



Trade Reforms and Productivity Growth in Manufacturing Industries of Pakistan

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ARTICLE DETAILS	ABSTRACT
<p>History <i>Revised format: November 2018</i> <i>Available Online: December 2018</i></p>	<p>Trade has significant influence on total factor productivity (TFP) growth. There is lack of research at level in Pakistan This paper investigates to what extent trade liberalization affects productivity growth employing endogenous growth model. Using DEA-Malmquist index to panel data in the first step we examine TFP growth, and decompose it into technological change and efficiency change. We found technological change is the key source of improvement in productivity growth. In the second step, we employ generalized method of moments (GMM) to assess the effect of trade liberalization on productivity growth and its components. We found trade liberalization, and other variables have substantial effect on productivity growth through the channels of learning by doing, knowledge spillovers, technology diffusion, and transformation. The results also support the hypothesis that human capital plays a crucial role in the creation, promotion, and absorption of technology. The study emphasis on the need to invest in human capital with the latest and scientific education to nurture human skills.</p>
<p>Keywords <i>DEA, Efficiency, Trade liberalization, Malmquist, Manufacturing, TFP, Technical change, GMM.</i></p>	
<p>JEL Classification: B17, C30, D60, L60</p>	

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1. Introduction

The role of international trade as an engine of growth has been at the center of trade policy debate over the past few decades. Trade is considered to enhance productivity growth through knowledge spillovers, learning by doing, and diffusion of technology. It offers better-quality products that boost access to international markets (Kemal et al., 2002). Trade liberalization leads to higher competition, which is in the long run met through higher TFP growth (GTFP). TFP growth the best overall measure of competitiveness reflects technological advancement. TFP indicates the enhancement in the quality of inputs with human resource development, and infrastructure.

Manufacturing sector plays a substantial role to meet domestic demand and to earn foreign exchange. Despite being

a key sector of Pakistan it is confronted by slow growth, poor infrastructure, unskilled labor, lack of up-to-date technology, and inconsistent policy. Nationalization of heavy industries, increased oil prices, and political uncertainty in the 1970s, led to high cost of production and loss of private investor's confidence which still prevails in the economy. The World Trade Organization (2005) gave momentum to the process of trade liberalization, sustained by country's export and import flows and the reduction in tariff. Pakistan also has liberalized its external sector since the 1990s under the structural / trade reforms. Despite these reforms, industries are still inefficient and, have poor infrastructure. Manufacturing industries are lacking behind in adaptation of advanced technology (Mahmood et al., 2007). However, the benefits from trade liberalization are not circulated uniformly. Trade liberalization is a key constituent of productivity growth through knowledge accumulation and transfer of technology (Sachs et al., 1995; Frankel & Romer, 1999; Goldar & Kumari, 2003; Jajri, 2007). Trade leads to more competent allocation of resources and stimulates efficiency (Edward, 1998; Dollar and Kraay, 2003). Whereas, the other group of studies declare that credit constraints hinder the adoption of foreign technology in emerging economies and technology gains may not be captivated by firms (Young, 1991); Pack, 1994; Topalova & Khandelwal, 2011). These diverse views about trade openness and growth have important policy implications and are source of motivation to attempt the current study.

The global market predictions for Pakistan industries have significantly induced private investment through technology upgradation. Adoption of advanced technology improves not only quality of products but also efficiency of production process. However, the current technology status is poor in Pakistan; therefore, the efficiency of production process has become an important element for the development of these industries. The frontier method (parametric and non-parametric) is important because it identifies the sources of TFP growth. The Data Envelopment Analysis (DEA) by Coelli et al. (1996) is justified because it can handle well with limited number of observations without requiring functional form.

