Advances in Asian Social Science
Vol. 1, No. 3, 2012

www.worldsciencepublisher.org

Empirical Nexus between Export and Productivity Growth: Evidence from Selected Manufacturing Industries in India

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Abstract: The objective of this paper is to investigate the export-productivity nexus in some selected manufacturing industries in India for the period 1979-80-2008-09. First, it estimates TFP growth by translog index and thereafter capacity adjusted TFP growth has been estimated to eliminate short run cyclical movements .Second, it examines export-productivity nexus by Error Correction Model. The empirical results provide support for a link between export growth and productivity growth. It is evident from the result that short run casuality from export to TFP is prevalent for cement industry and paper industry and reverse short run casuality from TFP to export for aluminium and iron &steel industry and for glass industry, short run casuality is undirectional.The results also indicate that long run causality is bi-directional in the case of cement, iron & steel and paper industries. The result seems to suggest that export generates both significantly short-run and long-run impacts on TFP growth in energy intensive industries in India.

Keywords: Total factor productivity, export, growth, causality.

JEL Classification: D24, F14, L60.

1. Introduction

The relationship between exports and productivity growth is a highly debated topic and, in recent years, there has been a sizeable volume of research on this issue. In recent past, researchers have devoted considerable attention to investigate the linkage and the degree of relationship between export and productivity growth both at micro and macro level. Participation in export is supposed to be one of the crucial factors that make some firms more productive as well as efficient than firms that do not export. Although it is commonly thought that export-oriented firms exhibit higher levels of productivity than non-exporting firms, evidence suggesting the direction of causality between exports and productivity is mixed. The economic theory suggests that the expansion of exports generates an improvement of the efficiency in allocating the productive resources and a rise of the production volume by accumulating capital (Romer, 1989and Edward, 1992). According to Edwards(1997), acceleration in export determines the increase of the degree of economic openness and consequently those economies will be able to absorb faster (by imitation) the technologies of the more advanced countries. Therefore, a rise of the total factor productivity will result inevitably which will positively influence the economic growth in the long run. Economic policies under export-led growth strategy have been widely supported on the argument that exposure to international market through export helps to increase the productivity of exporters. Economists supporting the export–led growth hypothesis consider that exports can serve as an engine of growth. The increase in demand for output of a country through the growth of exports allows the exploitation of economics of scale for an economy. On the other hand, the expansion in exports promotes specialization in the production of export products, which in turn boosts the productivity level and causes the general level of skills to rise in the export sector. Broadly, productivity growth can occur as a result of many factors such as capital accumulation, the adoption of new technologies, research and development (R&D), changes in the organization of firms and through export participation. On the theoretical front, there is a common opinion that international trade in general and export in particular enhances economic growth and improves the productivity of involved firms (Beckerman, 1962; Kaldor, 1970; Balassa, 1988; Bhagwati, 1988).

A growing body of literature has suggested that exporting contributes little or no benefit in the form of faster productivity growth at the plant level. In most of the cases, the higher productivity of firms actually predates their entry into export market. Despite there exists a huge volume of literature on the export-productivity linkage, the empirical evidences on whether exporting increases firms' productivity has surprisingly been mixed so far. Moreover, previous studies have focused on the link between exports and GDP or output growth explicitly, or the relationship between exports and labour productivity growth .What is absent in this area is an explicit assessment of the relationship between exports and technological progress represented by growth in total factor productivity (TFP). This study aims to fill the vacuum by evaluating the causal links between exports and productivity growth in the context of energy intensive industries in India.

To our knowledge, none of the above studies empirically investigate the nexus between export and total factor productivity growth in the context of India's energy intensive industries.

This study tries to highlight the direction of causality between productivity and export in the energy intensive industries in India and also attempts to make an enquiry whether there exists any long-run relationship between manufacturing export growth and growth in productivity that can revive the energy intensive sectors in India. The degree to which the relationship between export growth and productivity growth is 'causal' for India's energy intensive industries, and the extent to which export growth in those industries drives productivity growth or vice versa are the issues that have been addressed in this study.

The roadmap for the study is structured as follows. In section 2, brief review of literature is presented. Section 3 provides methodology and brief description of the data used in the analysis. Section 4 provides analytical result of the study and section 5 presents conclusions.

