IMPACT OF TRADE LIBERALIZATION AND DOMESTIC ECONOMIC REFORMS ON TECHNICAL EFFICIENCY OF AGRO-BASED INDUSTRIES IN PAKISTAN

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Abstract

Pakistan introduced a package of economic reforms consisting of liberalization, deregulation and privatization policies. The main focus of these reforms was on achieving macroeconomic stability and a reasonable rate of economic growth. Manufacturing sector is an important sector of the economy of Pakistan and contributes about 25% share in GDP. Agro-based industries have a special importance in Pakistan because these industries are the main source of foreign exchange earnings and employment. Presently these industries operate under imperfect market conditions and have high levels of inefficiency. The development of these industries is closely linked with the overall development of the country. The spillover effects are assumed to be very large for other industries in general and the agricultural sector in particular. The purpose of this paper is to evaluate the impact of trade related domestic reforms and openness on technical efficiency of the agro-based industries. Our analysis shows a favorable impact of trade related reforms on the efficiency level of agro-based industries.

I. INTRODUCTION

In Neoclassical growth model trade does not affect the steady state rate of output growth because growth is determined exogenously. Solow (1957) explained output growth by the accumulation of factor inputs and total factor productivity growth. Endogenous growth models pioneered by Locus (1988) and Romer (1994), on the other hand, emphasize the role of education, research and development (R&D) and trade in determining the rate of growth. Technological spillovers from trade and foreign direct investment (FDI) are additional possibilities to education and research and development (Grossman and Helpman, 1991; de Mello, 1996). Urata and Yokota (1994), Tybout (1995) and Kim (2000) have obtained strong evidence of increase in total factor productivity (TFP) due to trade related reforms. Krishna and Mitra (1998) have obtained some weaker evidence of an increase in the rate of growth of total factor productivity for India due to trade related reforms.

Trade brings the static as well as dynamic gains (Dijkstra, 2000). Static gains can arise from an improvement in either allocative efficiency or technical efficiency. Dynamic gains evolve from the elimination of rent seeking, improvement in technical efficiency and entrepreneurial effort. Growth of manufacturing exports is an indicator of dynamic efficiency (Dijkstra, 2000). Increasing returns to scale are also an important source of dynamic gains and these gains come from operating in more open trade regimes (Batsee and Coelli, 1992). The study of the effects of increased exposure on industrial efficiency needs more empirical investigation but most of the researchers, so far, believe that liberal trade and investment policies have a positive effect on industrial efficiency. In developing countries like Pakistan, where industries operate under imperfect market conditions, existence of inefficiency is believed to be a special characteristic of manufacturing industries. Removal of inefficiency can lead to improvements in welfare gains because firms strive to adopt new technology and reorganize their operations to become more competitive at the world market.

In early 1990s Pakistan introduced a package of reforms consisting of liberalization, deregulation and privatization policies. These reforms were also supported by the international donor agencies like the World Bank and IMF.

Agro-based industries contribute more than fifty percent of the total output of large scale manufacturing sector in Pakistan. These industries are the main source of employment and foreign exchange earnings and are largely concentrated in the provinces of the Punjab and Sindh where agricultural raw materials and cheap labor is easily available. Manufacture of textiles, wearing apparel, foods and beverages, leather and leather products, paper and paper products, manufacture of wood and cork products and cotton ginning and bailing are the main agro-based industries in Pakistan. Presently these industries operate under imperfect market conditions and are characterized by high levels of technical inefficiency. The purpose of this paper is to explore the impact of economic reforms and openness on technical efficiency of a panel of eleven large-scale agro-based industries. Section-II of this paper is devoted to theoretical background and review of literature, Section-III deals with methodological issues, estimation and results are presented in Section-IV and Section-V concludes.

II. THEORETICAL BACKGROUND AND REVIEW OF LITERATURE

Despite the volume of empirical work that addresses the relationship between trade and growth, efforts to measure gains from trade at the micro level have been inconclusive. In developing countries where oligopoly behavior is more likely, only a few studies link trade reforms with increased competition. In developing countries there is a lack of conclusive evidence on the linkages between trade reforms and productivity growth. There is, however, now plant level evidence confirming a positive relationship between trade reform and efficiency for some countries.[1] Some overviews on the links between reforms and productivity growth suggest that the debate is still unresolved.[2] Miltz and Ottaviano (2008) studied the effect of different trade liberalization policies on firm level productivity and found that competition from trade reforms could result in reallocation of resources from less productive firms to more productive firms. Market size and trade affect the toughness of competition resulting in lower average markups and higher aggregate productivity. Greenaway et al. (2002) using a dynamic panel framework and different measures of trade liberalization have found that liberalization does stimulate growth in developing countries but with a lagged effect. Their analysis shows a modest effect and J-curve response of trade liberalization on growth.