A number of studies show favorable / unfavorable effect of trade reforms on productivity growth at firm level (see, Harrison, 1994; Edwards, 1998; Jajri, 2007; Mahmood & Talat, 2008). Yet such studies are seriously lacking in case of Pakistan. Most of research has utilized aggregate data to investigate the effect of trade reforms on productivity growth (which shows average of all subsectors) whereas each sector reacts distinctly (Kemal et al. 2002; Yasmin and Jehan 2006; Din et al. 2003; Mahmood & Siddiqui, 2000; Dutta and Ahmed 2006). So far, there exists little research on the association of trade reforms and productivity growth at firm level. Sheikh and Ahmed (2011) examined effect of trade reforms on efficiency of 11 agro-based industries for the period 1970-2006. Analyzing efficiency with DEA and SFA he also explores the effects of reforms on efficiency. Results show favorable effects of trade reforms on productivity growth. A similar result has been derived by Ahmed et al. (2015) investigating trade and productivity linkage using variant of Cobb-Douglas production function and OLS (pre and post liberalization) at firm level. They found positive influence of trade liberalization using excise duty on productivity growth for the period 1980-2006. Using DEA-Bootstrapped model and truncated regression Mujadad and Ahmad (2016) have estimated technical efficiency of manufacturing sub sectors and its determinants. The study found adverse bearings of trade reforms on technical efficiency of manufacturing sectors over the period 1980-2006. The role of human capital is not investigated in determining the efficiency and productivity in these studies. Whereas High productive and exporting firms are managed by highly educated managers and employ educated labor (Grossman and Helpman, 1991). Some of current studies employing panel data give estimates for the entire data period. More research is needed at firm level, to arrive at better practical solutions for policy makers.

Considering the deficiencies of previous studies, the current study aims to address these gaps in the literature carried in Pakistan. It provides a more comprehensive analysis of productivity and efficiency, employing DEA-Malmquist index to examine the variations in TFP growth between eighteen industrial groups over time (Malmquist, 1953). The study contributes to investigate trade liberalization impact on efficiency and productivity between the periods of 1980-2006, using better measures of inputs and output. This renewed perception on trade and growth will be helpful in framing appropriate policies. Assessment of trade liberalization impact on productivity growth is worthwhile to detect the mechanisms through which trade reforms affect growth.

The study is ordered as follows: Section 2 describes data and methodology, section 3 gives some empirical results. Finally, conclusions and policy suggestion are given in section 4.

2. Data and Methodology

To appraise the association between trade liberalization and productivity growth we use balanced panel data (time series) of 3- digit level according to Pakistan Standard Industrial Classification (PSIC) covering a period of 1980-

2006. The data on value added, labor, capital stock, investment, and worker's wages have been collected from different issues of census of manufacturing industries (CMI) by Federal Bureau of Statistics (FBS), Government of Pakistan. CMI was conducted on the regular basis until 1990-91 but after that, it is being issued after every five years. The serious restraint of this study is the use of data up to 2005-06, as CMI 2010-11 is still in process. Due to this reason, the present study uses data with a gap of five years for each variable. CMI data for the year 2000-01 is different in classification from the data of 2005-06. Therefore, for comparability, some of industries are merged into one industry group based on major activities.

2.1 Methodology

2.1.1 Malmquist TFP Index

Data Envelopment analysis (DEA) by Charnes et al, (1978) measures performance of DMU/firms using data on input and output of group of industries. Given the limitation of reliable data on prices and quantities, Malmquist index at constant returns to scale technology is utilized. In analyzing the growth of certain set of industries, Malmquist index is a better way of deciding how much of this growth is caused by efficiency change / technological change.

Using the method established by Fare et al. (1994) the output-oriented DEA-Malmquist to panel data is employed to focus on the expansion of output with given inputs, as firms aim to maximize profit (Raheman et al., 2008). Panel data captures the relevant connection amongst variables over time. TFP changes from one year to the next year as a result of change in technological change (TECHCH) and, efficiency change (EFFCH). We use DEAP software developed by Coelli (1996), which has the added benefit of flouting technical efficiency into pure efficiency and scale efficiency. Moreover, labor and capital as inputs and value-added as output are used. Efficiency measures are calculated relative to the frontier that represents an efficient technology. Technical efficiency of a firm can be the result of returns to scale or actual improvement in efficiency (Banker et al. 1984). Fare et al. (1994) also break technical efficiency in to pure efficiency and scale efficiency however; their technical change measure is built on CRS technology.