2. Review of existing Literature

The issue of causality between productivity and export growth is an empirical one, as economic theory provides no conclusive basis to judge whether productivity causes export growth or vice versa. Rather, the association between exports and productivity is ambiguous (Kankesu, 2002). In the recent past, researchers have devoted considerable attention to investigate the linkage and the degree of relationship between export and productivity at both macro and micro level. Export participation is viewed as one of the major factor that makes some firms more productive or efficient than other firms who do not export. The powerful works of Bernard and Jensen (1999, 2004a, 2004b) and Bernard et al. (2007) have brought into focus the exceptional performance of exporting firms in terms of labour productivity and firms heterogeneity within sectors. And this initiated a new debate on the issue that whether exporting leads to productivity growth and are exporters more productive than non-exporters. Helpman, Melitz and Yeaple (2004) show that under the condition of equal trade and investment opportunity, the least productive firms operate only in domestic market and most productive serve international markets through export as well as foreign direct investment (FDI). Some careful studies by Aw and Hwang (1995) for Taiwan; Clerides, Lach and Tybout (1998) on Colombia found that firms that export are more productive than non-exporting firms.

Many recent studies have examined the export-productivity nexus by discriminating between exporters and non-exporters using both firm and industry level data (Greenaway and Kneller, 2005 and Wagner, 2007). There are two major hypotheses to explain the linkages between export and productivity at the firm-level. The first hypothesis is known as *Self-selection* hypothesis (Melitz, 2003) which addresses the self-selection of the more productive firms into the export markets. The logic behind this hypothesis is that there is the presence of sunk costs of entering and selling goods in foreign markets. Similarly Hussinger and Arnold (2005) for Germany and Kim et al., (2009) for Korea found that more productive firms self-select into export market and there is no strong evidence to suggest that exporting have any significant impact on the productivity of firms. Using a non-parametric technique Delgado et al., (2002) in a case of Spanish manufacturing firms reported favourable evidence for self-selection hypothesis and concluded that learning-by-exporting evidences are somewhat weak and limited to the early years of exporting. The second hypothesis is known as *Learning-by-exporting* (Lucas, 1988; Clerides et al. 1998) which indicates that exporting to foreign market produces many positive learning effects by exposing the domestic firms to advanced technological innovations from international buyers and competitors and helps them to improve their productivity (Bernard and Jensen 1997, 1999). On the other hand, empirical evidences in favor of *learning-by-exporting* are rather weak and less in number (see Wagner, 2007). Nevertheless, some important studies by Kraay (1999) for China, Baldwin and Gu, (2003) for Canada, Fernandes and Isgut, (2005) for Colombia found that past export performance has a significant impact on productivity which apparently provides support to learning-by exporting hypothesis. Similarly, Loecker (2007) and Yasar and Rejesus (2005) found that firms experience productivity improvement after entering export market. In another study, using quartile regression techniques on the plant level data of Turkish manufacturing firms, Yasar et al., (2006) found that exporting status (i.e., new exporter, continuous exporter) of firms are strongly associated with productivity. Further, the productivity effect of export is much stronger in case of firms that export continuously than the firms in other export status category. Contrary to the theoretical justification, Damjian and Kostevc (2006) for Slovenian manufacturing enterprises failed to find any evidence either for the self-selection or for the learning-by-exporting hypothesis. More importantly, the learning effects of exporting were found to be significant only in the early years of entry not in later years. In the light of above contrary evidences, it is very relevant to explore the issue to verify that which channel of export-productivity link is valid and operational in the case of Indian manufacturing.

Usually, exporters are found to be more productive, more skill-intensive, more wage payers, bigger in size and more capital-intensive. Growth of exports brings higher growth of productivity through an educative process. A higher level of contact with foreign competitors as result of export growth can motivate rapid technical changes and managerial know-how and reduce 'X-inefficiency' locally. If this is true, then export trade growth in form of liberalization is a precondition for improvement in productivity. Alternatively, high growth of productivity is essential for high growth of exports. Highly sophisticated management techniques may originate within local firms/industries regardless of any government policy towards exports.

Most of the empirical studies have provided support to the theoretical view that there is positive association between exporting activities and productivity of firms. While these results provide some strength to the learning-by-exporting hypothesis, some other careful and extensive studies have argued that firms which involve themselves in exporting are typically more productive or efficient than the firms who never export or enter into the international market (Clerides et al., 1998). Exposure to greater foreign competition generates improvements in exporters' performance, by eliminating organizational inefficiencies and raising growth either through learning from foreign rivals or through spillovers of technologies and knowledge. For instance, firms that participate in foreign markets are able to get access to technical expertise regarding product designs and production methods from their foreign buyers (see Clerides *et. al.* (1998), Egan and Mody (1992), Krueger (1990), Balassa (1978), Bhagwati and Srinivasan (1980) . The implication of the above discussion is that there are substantial differences in the export and non-export oriented industries, such that the former have higher factor productivity.