Kim (2000) while investigating the dynamic impact of trade liberalization on productivity and scale efficiency in South Korean industries found that trade liberalization had a positive impact on productivity and scale efficiency. He estimated the effects of trade reforms on 3 digit industries of South Korea during the period 1966 to 1988 and found that trade reforms had resulted in 2.0 percentage point increase in total factor productivity growth. Dijkstra (2000) has pointed out that trade liberalization leads to an increase in imports and exports. The growth of manufactured exports is an indicator of dynamic efficiency, which is very important for overall growth of the economy. Trade expansion is important because it affects the efficiency in industries, which has implications for employment in the manufacturing sector. Urata and Yokota (1994) estimated the effects of trade related reforms on TFP of 2 digit industries of Thailand for 1976-82 and 1982-88. They obtained a strong evidence of an increase in TFP due to trade reforms.

Krishana and Mitra (1998) using firm level data for India obtained a weaker evidence of increase in the rate of total factor productivity growth due to trade reforms during 1986 to 1993. Tybout and Westbrook (1995) using plant level data for Mexico for the period 1984 to 1990 found that openness was associated with relatively small-scale efficiency gains. Improvements in productivity and reductions in average cost were largest in open sectors where market shares shifted towards more productive plants. Edwards (1993) while studying the effects of openness and trade on growth in developing countries pointed out that trade generates technological progress. Countries with high degree of openness absorb technology more rapidly than with lower degree of openness.

Frankell and Romer (1999) studied the effects of trade on GDP growth. They used data for sixty three countries and found that trade had a positive effect on GDP growth. Their results show that a 1% increase in trade raises income by 0.5 %. They however pointed out that the role of geographical factors is very important in international trade. The characteristics like country size, distance from one another, sharing of a common border and being land locked or otherwise are the important determinants of country's overall trade. Cornwell et al. (1990) using panel data and instrumental variable technique estimated the productivity of U.S airline industry. They used stochastic frontier production function approach and derived the results which are quite intuitive and reasonable.

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[1] See, for example, Tybout et al. (1991)

[2] See, for example, Bhagwati (1988), Nishimizu and Page (1990) and Tybout (1992).

Their study shows that the rate of productivity growth was 1.5% and returns to scale were not significantly different from unity for U.S air industry. De Long and Summers (1991) using cross country data over 1960-1985 found that investment in machinery and equipment has a stronger association with growth than with any of the other components of investment. They also found that the social return to equipment investment is higher than the private return in well functioning market economies. Pack (1993) in his study on productivity and industrial development in Sub-Saharan Africa argues that if trade induces efficiency then the gains for the country should be large. Young (1995) using the production function approach for East Asian countries found that over the 1966–90 period most of the growth was due to rapid growth of factor inputs and there was nothing abnormal about the growth of total factor productivity.

Edwards (1998) using panel data for 93 countries studied the relationship between openness and total factor productivity growth. He used different measures of the degree of openness to measure the effect of openness on total factor productivity growth. His study shows that more open countries have experienced faster productivity growth. Romer (1989) in his model of endogenous growth pointed out that more open trade regimes allows countries to specialize in the production of a subset of intermediate inputs in which they have a comparative advantage. Under freer trade, then, a large number of inputs are available at a lower cost and as a result there is a higher equilibrium growth. Export expansion due to reduction in production costs thus leads to reduction in x-inefficiency. Kruger (1978) has pointed out that trade liberalization affect growth via direct effects including capacity utilization and more efficient investment projects ─ and second, there are indirect effects that work through exports. More liberalized economies have faster growth of exports and these in turn, result in more rapidly growing GNP.

III. METHODOLOGY

Stochastic frontiers have been used in the study of firm efficiency since they were first independently proposed by Aigner et al. (1977) and Meeusen and Broek (1977). Stochastic frontier production functions facilitate the measurement of firm level technical efficiency and make it possible to differentiate between random errors and differences in inefficiency. One of the advantages of stochastic frontier analysis is that it allows for decomposition of productivity change into technological change and changes in efficiency. Efficiency changes are reflected by movements toward or away from the production frontier whereas technological changes imply movements of the production frontier. Improvements in efficiency are attributed to accumulation of knowledge, diffusion of new technologies and improved managerial skills while technological changes are attributed to innovations and acquisition of new technologies. This decomposition is helpful for policy formulation and also helps to identify the effects of economic reforms on efficiency and technical change.