The Malmquist index between period "t," and the period "t+1" is given by,

$$M_o(x^{t+1}, y^{t+1}, x^t, y^t) = \left[\frac{D_o^t(x^{t+1}, y^{t+1})}{D_o^t(x^t, y^t)} \left[\frac{D_o^{t+1}(x^{t+1}, y^{t+1})}{D_o^{t+1}(x^t, y^t)} \right] \right]^{\frac{1}{2}} \quad (1)$$

We can distinguish between efficiency change and technical change.

$$M_o(x^{t+1}, y^{t+1}, x^t, y^t) = \frac{D_o^{t+1}(x^{t+1}, y^{t+1})}{D_o^t(x^t, y^t)} \times \left[\left\langle \frac{D_o^t(x^{t+1}, y^{t+1})}{D_o^{t+1}(x^{t+1}, y^{t+1})} \right\rangle \times \left\langle \frac{D_o^t(x^t, y^t)}{D_o^{t+1}(x^t, y^t)} \right\rangle \right]^{\frac{1}{2}} \quad (2)$$

$$MTFPI = \text{Efficiency change} \times \text{Technical change} \quad (3)$$

M_o is Malmquist index; the term outside the brackets shows the change in technical efficiency (catching up). Whereas the geometric mean of the two ratios inside the brackets measures the shift in technology. The catching up effect measures how much a firm is close to the frontier by capturing extent of diffusion of technology / improved utilization of existing resources.

2.1.2 Estimating Impact of Trade Liberalization on TFP Growth using GMM

Following the previous studies of Mahmood and Talat (2008) and Jajri (2007), we gauge the relative significance of the mechanisms: trade reforms (average tariff), human capital, and investment on productivity growth. We employ system GMM regression technique by Arellano Bover (1995) Blundell and Bond (1998). More specifically, we adopt the following models in the second stage:

$$GTFP_{it} = \gamma_0 + \gamma_1 HC_{it} + \gamma_2 IN_{it} + \gamma_3 TA_{it} + \varepsilon_{it} \quad (4)$$

$$TECHCH_{it} = \alpha_0 + \alpha_1 HC_{it} + \alpha_2 IN_{it} + \alpha_3 TA_{it} + \varepsilon_{it} \quad (5)$$

$$EFFCH_{it} = \beta_0 + \beta_1 HC_{it} + \beta_2 IN_{it} + \beta_3 TA_{it} + \varepsilon_{it} \tag{6}$$

It is expected that the elasticity parameters, $\gamma_0, \gamma_1, \gamma_2, > 0, \gamma_3 < 0$.

Where, TECHCH is technical change, EFFCH is efficiency change, GTFP is growth in overall TFP and $\gamma_{0000}, \gamma_{0000000000000000}, \gamma_{0000000000000000}$ are parameters of human capital, investment and average tariff, respectively. To handle the endogeneity in the explanatory variables of the dynamic growth model GMM is employed, by generating lagged values of the explanatory variables as internal instruments. GMM estimates are considered consistent as there is no second order correlation of the residual and have been applied in many empirical studies (Das and Paul, 2011).

3. Results and Discussion

3.1 Results for Total Factor Productivity Growth

Table 1 reveals that on average, productivity improved during the period of twenty-five years. The progress in TFP growth as given by the Malmquist productivity index at 3.2 percent. The comparison of the columns shows that growth in TFP is contributed mainly by technological invention (TECHCH), which improved by 2.7 percent. The efficiency change (EFFCH), stated in the third last column of the table shows a change of only 0.06 percent. Mahmood *et al.* (2007) found that manufacturing industries of Pakistan have lack of efficiency. This result is also in conformity with Mujaddad and Ahmad (2016) who suggest some improvement in efficiency caused by learning behavior in manufacturing industries for the period 1995-2006.