Haddad, et al (1996), in Morocco, accepted the hypothesis that export growth causes productivity growth and rejected the causality in the opposite direction. Sjoholm (1999) for Indonesia manufacturing industries, Iscan (1998) for Mexican manufacturing industries and Nishimizu and Robinson (1994) for Japan, Turkey, Yugoslavia and South Korea concluded that the larger the share of output that goes into exports ,the higher the productivity growth.

Some important studies in this category include: Aw et al. (2000) for the case of Korea and Taiwan; Mexico and Morocco; Girma et al. (2004) for United Kingdom. Focusing on the different phases of transition from exporter to non-exporter Bernard and Jensen (2004) argue that while exporters have noticeably higher productivity levels, but there is no evidence that export participation increases plant productivity growth rate.

There are several influential studies that provide a useful framework for analyzing the relationship between exports and economic growth, for example, Baldwin and Caves (1997), Rivera-Batiz and Romer (1991) and Grossman and Helpman (1991). The basic idea of these studies is that exports increase total factor productivity because of their impact on economies of scale and other externalities such as technology transfer, improving skills of workers, improving managerial skills, and increasing the productive capacity of the economy.

There are several studies, analyzing the role of exports in the economic growth for developing countries. Most of these studies conclude that there is a positive relationship between exports and economic growth, for example, Balassa (1978, 1985), Bahmani-Oskoee and Alse (1993), Bahmani-Oskoee et.al.(1991), Chow (1987), Jung and Marshall (1985) and Ram (1985, 1987). The key factors used in these studies to analyze the export-growth relationship are the effects due to economies of scale, increased capacity utilization, productivity gains, and greater product variety.

On the other hand, there are arguments suggesting that increased foreign competition may be injurious to domestic industries if it leads to a closure of factories (Van Biesbroek, 2003). Indeed, Rodrik (1991) finds that lower protection or higher import competition reduces a firm's investment in productivity enhancing technological upgrading. This is especially the case when the incentive to invest depends on the firm's output or market share — yet trade liberalization reduces that market share. Caesar, (2002) also argued that the magnitude of gains from liberalisation could be fairly low. If trade reduces the domestic market shares of unshielded domestic producers without expanding their international sales, their incentives to invest in improved technology will decrease as protection ceases. This effect reduces the benefits of tariff reductions that are supposed to lower the elative prices of imported capital goods and ease access to foreign technology for domestic firms (Pavcnik, 2000). It is also argued that liberalisation does not facilitate acquisition of better technology by domestic plants because acquisition is dependent on the flexibility of the domestic labour force. Muendler (2002) finds that foreign technology adoption may be relatively unimportant. This is because the efficiency difference between foreign and domestic inputs has only a minor impact on productivity in some cases. The explanation for the minor impact lie in the fact that foreign technology adoption takes time due to delays in learning, difficulties with factor complementarities and differences in production arrangements. Even in the context of economies of scale, theoretical trade literature offers conflicting predictions about the evolution of plant productivity following a liberalization episode, especially in cases where imperfect competition is present. Gains from economies of scale in developing countries may also be unlikely because increasing returns to scale are usually associated with import competing industries, whose output is likely to contract due to intensified foreign competition (Pavcnik, 2000) There seems to be one general conclusion from the various studies on TFP conducted across developing economies that TFP growth has not been encouraging. In fact, some estimates seem to suggest negative TFP growth, and therefore has not been a source of economic growth. (Caesar, 2002:) If there are benefits to a country's manufacturing sector that arise from trade, then these benefits should result from two sources. The first source is from greater efficiency in production through increased competition and specialization. The second source is from the opportunities that arise to exploit economies of scale in a larger market. Access to a larger market should encourage larger production runs in industries and so reduce average costs.

3. Methodology

3.1. Sources of data

The present study is based on industry-level time series data taken from several issues of Annual Survey of Industries, National Accounts Statistics, Centre for Monitoring Indian Economy(CMIE) and Economic Survey, Statistical Abstracts (several issues), RBI Bulletin on Currency and Finance, Handbook of Statistics on Indian Economy, Whole sale price in India prepared by the Index no of office of Economic Advisor, Ministry of Industry etc. Export data relevant to each industry is collected from International Financial Statistics, Handbook of Statistics on Indian Economy and Statistical Abstract but data collected from Annual Survey of Industries is mainly utilized for computation of TFP. This study covers a period of 30 years from 1979-80 to 2008-09. Selection of time period is largely guided by availability of data. Till 1988 – 89, the classification of industries followed in ASI was based on the National Industrial classification 1970 (NIC 1970). The switch to the NIC-1987 from 1989-90 and also switch to NIC1998 requires some matching. Considering NIC1987 as base and further NIC 1998 as base, all energy intensive industries under our consideration have been merged accordingly. For price correction of variable, wholesale price indices taken from official publication of CMIE have been used to construct deflators.