Panel data version of generalized stochastic production function can be written as:

$$\ln Q_{it} = X'_{it}\beta + v_{it} - \mu_{it} \qquad (1)$$

Where Q_{it} is the output or value added for the i^{th} firm or industry in year t, X_{it} is a vector of input variables of the i^{th} firm or industry in year t and β is a vector of unknown parameters to be estimated. The conventional error term v_{it} is assumed to be independent and identically distributed as $N(0, \sigma^2_v)$ and captures the effects that are beyond the control of the industry. The remainder component of the error term μ_{it} captures industry specific technical inefficiency in production. Technical efficiency (TE) of the i^{th} firm or industry at time t in the context of a stochastic frontier production function is then expressed as:

$$TE_{it} = \frac{Q_{it}}{\exp(f(X_{it}, \beta))} = \exp(-\mu_{it}) \qquad (2)$$

It measures the output of the i^{th} firm or industry relative to the output that could be produced by a fully efficient firm or industry using the same input vector.[3] Since μ_{it} is by definition a non-negative random variable, the technical efficiency (TE) assumes a value between zero and unity, where unity indicates the firm or industry is technically efficient. Stochastic frontier literature for panel models has two main groups. First, assumes technical efficiency to be time invariant and the second assumes technical efficiency to be time-varying.

[3] Coelli et al. (2005), "*An Introduction to Efficiency and Productivity Analysis",* Second Edition , Springer, USA, p. 244.

3.1 Time-invariant inefficiency decay models

In this specification the inefficiency term (μ_{it}) is assumed to have a truncated normal distribution that is constant over time within panel. Therefore, in case of time-invariant models the following restriction is imposed on inefficiency effect.

$$\mu_{it} = \mu_i \text{ with } i = 1, 2, \ldots, I; \quad t = 1, 2, \ldots, T \qquad (3)$$

These models can be estimated using either least squares (LS) or maximum likelihood (ML) method.

3.2 Time-varying inefficiency decay models

This analysis follows Battese and Coelli (1988) parameterization of time effects. The inefficiency term is modeled as a truncated normal random variable multiplied by a specific function of time.

$$\mu_{it} = \mu_i \exp[\eta (t - T)] \qquad (4)$$

Where, T corresponds to last time period, η is decay parameter to be estimated and μ_i is distributed N (μ, σ^2_μ). These models can be estimated using maximum likelihood or feasible generalized least squares (FGLS) method.

To carry out efficiency analysis an underlying production function has to be fitted to the available data. Both Cobb-Douglas production function and Translog production function[4] can be used under time invariant and time varying propositions. The Cobb-Douglas production function takes the following form:

$$\ln(Q_{it}) = \beta_0 + \beta_k \ln(K_{it}) + \beta_l \ln(L_{it}) + \beta_m \ln(M_{it}) + \sum_t \lambda_t D_t + (v_{it} - \mu_{it}) \qquad (5)$$

Where,

Y = value of output produced annually,
K = value of fixed assets at the end of the year,
L = employment cost during the year,
M = material cost during the year,
D = time dummy having value of one for the t^{th} time period and zero otherwise.

The stochastic form of translog production function for panel data is given as following.

$$\ln(Q_{it}) = \beta_0 + \beta_k \ln(K_{it}) + \beta_l \ln(L_{it}) + \beta_m \ln(M_{it}) + \beta_{kl} \ln(K_{it})\ln(L_{it}) + \beta_{km} \ln(K_{it})\ln(M_{it}) + \beta_{lm} \ln(L_{it})\ln(M_{it}) + \left(\frac{1}{2}\right)\{\beta_{kk} \ln(K_{it})^2 + \beta_{mm} \ln(M_{it})^2\} + \sum_t \lambda_t D_t + (v_{it} + \mu_{it}) \text{ with } i = 1, \ldots, I \text{ and } t = 1, \ldots, T \qquad (6)$$

To study the impact of trade liberalization on technical efficiency of agro-based industries data for the period 1981-2006 was obtained from the census of manufacturing industries (CMI), conducted by the Federal Bureau of Statistics, Government of Pakistan. The analysis will be carried out in two steps. In Step-I we will estimate Translog production function for pre reform period (1981-90) and post reform period (1991-2006) and interpret the results on the basis of estimated output elasticities, returns to scale and technical efficiency. In Step-II we will estimate the following model to study the effects of domestic economic reforms and openness on technical efficiency of agro-based industries in Pakistan.

$$TE_{it} = \alpha + \beta \, Trade_{it} + \gamma \, Industry_{it} + \varepsilon_{it} \qquad (7)$$

Where,

TE_{it} = technical efficiency of i^{th} industry in time t.
$Trade_{it}$ = some trade related variable showing the degree of openness.