Table 1: Malmquist Index of Sectors Means (1980-2006)

No.	Name of Industries	TFP Change	TECH Change	EFF Change	PE Change	SE Change
1	Food	1.051	1.033	1.016	1.000	1.016
2	Tobacco	1.060	1.034	1.025	1.000	1.025
3	Beverages	1.052	1.041	1.011	1.000	1.010
4	Petroleum	0.977	1.020	0.956	0.959	0.988
5	Drugs & medicine	1.010	1.015	0.994	1.020	0.957
6	Electricals	1.035	1.029	1.005	1.354	0.742
7	Fabricated metal	1.021	1.011	1.010	1.000	1.010
8	Glass & products	1.053	1.036	1.024	1.010	1.014
9	Industrial chemical	1.047	1.031	1.015	1.005	1.010
10	Iron & Steel	1.036	1.018	1.024	1.004	1.020
11	Leather & footwear	1.038	1.023	1.015	1.005	1.010
12	Machinery industry	1.011	1.029	0.981	0.995	0.896
13	Other chemicals	1.042	1.036	1.006	1.000	1.006
14	Wood, Paper, Publish	1.030	1.030	0.999	1.000	0.999
15	Rubber	0.947	0.973	0.974	0.938	0.977
16	Textile	1.063	1.049	1.014	1.010	1.004
17	Transport goods	1.060	1.039	1.020	1.005	1.015
18	Wearing apparel	1.058	1.039	1.018	1.010	1.008
Mean		1.032	1.027	1.006	1.011	0.989

Note. An index value greater than 1 indicates growth in productivity, and the value less than unity shows decline in TFP growth. Scale value > 1 shows increasing returns to scale.

The performance of each separate industry relative to the best practice in the sample is revealed in table 1. The results show u-shaped trend in most of the industries, which explains average productivity growth was higher in the 1980s. Nevertheless, most of the industries are showing falling trend in the 1990s, which is due to macro-economic imbalances, recurrent changes of regimes and fluctuating policies. Due to unfavorable external and internal environment the economy suffered by lack of private investment and high inflation which affected the growth of industrial sector. The industries improved in the decade of 2000-01 as the economy exhibited an average GDP growth of 7% (World Bank report, 2002). Favorable external environment, removal of sanctions imposed, and high

growth in remittances led to improved growth in manufacturing industries. These conclusions are in accordance with the empirical studies of Din et al. (2003) and Zaidi (2005).

Industry-by-industry results show that textile group on average has the highest TFP growth at 6.3% per annum, during the period. Tobacco (6.0%), transport goods (6.0%), wearing apparel (5.8%), glass & non-metallic mineral products (5.3%), and beverages (5.2%) follow the textile industry*bench mark industry here). On the other hand, petroleum and rubber industries show negative trend in TFP growth accounting 0.977% and 0.947% respectively.

The overall technical change in all industries is found positive except in rubber industry (0.973%), which has poor technological adoption. Textile (4.9%), beverages (4.1%), and transport (3.9%) industries display highest technology adoption. Technical change have played major role in shifting the frontier outwards over the time. Efficiency change shows the maximum output production by utilizing the existing inputs. Table 1 in column 5 reports that on average tobacco, glass, non-metallic mineral products and steel & iron industries are highest performers in efficiency change. However, in the entire period, almost all industries performed poorly in terms of efficiency change.