This was partly because: though Indian economy was liberalized in 1991, with some tentativeness, it has been opened to the world economy during mid 80s and partly because of the non-availability of all types of data required for our study before 1979-80. The data used in the study are transformed in to natural log to minimize the variance in time series data set. The data series are denoted as lnTFP (log of total factor productivity growth) and lnEXP (log of total exports).

In assessing TFP, data has been sourced from various issues of Annual Survey of Industries. Gross output has been used as a measure of output suitably deflated by wholesale price index of manufactured. 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 and the reported series on materials has been deflated to obtain material inputs at constant prices. Total number of persons engaged in Indian energy intensive industries is used as a measure of labor inputs as is reported in Annual Survey of Industries(ASI) which includes production workers and non-production workers like administrative, technical and clerical staff .

3.2. Model for measuring total factor productivity growth

Before conducting the formal tests, we have computed the total factor productivity growth of those energy intensive industries under our investigation by Translog index.

TFPG is estimated under three input framework applying translog index of TFP as below: -

$$\Delta \mathrm{LnTFP}(t) = \Delta \mathrm{LnQ}(t) - \left[\frac{S_L(t)+S_L(t-1)}{2} \mathrm{x} \Delta \mathrm{LnL}(t)\right] - \left[\frac{S_K(t)+S_K(t-1)}{2} \mathrm{x} \Delta \mathrm{LnK}(t)\right] - \left[\frac{S_M(t)+S_M(t-1)}{2} \mathrm{x} \Delta \mathrm{LnM}(t)\right] \ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Q denotes gross value added, L Labour, K Capital, M material including energy input.

$$\Delta \mathrm{Ln}\ Q(t) = \mathrm{Ln}\ Q(t) - \mathrm{Ln}\ Q(t-1)$$
$$\Delta \mathrm{Ln}\ L(t) = \mathrm{Ln}\ L(t) - \mathrm{Ln}\ L(t-1)$$
$$\Delta \mathrm{Ln}\ K(t) = \mathrm{Ln}\ K(t) - \mathrm{Ln}\ K(t-1)$$
$$\Delta \mathrm{Ln}\ M(t) = \mathrm{Ln}\ M(t) - \mathrm{Ln}\ M(t-1)$$

S_K, S_L and S_M being income share of capital, labor and material respectively and these factors add up to unity. ΔLn TFP is the rate of technological change or the rate of growth of TFP.

Using the above equation, growth rates of total factor productivity have been computed for each year. These have been used to obtain an index of TFP in the following way. Let Z denote the index of TFP. The index for the base year, Z(0), is taken as 100. The index for the subsequent years is computed using the following equation:

$$Z(t) / Z(t-1) = \exp[\Delta \mathrm{LnTFP}(t)].$$

The translog index of TFP is a discrete approximation to the Divisia index of technical change. It has the advantage that it does not make rigid assumption about elasticity of substitution between factors of production (as done by Solow index). It allows for variable elasticity of substitution. Another advantage of translog index is that it does not require technological progress to be Hicks-neutral. The translog provides an estimate of the shift of the production function if the technological change is non-neutral.

Many existing studies on the export–productivity nexus use labor productivity as the productivity measure. Partial productivity measures have long been criticized for their incomplete picture of performance, thereby causing misleading analysis because this measure does not allow for consideration of the effect of factor substitution between capital and labor. It would be difficult to distinguish whether higher labour productivity in a sector is because of a high degree of technological efficiency or because of a large stock of physical capital, given that labour productivity fails to capture all of the influences on productivity. Measures of labor productivity generally include the effects of capital deepening, along with technological progress and structural efficiency changes that determine TFP.It has been found out that India's economic growth was driven mostly by factor accumulation rather than by productivity growth. Therefore, TFP, rather than capital deepening or labor productivity growth resulting from trade-induced economies-of-scale, is used as the measure of productivity in order to measure the effects of trade on structural and technological changes. TFP growth mitigates the impact of factor substitution and scale economies and evaluates technological progress and constitutes a measure of the efficiency with which all the factors of production are employed. Therefore, using TFP instead of labour productivity allows us to assess the impact of exports on technological progress.