[4] Cobb-Douglas production is log linear and pre assumes a unitary alasticity of substitution where as Translog production function is more flexible and does not impose any restriction any restriction on elasticity of substitution.

$Industry_{it}$ = some industry related variables showing the characteristics of the industry.

α = common intercept indicating the effect of omitted variables.

ε_{it} = random error term with zero mean and constant variance.

IV. ESTIMATION AND RESULTS

Three digit industrial classification data on eleven agro-based industries has been taken from the Census of Manufacturing Industries (CMI), conducted by the Federal Bureau of Statistics, government of Pakistan. The data set includes value of output, employment cost, industrial cost and the value of fixed assets all expressed at constant factor cost of 2004-05. The output (Q) is the real value of aggregate output produced on annual basis in million Rupees. It consists of the value of finished products and by products, receipts for work done for others, value of sales of semi-finished products and by products, value of sales of goods purchased for resale and the value of wastes and used goods. Valuation is made at ex-factory prices that include indirect taxes and exclude transport cost outside the factory gate. Employment cost includes the wages and salaries, cash and non-cash benefits paid to workers. Industrial cost consists of raw materials, fuels and electricity consumed, payments for repair and maintenance, payments for work done and cost of goods purchased for resale. Value of capital stock (fixed assets) consists of the value of fixed assets at the end of the year and includes value of the fixed assets at the beginning of the year plus additions to the fixed assets out of own production. The data on trade related variables has been taken from the Pakistan Economic Survey, Economic Advisor's Wing, Ministry of Finance, Government of Pakistan (Various Issues).

Step-I: Estimation of Production Function

Regression results obtained through Time-varying efficiency decay Translog production function for the period 1981-90 are given in Table-1. The output elasticities of capital, labor and material inputs are very low and show the prevalence of constant returns to scale. Technical efficiency estimated on the basis of inefficiency parameter (μ) is 0.26 or 26%. This is an indicator of very high inefficiency level in the agro-based industries during pre reform period.

Table-1 Time-varying Inefficiency: Translog Production Function (1981-90)

Stochastic Frontier Model: Dependent Variable ln(Y)						
Variable	Parameter	Coef.	Std. Err.	Z	P>|z|	[95% Conf. Interval]
Ln(K)	β_k	-0.140	0.180	-0.78	0.434	-0.494 0.212
ln(L)	β_l	0.502	0.234	2.15	0.032	0.043 0.961
ln(M)	β_m	0.646	0.216	2.99	0.003	0.222 1.071
$(\frac{1}{2})\ln(K^2)$	β_{kk}	0.125	0.045	2.76	0.006	0.036 0.214
$(\frac{1}{2})\ln(L^2)$	β_{ll}	-0.091	0.127	-0.71	0.476	-0.341 0.159
$(\frac{1}{2})\ln(M^2)$	β_{mm}	0.102	0.068	1.50	0.135	-0.031 0.237
$\ln(K)\times\ln(L)$	β_{kl}	0.026	0.067	0.39	0.697	-0.106 0.159
$\ln(K)\times\ln(M)$	β_{km}	-0.112	0.039	-2.83	0.005	-0.190 -0.034
$\ln(L)\times\ln(M)$	β_{lm}	0.009	0.073	0.13	0.895	-0.133 -0.143
Constant	β_0	2.425	0.471	5.14	0.000	1.500 3.350
Mu	μ	1.361	0.185	5.13	0.000	0.997 1.725
Eta	η	-0.026	0.006	-4.50	0.000	-0.038 -0.150

Group variable	Industry	Wald chi^2	2090.680
Time variable	Year	Prob>chi^2	0.000
Number of obs	110	Log likelihood	110.356
Number of groups	11		

Source: STATA regression output obtained from Census of Manufacturing Industries (CMI) data.

Regression results for post reform period (1991-2006) have been presented in Table-2. Both Capital and labor inputs have less than unitary elasticities but material input has now output elasticity greater than one. The sum of output elasticies is 1.4 which shows an improvement in the economies of scale during the post reform period. Technical efficiency estimated on the basis of inefficiency parameter(μ) is 0.44 or 44% and shows a significant improvement during the post reform period.