3.2 Empirical Results: Impact of Trade Liberalization on TFP Growth using GMM

To examine the linkage between trade liberalization and productivity growth, system GMM is employed. It helps to avoid dynamic panel bias by instrumenting endogenous explanatory variables, using their own lag-values to account for endogeneity. Table 2 reports the findings of panel regression model;The substantial outcome of trade policy on productivity growth reflects that trade is a crucial factor of productivity growth. The result confirms the association of trade and growth in theoretical and empirical literature of growth (Dollar and Kraay, 2003; Jajri 2007). The finding is also in confirmation with the literature in the perspective of Pakistan (Dutta and Ahmed, 2000; Kemal, et al. 2002; Ahmed et al., 2015).

Table 2: Panel GMM results of explanatory variables on GTFP (1980-2005)

	B	HC	IN	TA	R2	P-J
GTFP	0.75 (2.26)	1.7 (4.3)***	0.03 (2.3)*	1.1 (2.1)*	0.88	0.45

Source: Estimated by author, Notes: all values in parenthesis denote t-stat. show level of significance at***Significant at 1%, **significant at 5%,*Significant at 10%. TA (tariff), H (human capital), I (investment).

The favorable and momentous impact of human capital (HC) on TFP growth (coefficient is 2.2) suggests the critical importance of human capital in refining production technologies (confirms endogenous growth hypothesis). Quality aspect of human capital has greater potential in absorption and in explaining growth. Education is a critical determinant in taming techniques of production and achieving efficiency in developing countries (Haq, 2004). The model also displays the positive and statistically significant (5%) association of investment with productivity growth; however coefficient (0.03) shows weak effect. This is because investment levels fell down in Pakistan with the erosion of business confidence in private sector in the 1990s. We found favorable effect of trade reforms on productivity growth; with the reduction in import tariff rate, import price declines relative to export price, move resources from imports to exports.

3.3 Empirical Results: Impact of Trade Liberalization on Technical Change (TECHCH)

Table 3 reports the findings of the model 2 (row 1) that show positive and statistically significant association of trade liberalization and other determinants with technological change. Human capital (HC) has a key feature in adopting, absorbing, and enlightening production technologies. Human capital and knowledge capital have a significant role in utilization of technology apparatus (Mahmood& Siddiqui, 2000). The investment coefficient displays positive linkage with technical change. It also reflects low investment during that period caused by political instability, uncertain business conditions, and lack of investor's confidence. Due to neglect of social development by past regimes, and poor governance could not create favorable macroeconomics environment to benefit projects by trade reforms and FDI. These findings are in conformation with empirical study of Khan and Khan(2011).

3.4 Trade Liberalization and Efficiency Change (EFFCH)

Table 3 (row 2) presents findings of the model 3 (efficiency change). Reduction in tariff positively but insignificantly effects efficiency growth. The coefficient (0.001) shows, low efficiency growth, observed in a weak institutional setting. industrial inefficiency prevails due to import substitution bias. High tariff protection still

prevails in major sectors of Pakistan economy. However, government neoliberalism policies in fiscal year 2000 led to some improvement in industrial efficiency. Mahmood *et al.* (2007) also found some improvement in efficiency of Pakistan manufacturing.

Table 3: Panel GMM Results of Explanatory Variables on TECHCH and EFFCH

	B	HC	IN	TA	R2	P-J
TECHCH	0.69 (2.79)	1.5 (2.9)***	0.02 (1.94)*	0.4 (1.89)*	0.92	0.24
EFFCH	0.96 (2.6)	-3.5 (2.2)*	2.9 (2.4)*	0.001 (1.7)	0.41	0.19

Source: Estimated by author. Notes: all values in parenthesis denote t-value. Shows level of significance, at***Significant at 1%, **significant at 5%, *Significant at 10% Panel GMM, 1985-2006.

The negative and significant influence of human capital on efficiency change reveals the neglect of social development in the country. The result is in conformation with Awan *et al.*, (2011) and among international research the study is in accordance with Bils & Klenow (2000), and Temple (2001). The existing status of human capital in Pakistan is not capable enough to absorb latest technology. There is immense need to invest in human capital with latest and scientific education to improve efficiency (Jadoon *et al.*, 2015). The test of over-identifying restriction, the Sargen test fails to reject the null hypothesis and confirms the validity of instrumental variables.