3.3.Econometric Model for estimating capacity utilization and data description

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

$$CU = Y/Y^* \qquad (1)$$

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

$$VC = f\,(P_L, P_E, K, Y) \qquad (2)$$

Short run total cost function is expressed as

$$STC = f\,(P_L, P_E, K, Y) + P_K . K \qquad (3)$$

P_K is the rental price of Capital.

Variable cost equation which is variant of general quadratic form for (2) that provide a closed form expression for Y* is specified as

$$VC = \alpha_0 + K_{-1}\left(\alpha_K + \tfrac{1}{2}\beta_{KK}\left[\frac{K_{-1}}{Y}\right] + \beta_{KL}.P_L + \beta_{KE}.P_E \right) + P_L(\alpha_L + \tfrac{1}{2}\beta_{LL}.P_L + \beta_{LE}.P_E + \beta_{LY}.Y) + P_E(\alpha_E + \tfrac{1}{2}\beta_{EE}.P_E + \beta_{EY}.Y) + Y(\alpha_Y + \tfrac{1}{2}\beta_{YY}.Y) \qquad (4)$$

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.

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.

$$\partial STC/\partial K = \partial VC/\partial K + P_K = \qquad (5)$$

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

$$Y^* = \frac{-\beta_{KK}.K_{-1}}{(\alpha_K + \beta_{KL}P_L + \beta_{KE}P_E + P_K)} \qquad (6)$$

The estimates of CU can be obtained by combining equation (6) and (1).

In CU measurement, output is measured as real value added produced by manufacturers ($Y = P_L L + P_K.K_{-1} + P_E.E$) suitably deflated by WIP index for manufactured product (base 1981-'82 = 100) to offset the influence of price changes. Variable cost is sum of the expenditure on variable inputs ($VC = P_L L + P_E.E$).Total number of persons engaged in Indian chemical 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):

$P^t_K = r_t + d_t - \frac{P^{\bullet}_k}{P_k}$ 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 $\frac{P^{\bullet}_k}{P_k}$ 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.

3.4.Capacity utilization adjusted TFP Growth

If measured productivities are indeed influenced by cyclical movements like capacity utilization, an empirical correlation between trade and productivity may be spurious in the sense that it is driven by a correlation between trade and business cycles. For this reason, it is desirable to control for cyclical bias in the productivity measure. To address this, the study follows the method suggested by

Basu and Kimball (1997) and Ball and Moffitt (2001).This first step in this method is to regress the log difference (natural log) of the measured productivity on the log difference of the capacity utilization rate, which is a proxy for business cycle. The next step is to adjust the average of the regression error term so that it equals the original productivity measure when the productivity measure is adjusted for cyclical factors. The purpose of adjusting TFP is to eliminate any error that may exist in the total factor productivity measure in order to represent original productivity (unadjusted total factor productivity minus error terms)

$$\Delta \text{ Ln TFP}_t = a + b\Delta \text{ Ln CU}_{t-1} + u$$

Where CU is economic capacity utilization. While capacity utilization can affect measured productivity, productivity can also affect capacity utilization. To eliminate this endogeniety problem, we include lagged value of the capacity utilization rate as explanatory variable in the regression.

We have adopted different econometric approaches and methods to test the long run and short run relationships as well as causal relationship between the TFP growth and total exports.

3.5.Robustness Check

We also employ more predictable methods to check the robustness of our results . The examination procedure conducted in this paper is as follows: first, unit root test at levels and first differences are conducted to determine whether each variable is stationary or non-stationary. To test the stationary of variables, we use the Augmented Dickey Fuller (ADF) test which is mostly used to test for unit root. Following equation checks the stationarity of time series data used in the study:

$$\Delta y_t = \beta_1 + \beta_1 t + \alpha y_{t-1} + \gamma \sum_{t=1}^{n} \Delta y_{t-1} + \varepsilon_t$$

Where ε_t is white nose error term in the model of unit root test, with a null hypothesis that variable has unit root. Second, Eagle-Granger residual based test tests the existence of co integration among the variables for each industry. Third, if a co integration relationship does not exist, VAR analysis in the first difference is applied, however, if the variables are co integrated, the analysis continues in a cointegration framework.