Table-2 Time-varying Inefficiency: Translog Production Function (1991-2006)

Stochastic Frontier Model: Dependent Variable ln(Q)						
Variable	Parameter	Coef.	Std. Err.	Z	P>|z|	[95% Conf. Interval]
Ln(K)	β_k	-0.752	0.029	-2.55	0.011	-1.332 -0.173
ln(L)	β_l	0.683	0.312	2.19	0.028	0.072 1.293
ln(M)	β_m	1.469	0.164	8.95	0.000	1.148 1.791
$(\frac{1}{2})\ln(K^2)$	β_{kk}	0.221	0.066	3.32	0.001	0.091 0.352
$(\frac{1}{2})\ln(L^2)$	β_{ll}	-0.044	0.128	-0.34	0.730	-0.296 0.207
$(\frac{1}{2})\ln(M^2)$	β_{mm}	-0.021	0.027	-0.78	0.434	-0.073 0.031
$\ln(K)\times\ln(L)$	β_{kl}	0.018	0.075	0.25	0.805	-0.129 0.166
$\ln(K)\times\ln(M)$	β_{km}	-0.083	0.046	-1.79	0.074	-0.174 0.008
$\ln(L)\times\ln(M)$	β_{lm}	-0.046	0.054	-0.85	0.396	-0.152 0.060
Constant	β_0	1.661	0.683	2.43	0.015	0.322 2.999
Mu	μ	0.831	0.154	5.38	0.000	0.528 1.134
Eta	η	0.030	0.006	5.07	0.000	0.018 0.042
Group variable	Industry			Wald chi^2	1255.870	
Time variable	Year			Prob>chi^2	0.000	
Number of obs	176			Log likelihood	87.199	
Number of groups	11					

Source: STATA regression results obtained from Census of Manufacturing industries (CMI) data.

Step-II:

Once we have obtained the value of efficiency scores using relationship given in Equation-2, we can estimate the impact of trade liberalization on technical efficiency of agro-based industries using Equation-7, given above. We will use effective tariff rates (ETR) as a measure of openness and the ratio of annual expenditure on machinery and equipment to total value of output (I/Q) and the ratio of labor cost to total value of output (L/Q) as industry related characteristics. The model thus can be written as:

$$TE_{it} = \alpha + \beta\, ETR_{it} + \gamma_1 (I/Q)_{it} + \gamma_2 (L/Q)_{it} + \delta D_{it} + \varepsilon_{it} \quad (8)$$

Where, D is a dummy variable having value = 1 if effective tariff rate is less than 15% and zero otherwise. Panel data estimates using Time- varying Generalized Least Squares method are presented in Table-3. The estimated value of the coefficient of ETR has a positive sign and is statistically significant, which shows a positive effect of liberalization on technical efficiency of agro-based industries. The coefficient of I/Q variable has a negative sign and the coefficient of L/Q variable has a positive sign but both are statistically insignificant. These results show that a decrease in I/Q ratio and an increase in L/Q ratio will have an insignificant positive effect on technical efficiency of agro-based industries. One important implication that emerges from these results is that trade liberalization reinforced with efficient use of capital and labor can lead to removal of inefficiencies in agro-based industries in Pakistan.

Table-3Time-varying Generalized Least Squares Regression Results (1991-2006)

Random-effects GLS regression:	Dependent Variable TE					
Variable	Parameter	Coef.	Std. Err.	Z	P>|z|	[95% Conf. Interval]
ETR	β	0.074	0.028	2.66	0.008	0.019 0.129
I/Q	γ_1	-0.099	0.190	-0.52	0.603	-0.473 0.274
L/Q	γ_2	0.073	0.169	0.43	0.666	0.258 0.404
D	δ	0.136	0.115	12.47	0.000	0.243 0.302
Cons	α	0.273	0.015	18.03	0.000	0.243 0.302
Group variable	Industry			Wald chi^2 (4)	163.440	
Time variable	Year			Prob>chi^2	0.000	
Number of obs	176			R-sq: Within	0.489	
Number of groups	11			Overall	0.488	
Random effects u_i ~ Gaussian						

Source: Authors' own calculations based on Table-1 and Table-2.

V.CONCLUDING REMARKS

Like many other developing countries of Asia, Africa and Latin America, Pakistan introduced economic reforms recommended and supported by international agencies like World Bank, IMF and WTO in early 1990s. These reforms focused on achieving macroeconomic stability and structural adjustments in order to alleviate poverty and achieve reasonable rate of economic growth. We have attempted to analyze the impact of trade liberalization and other domestic economic reforms on the technical efficiency of agro-based industries in Pakistan. Our analysis shows that trade liberalization has a significant and favorable effect but domestic industrial characteristics had an insignificant effect on technical efficiency of agro-based industries during the study period.

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