4. Conclusion

In this paper we analyzed the implications of trade reforms, human capital and investment on productivity growth by employing endogenous growth model of Romer, (1990) and Lucas, (1988) with panel data at firm level. Our findings display trade liberalization has a favorable effect on industrial productivity. The results justify the implementation of substantial trade reforms in the 1990s and early 2000. All the estimated equations render support to the prediction that trade liberalization enhances productivity growth. Technological change is the key contributor of TFP growth in manufacturing industries however efficiency change has a negligible contribution. In light of the ongoing debate on the association of trade liberalization and productivity growth and its components. Trade affects growth through the channels of knowledge spillovers and technology transmission. However, these effects are weaker on efficiency change. Efficiency change is carefully connected to human skills and education. It highlights the deficiency of efficiency due to neglect of social sector in the country. The limitation of this study is the data availability until 2005-06. Growth evaluation of these industries with new dimension is of great importance for their relative position. The dynamics of our industrial sector are almost same and this renewed perception on growth will be helpful in framing appropriate policies. We can presume some policy implications, first outward oriented strategy should be continued to promote exports and imports. Education especially technical education and on the job training can equip the firms with efficient labor to adopt and benefit foreign technologies. Public sector enterprises can be privatized to flourish private sector. Foreign investors should be made to feel comfortable in the transfer of technology.

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Appendix

Table A-1

No. of Industries All industries		No. of Industries All industries	
1	Food	10	Iron bars and Steel Industry
2	Tobacco	11	Leather & Foot Wear Industry
3	Beverages	12	Machinery Industry
4	Coal and Petroleum	13	Other chemicals
5	Drugs and medicine industry	14	Paper Printing and Wood
6	Electrical goods	15	Rubber Products
7	Fabricated metal products	16	Textile
8	GLASS & non-metallic products	17	Transport goods
9	Industrial Chemicals	18	Wearing Apparel

Table A-2: Definitions and Construction of Variables

Variables	Variable description
Capital Stock(K)	Fixed asset. The value of capital stock (K) consists of the value of machinery and other fixed assets.
Employment (L)	Average daily workers involved in manufacturing include employees, working proprietaries, home workers.
Average tariff rate(T)	It is constructed as the ratio of import duties to volume of imports.
Value-added (Y)	It is the total value of output minus the input costs.
Human capital(HC)	Average wage, calculated as employment cost(wages ,salaries plus benefits) divided by number of employees for each industry, is used for the proxy of human capital
Investment(I)	Gross fixed capital formation (GFCF) or fixed assets minus disposal of assets

Source: calculated by author

Table A-3: Trends in Average Tariff, Exports, and Imports

Year	Average Tariff	Exports	Imports
1990	40.0	189.22	155.32
1991	32.6	175.23	157.11
1992	35.3	179.77	159.43
1993	34.7	180.32	159.98
1994	33.5	180.23	160.55
1995	34.6	186.63	161.17
1996	22.9	199.88	198.76
1997	20.7	210.74	203.43
1998	17.7	267.89	220.74
1999	17.7	275.59	226.26
2000	17.0	266.96	224.61
2001	15.1	279.84	251.51
2002	15.6	281.83	224.97
2003	7.5	248.93	240.82
2004	13.3	274.02	287.81
2005	13.1	284.72	301.0
2006	13.1	289.58	340.71
2007	12.7	300.76	375.06
2008	11.7	318.97	427.0
2009	12.5	387.9	559.24
2010	12.7	411.0	612.7
2011	9.7	559.56	747.32
2012	10.0	641.15	823.33

Source: Statistical Bulletins, state Bank of Pakistan(1990-91=100)