3.6.Econometric specification for analyzing the nexus between export and TFP growth

The paper is based on the following hypotheses for testing the causality and co-integration for selected energy intensive industries in India (i) whether there is bi-directional causality between TFP growth and total export, (ii) whether there is unidirectional causality between the two variables, (iii) whether there is no causality between TFP growth and total exports (iv) whether there exists a long run relationship between TFP growth and total exports.

The link between productivity and export growth can be described using the following model:

$$TFP_t = \alpha + \beta EXP_t + U t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \ (1)$$

Where
TFP = Total Factor Productivity growth
EXP = Export growth in the sector
t= time subscript.

The standard Granger causality test (Granger, 1988) seeks to determine whether past values of a variable helps to predict changes in another variable. In the context of this analysis, the Granger method involves the estimation of the following equations:

$$\Delta TFP_t = \delta_0 + \sum_{i=1}^{q} \delta_1 i \, \Delta TFP \, t-1 + \sum_{i=1}^{q} \delta_2 i \Delta EXP \, t-1 + \varepsilon_{1\,t} \qquad (2)$$

$$\Delta EXP_t = \gamma_0 + \sum_{i=1}^{r} \gamma_1 i \, \Delta EXP \, t-1 + \sum_{i=1}^{r} \gamma_2 \, i \Delta TFP_{t-1} + \varepsilon_{2\,t} \qquad (3)$$

where, TFP_t and EXP_t represent total factor productivity index and exports, respectively, $\varepsilon_{1\,t}$ and $\varepsilon_{2\,t}$ are uncorrelated stationary random process, and subscript t denotes the time period. Failing to reject: H_0: $\delta_{21} = \delta_{22} = \ldots = \delta_{2q} = 0$ implies that exports do not Granger cause industrial productivity. On the other hand, failing to reject H_0: $\gamma_{21} = \gamma_{22} = \ldots = \gamma_{2r} = 0$ implies that industrial productivity do not Granger cause exports.

Empirical works based on time series data assume that the underlying time series is stationary. However, many studies have shown that majority of time series variables are nonstationary or integrated of order 1 (Engle and Granger, 1987). The time series properties of the data at hand are therefore studied in the outset. Formal tests will be carried out to find the time series properties of the variables. If the variables are I (1), Engle and Granger (1987) assert that causality must exist in, at least, one direction. The Granger causality test is then augmented with an error correction term (ECT) as shown below:

$$\Delta TFP \, t = \delta 0 + \sum_{i=1}^{q} \delta_1 i \, \Delta TFP \, t-1 + \sum_{i=1}^{q} \delta_2 i \Delta EXP \, t-1 + \beta_1 Z \, t-1 + \varepsilon_{1\,t} \qquad (4)$$

$$\Delta EXP_t = \gamma_0 + \sum_{i=1}^{r}\gamma_{1i}\,\Delta EXP_{t-1} + \sum_{i=1}^{r}\gamma_{2i}\,\Delta TFP_{t-1} + \lambda_1 Z_{t-1} + \varepsilon_{2t} \quad .(5)$$

where Z_{t-1} is the ECT obtained from the long run co-integrating relationship between industrial productivity and exports earnings. The above error correction model (ECM) implies that possible sources of causality are two: lagged dynamic regressors and lagged co-integrating vector. Accordingly, by equation (4), exports Granger causes industrial productivity index, if the null of either $\Sigma\, \delta_{2i} = 0$ or $\beta_1 = 0$ is rejected.

On the other hand, by equation (5), industrial productivity index Granger causes exports, if λ_1 is significant or $\Sigma\gamma_{2i}$ are jointly significant. Industrial productivity and exports cause

4. Empirical Results

This section analyses the Granger casuality equation in order to examine the long run relationship among TFP and export. Before presenting the main analysis, descriptive analysis is presented in table-1 which depicts relatively high variability.

Table-1:Descriptive Statistics for selected variables from 1979-80 to 2008-09

Industry	variables	Mean	Standard deviation	Minimum	Maximum	Skewness	Kurtosis
Cement	**TFP** **Export**	1.0193 508.98	0.0778 644.72	0.8161 2.61	1.2133 1952.41	0.1434 1.1298	2.12 0.028
Iron&steel	**TFP** **Export**	1.0068 1980.63	0.0647 2901.92	0.8931 27.95	1.181 11385.72	0.4660 2.09	0.7601 4.4966
Paper&pulp	**TFP** **Export**	0.9960 366.99	0.0409 505.24	0.9024 4.98	1.096 1679.2	0.1040 1.53	0.7325 1.384
Aluminium	**TFP** **Export**	1.004 480.37	0.066 609.49	0.873 7.96	1.21 1860.6	0.6915 1.3506	3.37 0.5896
Glass	**TFP** **Export**	0.9899 204.74	0.0584 279.08	0.9216 12.87	1.1364 965	1.1703 1.6587	0.5362 1.803

Source: Own estimate

4.1. Unit root test

The ADF test for unit root was conducted for the variables in the model. The objective of unit root test is to test empirically whether a series contains a unit root .If the series contains a unit root , it means that the series is non-stationary, otherwise the series will be categorized as stationary. Generally, Augmented Dickey-Fuller test is conducted to test the presence of unit root. Before implementing all the tests, exports and TFP have been converted into their logarithmic form to capture the rate of change.

