8.245)	5.930* (8.156)	5.892* (6.077)
R^2	0.818	0.842	0.824
R^2	0.785	0.795	0.771
DW	1.202	1.661	1.217
F	24.785	17.795	15.581

* Coefficient significant at 1 % level of significance

** Coefficient significant at 5 % level of significance

*** Coefficient significant at 10 % level of significance

The cross section regression was made after adjusting for hetroscedasticity, and the results are given in table-2. We find from table that both the leverages have proper signs and significant at 1 % level of significance. The regression explains more than 81% of variation in almost in all the three models in 2006. However, when it was adjusted for degree of freedom it was more than 77% only. Durbin Watson statistic lies in the inconclusive range, so we checked up with the auto correlation coefficient of error term and it was found to be insignificant at 5% level of significance. The size did not play any role in the determination of total factor productivity.

Table-3

Estimated results of Steel Industry -- Cross- Section 2007

Dependent variable = Log TFP

Variables	Model1	Model2	Model3
Lev1	0.010 (0.932)	0.0104 (0.901)	0.011 (0.994)
Lev2	-0.397* (-4.191)	-0.396* (-3.974)	-0.369* (-3.437)
SIZE1		0.00002 (0.171)	

SIZE2			0.004 (0.628)
CONSTANT	4.517* (12.549)	4.955* (9.414)	5.413* (8.744)
R^2	0.651	0.652	0.666
R^2	0.582	0.537	0.555
DW	1.912	1.841	1.955
F	9.338	5.631	5.980

* Coefficient significant at 1 % level of significance
** Coefficient significant at 5 % level of significance
*** Coefficient significant at 10 % level of significance

In 2007 (table-3), the Lev1 has adverse sign but the coefficients were insignificant at 5% level of significance in all the three models. However Lev 2 representing short term borrowings as a ratio of current assets had proper signs and the error coefficients are significant at 1% level of significance.

In this year (2007) also, size did not have any significant effect on total factor productivity. The regressions of all the three models explain more than 65% variations in the dependent variable. However when the variation was adjusted for degree of freedom then it was more than 53% only.

Table-4

Estimated results of Steel Industry -- Cross- Section 2008

Dependent variable = Log TFP

Variables	Model1	Model2	Model3
Lev1	0.004 (0.157)	-0.004 (-0.135)	0.005 (0.157)
Lev2	-0.349* (-4.147)	-0.385* (-4.265)	-0.349* (-4.147)
SIZE1		-0.00003 (-0.301)	
SIZE2			0.006 (1.639)
CONSTANT	3.537* (9.075)	4.147* (9.716)	4.234* (9.075)
R^2	0.696	0.625	0.696
R^2	0.613	0.523	0.613
DW	1.538	1.431	1.538
F	8.394	6.107	8.394

* Coefficient significant at 1 % level of significance
** Coefficient significant at 5 % level of significance
*** Coefficient significant at 10 % level of significance

The results of the year 2008 are given in table-4. We see that the behavior of the three models is the same as was in 2007, i.e., the Lev1 is insignificant in all the three models and Lev2 has proper signs and its coefficients are significant at 1% level of significance.

In this year also size has not played any role in determining total factor productivity. The models explain more than 62% variations in dependent variable and when adjusted for degree of freedom this came out to be more than 52% only. In this case also Durbin Watson statistic lies in the inconclusive range, so again auto-correlation coefficients among error terms was checked and were found to be insignificant.

Table-5

Estimated results of Steel Industry -- Cross- Section 2009

Dependent variable = Log TFP

Variables	Model1	Model2	Model3
Lev1	-0.026 (-0.815)	-0.0276 (-0.826)	-0.024 (-0.716)
Lev2	-0.375 (-0.6245)	-0.376* (-6.015)	-0.369* (-5.718)
SIZE1		-0.00002 (-0.318)	
SIZE2			0.001 (0.337)
CONSTANT	5.695* (17.331)	7.674* (14.008)	10.107* (12.826)
R^2	0.7666	0.768	0.768
R^2	0.727	0.705	0.705
DW	1.572	1.521	1.590
F	19.637	12.444	12.163

* Coefficient significant at 1 % level of significance
** Coefficient significant at 5 % level of significance
*** Coefficient significant at 10 % level of significance

The results of 2009 are given in table-5. In this year also all the three models have behaved as they behaved in 2007 and 2008, i.e., the long term borrowings have not been an important determinant of total factor productivity. Lev2 has been significant determinant in the case of model 2 and model 3 at 1% level of significance. Again, the sizes of the firm have not played any role in the determination of total factor productivity. All the three models

explain more than 76% variation in the dependent variable. But when these were adjusted for degrees of freedom the models explained more than 70% of variation in the dependent variable only. Durbin Watson in this year lies in inconclusive range and auto-correlation coefficient among the error terms were checked, which were found to be insignificant at 5% level of freedom.

Table-6

Estimated results of Steel Industry -- Cross- Section 2010

Dependent variable = Log TFP

Variables	Model1	Model2	Model3
Lev1	-0.023 (-0.627)	-0.021 (-0.722)	-0.013 (-0.318)
Lev2	-0.616* (-4.943)	-0.578* (-6.067)	-0.542* (-4.141)
SIZE1		-0.00005 (-0.745)	
SIZE2			-0.00004 (-0.230)
CONSTANT	7.632* (15.798)	13.826* (17.417)	23.709* (12.101)
R^2	0.654	0.758	0.589
R^2	0.601	0.697	0.487
DW	0.542	1.476	1.555
F	12.291	12.509	5.744

* Coefficient significant at 1 % level of significance
** Coefficient significant at 5 % level of significance
*** Coefficient significant at 10 % level of significance

The results of 2010 are given in table-6. in this year also the behavior of all the three models is similar as in year 2007, 2008 and 2009, i.e., the coefficient of long term debt ratio have proper signs but are insignificant at 5% level of significance. However the coefficient of Lev 2 is having proper signs and is significant at 1% level of significance. In this year also size variable has not been an important determinant of total factor productivity; all the three models explain more than 58% variation in the dependent variable. However when adjusted for degree of freedom, the variation explained came out to be more than 48% only.

The Durbin Watson statistic in the case of model 2 and model 3 was in the inconclusive range and that of model 1 it indicated auto correlation in the error term.

Data Description

Estimation is conducted on a sample of fifteen Indian companies of steel industry each from BSE500 (BSE-500 index represents nearly 93% of the total market capitalization on BSE. BSE-500 covers all 20 major industries of the economy) for the above two industries from 2006 to 2010, i.e., five years period. The data is collected from the websites which are money control.com, India and corporate information's, the Investors Service. The data has been processed in RATS 4

Conclusions of the Study

The Steel Industry's pooled regression indicated that the total factor productivity is positively impacted by long term borrowings, although it is asserted in the literature that innovative firms do not use more debt. The positive sign of Lev1 indicate that the debt has been instrumental in modernizing the steel industry whereas the Lev2, i.e., the ratio of short term borrowings and current assets impacted adversely to total factor productivity indicating the riskiness of such borrowings. Both Size1 and Size2 are affecting the total factor productivity adversely which suggests the overcapitalization of the industry leading to low marginal productivity (Size1 was measured by capital employed and Size2 was measured by book value). The study suggests that book value is not a significant determinant of total factor productivity.

The cross sectional analysis was made after adjusting for hetroscedasticity. The results show that in all the three models, as expected the long term borrowings have not been an important determinant of total factor productivity on year to tear basis whereas Lev2 (ratio of short term borrowings and current assets) has been a significant determinant for the determination of total factor productivity and impacting adversely due to greater riskiness of such borrowings.

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