The Unit Root test at levels and first differences are presented in table2.Accordingly, the null hypothesis is that there is a unit root in each variable and each variable is not stationary.

Generally, the rule of thumb is that the null hypothesis of unit root should be accepted if ADF statistic is less negative,i.e greater than the critical value. The results in table 2 shows that results are non stationary at their levels since the ADF test results fail to reject the null hypothesis. This is also confirmed by the value of Mackinnon associated one sided P values in each variable. Therefore, a further test for unit root using the first difference was conducted to determine the order of integration of the time series. The results indicate that the first difference of the variables are on a stationary process and hence both real export and TFP are integrated of order 1 i.e I(1).

Table:2: Unit Root Test for Stationarity

Industry	Variable	Augmented Dickey Fuller Test			
		Observations	Without constant	With constant	With constant and trend
Cement	LnEXPORT Levels First diff.	 30 29	 3.24 -3.82	 1.56 -5.33	 -0.57 -6.27
	LnTFP Levels	 30	 3.34	 0.58	 -1.46

	First diff.	29	-3.97	-4.34	-4.83
Iron&steel	LnEXPORT Levels First diff.	 30 29	 2.54 -3.62	 -1.09 -3.21	 -2.31 -3.24
	LnTFP Levels First diff.	 30 29	 6.13 -3.73	 2.84 -4.67	 -0.83 -6.49
Paper&paper product	LnEXPORT Levels First diff.	 30 29	 3.33 -3.71	 2.17 -5.67	 -0.89 -7.42
	LnTFP Levels First diff.	 30 29	 5.74 -3.34	 0.77 -5.73	 -2.26 -6.70
Aluminium	LnEXPORT Levels First diff.	 30 29	 3.96 -3.32	 1.29 -3.56	 -1.96 -3.79
	LnTFP Levels First diff.	 30 29	 5.62 -3.67	 2.36 -5.53	 -1.13 -6.36
Glass	LnEXPORT Levels First diff.	 30 29	 3.67 -3.31	 1.27 -3.43	 -2.14 -3.84
	LnTFP Levels First diff.	 30 29	 5.67 -2.67	 2.13 -5.19	 -1.15 -7.21

 # Both real export and TFP are integrated of order 1 i.e I(1) for all industries.
Source: Own estimate

4.2. Test for co integration

Now, Johansen's cointegration test is adopted to examine whether the two variables-export and TFP are cointegrated or not. In table 3, trace test confirms that there exists one cointegration relation between export and TFP for all industries. The relationship also confirms that in the long run, TFP has a significant impact on export growth. The evidence of co integration indicates that productivity growth will influence export growth when it is included in a package of variables. When cointegration exists, Eagle –Granger theorem establishes the encompassing power of ECM over other forms of dynamic specifications.

The tight linkage between co integration and error correction model stems from the Granger representation theorem. According to this theorem, two or more integrated time series that are cointegrated have an error correction representation and two or more time series that are error correcting are cointegrated (Eagle and Granger,1987). An error-correction model is a dynamic model in which "the movement of the variables in any periods is related to the previous period's gap from long-run equilibrium."

Table:3 :Johansen's co integration test

Industry	Rank	Eigen value	Likelihood ratio(Trace statistic)	0.05 Critical value	Hypothesized No of CE(s)
Cement	0	0.3693	21.53	19.82	None*

	1	0.1211	4.37	9.31	At most 1
Iron&steel	0 1	0.7482 0.1986	35.64 5.14	19.82 9.31	None* At most 1
Paper&paper product	0 1	0.3379 0.0021	14.89 0.089	15.53 3.91	None* At most 1
Aluminium	0 1	0.3872 0.1994	25.13 7.44	19.82 9.31	None* At most 1
Glass	0 1	0.5183 0.0899	31.24 3.69	19.82 9.31	None* At most 1

***denotes rejection of hypothesis at 5% significance level. Source: Own estimate**

The error correction method is preferred method for estimation when two integrated time series are statistically related or cointegrated since the error correction model can be formally derived from the properties of integrated time series. The error correction model is particularly powerful since it allows an analysist to estimate both short run and long run effects of explanatory time series variables .In this study, error correction model (ECM) is estimated to determine the direction of casuality between export growth and TFP growth. The selection of lag length is based on Akaike's information criteria (AIC).

4.3.Results of casuality from Error Correction Model

Since the error correction representation can be used to test the Granger Causality, the result in Table 4 is also the Granger-Causality result. In table 4, t statistics for error correction terms are presented in column 3 and F statistics for the joint significance of the lagged independent variables of the casuality equations are presented in column 4.

Table:4: Casuality results from Error Correction Model(ECM)

Industry	Direction of causality	Error correction term: t statistics	F statistics
Cement	Export to TFP TFP to Export	-3.56* -3.97*	5.63* 2.43
Iron&steel	Export to TFP TFP to Export	6.37* 4.02*	1.91 4.84*
Paper&paper product	Export to TFP TFP to Export	2.62* 3.87*	4.53* 1.69
Aluminium	Export to TFP TFP to Export	-2.64* 1.79	2.11 3.41*
Glass	Export to TFP TFP to Export	-5.24* -0.61	0.327 0.639

*denotes significant at 5% significance level.

In the result, the existence of long run as well as short run casuality are indicated from statistical significance of error correction term and the F statistic respectively. It is supported from the result that short run casuality from export to TFP is prevalent for cement industry and paper industry indicating that export-led TFP growth exists in these two industries. The export-led productivity scenario found in the cement industry and paper industry provides support for outward-oriented trade strategies under which competition in export markets could lead to greater efficiency as local firms face greater competition from foreign firms.

Reverse short run casuality from TFP to export for aluminium and iron &steel industry implies that productivity led exports appear to be likely in aluminium and iron &steel industry. The result of aluminium and iron &steel industry suggests that the productivity growth does not respond to lagged changes in exports. This is contradictory to the conventional argument that openness, especially exports, trigged economic and productivity growth. Rather, productivity is found significant in explaining the future path of exports, confirming the productivity-led export hypothesis. For glass industry, there seems to be no short run casuality for either direction.

From the long run viewpoint, there exist strong bi-directional casuality for cement, iron&steel and paper industries implying that exports and productivity growth have reinforced each other whereas long run casuality from export to TFP is noticed for glass and alunimium industries.

5. Conclusion

This paper examines the relationship between export and total factor productivity at the aggregate industry level for the period of 1979-80-2008-09. Our main findings are that (1) the long-run relationship between productivity growth and export performance exists for all the industries under our consideration ; 2) long run causality is bi-directional in the case of cement, iron&steel and paper industries while unidirectional from export to TFP for glass and alunimium industries.3) short run casuality exists in most of the industries which is unidirectional ,short run casuality from export to TFP for cement industry and paper industry and reverse short run casuality from TFP to export for aluminium and iron &steel industry is found and for glass industry, there seems to be no such casuality for either direction.

It can be generalized from the result that increased export may enhance productivity and vice versa in most of the industries under our investigation. In the era of globalization, there is urgent need to modernize the existing plants of the said industries to enhance productivity growth not for meeting domestic demand but for driving towards export led growth. On the other hand, the positive and significant impact of productivity on export suggests that trade policy should focus on productivity enhancing industrial policies that will, in turn, help firms to enter export market after gaining real competitive edge. Further, the chances of survival in the highly competitive international market are high for more productive firms than the less productive firms.

The results of this study might be a superior orientation for upcoming studies on the nexus between export and TFP growth. However, it has following restrictions. First, from qualitative aspect of data collection, the study has utilized various sources of data, thus uniformity of data might be questionable. Second, the short time-series of 30 annual observations from 1979-80 to 2008-09 though acceptable for statistical analysis, the problem of degree of freedom may depict apprehension. Third, besides removing short run cyclical influence like capacity utilization from TFP, a set of other control variables is suspected to be associated with productivity. Therefore the control variables like import growth rate, growth rate of foreign income, relative income and imported capital goods and imported technology that affect TFP should have been considered in the model.

In conclusion, the result of this study has strongly indicated that the promotion of export is crucial for TFP growth vis-à-vis sustainability of economic growth in Indian manufacturing. Hence, an export-oriented, outward-looking approach is required on the part of India Government if India desires to pursue high rates of economic growth.

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